

Normal Reference Laboratory Values

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BLOOD, PLASMA, OR SERUM VALUES

| Determination | Reference Range | | Minimal mL Required [†] | Note |
|---------------------------|-------------------|------------------------------------|----------------------------------|---|
| | Conventional | SI | | |
| Acetoacetate plus acetone | Negative | | 1-B | |
| Aldolase | 1.3-8.2 U/L | 22-137 nmol · sec ⁻¹ /L | 2-S | Use unhemolyzed serum |
| Ammonia | 12-55 µmol/L | 12-55 µmol/L | 2-B | Collect in heparinized tube; deliver <i>immediately</i> packed in ice |
| Amylase | 4-25 units/mL | 4-25 arb. unit | 1-S | |
| Ascorbic acid | 0.4-1.5 mg/100 mL | 23-85 µmol/L | 7-B | Collect in heparinized tube before any food is given |

[†] Abbreviations used: SI, Système International d'Unités; P, plasma; S, serum; B, blood; and U, urine.

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-------------------------------|-----------------|----------------------------------|------|
| | Conventional | SI | | |
| Bilirubin | Direct: up to 0.4 mg/100 mL | Up to 7 µmol/L | 1-S | |
| | Total: up to 1.0 mg/100 mL | Up to 17 µmol/L | | |
| Blood volume | 8.5-9.0% of body weight in kg | 80-85 mL/kg | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------|--|----------------|----------------------------------|--|
| | Conventional | SI | | |
| CA-125 | <20 U/mL | <20 kU/L | 5 | Collect in plain red top tube |
| Calcium | 8.5-10.5 mg/100 ml (slightly higher in children) | 2.1-2.6 mmol/L | 1-S | |
| Carbamazepine | 4.0-12.0 µg/mL | 17-51 µmol/L | | |
| Carbon dioxide content | 24-30 mEq/L | 24-30 mmol/L | 1-S | Fill tube to top |
| Carbon monoxide | <5% of total hemoglobin | | 3-B | Fill tube to top |
| Carcinoembryonic antigen | 0.0-2.5 ng/mL | 0.0-2.5 µg/L | 0.5 | Collect in plain red top tube |
| Carotenoids | 0.8-4.0 µg/mL | 1.5-7.4 µmol/L | 3-S | Vitamin A may be done on same specimen |
| Ceruloplasmin | 27-37 mg/100 mL | 1.8-2.5 µmol/L | 2-S | |
| Chloramphenicol | 10-20 µg/mL | 31-62 µmol/L | 0.2-S | |
| Chloride | 100-106 mEq/L | 100-106 mmol/L | 1-S | |
| CK isoenzymes | 5% MB or less | | 0.2-S | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|----------------------|--------------------------|--------------------------------------|----------------------------------|---|
| | Conventional | SI | | |
| Copper | Total: 100-200 µg/100 mL | 16-31 µmol/L | 1-S | |
| C reactive protein | 0-1.0 mg/dL | 0-10 mg/L | 0.5 | Collect in serum separator tube or heparinized plasma |
| Creatine kinase (CK) | Female: 10-79 U/L | 167-1317 nmol · sec ⁻¹ /L | 1-S | |
| | Male: 17-148 U/L | 283-2467 nmol · sec ⁻¹ /L | | |
| Creatinine | 0.6-1.5 mg/100 mL | 53-133 µmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|----------|----------------------------------|------------------------------------|
| | Conventional | SI | | |
| Ethanol | 0 mg/100 mL | 0 mmol/L | 2-B | Collect in oxalate and refrigerate |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|---------------------------|----------------|----------------------------------|---------------------------------------|
| | Conventional | SI | | |
| Glucose | Fasting: 70-110 mg/100 mL | 3.9-5.6 mmol/L | 1-P | Collect with oxalate-fluoride mixture |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|-----------------------|------------------------------------|------------------|----------------------------------|------|
| | Conventional | SI | | |
| Iron | 50-150 µg/100 mL (higher in males) | 9.0-26.9 µmol/L | 1-S | |
| Iron-binding capacity | 250-410 µg/100 mL | 44.8-73.4 µmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|-----------------------------------|----------------------|--------------------------------------|----------------------------------|--|
| | Conventional | SI | | |
| Lactic acid | 0.6-1.8 mEq/L | 0.6-1.8 mmol/L | 2-B | Collect with oxalate-fluoride mixture; deliver immediately packed in ice |
| Lactic dehydrogenase | 45-90 U/L | 750-1500 nmol · sec ⁻¹ /L | 1-S | Unsuitable if hemolyzed |
| Lead | 50 µg/100 mL or less | Up to 2.4 µmol/L | 2-B | Collect with oxalate-fluoride mixture |
| Lipase | 2 units/mL or less | Up to 2 arb. unit | 1-S | |
| Lipids | | | | |
| Cholesterol | <200 mg/dL | <5.18 mmol/L | 1-S | Fasting |
| Triglycerides | 40-150 mg/100 mL | 0.4-1.5 g/L | 1-S | Fasting |
| Lipoprotein electrophoresis (LEP) | | | 2-S | Fasting, do not freeze serum |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|----------------|----------------------------------|------|
| | Conventional | SI | | |
| Lithium | 0.6-1.2 mEq/L | 0.6-1.2 nmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|----------------|----------------------------------|------|
| | Conventional | SI | | |
| Magnesium | 1.5-2.0 mEq/L | 0.8-1.3 mmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|-----------------|-----------------|------------------------------------|----------------------------------|------|
| | Conventional | SI | | |
| 5' Nucleotidase | 1-11 U/L | 17-183 nmol · sec ⁻¹ /L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|------------------------------|-----------------------|-----------------|----------------------------------|---|
| | Conventional | SI | | |
| Osmolality | 280-296 mOsm/kg water | 280-296 mmol/kg | 1-S | |
| Oxygen saturation (arterial) | 96-100% | 0.96-1.00 | 3-B | Deliver in sealed heparinized syringe packed in ice |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|------------------------|---|--|----------------------------------|--|
| | Conventional | SI | | |
| Pco ₂ | 35-45 mm Hg | 4.7-6.0 kPa | 2-B | Collect and deliver in sealed heparinized syringe |
| pH | 7.35-7.45 | Same | 2-B | Collect without stasis in sealed heparinized syringe; deliver packed in ice |
| Po ₂ | 75-100 mm Hg (dependent on age) while breathing room air | 10.0-13.3 kPa | 2-B | |
| | Above 500 mm Hg while on 100% O ₂ | | | |
| Phenobarbital | 15-50 µg/mL | 65-215 µmol/L | 1-S | |
| Phenytoin (Dilantin) | 10-20 µg/mL | 20-80 µmol/L | 1-S | |
| Phosphatase (acid) | Male-Total: 0.13-0.63 sigma U/mL | 36-175 nmol · sec ⁻¹ /L | 1-S | Must always be drawn just before analysis or stored as frozen serum; avoid hemolysis |
| | Female-Total: 0.01-0.56 sigma U/mL | 2.8-156 nmol · sec ⁻¹ /L | | |
| | Prostatic: 0-0.05 Fishman-Lerner U/100 mL | | | |
| Phosphatase (alkaline) | 13-39 U/L, infants and adolescents up to 104 U/L | 217-650 nmol · sec ⁻¹ /L, up to 1.26 µmol/L | 1-S | |
| Phosphorus (inorganic) | 3.0-4.5 mg/100 mL (infants in first year up to 6.0 mg/100 mL) | 1.0-1.5 mmol/L | 1-S | |
| Potassium | 3.5-5.0 mEq/L | 3.5-5.0 mmol/L | 1-S | Serum must be separated promptly from cells |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------------------|----------------------|---------------|----------------------------------|--|
| | Conventional | SI | | |
| Primidone (Mysoline) | 4-12 µg/mL | 18-55 µmol/L | 1-S | |
| Procainamide | 4-10 µg/mL | 17-42 µmol/L | 1-S | |
| Prostate-specific antigen | <4.0 ng/mL | <4.0 µ/L | 2 | Serum separator or EDTA plasma |
| Protein: Total | 6.0-8.4 g/100 mL | 60-84 g/L | 1-S | |
| Albumin | 3.5-5.0 g/100 mL | 35-50 g/L | 1-S | |
| Globulin | 2.3-3.5 g/100 mL | 23-35 g/L | | Globulin equals total protein minus albumin |
| Electrophoresis | (% of total protein) | | 1-S | Quantitation by densitometry |
| Albumin | 52-68 | | | |
| Globulin: | | | | |
| Alpha ₁ | 4.2-7.2 | | | |
| Alpha ₂ | 6.8-12 | | | |
| Beta | 9.3-15 | | | |
| Gamma | 13-23 | | | |
| Pyruvic acid | 0-0.11 mEq/L | 0-0.11 mmol/L | 2-B | Collect with oxalate fluoride. Deliver immediately packed in ice |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|-----------------|----------------------------------|------|
| | Conventional | SI | | |
| Quinidine | 1.2-4.0 µg/mL | 3.7-12.3 µmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|---|----------------------------------|----------------------------------|------|
| | Conventional | SI | | |
| Salicylate: | 0 | | 2-P | |
| Therapeutic | 20-25 mg/100 mL; 25-30 mg/100 mL to age 10 yr 3 hr post dose | 1.4-1.8 mmol/L 1.8-2.2 mmol/L | | |
| Sodium | 135-145 mEq/L | 135-145 mmol/L | 1-S | |
| Sulfonamide | 5-15 mg/100 mL | | 2-P | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--|-----------------|-------------------------------------|----------------------------------|---------------------------------|
| | Conventional | SI | | |
| Transaminase, aspartate aminotransferase | 7-27 U/L | 117-450 nmol · sec ⁻¹ /L | 1-S | |
| Transaminase, alanine aminotransferase | 1-21 U/L | 17-350 nmol · sec ⁻¹ /L | 1-S | |
| Troponin-I | 0-0.5 ng/mL | 0-0.5 µg/L | 0.6 | Collect in light green top tube |
| Troponin-I | 0-0.5 ng/mL | | 0.6 | Collect in light green top tube |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------------|-------------------|------------------|----------------------------------|------|
| | Conventional | SI | | |
| Urea nitrogen (BUN) | 8-25 mg/100 mL | 2.9-8.9 mmol/L | 1-S | |
| Uric acid | 3.0-7.0 mg/100 mL | 0.18-0.42 mmol/L | 1-S | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|----------------|----------------------------------|------|
| | Conventional | SI | | |
| Vitamin A | 0.15-0.6 µg/mL | 0.5-2.1 µmol/L | 3-S | |

URINE VALUES

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|--|-----------------|-----------------|----------------------------------|------|
| | Conventional | SI | | |
| Acetone plus acetoacetate (quantitative) | 0 | 0 mg/L | 2 mL | |
| Amylase | 24-76 units/mL | 24-76 arb. unit | | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|------------------------|--|--|----------------------------------|---|
| | Conventional | SI | | |
| Calcium | 300 mg/day or less | 7.5 mmol/day or less | 24-hr specimen | Collect in special bottle with 10 mL of concentrated HCl |
| Catecholamines | Epinephrine: under 20 µg/day | <109 nmol/day | 24-hr specimen | Should be collected with 10 mL of concentrated HCl (pH should be between 2.0 and 3.0) |
| | Norepinephrine: under 100 µg/day | <590 nmol/day | | |
| Chorionic gonadotropin | 0 | 0 arb. unit | 1st morning void | |
| Copper | 0-100 µg/day | 0-1.6 µmol/day | 24-hr specimen | |
| Coprotophyrin | 50-250 µg/day | 80-380 nmol/day | 24-hr specimen | Collect with 5 g of sodium carbonate |
| | Children under 80 lb (36 kg): 0-75 µg/day | 0-115 nmol/day | | |
| Creatine | Under 100 mg/day or less than 6% of creatinine. In pregnancy: up to 12%. In children under 1 yr: may equal creatinine. In older children: up to 30% of creatinine. | <0.75 mmol/day | 24-hr specimen | Also order creatinine |
| Creatinine | 15-25 mg/kg of body weight/day | 0.13-0.22 mmol · kg ⁻¹ /day | 24-hr specimen | |
| Cystine or cysteine | 0 | 0 | 10 mL | Qualitative |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------|-----------------|----|----------------------------------|-------------------------------------|
| | Conventional | SI | | |
| Hemoglobin and myoglobin | 0 | | Freshly voided sample | Chemical examination with benzidine |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|----------------------------|-----------------------------------|--------------------|----------------------------------|--|
| | Conventional | SI | | |
| 5-Hydroxyindoleacetic acid | 2-9 mg/day (women lower than men) | 10-45 µmol/day | 24-hr specimen | Collect with 10 mL of concentrated HCl |
| Lead | 0.08µg/mL or 120 µg/day or less | 0.39µmol/L or less | 24-hr specimen | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|------------------------|--------------------------------------|-------------|----------------------------------|--|
| | Conventional | SI | | |
| Phosphorus (inorganic) | Varies with intake; average, 1 g/day | 32 mmol/day | 24-hr specimen | Collect with 10 mL of concentrated HCl |
| Porphobilinogen | 0 | 0 | 10 mL | Use freshly voided urine |
| Protein: | | | | |
| Quantitative | <150 mg/24 hr | <0.15 g/day | 24-hr specimen | |

| Determination | Reference Range | | | | | Minimal mL Required ^a | Note |
|---------------------------|-----------------------------------|--------|--------|-------------------------------------|-----------|----------------------------------|--|
| | Conventional | | | SI | | | |
| Steroids: | | | | | | | |
| 17-Ketosteroids (per day) | Age | Male | Female | | | 24-hr specimen | Not valid if patient is receiving meprobamate |
| | 10 | 1-4 mg | 1-4 mg | 3-14 µmol | 3-14 µmol | | |
| | 20 | 6-21 | 4-16 | 21-73 | 14-56 | | |
| | 30 | 8-26 | 4-14 | 28-90 | 14-49 | | |
| | 50 | 5-18 | 3-9 | 17-62 | 10-31 | | |
| | 70 | 2-10 | 1-7 | 7-35 | 3-24 | | |
| 17-Hydroxysteroids | 3-8 mg/day (women lower than men) | | | 8-22 µmol/day as tetrahydrocortisol | | 24-hr specimen | Keep cold; chlorpromazine and related drugs interfere with assay |
| Sugar: | | | | | | | |
| Quantitative glucose | 0 | | | 0 mmol/L | | 24-hr or other timed specimen | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|---------------------|------------------|----------------------------------|------|
| | Conventional | SI | | |
| Urobilinogen | Up to 1.0 Ehrlich U | To 1.0 arb. unit | 2-hr sample (1-3 p.m.) | |
| Uroporphyrin | 0-30 µg/day | <36 nmol/day | SEE: Coproporphyrin | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-----------------------------|------------------|-------------------|----------------------------------|-------------------------------|
| | Conventional | SI | | |
| Vanillylmandelic acid (VMA) | Up to 9 mg/24 hr | Up to 45 µmol/day | 24-hr specimen | Collect as for catecholamines |

SPECIAL ENDOCRINE TESTS

Steroid Hormones

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|-----------------|-----------------|----------------------------------|---------------------------------------|
| | Conventional | SI | | |
| Aldosterone | Excretion: | | 5/day | Keep specimen cold |
| | 5-19 µg/24 hr | 14-53 nmol/day | | |
| | Supine: | | 3-S, P | Fasting, at rest, 210-mEq sodium diet |
| | 48±29 pg/mL | 133±80 pmol/L | | |
| | Upright (2 hr): | | | Upright, 2 hr, 210-mEq sodium diet |
| | 65± 23 pg/mL | 180±64 pmol/L | | |
| | Supine: | | | Fasting, at rest, 110-mEq sodium diet |
| | 107±45 pg/mL | 279±125 pmol/L | | |
| | Upright (2 hr): | | | Upright, 2 hr, 110-mEq sodium diet |
| | 239±123 pg/mL | 663±341 pmol/L | | |
| | Supine: | | | Fasting, at rest, 10-mEq sodium diet |
| | 175±75 pg/mL | 485±208 pmol/L | | |
| | Upright (2 hr): | | | Upright, 2 hr, 10-mEq sodium diet |
| | 532±228 pg/mL | 1476±632 pmol/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------------------|------------------|----------------------------------|---|
| | Conventional | SI | | |
| Cortisol | 8 a.m. : | | 1-P | Fasting |
| | 5-25 µg/100 mL | 0.14-0.69 µmol/L | | |
| | 8 p.m. : | | 1-P | At rest |
| | Below 10 µg/100 mL | 0-0.28 µmol/L | | |
| | 4-hr ACTH test: | | 1-P | 20 U ACTH, IV per 4 hr |
| | 30-45 µg/100 mL | 0.83-1.24 µmol/L | | |
| | Overnight suppression test: | | 1-P | 8 a.m. sample after 0.5 mg dexamethasone by mouth at midnight |
| | Below 5 µg/100 mL | 0.14 nmol/L | | |
| | Excretion: | | 2/day | Keep specimen cold |
| | 20-70 µg/24 hr | 55-193 nmol/day | | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|-------------------------------|-----------------|---------------|----------------------------------|------|
| | Conventional | SI | | |
| Dehydroepiandrosterone (DHEA) | Male | | 2-S, P | |
| | | 0.5-5.5 ng/mL | 1.7-19 nmol/L | |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---|-----------------|--------------------|----------------------------------|---|
| | Conventional | SI | | |
| | Female | | | |
| | 1.4-8.0 ng/mL | 4.9-28 nmol/L | Adult | |
| | 0.3-4.5 ng/mL | 1.0-15.6 nmol/L | Postmenopausal | |
| Dehydroepiandrosterone sulfate (DHEA-S) | Male | | 2-S, P | |
| | | 151-446 µg/100 mL | 3.9-11.4 µgmol/L | |
| | Female | | | |
| | | 84-433 µg/100 mL | 2.2-11.1 µmol/L | Adult |
| | | 1.7-177 µg/100 mL | 0.04-4.5 µmol/L | Postmenopausal |
| 11-Deoxycortisol | Responsive | | 1-P | 8 a.m. sample, preceded by 4.5 g of metyrapone by mouth per 24 hr or by single dose of 2.5 g by mouth at midnight |
| | | Over 7.5 µg/100 mL | >0.22 µmol/L | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|----------------------|-------------|----------------------------------|----------------|
| | Conventional | SI | | |
| Estradiol | Male: <50 pg/mL | | <184 pmol/L | 5-S, P |
| | Female: 23-361 pg/mL | | 84-1325 pmol/L | Adult |
| | <30 pg/mL | <110 pmol/L | | Postmenopausal |
| | <20 pg/mL | <73 pmol/L | | Prepubertal |

| Determination | Reference Range | | Minimal ml Required ^a | Note |
|---------------|------------------|----------------|----------------------------------|------------------|
| | Conventional | SI | | |
| Progesterone | Male: <1.0 ng/mL | | <3.2 nmol/L | 5-S, P |
| | Female | | | |
| | 0.2-0.6 ng/mL | 0.6-1.9 nmol/L | | Follicular phase |
| | 0.3-3.5 ng/mL | 0.95-11 nmol/L | | Midcycle peak |
| | 6.5-32.2 ng/ml | 21-102 nmol/L | | Postovulatory |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|--------------------|------------------|----------------------------------|-------------|
| | Conventional | SI | | |
| Testosterone | Adult male: | | 1-P | a.m. sample |
| | 300-1100 ng/100 mL | 10.4-38.1 nmol/L | | |
| | Adolescent male: | | | |
| | Over 100 ng/100 mL | >3.5 nmol/L | | |
| | Female | | | |
| | 25-90 ng/100 mL | 0.87-3.12 nmol/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|----------------------|---------------------|-----------------|----------------------------------|-------------|
| | Conventional | SI | | |
| Unbound testosterone | Adult male: | | 2-P | a.m. sample |
| | 3.06-24.0 ng/100 mL | 106-832 pmol/L | | |
| | Adult female: | | | |
| | 0.09-1.28 ng/100 mL | 3.1-44.4 pmol/L | | |

Polypeptide Hormones

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|----------------------------|-----------------|-----------------|----------------------------------|--|
| | Conventional | SI | | |
| Adrenocorticotropin (ACTH) | 15-70 pg/mL | 3.3-15.4 pmol/L | 5-P | Place specimen on ice and send promptly to laboratory. Use EDTA tube only. |
| Alpha subunit | <0.5-2.5 ng/mL | <0.4-2.0 nmol/L | 2-S | Adult male or female |
| | <0.5-5.0 ng/mL | <0.4-4.0 nmol/L | | Postmenopausal female |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------------------------|--------------|----------------------------------|--|
| | Conventional | SI | | |
| Calcitonin | Male: 0-14 pg/mL | 0-4.1 pmol/L | 5-S | Test done only on known or suspected cases of medullary carcinoma of the thyroid |
| | Female: 0-28 pg/mL | 0-8.2 pmol/L | | |
| | >100 pg/mL in medullary carcinoma | >29.3 pmol/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|------------------------------------|------------------------|--------------------|----------------------------------|--------------------------------|
| | Conventional | SI | | |
| Follicle-stimulating hormone (FSH) | Male 3-18 mU/mL | 3-18 arb. unit | 5-S, P | Same sample may be used for LH |
| | Female: 4.6-22.4 mU/mL | 4.6-22.4 arb. unit | | Pre- or postovulatory |
| | 13-41 mU/mL | 13-41 arb. unit | | Midcycle peak |
| | 30-170 mU/mL | 30-170 arb. unit | | Postmenopausal |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|----------------|-------------------------|---------------|----------------------------------|--------------------|
| | Conventional | SI | | |
| Growth hormone | Below 5 ng/mL | <233 pmol/L | 1-S | Fasting, at rest |
| | Children: Over 10 ng/mL | >465 pmol/L | | After exercise |
| | Male: Below 5 ng/mL | <233 pmol/L | | |
| | Female: Up to 30 ng/mL | 0-1395 pmol/L | | |
| | Male: Below 5 ng/mL | <233 pmol/L | | After glucose load |
| | Female: Below 5 ng/mL | <233 pmol/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------|---------------|----------------------------------|---------------------|
| | Conventional | SI | | |
| Insulin | 6-26 µU/mL | 43-187 pmol/L | 1-S | Fasting |
| | Below 20 µU/mL | <144 pmol/L | | During hypoglycemia |
| | Up to 150 µU/mL | 0-1078 pmol/L | | After glucose load |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------|------------------|--------------------|----------------------------------|---------------------------------|
| | Conventional | SI | | |
| Luteinizing hormone (LH) | Male: 3-18 mU/mL | 3-18 arb. unit | 5-S, P | Same sample may be used for FSH |
| | Female: | | | |
| | 2.4-34.5 mU/mL | 2.4-34.5 arb. unit | | Pre- or postovulatory |
| | 43-187 mU/mL | 43-187 arb. unit | | Midcycle peak |
| | 30-150 mU/mL | 30-150 arb. unit | | Postmenopausal |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------------|-----------------|-----------------|----------------------------------|--|
| | Conventional | SI | | |
| Parathyroid hormone | <25 pg/mL | <2.94 pmol/L | 5-P | Keep blood on ice, or plasma frozen, if it is to be sent any distance; a.m. sample |
| Prolactin | 2-15 ng/mL | 0.08-6.0 nmol/L | 2-S | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-------------------|-------------------|-------------------|----------------------------------|---------------------------------|
| | Conventional | SI | | |
| Renin activity | Supine : | | 4-P | EDTA tubes, on ice, normal diet |
| | 1.1±0.8 ng/mL/hr | 0.9±0.6 nmol/L/hr | | |
| | Upright: | | | |
| | 1.9±1.7 ng/mL/hr | 1.5±1.3 nmol/L/hr | | |
| | Supine: | | | Low-sodium diet |
| | 2.7±1.8 ng/mL/hr | 2.1±1.4 nmol/L/hr | | |
| | Upright: | | | |
| | 6.6±2.5 ng/mL/hr | 5.1±1.9 nmol/L/hr | | |
| | Diuretics: | | | Low-sodium diet |
| 10.0±3.7 ng/mL/hr | 7.7±2.9 nmol/L/hr | | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-----------------------------|-----------------|--------------------|----------------------------------|-------------------------|
| | Conventional | SI | | |
| Somatomedin C (Sm-C, IGF-1) | 0.08-2.8 U/mL | 0.08-2.8 arb. unit | 2-P | EDTA plasma prepubertal |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------|--------------------|----------------------------------|----------------|
| | Conventional | SI | | |
| | 0.9-5.9 U/mL | 0.9-5.9 arb. unit | | During puberty |
| | 0.34-1.9 U/mL | 0.34-1.9 arb. unit | | Adult males |
| | 0.45-2.2 U/mL | 0.45-2.2 arb. unit | | Adult females |

Thyroid Hormones

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---|------------------------|-------------------|----------------------------------|------|
| | Conventional | SI | | |
| Thyroid-stimulating hormone (TSH) | 0.5-5.0 µU/mL | 0.5-5.0 arb. unit | 2-S | |
| Thyroxine-binding globulin capacity | 15-25 µg | 193-322 nmol/L | 2-S | |
| | T ₄ /100 mL | | | |
| Total triiodothyronine (T ₃) | 75-195 ng/100 mL | 1.16-3.00 nmol/L | 2-S | |
| Reverse triiodothyronine (rT ₃) | 13-53 ng/mL | 0.2-0.8 nmol/L | 2-S | |
| Total thyroxine by RIA (T ₄) | 4-12 µg/100 mL | 52-154 nmol/L | 1-S | |
| T ₃ resin uptake | 25-35% | 0.25-0.35 | 2-S | |
| Free thyroxine index (FT ₄ I) | 1-4 | | 2-S | |

VITAMIN D DERIVATIVES

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------|-----------------|-----------------|----------------------------------|------|
| | Conventional | SI | | |
| 1,25-Dihydroxy-vitamin D | 26-65 pg/mL | 62-155 pmol/L | 1-S | |
| 25-Hydroxy-vitamin D | 8-55 ng/mL | 19.4-137 nmol/L | 1-S | |

HEMATOLOGIC VALUES

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|------------------------------------|--------------------|-----------------|----------------------------------|---|
| | Conventional | SI | | |
| Coagulation factors | | | | |
| Factor I (fibrinogen) | 0.15-0.35 g/100 mL | 4.0-10.0 µmol/L | 4.5-P | Collect in Vacutainer containing sodium citrate |
| Factor II (prothrombin) | 60-140% | 0.60-1.40 | 4.5-P | Collect in plastic tubes with 3.8% sodium citrate |
| Factor V (accelerator globulin) | 60-140% | 0.60-1.40 | 4.5-P | Collect as in factor II |
| Factor VII-X (proconvertin-Stuart) | 70-130% | 0.70-1.30 | 4.5-P | Collect as in factor II |
| Factor X (Stuart factor) | 70-130% | 0.70-1.30 | 4.5-P | Collect as in factor II |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--|--|--|----------------------------------|---|
| | Conventional | SI | | |
| Factor VIII (antihemophilic globulin) | 50-200% | 0.50-2.0 | 4.5-P | Collect as in factor II |
| Factor IX (plasma thromboplastic cofactor) | 60-140% | 0.60-1.40 | 4.5-P | Collect as in factor II |
| Factor XI (plasma thromboplastic antecedent) | 60-140% | 0.60-1.40 | 4.5-P | Collect as in factor II |
| Factor XII (Hageman factor) | 60-140% | 0.60-1.40 | 4.5-P | Collect as in factor II |
| Coagulation screening tests: | | | | |
| Bleeding time (Simplate) | 3-9.5 min | 180-570 sec | | |
| d-dimer | <500 ng/mL | <500 µg/L | 4.5 mL | Collect in 3.8% sodium citrate |
| Prothrombin time | Less than 2-sec deviation from control | Less than 2-sec deviation from control | 4.5-P | Collect in Vacutainer containing 3.8% sodium citrate |
| International Normalized Ratio (INR) | 1.0 | 1.0 | 4.5 mL | Collect in 3.8% sodium citrate |
| Partial thromboplastin time (activated) | 25-38 sec | 25-38 sec | 4.5-P | Collect in Vacutainer containing 3.8% sodium citrate |
| Whole-blood clot lysis | No clot lysis in 24 hr | 0/day | 2.0-whole blood | Collect in sterile tube and incubate at 37°C |
| Fibrinolytic studies: | | | | |
| Euglobin lysis | No lysis in 2 hr | 0/2 hr | 4.5-P | Collect as in factor II |
| Fibrinogen split products | Negative reaction at >1:4 dilution | 0 (at 1:4 dilution) | 4.5-S | Collect in special tube containing thrombin and epsilon aminocaproic acid |
| Thrombin time | Control ±5 sec | Control ± 5 sec | 4.5-P | Collect as in factor II |
| "Complete" blood count: | | | | |
| Hematocrit | Male: 45-52% | Male: 0.45-0.52 | 1-B | Use EDTA as anticoagulant; the seven listed tests are performed automatically on the Ortho ELT 800, which directly determines cell counts, hemoglobin (as the cyanmethemoglobin derivative), and MCV and computes hematocrit, MCH, and MCHC |
| | Female: 37-48% | Female: 0.37-0.48 | | |
| Hemoglobin | Male: 13-18 g/100 mL | Male: 8.1-11.2 mmol/L | | |
| | Female: 12-16 g/100 mL | Female: 7.4-9.9 mmol/L | | |
| Leukocyte count | 4,300-10,800/mm ³ | 4.3-10.8 × 10 ⁹ /L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--|---------------------------------|-------------------------------|----------------------------------|------|
| | Conventional | SI | | |
| Erythrocyte count | 4.2-5.9 million/mm ³ | 4.2-5.9 × 10 ¹² /L | | |
| Mean corpuscular volume (MCV) | 86-98 μm ³ /cell | 86-98 fl | | |
| Mean corpuscular hemoglobin (MCH) | 27-32 pg/RBC | 1.7-2.0 pg/cell | | |
| Mean corpuscular hemoglobin concentration (MCHC) | 32-36% | 0.32-0.36 | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-----------------------------------|--------------------|--------------------|----------------------------------|--|
| | Conventional | SI | | |
| Erythrocyte sedimentation rate | Male: 1-13 mm/hr | Male: 1-13 mm/hr | 5-B | Use EDTA as anticoagulant |
| | Female: 1-20 mm/hr | Female: 1-20 mm/hr | | |
| Erythrocyte enzymes | | | | |
| Glucose-6-phosphate dehydrogenase | 5-15 U/g Hb | 5-15 U/g | 9-B | Use special anticoagulant (ACD solution) |
| Pyruvate kinase | 13-17 U/g Hb | 13-17 U/g | 8-B | Use special anticoagulant (ACD solution) |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|------------------|------------------|-------------------------|----------------------------------|------|
| | Conventional | SI | | |
| Ferritin (serum) | | | | |
| Iron deficiency | 0-12 ng/mL | 0-4.8 nmol/L | | |
| | 13-20 Borderline | 5.2-8 nmol/L Borderline | | |
| Iron excess | >400 ng/L | >160 nmol/L | | |
| Folic acid | | | | |
| Normal | >3.3 ng/mL | >7.3 nmol/L | 1-S | |
| Borderline | 2.5-3.2 ng/mL | 5.75-7.39 nmol/L | 1-S | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---|------------------|--------------|----------------------------------|------------------------------|
| | Conventional | SI | | |
| Haptoglobin | 40-336 mg/100 mL | 0.4-3.36 g/L | 1-S | |
| Hemoglobin studies: | | | | |
| Electrophoresis for abnormal hemoglobin | | | 5-B | Collect with anticoagulant |
| Electrophoresis for: | | | 5-B | Use oxalate as anticoagulant |
| A ₂ hemoglobin | 3.0% | 0.015-0.035 | | |
| Borderline | 0.3-3.5% | 0.03-0.035 | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------------------------|-----------------|---------------------|----------------------------------|------------------------------|
| | Conventional | SI | | |
| Hemoglobin F (fetal hemoglobin) | Less than 2% | <0.02 | 5-B | Collect with anticoagulant |
| Hemoglobin, met- and sulf- | 0 | 0 | 5-B | Use heparin as anticoagulant |
| Serum hemoglobin | 2-3 mg/100 mL | 1.2-1.9 μ mol/L | 2-S | |
| Thermolabile hemoglobin | 0 | 0 | 1-B | Any anticoagulant |
| Lupus anticoagulant | 0 | 0 | 4.5-P | Collect as in factor II |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------------------------------|--|----------|----------------------------------|-------------------------------------|
| | Conventional | SI | | |
| LE (lupus erythematosus) preparation: | | | | |
| Method I | 0 | 0 | 5-B | Use heparin as anticoagulant |
| Method II | 0 | 0 | 5-B | Use defibrinated blood |
| Leukocyte alkaline phosphatase: | | | 20-Isolated blood leukocytes | Special handling of blood necessary |
| Qualitative method | Males: 33-188 U | 33-188 U | Smear-B | |
| | Females (off contraceptive pill): 30-160 U | 30-160 U | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------------|---------------|----------------------------------|------|
| | Conventional | SI | | |
| Muramidase | Serum, 3-7 μ g/mL | 3-7 mg/L | 1-S | |
| | Urine, 0-2 μ g/mL | 0-2 μ g/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-----------------------------------|--|----|----------------------------------|------------------------------|
| | Conventional | SI | | |
| Osmotic fragility of erythrocytes | Increased if hemolysis occurs in over 0.5% NaCl; decreased if hemolysis is incomplete in 0.3% NaCl | | 5-B | Use heparin as anticoagulant |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------|---------------------------------|------------------------------|----------------------------------|--|
| | Conventional | SI | | |
| Peroxide hemolysis | Less than 10% | 0.10 | 6-B | Use EDTA as anticoagulant |
| Platelet count | 150,000-350,000/mm ³ | 150-350 x 10 ⁹ /L | 0.5-B | Use EDTA as anticoagulant; counts are performed on Clay Adams Ultraflow; when counts are low, results are confirmed by hand counting |
| Platelet function tests: | | | | |
| Clot retraction | 50-100%/2 hr | 0.50-1.00/2 hr | 4.5-P | Collect as in factor II |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|------------------------------|---|-----------|----------------------------------|-------------------------|
| | Conventional | SI | | |
| Platelet aggregation | Full response to ADP, epinephrine, and collagen | 1.0 | 18-P | Collect as in factor II |
| Platelet factor ₃ | 33-57 sec | 33-57 sec | 4.5-P | Collect as in factor II |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------|--------------------|-------------|----------------------------------|------|
| | Conventional | SI | | |
| Reticulocyte count | 0.5-2.5% red cells | 0.005-0.025 | 0.1-B | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-------------------------|-----------------|------------------|----------------------------------|------|
| | Conventional | SI | | |
| Vitamin B ₁₂ | 205-876 pg/mL | 150-674 pmol/L | 12-S | |
| Borderline | 140-204 pg/mL | 102.6-149 pmol/L | | |

CEREBROSPINAL FLUID VALUES

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------|------------------------|------------------|----------------------------------|------|
| | Conventional | SI | | |
| Bilirubin | 0 | 0 | 2 | |
| Cell count | 0-5 mononuclear cells | | 0.5 | |
| Chloride | 120-130 mEq/L | 120-130 mmol/L | 0.5 | |
| Colloidal gold | 0000000000-0001222111 | Same | 0.1 | |
| Albumin | Mean: 29.5 mg/100 mL | 0.295 g/L | 2.5 | |
| | ±2 SD: 11-48 mg/100 mL | ±2 SD: 0.11-0.48 | | |
| IgG | Mean: 4.3 mg/100 mL | 0.043 g/L | | |
| | ±2 SD: 0-8.6 mg/100 mL | ±2 SD: -0.086 | | |
| Glucose | 50-75 mg/100 mL | 2.8-4.2 mmol/L | 0.5 | |
| Pressure (initial) | 70-180 mm of water | 70-180 arb. unit | | |
| Protein: | | | | |
| Lumbar | 15-45 mg/100 mL | 0.15-0.45 g/L | 1 | |
| Cisternal | 15-25 mg/100 mL | 0.15-0.25 g/L | 1 | |
| Ventricular | 5-15 mg/100 mL | 0.05-0.15 g/L | 1 | |

MISCELLANEOUS VALUES

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------------------|-----------------|------------|----------------------------------|---------------------|
| | Conventional | SI | | |
| Carcinoembryonic antigen (CEA) | 0-2.5 ng/mL | 0-2.5 µg/L | 20-P | Must be sent on ice |
| Chylous fluid | | | | Use fresh specimen |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-------------------|-----------------|-----------------|----------------------------------|---|
| | Conventional | SI | | |
| Digitoxin | 17±6 ng/mL | 22±7.8 nmol/L | 1-S | Medication with digitoxin or digitalis |
| Digoxin | 1.2±0.4 ng/mL | 1.54±0.5 nmol/L | 1-S | Medication with digoxin 0.25 mg per day |
| | 1.5±0.4 ng/mL | 1.92±0.5 nmol/L | 1-S | Medication with digoxin 0.5 mg per day |
| Duodenal drainage | | | | pH should be in proper range with minimal amount of gastric juice |
| pH (urine) | 5-7 | 5-7 | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|------------------|-------------------------------------|------------------|----------------------------------|--------------------|
| | Conventional | SI | | |
| Gastric analysis | Basal: | | | |
| | Females: 2.0±1.8 mEq/hr | 0.6±0.5 µmol/sec | | |
| | Males: 3.0±2.0 mEq/hr | 0.8±0.6 µmol/sec | | |
| | Maximal (after histalog or gastrin) | | | |
| | Females: 16±5 mEq/hr | 4.4±1.4 µmol/sec | | |
| | Males: 23±5 mEq/hr | 6.4±1.4 µmol/sec | | |
| Gastrin-I | 0-200 pg/mL | 0-95 pmol/L | 4-P | Heparinized sample |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------------------------------|--------------------------------------|---------------|----------------------------------|-----------------------------|
| | Conventional | SI | | |
| Immunologic tests: | | | | |
| Alpha-fetoprotein | Undetectable in normal adults | | 2-S | |
| Alpha-1-antitrypsin | 85-213 mg/100 mL | 0.85-2.13 g/L | 10-B | |
| Rheumatoid factor | <60 IU/mL | | 10 mL clotted blood | Fasting sample preferred |
| Antinuclear antibodies | Negative at a 1:8 dilution of serum | | 2-S | Send to laboratory promptly |
| Anti-DNA antibodies | Negative at a 1:10 dilution of serum | | 2-S | |
| Antibodies to Sm and RNP (ENA) | None detected | | 10 mL clotted blood | |
| Antibodies to SS-A (Ro) and SS-B (La) | None detected | | 10 mL clotted blood | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--------------------|-----------------|----|----------------------------------|------|
| | Conventional | SI | | |
| Autoantibodies to: | | | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---|--------------------------------------|----|----------------------------------|---|
| | Conventional | SI | | |
| Thyroid colloid and microsomal antigens | Negative at a 1:10 dilution of serum | | 2-S | Low titers in some elderly normal women |
| Gastric parietal cells | Negative at a 1:20 dilution of serum | | 2-S | |
| Smooth muscle | Negative at a 1:20 dilution of serum | | 2-S | |
| Mitochondria | Negative at a 1:20 dilution of serum | | 2-S | |
| Interstitial cells of the testes | Negative at a 1:10 dilution of serum | | 2-S | |
| Skeletal muscle | Negative at a 1:60 dilution of serum | | 2-S | |
| Adrenal gland | Negative at a 1:10 dilution of serum | | 2-S | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-----------------------------|---|---------------|----------------------------------|-------------------------------|
| | Conventional | SI | | |
| Bence Jones Protein | No Bence Jones protein detected in a 50-fold concentrate of urine | | 50-U | |
| Complement, total hemolytic | 150-250 U/mL | | 10-B | Must be sent on ice |
| Cryoprecipitable proteins | None detected | 0 arb. unit | 10-S | Collect and transport at 37°C |
| C3 | Range, 83-177 mg/100 mL | 0.83-1.77 g/L | 2-S | |
| C4 | Range, 15-45 mg/100 mL | 0.15-0.45 g/L | 2-S | |
| Factor B | 12-30 mg/100 mL | | 5 mL clotted blood | |
| C1 esterase inhibitor | 13.2-24 mg/100 mL | | 5 mL clotted blood | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|-------------------------------------|---|----------------|----------------------------------|--|
| | Conventional | SI | | |
| Hemoglobin A _{1e} | 3.8-6.4% | 0.038-0.064 | 5-P | Send EDTA tube on ice promptly to laboratory |
| Hypersensitivity pneumonitis screen | No antibodies to those antigens assayed | | 5 mL clotted blood | |
| Immunoglobulins: | | | | |
| IgG | 639-1349 mg/100 mL | 6.39-13.49 g/L | 2-S | |
| IgA | 70-312 mg/100 mL | 0.7-3.12 g/L | 2-S | |
| IgM | 86-352 mg/100 mL | 0.86-3.52 g/L | 2-S | |
| Viscosity | 1.4-1.8 relative viscosity units | | 10-B | Expressed as the relative viscosity of serum compared with water |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|---------------|-----------------------------|-------------|----------------------------------|--------------------------------|
| | Conventional | SI | | |
| Iontophoresis | Children: 0-40 mEq sodium/L | 0-40 mmol/L | | Value given in terms of sodium |
| | Adults 0-60 mEq sodium/L | 0-60 mmol/L | | |

| Determination | Reference Range | | Minimal mL Required ^a | Note |
|--|--|--------------------|----------------------------------|---|
| | Conventional | SI | | |
| Propranolol (includes bioactive 4-OH metabolite) | 100-300 ng/mL | 386-1158 nmol/L | 1-S | Obtain blood sample 4 hr after last dose of beta-blocking agent |
| Stool fat | Less than 5 g in 24 hr or less than 4.0% of measured fat intake in 3-day period | <5 g/day | 24-hr or 3-day specimen | |
| Stool nitrogen | Less than 2 g/day or 10% of urinary nitrogen | <2 g/day | 24-hr or 3-day specimen | |
| Synovial fluid: | | | | |
| Glucose | Not less than 20 mg/100 mL lower than simultaneously drawn blood sugar | SEE: Blood glucose | mL of fresh fluid | Collect with oxalate-fluoride mixture |
| d -Xylose absorption | 5-8 g/5 hr in urine; 40 mg per 100 mL in blood 2 hr after ingestion of 25 g of d -Xylose | 33-53 mmol/day | 5-U | For directions see Benson et al.: N Engl J Med 256:335, 1957 |
| | | 2.7 mmol/L | 5-B | |

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