Listed here is basic information for the common blood tests. Note that while standard normal ranges are provided, these may vary from one laboratory to another. We have used reference ranges from the UAHN lab. The units listed are those most commonly used in clinical practice. The differential diagnoses listed are highly condensed.

*Note:* These values and interpretation are for adult patients and may not apply to pediatric or adolescent populations.

1. **Complete Blood Count (CBC)**
   Description: Measures the number and size of cellular components of blood.

   **Components:**
   - **White blood cell (WBC) count**
     Normal Range: 3.4 to 10.4 K/μL
     Elevated:
       - Reactive: Infection, trauma, surgery
       - Primary: Leukemia
     Depressed:
       - Reactive: Chemotherapy, viral infections, overwhelming infections
       - Primary: Bone marrow disease

   **Hemoglobin (Hgb)**
   Normal Range: Male, 13.5 to 17.5 g/dL; female, 11.5 to 15.5 g/dL
   Elevated:
     - Hemoconcentration: Volume depletion
     - Polycythemia: Essential or secondary
   Depressed:
     - Increased Destruction: Bleeding, hemolysis
     - Decreased Production: Substrate deficiency (iron, B_{12}), chronic disease, hematologic neoplasm

   **Hematocrit (Hct)**
   Normal Range: Male, 40 to 51 mL/dL; female, 35 to 46 mL/dL (The units are also listed at “%,” since the ratio of mL to dL is 1:100).
   Elevations and depressions should follow Hgb; if not, disparities between RBC and hemoglobin reflect the patient’s volume status.
Mean Corpuscular Volume (MCV)
Normal Range: 80 to 100 fL
Elevated:
  - Megaloblastic anemia
  - Bone marrow infiltration or dysfunction
  - Liver Disease
  - Reticulocytosis
  - Some drugs
Depressed:
  - Iron deficiency
  - Thalassemia trait
  - Lead poisoning
  - Sideroblastic anemias

Platelets (Plt)
Normal range: 150 to 425 K/μL
Elevated:
  - Reactive marrow
  - Essential thrombocytethemia
Depressed:
  - Increased Destruction: Idiopathic thrombocytopenic purpura, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation
  - Decreased Production: Marrow suppression
  - Dilution (e.g., after blood transfusion)
  - Sequestration (splenomegaly)

2. Biochemistry Profile (including Basic Metabolic Profile-BMP, Comprehensive Metabolic Profile-CMP)
Description: Measures the concentrations of various salts, enzymes, and other substances in serum
Basic Metabolic Panel: Na, K, Cl, CO2, BUN, Cr, Glucose, Ca
Comprehensive Metabolic Panel: BMP plus AST, ALT, alkaline phosphatase, total bilirubin, albumin, total protein

Components:
Sodium (Na)
Normal Range: 136 to 145 mmol/L
Elevated:
  - Decreased water intake: Coma, decreased thirst
  - Increased water loss in urine, stool, skin, wounds, or respiratory tract
  - Sodium Loading: Iatrogenic, aldosterone effect
Depressed:
  - Always evaluate volume status first!
  - Volume Depletion: Fluid loss from any cause
  - Volume Overload: Congestive heart failure, cirrhosis, nephritic, edema
  - Euvolemia: Syndrome of inappropriate secretion of antidiuretic hormone (SIADH), Addison’s disease, hypothyroidism
**Potassium (K)**
Normal Range: 3.5 to 5.1 mmol/L
Elevated:
- K Loading: Exogenous, cell lysis (rhabdomyolysis, tumor, etc.)
- K Shift from Intracellular to Extracellular Compartment: Acidosis
- K Retention: Renal failure, drug, renal tubular acidosis (type IV), low aldosterone
- Spurious: Hemolysis in blood tube, leukocytosis
Depressed:
- Low intake (rare except iatrogenically)
- K Shift from Extracellular to Intracellular Compartment: Alkalosis, insulin
- K Loss: Renal (drug!), gastrointestinal (diarrhea, etc.), high aldosterone, renal tubular acidosis (type I and II)

**Chloride (Cl)**
Normal Range: 101 to 111 mmol/L
Generally follows sodium. Primary chloride disorders are unusual, except in the instances listed below.
Elevated:
- Chloride loading (especially “normal saline,” a solution of sodium chloride)
Depressed:
- Nasogastric suctioning
- Vomiting

**Bicarbonate (HCO₃, CO₂)**
Normal Range: 20 to 29 mmol/L
Elevated:
- Metabolic alkalosis (especially volume depletion)
- Renal compensation for respiratory acidosis
Depressed:
- Metabolic acidosis (especially sepsis)
- Renal compensation for respiratory alkalosis
- Carbonic anhydrase inhibitors
**Anion Gap (AG, “delta”)**
The anion gap is calculated: $AG = Na - (Cl + HCO_3^-)$. It represents the number of negatively charged ions that are not measured on the profile.

- **Normal Range:** 7 to 12 mmol/L
- **Elevated:**
  - Metabolic acidosis from unmeasured anions:
  - Methanol intoxication
  - Renal failure
  - Ketoacidosis due to diabetes mellitus, alcohol, fasting
  - Lactic acidosis, as in sepsis or unperfused tissue
  - Ethylene glycol intoxication
  - Salicylate intoxication
- **Depressed:**
  - Occasionally in multiple myeloma
  - Decreased albumin: the AG decreases (and must be corrected upward) by 2.5 mmol/L for every 1 g/dL the serum albumin is below 4

**Blood Urea Nitrogen (BUN)**
- **Normal Range:** 9 to 26 mg/dL
- **Elevated:**
  - Decreased renal function
  - Decreased renal perfusion
  - Blood in gastrointestinal tract
- **Depressed:**
  - Starvation
  - Catabolic illness

**Creatinine (Cr)**
- **Normal Range:** 0.7 to 1.3 mg/dL (male); 0.6 -1.1 (female)
- **Elevated:**
  - Decreased renal function
  - Muscle breakdown
- **Depressed:**
  - Starvation
  - Catabolic illness

**Blood Urea Nitrogen to Creatinine (BUN/Cr) Ratio**
- **Normal Range:** <20
- **Increased:**
  - Renal hypoperfusion (systemic volume depletion, systemic hypotension, congestive heart failure, cirrhosis, renal artery stenosis)
- **Depressed:**
  - Not significant
**Calcium (Ca)**
Normal Range: 8.6 to 10.6 mg/dL

*If the serum albumin is low, calcium needs to be adjusted;* Ca decreases 0.8 mg/dL for every decrease 1.0 g/dL alb. For example, if Ca is 8.0 with alb 3.0, “corrected Ca” is 8.8.

**Elevated:**
- Hyperparathyroidism
- Malignancy
- Vitamin D intoxication
- Thiazides
- Granulomatous diseases

**Depressed:**
- Hypoparathyroidism
- Renal failure
- Low vitamin D
- Transfusion

**Aspartate Aminotransferase (AST) and alanine aminotransferase (ALT)**
Normal Range: AST 5 to 34 IU/L; ALT 0 to 55 IU/L

**Elevated:**
- Liver disease (with alcohol abuse, the ratio of AST:ALT is 2:1 or greater)
- Muscle disorders
- Thyroid disorders
- Celiac disease
- Adrenal insufficiency

**Depressed:**
- Not significant

**Alkaline Phosphatase (Alk Phos)**
Normal Range: 40 to 150 IU/L

**Elevated:**
- Hepatobiliary disease (cholestasis, biliary obstruction)
- Bone disease: Paget’s disease, metastases, hyperparathyroidism
- Placental production: pregnancy, especially with complications

**Depressed:**
- Not significant

**γ-glutamyltransferase (GGT)**
The main function of GGT is to assess the source of an elevated alk phos or transaminases. If alk phos is elevated, an elevated GGT indicates a hepatobiliary source. Normal GGT indicates a bone or placental source.

Normal Range: 9 to 64 IU/L

**Elevated:**
- Hepatobiliary disease
- Acute pancreatitis

**Depressed:**
- Not significant
**Bilirubin (Bili)**
Normal Range: 0.2 to 1.2 mg/dL
Bilirubin should be considered in terms of its two components:

*Direct Bilirubin (Direct Bili)*
Normal Range: 0 to 0.5 mg/dL
Elevated:
- Biliary obstruction, cholestasis, hepatocyte disfunction
Depressed:
- Not significant

*Indirect Bilirubin (Indirect Bili)*
Normal Range: 0.1 to 0.8 mg/dL
Elevated:
- Hepatocyte disfunction, decreased hepatic conjugation, hemolysis
Depressed:
- Not significant

**Albumin (Alb)**
Normal Range: 3.4 to 4.8 g/dL
Elevated:
- Volume depletion
Depressed:
- Catabolic states (starvation, cancer, chronic infections, inflammatory disease)
- Protein loss (nephrotic syndrome, burns, protein-losing enteropathy)
- Cirrhosis
- Malnutrition

**Total Protein (TP)**
Normal Range: 6.4 to 8.3 g/dL
Elevated:
- Immune activation (infection, collagen-vascular diseases)
- Primary hematologic disorder: Myeloma, Waldenström’s macroglobulinemia
Depressed: malnutrition, chronic disease

**Lactate Dehydrogenase (LDH)**
Normal Range: 125 to 243 U/L
Elevated:
- Any cell breakdown, especially acute MI, hemolysis, liver disease, lymphoma
- *Pneumocystis* pneumonia
Depressed:
- Not significant

**Creatine Phosphokinase, Creatine Kinase (CPK, CK)**
Normal Range: 29 to 168 IU/L
Elevated:
Any form of muscle damage: MI, rhabdomyolysis, intramuscular injection, trauma
Isoenzymes are useful in diagnosis of acute MI (MB fraction >5%).

Depressed:
Not significant

**Phosphorus (PO₄, Phos)**
Normal Range: 2.3 to 4.7 mg/dL
Elevated:
- Hypoparathyroid, renal failure, cell lysis
Depressed:
- Hyperparathyroid, starvation

**Troponin I**
Normal range: 0 to 0.02 ng/mL
Elevated:
- Myocardial damage; probable MI is indicated at 0.30 ng/mL
Depressed:
- Not significant

### 3. Miscellaneous

**Prothrombin Time (PT)**
Description: used to assess the extrinsic coagulation pathway
Normal range: 11.9 - 15 seconds
Elevated:
- Vitamin K deficiency
- Warfarin administration
- Liver disease
- Deficiencies or inhibitors of factors V, VII, X, prothrombin or fibrinogen
- Disseminated intravascular coagulation

**International Ratio (INR)**
Description: compensates for differences in sensitivity of various PT reagents to the effects of warfarin
Range: Used to monitor warfarin therapy; the range various with the Indication for warfarin, but is often 2.0-3.0

**Activated Partial Thromboplastin Time (aPTT, PTT)**
Description: used to assess the intrinsic coagulation pathway
Normal range: 22.6 to 35.5 seconds
Elevated:
- Heparin administration
- Deficiencies or inhibitors of factors VIII, IX, XI, XII
- Disseminated intravascular coagulation
- Von Willebrand disease
- Lupus Anticoagulant
- Liver disease

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**D-dimer**
Description: degradation product of cross-linked fibrin
Normal range: < 500 ng/mL or < 0.50 mcg/mL
Elevated:
- Venous thromboembolism, arterial thromboembolic disease,
- disseminated intravascular coagulation, infection, sepsis, inflammation,
- surgery, trauma, severe liver disease, renal disease, malignancy,
- pregnancy
Note: D-dimer is almost exclusively used to help lessen the probability of venous thromboembolism, as it has a high negative predictive value (e.g. high sensitivity) for this disease.

**B-type or Brain Natriuretic Peptide (BNP)**
Description: a hormone released by the brain and the ventricles in response to volume overload or increased wall stress
Normal range: < 100 pg/mL
Elevated:
- Heart failure, valvular heart disease (mitral regurgitation, aortic stenosis),
- pulmonary embolism, acute coronary syndromes, pulmonary hypertension, renal failure
Note: BNP is used mostly to help differentiate heart failure from other causes of dyspnea when the diagnosis is not clear. Heart failure is a clinical diagnosis.

**Erythrocyte Sedimentation Rate (ESR)**
Description: The rate at which RBCs settle when placed in a vertical tube. An acute phase reactant.
Normal range: 0 – 30 mm/hr (affected by age and sex)
Elevated:
- Inflammation (e.g., infection, collagen-vascular disease, malignancy),
- obesity
Note: ESR increases with age and is higher in women. A value of > 100 is always pathologic and often seen with vasculitis, etc.

**C-Reactive Protein (CRP)**
Description: A blood protein that rises in response to cytokine activation.
Normal range: < 0.6 mg/dL (UMC); values < 0.5 mg/dL are reported only as < 0.5 mg/dL
Elevated:
- Inflammation (e.g., infection, collagen-vascular disease, malignancy),
- obesity
High-sensitive CRP (hs-CRP)
Description: A blood protein that rises in response to cytokine activation. It is essentially the same test as CRP but used for further risk stratification of patients at intermediate risk for CHD, if such information will change management. Routine use is controversial.
Classification:
- < 1 mg/L: low cardiovascular risk
- 1 – 2 mg/L: average cardiovascular risk
- > 3 mg/L: high cardiovascular risk
Note: hs-CRP essentially measures the “gap” between 0 and where the regular CRP starts reporting values (> 0.5 mg/dL). Different units (mg/L vs. mg/dL) create a 10-fold difference in values between CRP and hs-CRP. As such, if a hs-CRP is ordered for CHD risk stratification and the result is 12 mg/L, this converts to 1.2 mg/dL and is consistent with systemic inflammation (with resultant implications). Some labs do not distinguish between regular CRP and hs-CRP and run all CRP requests as mg/L, using 8 mg/L as a cut-off for systemic inflammation.

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