Clinical Laboratory Tests

Haematological Tests

- These involve the analysis of blood components and are crucial for identifying disorders like anemia, infections, clotting problems, and blood cancers.
- Common hematology tests include:

Complete Blood Count (CBC)

- A standard test that gives information on:
  - **Hemoglobin (Hb)**: Low in anemia; high in polycythemia.
  - **Hematocrit (Hct)**: Proportion of RBCs in blood; helps in anemia diagnosis.
  - **Red Blood Cell (RBC) Count**: Decreased in anemia; increased in polycythemia.
  - **White Blood Cell (WBC) Count**: Elevated in infection or leukemia; low in bone marrow suppression or certain viral infections.
  - **Platelet Count**: Important for blood clotting. Low platelets (thrombocytopenia) increase bleeding risk.
  - **Mean Corpuscular Volume (MCV)**: Helps categorize anemia (microcytic, normocytic, macrocytic).
  - **Mean Corpuscular Hemoglobin (MCH)** and **MCH Concentration (MCHC)**: Indicators of RBC hemoglobin content.

Key Parameters:

Parameter	Normal Range	Clinical Significance
Hemoglobin (Hb)	M: 13.5–17.5 g/dL; F: 12–16 g/dL	Low: anemia; High: polycythemia
RBC count	M: 4.7–6.1 million/µL; F: 4.2–5.4 million/µL	Affected in anemia or bone marrow disorders
WBC count	4,000–11,000 /µL	Elevated in infections, leukemia; low in bone marrow suppression
Platelets	150,000–450,000 /µL	Low: thrombocytopenia; High: thrombocytosis
Hematocrit (HCT)	M: 40–54%; F: 36–48%	Indicates hydration, anemia
ESR (Erythrocyte Sedimentation Rate)	M: <15 mm/hr; F: <20 mm/hr	Elevated in inflammation, autoimmune disorders

Clinical Relevance in Pharmacy:

- Monitoring myelosuppression in chemotherapy.
- Detecting drug-induced anemia (e.g., from zidovudine, methotrexate).
- Checking for thrombocytopenia due to drugs (e.g., heparin-induced thrombocytopenia).

Liver Function Tests (LFTs)

These tests assess liver integrity and function and include:

1. Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST)

- Elevated in hepatocellular injury (e.g., hepatitis, drug-induced liver injury).
- ALT is more liver-specific than AST.
- AST/ALT ratio: >2 in alcoholic liver disease.

2. Alkaline Phosphatase (ALP) and Gamma-glutamyl Transferase (GGT)

- Elevated in cholestatic liver disease (bile duct obstruction).
- ALP is also found in bones – increased in bone diseases.
- GGT is more specific to the liver and helps confirm hepatic origin of raised ALP.

3. Total Bilirubin (Direct and Indirect)

- Elevated in jaundice; may suggest liver dysfunction, hemolysis, or bile duct obstruction.

4. Serum Albumin and Total Protein

- Low albumin may indicate chronic liver disease, malnutrition, or nephrotic syndrome.
- Important in assessing synthetic function of the liver.

5. Prothrombin Time (PT) / INR

- Prolonged in liver failure, as liver synthesizes clotting factors.

Key Parameters

Test	Normal Range	Interpretation
ALT (SGPT)	7–56 U/L	Elevated in hepatocellular injury
AST (SGOT)	10–40 U/L	Indicates liver/muscle damage
ALP (Alkaline Phosphatase)	44–147 U/L	High in cholestasis or bone disease
Bilirubin (Total)	0.3–1.2 mg/dL	Jaundice indicator
Albumin	3.5–5.5 g/dL	Marker of synthetic liver function
PT/INR	PT: 11–13.5s; INR: 0.8–1.1	Measures clotting; prolonged in hepatic failure

Clinical Relevance in Pharmacy:

- Monitoring hepatotoxicity from drugs like isoniazid, paracetamol, statins.
- Adjusting drug doses for hepatically metabolized drugs.
- Determining liver function before using hepatotoxic drugs.

Renal Function Tests

Essential test to evaluate kidney function

A. Serum Creatinine

- Byproduct of muscle metabolism, excreted by kidneys.
- Elevated levels indicate impaired renal function.
- However, not sensitive in early kidney disease.

B. Blood Urea Nitrogen (BUN)

- Less specific than creatinine.
- Elevated in renal impairment, dehydration, or high protein intake.

C. Creatinine Clearance (CrCl) and Estimated Glomerular Filtration Rate (eGFR)

- Used to quantify kidney function.
- CrCl is calculated using Cockcroft-Gault or MDRD formula.
- eGFR is used for CKD staging.

D. Urinalysis

- Detects protein, glucose, ketones, blood, WBCs, RBCs, casts, etc.
- Helpful in diagnosing conditions like glomerulonephritis, infections, or drug-induced nephrotoxicity.

Key Parameters

Test	Normal Range	Significance
Serum Creatinine	0.6–1.3 mg/dL	Indicates GFR; elevated in renal dysfunction
Blood Urea Nitrogen (BUN)	7–20 mg/dL	High in renal failure, dehydration
Creatinine Clearance (CrCl)	90–120 mL/min	Reflects GFR
eGFR (estimated GFR)	>90 mL/min/1.73 m^2	Used for CKD staging

BUN:Creatinine ratio	10:1 to 20:1	Differentiates pre-renal vs intrinsic renal injury

Clinical Relevance in Pharmacy:

- Dose adjustment of antibiotics (e.g., aminoglycosides, vancomycin), antidiabetics (e.g., metformin), etc.
- Monitoring for nephrotoxicity (e.g., due to NSAIDs, amphotericin B, ACE inhibitors).
- Avoiding accumulation of renally-excreted drugs in renal failure.

Thyroid Function Tests

- Thyroid hormones regulate metabolism, and their dysfunction affects drug metabolism and cardiac function.



1. Thyroid-Stimulating Hormone (TSH)

- Most sensitive test.
- Elevated in hypothyroidism, suppressed in hyperthyroidism.

2. Free T4 (Thyroxine) and Free T3 (Triiodothyronine)

- T4 is converted into T3 (active form).
- Low T4 in hypothyroidism; high T3/T4 in hyperthyroidism.

3. Thyroid Antibodies

- e.g., Anti-TPO (thyroid peroxidase antibodies) in Hashimoto's thyroiditis.

Key Parameters

Test	Normal Range	Interpretation
TSH (Thyroid Stimulating Hormone)	0.4–4.0 mIU/L	High: Hypothyroidism; Low: Hyperthyroidism
T3 (Triiodothyronine)	80–200 ng/dL	Elevated in hyperthyroidism
T4 (Thyroxine)	5.0–12.0 µg/dL	Indicates thyroid hormone status
Free T3 / Free T4	Free from protein binding	More accurate reflection of active hormone
Anti-TPO antibodies	Negative	Present in autoimmune thyroid disease

Clinical Relevance in Pharmacy:

- Monitoring efficacy of levothyroxine in hypothyroid patients.
- Adjusting drug doses (e.g., warfarin, digoxin) based on thyroid status.
- Recognizing drug-induced thyroid disorders (e.g., amiodarone-induced thyrotoxicosis).

Tests Associated with Cardiac Disorders

- Cardiovascular diseases (CVDs) are leading causes of morbidity and mortality.
- Laboratory tests are vital for diagnosis, prognosis, and therapeutic monitoring.

Key Tests Include:

1. Cardiac Enzymes and Biomarkers

A. Troponins (Troponin I and T)

- Most specific and sensitive markers for myocardial infarction (MI).
- Begin to rise within 3-6 hours of MI, peak at 12-24 hours, stay elevated for 7–10 days.
- Troponin levels correlate with extent of myocardial injury.

B. Creatine Kinase-MB (CK-MB)

- Rises 3–12 hours after MI, peaks at 24 hours, normalizes within 48–72 hours.
- Less specific than troponins, but useful in re-infarction detection.

C. Myoglobin

- Rises early (1-4 hours) after MI but not specific.

2. Brain Natriuretic Peptide (BNP) and NT-proBNP

- Secreted by ventricles in response to volume overload.
- Elevated in heart failure.
- Helps differentiate cardiac vs. pulmonary causes of dyspnea.

3. C-Reactive Protein (CRP) and High-sensitivity CRP (hs-CRP)

- CRP is a general marker of inflammation.
- hs-CRP is used for cardiovascular risk assessment.
- Elevated levels are associated with atherosclerosis and cardiac events.

4. Lipid Profile

- Total cholesterol, LDL, HDL, triglycerides.
- Important for assessing cardiovascular risk.

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