

Pathology of Blood and Urine

Clinical Pathology Overview

- Clinical pathology involves the analysis of bodily fluids, primarily blood and urine, to diagnose diseases.
- **It helps in assessing:**
 - Physiological functions of the organs
 - Presence of infections or abnormalities
 - Overall health status

Pathology of Blood

Definition:

- The pathology of blood involves the study of abnormalities in blood cells (RBCs, WBCs, platelets), plasma proteins, and clotting factors, which may indicate systemic or hematologic diseases.

Common Hematological Disorders:

1. **Anemias** – reduction in RBCs or hemoglobin.
2. **Leukemias** – malignancies of white blood cells.
3. **Lymphomas** – neoplasms of lymphoid tissue.
4. **Bleeding disorders** – due to platelet dysfunction or clotting factor deficiencies (e.g., hemophilia).
5. **Infections** – changes in WBC count (e.g., leukocytosis or leukopenia).
6. **Polycythemia** – increased RBC mass.

Tests Used in Blood Pathology:

- **Complete Blood Count (CBC)** – Evaluates RBCs, WBCs, platelets.
- **Peripheral Smear Examination** – Morphology of blood cells.
- **Coagulation Profile** – PT, aPTT, INR for bleeding disorders.
- **Bone Marrow Aspiration/Biopsy** – For diagnosing leukemia or marrow failure.

Pathology of Urine

Definition:

- The pathology of urine involves analysis of urine characteristics to detect diseases affecting the kidneys, urinary tract, and systemic metabolic disorders.

Common Urinary Abnormalities:

1. **Proteinuria** – seen in nephrotic syndrome, diabetes, hypertension.
2. **Hematuria** – blood in urine due to infection, stones, tumors.
3. **Glycosuria** – glucose in urine; common in uncontrolled diabetes.
4. **Pyuria** – pus cells in urine indicating UTI.
5. **Casts and Crystals** – indicative of renal disease or metabolic disorders.

Routine Urine Tests:

- **Urine Routine and Microscopy (R/M)**
- **Urine Culture and Sensitivity (C/S)**
- **24-hour Urine Collection** – for protein, creatinine clearance.
- **Dipstick Tests** – for glucose, ketones, protein, bilirubin, pH, specific gravity.

Lymphocytes – Their Role in Health and Disease

Definition

- Lymphocytes are a type of white blood cell (WBC) that play a vital role in the immune system, particularly in adaptive immunity, helping the body to recognize and remember specific pathogens.

Origin

- Derived from hematopoietic stem cells in the bone marrow.
- Mature in bone marrow (B cells) or thymus (T cells).

Types:

- **B-lymphocytes (B cells):** Produce antibodies.
- **T-lymphocytes (T cells):** Destroy infected or abnormal cells.
 - Helper T cells (CD4+): Activate immune response.
 - Cytotoxic T cells (CD8+): Kill infected cells.
- **Natural Killer (NK) cells:** Part of innate immunity; kill virus-infected or tumor cells.

Functions of Lymphocytes

A. B Cells

- Recognize antigens and produce antibodies (immunoglobulins).
- Differentiate into:
 - **Plasma cells:** actively secrete antibodies.
 - **Memory B cells:** retain antigen memory for rapid future response.

B. T Cells

- **Helper T cells (CD4⁺):** Activate B cells, cytotoxic T cells, and macrophages.
- **Cytotoxic T cells (CD8⁺):** Destroy virus-infected and tumor cells.
- **Regulatory T cells:** Suppress excessive immune responses to prevent autoimmunity.

C. Natural Killer (NK) Cells

- Recognize and kill cells lacking **MHC I** (e.g., virus-infected, tumor cells).
- Act **without prior sensitization**, unlike T and B cells.

Role in Health:

- **Immune defense** against viral, bacterial, and fungal infections.
- **Memory formation** for quicker immune response on re-exposure.
- **Tumor surveillance** and elimination of cancerous cells.

Role in Disease:

- **Lymphocytosis:** Elevated lymphocyte count.
 - **Causes:** Viral infections (e.g., mononucleosis), chronic lymphocytic leukemia (CLL).
- **Lymphocytopenia:** Reduced lymphocyte count.
 - **Causes:** HIV/AIDS, chemotherapy, bone marrow failure.

Platelets (Thrombocytes) – Their Role in Health and Disease

Definition

- Platelets are small, nucleated cell fragments derived from megakaryocytes in the bone marrow, playing a critical role in blood clotting (hemostasis).

Origin

- Formed from cytoplasmic fragments of megakaryocytes in the bone marrow.
- Lifespan: ~8–10 days.
- Removed by the spleen and liver.

Structure

- Small (2–4 μm) disc-shaped cells.
- Contain:
 - Granules with clotting factors and enzymes.
 - Surface glycoproteins are essential for adhesion and aggregation.

Functions of Platelets and Their Descriptions

1. Primary Hemostasis

- Adhere to damaged vessel walls and form a temporary plug.

2. Secrete Clotting Factors

- Release substances (e.g., ADP, thromboxane A₂) to recruit more platelets.

3. Activate Coagulation Cascade

- Aid in fibrin clot formation (secondary hemostasis).

4. Wound Healing

- Release growth factors (e.g., PDGF) to promote tissue repair.

5. Immunomodulation

- Interact with immune cells during inflammation.

Role in Health:

- **Primary Hemostasis:** Adhere to damaged endothelium and aggregate to form a platelet plug.
- **Secretion of granules:** Release factors like ADP, serotonin, and thromboxane A₂ to amplify clotting.
- **Support wound healing.**

Role in Disease:

A. Thrombocytopenia (Low platelet count):

- **Causes:** Dengue fever, ITP (Immune Thrombocytopenic Purpura), leukemia.
- **Effects:** Bleeding gums, petechiae, prolonged bleeding.

B. Thrombocytosis (High platelet count):

- **Causes:** Inflammation, iron deficiency, myeloproliferative disorders.
- **Effects:** Risk of thrombosis (stroke, myocardial infarction).



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