MLT-2461: HEMATOLOGY

Cuyahoga Community College

Viewing: MLT-2461 : Hematology

Board of Trustees:
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Academic Term:
Fall 2025

Subject Code
MLT - Medical Laboratory Technology

Course Number:
2461

Title:
Hematology

Catalog Description:
An introduction to the theory, principles and procedures used in hematology and coagulation (hemostasis). Hematopoiesis, enumeration, differentiation and evaluation of blood formed elements and the basic process of coagulation are discussed. Manual and automated techniques are explained, demonstrated, and performed. Anemias, leukemias and other hematological disorders are studied, correlating test results with disease states. Problem solving skills are applied in related case studies and unknowns.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
BIO-1500 Principles of Biology I and HTEC-1060 Medical Terminology I; or BIO-2341 Anatomy and Physiology II; and MLT-1001 Introduction to Medical Laboratory Science.

Outcomes

Course Outcome(s):
A. Demonstrate safe and accountable behaviors within the laboratory setting.

Objective(s):
1. Apply knowledge of personal protective equipment (PPE) and standard precautions to ensure personal safety and prevent contamination.
2. Operate laboratory equipment safely and correctly to minimize risk and achieve accurate results.
3. Adhere to laboratory safety protocols and procedures to maintain a secure working environment for oneself and others.

Course Outcome(s):
B. Demonstrate ethical and professional behaviors within the laboratory setting.

Objective(s):
1. Document laboratory findings accurately and with appropriate identifying information.
2. Apply proper procedures for correcting laboratory documentation, ensuring transparency and traceability.
3. Practice clear and concise communication in lecture and laboratory settings.
4. Actively listen to and respectfully address questions, concerns, and feedback from others in the laboratory.

5. Foster a collaborative and inclusive environment by valuing diverse perspectives and contributions.
6. Reflect on personal performance and identify areas for improvement.

Course Outcome(s):

C. Describe the fundamental concepts and processes of hematopoiesis with respect to the production, development, maturation, and differentiation of blood cells, including the anatomy and physiology of the hematopoietic system.

Objective(s):

1. Define hematopoiesis and differentiate between intramedullary and extramedullary hematopoiesis.
2. Identify phases and sites of hematopoiesis in embryos, fetuses, infants, young children, and adults.
3. Explain the role of the mononuclear phagocytic system, spleen, liver, lymph nodes, and thymus in hematopoiesis.
4. Describe the key cytological features used to identify each stage in the maturation of erythrocytes, leukocytes, and platelets.
5. Explain the bone marrow response to effective erythropoiesis.
6. Identify the types of blood cells normally found in the peripheral blood and state their typical lifespan in circulation.

Course Outcome(s):

D. Discuss red blood cell (RBC) morphology and function.

Objective(s):

1. Define erythropoietin and explain its role in erythropoiesis.
2. Outline erythropoietic production from origin to maturation, emphasizing the stages of RBC development.
3. Identify and describe the distinctive features used to characterize developing RBCs.
4. List the maturation sequence of developing RBC using both erythrocytic and rubriblastic nomenclature.
5. Distinguish nucleated RBC precursors from other hematopoietic elements based on morphological characteristics.
6. Identify the different types of blood cell morphologies.
7. Explain the key structural components of a mature RBC and how they contribute to its survival and function.
8. Explain the causes and clinical significance of various RBC morphologies.
9. Describe the purpose of the Embden-Meyerhof pathway, hexose monophosphate shunt, and methemoglobin reductase pathway in RBC metabolism.
10. Recognize, describe, and indicate the clinical significance of immature RBCs in peripheral blood.
11. Identify various inclusions found in the RBCs and discuss their clinical significance.

Course Outcome(s):

E. Discuss hemoglobin function, hemolysis, and its clinical significance.

Objective(s):

1. Identify the components of hemoglobin.
2. Describe the primary function of hemoglobin function in oxygen transport.
3. Explain the origin of hemoglobin synthesis in erythroid precursors.
4. List the types of embryonic and adult hemoglobin.
5. Interpret normal hemoglobin-oxygen function using the oxygen dissociation curve (ODC).
6. Identify factors that affect the ODC.
7. Describe the mechanisms of RBC catabolism including hemoglobin breakdown and the formation of biliverdin, bilirubin, and urobilinogen.
8. Compare and contrast the key processes of extravascular hemolysis and intravascular hemolysis.

Course Outcome(s):

F. Explain the structure and function of bone marrow and peripheral blood cells.

Objective(s):

1. Define key terms used to assess bone marrow structure and function, Myeloid: erythroid (M:E) ratio, cellularity, erythropoiesis, granulopoiesis and their significance.

2. Compare and contrast the morphological and functional characteristics of normal and abnormal hematopoietic cells found in peripheral blood.
3. Explain the key cellular and non-cellular components of blood.
4. Explain the structure and function of RBCs, white blood cells (WBCs), and platelets.

Course Outcome(s):

G. Discuss the role of the hematology laboratory in bone marrow studies.

Objective(s):

1. List the clinical indications for performing bone marrow studies.
2. Identify the sites for obtaining bone marrow samples in adults and children.
3. Describe bone marrow collection techniques and discuss preferred techniques in different clinical situations.
4. List disorders that can be identified by bone marrow studies.

Course Outcome(s):

H. Discuss and perform evaluations of blood-formed elements on stained preparation.

Objective(s):

1. Name stains commonly used in morphological studies and the importance of pH and filtering on staining quality.
2. Define acidophilic, eosinophilic, azurophilic, and basophilic properties.
3. Describe appropriate area of peripheral blood smear for performing manual differential.
4. Describe the criteria for making an acceptable peripheral blood smear.
5. Define differential count and list normal values for men, women, newborns, and children according to ASCP guidelines.
6. Explain how WBC and platelet estimations are performed on a blood smear.
7. Properly make and stain a peripheral blood smear and perform a WBC estimate, platelet estimate, WBC differential, platelet morphology and RBC morphology on the smear within acceptable limits.
8. Differentiate between normal and abnormal hematopoietic elements found within the peripheral blood.
9. Identify and classify normal WBCs on a properly stained peripheral smear.
10. Correlate abnormalities in formed elements identified on a stained smear with the disease states in which they are commonly associated.
11. Define reticulocyte and describe the staining process needed to identify them on a peripheral smear.

Course Outcome(s):

I. Explain the morphology, development, function, and clinical significance of (White Blood Cells) WBC.

Objective(s):

1. Review the maturation and life spans of each cell line of WBCs.
2. List morphologic features used to differentiate developing leukocytes.
3. Explain the function of neutrophils, monocytes, eosinophils, basophils, lymphocytes, and macrophages.
4. Describe and identity normal and immature granulocytes, monocytes and lymphocytes.
5. Differentiate absolute WBC counts from relative WBC counts.
6. Explain the function of the myeloid stem cell relative to the lymphoid stem cell.
7. Describe the use of monoclonal antibodies to differentiate lymphocytes by CD antigens.
8. Identify the sites of formation and production of lymphocytes.
9. Discuss the appearance and function of the different lymphocytes.

Course Outcome(s):

J. Explain and perform common tests used for the evaluation of whole blood in the hematology department.

Objective(s):

1. Identify the preferred sample type required for hematology testing.
2. List the components of an EDTA whole blood sample.

3. Define components of the complete blood count (CBC) and list the reference ranges according to the ASCP.
4. Explain the clinical significance of the following RBC indices: Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC).
5. Explain the clinical significance of the RBC Distribution Width (RDW)
6. Calculate the RBC indices.
7. Perform a microhematocrit within acceptable limits.
8. Describe Neubauer hemocytometer and its application for cell counts.
9. Perform an RBC and WBC count using a hemocytometer.
10. Perform erythrocyte sedimentation rate (ESR) test procedure.
11. State normal values of ESR and explain clinical significance of ESR values
12. Discuss quality control procedures used in the hematology laboratory including its use with hematology and coagulation analyzers.
13. Discuss CBC results from automated analyzer.
14. State the principles and clinical utility of histograms and scatterplots in reviewing patient samples.
15. Identify and classify normal WBCs on a properly stained peripheral smear.
16. Calculate corrected leukocyte counts for the presence. of nucleated RBCs
17. Discuss principles, components and operation of automated hematology analyzers.

Course Outcome(s):

K. Discuss the clinical importance of testing in the hematology department in the medical laboratory and correlate results with normal and abnormal disease states.

Objective(s):

1. State common causes of changes in absolute and relative cell counts for mature myeloid cells.
2. Discuss qualitative and quantitative leukocyte disorders along with expected results.
3. Identify morphologic changes in neutrophils that are associated with nonmalignant disorders, including left shift, toxic granulation, Dohle bodies, vacuolization, hyposegmentation, and hypersegmentation.
4. State physical abnormalities and clinical features that are associated with disorders of neutrophils, including Pelger-Huet anomaly, Alder-Reilly anomaly, and Chediak-Higashi anomaly.
5. Define monocytosis, lymphocytosis, and leukocytosis.
6. Compare and contrast the cellular features of reactive lymphocytes and normal lymphocytes.
7. Discuss causes of reactive lymphocytosis.
8. Define leukemia.
9. Describe general criteria for classifying leukemia.
10. Differentiate chronic and acute leukemias, describing characteristics of each
11. Describe the characteristics and laboratory findings of myelodysplastic syndromes (MDS) and chronic myeloproliferative neoplasms (MPN)
12. Describe the characteristics and lab findings of chronic lymphoproliferative disorders and lymphomas
13. Define anemia
14. State the clinical signs and symptoms of anemia along with the expected laboratory results of the various types of anemia.
15. Explain sources of error of that can occur in the RBC indices.
16. Define and identify the following: Anisocytosis, poikilocytosis, polychromatic, rouleaux, and agglutination
17. Define the following and discuss the RBC morphology expected in each: Polycythemia, Megaloblastic Anemia, Hypo-proliferative anemia, Hemolytic anemia, Hemoglobinopathies, anemia from acute blood loss, Iron Deficiency Anemia (IDA).

Course Outcome(s):

L. Explain the process of thrombopoiesis, platelet evaluation, and the clinical significance of quantitative and qualitative platelet disorders.

Objective(s):

1. Describe the process of platelet production, including the role of megakaryocyte and thrombopoietin.
2. Define thrombocytopenia and thrombocytosis, and explain the causes for each condition.
3. Identify factors that may affect the platelet counts, such as platelet satellitism, platelet clumping, and giant platelets.
4. Discuss the use of a sodium citrate tube to resolve platelet clumping and perform the necessary calculations to correct the platelet count.

Course Outcome(s):

M. Explain the mechanisms of hemostasis and fibrinolysis, the role of coagulation factors and the clinical significance of coagulation disorders and anticoagulant therapy.

Objective(s):

1. Define hemostasis and fibrinolysis.
2. Describe the characteristics of coagulation factors and their interactions in the intrinsic, extrinsic, and common pathways of the coagulation cascade.
3. Diagram the stages of the intrinsic and extrinsic pathways.
4. Explain where and how each coagulation factor is formed.
5. Explain the functions of the vascular system in maintaining hemostasis.
6. Discuss the physiological role of platelets in hemostasis.
7. Describe the changes that happen in platelets following physiologic stimulation.
8. Identify substances that are contact activators.
9. Explain the role of coagulation and fibrinolytic systems in maintaining hemostasis.
10. Discuss the characteristics of coagulation factors, including how they interact with the intrinsic, extrinsic and common pathways.

11. Discuss coagulation tests including (Prothrombin Time) PT, (Activated Partial Thromboplastin Time) aPTT, D-dimer and fibrinogen.
12. Describe the symptoms and lab findings of various coagulation disorders, including hemophilia, von Willebrand disease, DIC, and vitamin K deficiency.
13. Discuss anticoagulation therapy, including the action and monitoring of warfarin and heparin.

Methods of Evaluation:

1. Written assignments
2. Group activities
3. Projects
4. Discussions
5. Case studies
6. Skills assessments
7. Lab exercises
8. Quizzes
9. Exams
10. Lab Practicals

Course Content Outline:

1. Safety
    a. Personal protective equipment (PPE)
    b. Standard Precautions
    c. Laboratory equipment
    d. Safety protocols and procedures
2. Professionalism
    a. Ethical conduct
    b. Professional conduct
    c. Accurate documentation
    d. Accurate communication
    e. Collaboration
    f. Inclusivity
    g. Self-reflection
    h. Continuous improvement
3. Hematopoiesis
    a. Definition
    b. Types
        i. Intramedullary
        ii. Extramedullary
    c. Phases and site

i. Embryo and Fetuses
1. Yolk sac
2. Mesoblastic phase
3. Hepatic phase
4. Medullary phase

ii. Infant and children
1. Red marrow spaces
2. Thymus
3. Secondary lymphoid tissue

iii. Adult
1. Red marrow spaces
2. Primary and secondary lymphoid tissue

d. Organs
i. Spleen
1. Structures
2. Function

ii. Liver
1. Structures
2. Function

iii. Lymph Nodes
1. Structures
2. Function

iv. Thymus
1. Structures
2. Function

e. Maturation
i. Cytological Features
1. Erythrocytes
2. Leukocytes
3. Platelets

ii. Bone Marrow
1. Erythropoiesis

iii. Standard Blood Cell
1. Types
2. Lifespans

4. Erythrocyte Morphology and Function
a. Structure
i. Cell membrane
1. Cytoskeleton
2. Hemoglobin
3. Enzymes

ii. Function
1. Cell membrane
2. Cytoskeleton
3. Hemoglobin
4. Enzymes

iii. Hemoglobin
1. Synthesis
2. Types

iv. Oxygen Transport
v. Oxygen Dissociation Curve

b. Maturation
i. Erythropoiesis
1. Stages
2. Features

ii. Nomenclature
1. Erythrocytic
2. Rubriblastic

c. Morphology

i. Normal
ii. Abnormal
iii. Inclusions
iv. Clinical Significance

d. Metabolism
i. Embden-Meyerhof Pathway
ii. Hexose Monophosphate Shunt
iii. Methemoglobin Reductase Pathway

e. Catabolism
i. Hemolysis
1. Extravascular
2. Intravascular
ii. Hemoglobin Breakdown
iii. Bilirubin Formation

5. Bone Marrow
a. Structure
b. Function
c. M:E ratio
d. Cellularity
e. Erythropoiesis
f. Granulopoiesis
g. Hematopoietic Cells
i. Normal
ii. Abnormal
h. Bone Marrow Studies
i. Clinical Indications
ii. Collection Sites and Techniques
iii. Identifiable Disorders

6. Peripheral Blood Composition
a. Cellular
b. Non-cellular Components

7. Peripheral Blood Smear Evaluation
a. Staining
i. Common stain
1. Wright
2. Prussian Blue
3. Supravital
ii. Indicated use
iii. Properties
b. Preparation
i. Length
ii. Depth
iii. Feathered edge
c. Differential Count
i. Cell identifications
ii. Cell Estimations
iii. Normal Values
d. WBC Estimation
e. Platelet Estimation
f. Morphological Identification
i. Hematopoietic Elements
1. Normal
2. Abnormal
ii. WBC
1. Normal
2. Abnormal
g. Reticulocyte

        i. Identification
        ii. Count
        iii. Miller disc
8. White Blood Cell (WBC)
    a. Types
        i. Myeloid
        ii. Lymphoid
        iii. Granulocytes
    b. Maturation
        i. Sequence
        ii. Name
        iii. Feature
    c. Function
    d. Morphology
        i. Normal
        ii. Abnormal
        iii. Immature
    e. Differentiation
        i. Monoclonal Antibodies
        ii. CD Antigens
        iii. Flow cytometry
9. Laboratory Testing
    a. Specimens
        i. Types
        ii. Preparation
        iii. Preferred specimens
        iv. Anticoagulants
    b. Complete Blood Count (CBC)
        i. Components
        ii. Reference ranges according to ASCP
        iii. RBC Indices
            1. Mean Corpuscular Volume (MCV)
            2. Mean Corpuscular Hemoglobin (MCH)
            3. Mean Corpuscular Hemoglobin concentration (MCHC)
            4. Red Cell Distribution Width (RDW)
            5. Clinical significance
            6. Calculations
    c. Manual Cell Counts
        i. Microhematocrit Procedure
        ii. Neubauer Hemocytometer
            1. RBC counts
            2. WBC counts
    d. Erythrocyte Sedimentation Rate (ESR)
        i. Procedure
        ii. Clinical Significance
10. Hematology Analyzers
    a. Principles
    b. Components
    c. Operation
    d. Histograms
    e. Scatterplots
    f. Quality Control Procedures
        i. Importance
            1. Hematology
            2. Coagulation
        ii. Hematology Analyzers
11. Leukocyte Disorders
    a. Quantitative
    b. Qualitative

- c. Absolute cell counts
- d. Relative cell counts
- e. Expected laboratory results
- f. Neutrophil Abnormalities
  - i. Morphological Changes
    1. Left shift
    2. Toxic granulation
  - ii. Physical abnormalities
  - iii. Clinical features
- g. Other disorders
  - i. Monocytosis
  - ii. Lymphocytosis
    1. Reactive Lymphocytosis
    2. Causes
  - iii. Leukocytosis

12. Leukemias and Related Disorders
    - a. Leukemia Classification
      - i. General Criteria
      - ii. Chronic vs Acute
    - b. Myelodysplastic Syndromes (MDS)
      - i. Characteristics
      - ii. Laboratory findings
    - c. Chronic Myeloproliferative Neoplasms (MPN)
      - i. Characteristics
      - ii. Laboratory findings
    - d. Chronic Lymphoproliferative Disorders
      - i. Characteristics
      - ii. Laboratory findings
    - e. Lymphomas
      - i. Characteristics
      - ii. Laboratory findings
13. Anemias
    - a. Definition
    - b. Clinical Signs
    - c. Symptoms
    - d. Laboratory Results
    - e. Sources of Error in RBC Indices
    - f. RBC Terminology and Morphology
      - i. Anisocytosis
      - ii. Poikilocytosis
      - iii. Polychromasia
      - iv. Rouleaux
      - v. Agglutination
    - g. Types
      - i. Polycythemia
      - ii. Megaloblastic Anemia
      - iii. Hypoproliferative Anemia
      - iv. Hemolytic Anemia
      - v. Hemoglobinopathies
      - vi. Acute Blood Loss
      - vii. Iron Deficiency Anemia (IDA)
    - h. Expected RBC Morphology
14. Platelets
    - a. Thrombopoiesis
    - b. Platelet Evaluation
      - i. Satellitism
      - ii. Clumping
      - iii. Giant Platelets
    - c. Platelet Production

   d. Megakaryocytes
   e. Thrombopoietin
   f. Thrombocytopenia
   g. Thrombocytosis
   h. Platelet
      i. Clumping
      ii. Correcting
15. Hemostasis and Fibrinolysis
   a. Definitions
   b. Coagulation factors
   c. Coagulation cascade
      i. Interactions
      ii. Intrinsic pathway
      iii. Extrinsic pathway
      iv. Common pathway
   d. Vascular System
   e. Platelets
   f. Coagulation
   g. Fibrinolytic Systems
16. Coagulation Testing
   a. PT
   b. aPTT
   c. D-dimer
   d. Fibrinogen
17. Coagulation Disorders
   a. Hemophilia
      i. Symptoms
      ii. Lab Findings
   b. von Willebrand Disease
      i. Symptoms
      ii. Lab Findings
   c. DIC
      i. Symptoms
      ii. Lab Findings
   d. Vitamin K Deficiency
      i. Symptoms
      ii. Lab Findings
18. Anticoagulation Therapy
   a. Warfarin
      i. Action
      ii. Monitoring
   b. Heparin
      i. Action
      ii. Monitoring

Resources

Beck, S.J., & LeGrys, V.A. (2019) *Clinical Laboratory Education*, McLean: The American Society for Clinical Laboratory Sciences.

Carr, Jacqueline. (2021) *Clinical Hematology Atlas*, St. Louis, MO:Elsevier.

Ciesla, Betty. (2019) *Hematology In Practice*, Philadelphia:F.A. Davis.

Keohane, Elaine, et al. (2019) *Rodak's Hematology: Clinical Principles and Applications.*, St. Louis, MO: Elsevier.

McKenzie, Shirlyn, et al. . (2019) *Clinical Laboratory Hematology*, New York, NY: Pearson.

Polancic, J & Riding, K. *Entry Level Curriculum for Medical Laboratory Technician (MLT)*, McLean: American Society for Clinical Laboratory Science.

Turgeon, Mary. (2023) *Clinical Laboratory Science: Concepts, Procedures, and Clinical Applications*, St. Louis, MO: Elsevier.

Resources Other

ASCP. July 2023. Medical Laboratory Technician, MLT(ASCP) Examination Content Guideline. 9 Sept. 2024. https://www.ascp.org/content/board-of-certification#

Instructional Services

OAN Number:

Transfer Assurance Guide OHL009

Top of page

Key: 3006