Entry Level Curriculum Update – Hematology and Hemostasis

The *Entry Level Curriculum* was created to provide guidance as to the knowledge and skills a new graduate at the MLT or MLS level should possess upon entry into the workforce. In this session, we will discuss changes to the hematology and hemostasis sections of these recently published documents and how best to utilize these in your curriculum.

Learning Objectives

1. Discuss the usefulness of the Entry Level Curriculum (ELC).
2. Explain changes that occurred in the recent update.
3. Identify and evaluate ways in which the ELC can be incorporated into your curriculum.

Development Process

The first Entry Level Curriculum (ELC) was published in 2002 and created by educators and practitioners using the Body of Knowledge (BOK) published by ASCLS. The ELC was revised during the 2015-16 year by a sub-committee of the Education Scientific Assembly (ESA) Committee for Educational Programs and Initiatives (CEPI). The two main goals with the revision were:

- Use the recently updated (2014 version) ASCLS Body of Knowledge (BOK) and personal expertise in entry level practice to update the curriculum by removing dated topics and adding new items.
- Ensure differentiation of the MLT and MLS curriculum based on the level of education required for each.

There were 4 rounds of revisions in 2015-16:

- 1st revision reviewed at CLEC 2016 and from educators who could not attend
- 2nd revision reviewed by ASCLS members
- 3rd revision to BOD and 2016 House of Delegates
- 4th revision to ASCLS for publication

ELC committee members finalized all documents by applying the Beck/Moon algorithm introduced at CLEC 2016. The algorithm included three basic questions:

- Is it current practice?
- Is it entry level?
- Is it foundational?

In situations where conflicting comments were received, this algorithm provided the criteria for removing dated information from the documents.

Format

The curriculum format is delineated by discipline area within the MLS and MLT levels. Each discipline area is further delineated by major topics using a learning objective format which includes a sequence of concepts, principles/theories, and skills. Taxonomic levels (cognitive, psychomotor, affective) were included to assist new instructors and new programs.

It is understood that all listed technical items may not be available at each educational institution so that in some programs, only cognitive aspects (state, explain, describe) will be taught and at others the psychomotor may also be taught (perform or observe). The committee also expects that some programs will teach beyond what may be included, based upon regional needs of their graduates and availability of resources.

What's New/What Changed?

Molecular diagnostics is a new addition to the 2016 version of the ELC. Other changes included **moving body fluids** from the Chemistry section to create a new Urinalysis and Body Fluids section.

Where there is overlap in some discipline areas, it is **cross-referenced** to another section within the ELC disciplines. For example, microscopic analysis in Hematology, Urinalysis & Body Fluids, and Microbiology are all cross-referenced to the more detailed microscope section in the General Practice document.

Differentiation in MLT vs MLS curriculum was based on the background knowledge (pre-requisite and/or core courses). Different cognitive levels were reflected in the verbs used to elucidate the tasks or knowledge. For example:

MLT version – Identify basic concepts of spectrophotometry

MLS version - Recognize and explain basic concepts of spectrophotometry

In many instances, the verb levels and expectations were the same, for example in performing tests or identifying abnormal results. A specific example is provided on page 3.

Finally, to assist educators in knowing which **items were deleted from the previous edition of the ELCs and which items were added**, **a summary list is included at the end of each discipline section**. This information could be useful when revising and updating course material. The addition/deletion lists for MLS Hematology are listed on pages 5-11 and for MLT on pages 11-17 of this document.

Uses

The ELC is designed to

- help develop the curriculum for a new program
- assist the new instructor/professor with course development
- update a current program or course

In addition, the document can provide guidance to other organizations for entry level knowledge and skills of the MLS a or MLT graduate.

See example of differences in verb levels between MLS and MLT levels on next page:

MLT Entry Level Curriculum	MLS Entry Level Curriculum
Normal Hematopoietic System	**Normal hematopoietic system**
Define hematopoiesis Level 1 Theory of pluripotent stem cell development Stem cell kinetics: Generative cell cycle Regulatory growth factors and inhibitors	Define hematopoiesis Level 1 Theory of pluripotent stem cell development Stem cell kinetics: Generative cell cycle Hematopoietic inductive environment of regulatory growth factors and inhibitors Apoptosis
Identify phases and site of origin for cellular development of active hematopoietic tissue in Embry and fetus Level 1 Mesoblastic phase Hepatic phase (extramedullary) Medullary/myeloid phase	Describe phases and site of origin for cellular development of active hematopoietic tissue in embryo and fetus Level 1 Yolk sac Mesoblastic phase Hepatic phase (extramedullary) Medullary/myeloid phase
Identify phases and site of origin for cellular development of active hematopoietic tissue in Infant and young child Level 1 All red marrow spaces (all cell lines) Thymus fully developed (T lymphs) Secondary lymphoid tissue (T and B lymphs)	Describe phases and site of origin for cellular development of active hematopoietic tissue in infant and young child Level 1 All red marrow spaces (all cell lines) Thymus fully developed (T lymphs) Secondary lymphoid tissue (B-cell, T-cell and NK-cell)
Identify phases and site of origin for cellular development of active hematopoietic tissue in Adults Level 1 Red marrow (axial skeleton and proximal ends of long bones) Primary and secondary lymphoid tissue (T and B lymphs)	Describe phases and site of origin for cellular development of active hematopoietic tissue in adult Level 1 Red marrow (axial skeleton and proximal ends of long bones) Primary and secondary lymphoid tissue (B-cell, T-cell and NK-cell)
Explain the role of other organ systems in hematopoiesis Level 1 Mononuclear phagocyte system Spleen (structure, blood flow, function)	Explain the role of other organ systems in hematopoiesis Level 1 Mononuclear phagocyte system Spleen (Structure, blood flow, function)

Liver (structure, blood flow, function) Lymph nodes (structure, blood flow, function) Thymus (structure, blood flow, function) State the physical findings commonly present in hematologic disease Level 2 Splenomegaly Hypersplenism Hepatosplenomegaly Lymphadenopathy Bone marrow tissue Describe bone marrow collection techniques Level 1 Aspiration Core biopsy Describe the preparation of bone marrow smears and stains used Level 1 Romanowsky polychrome stain Prussian Blue (iron) Stain Describe key terms used to assess bone marrow structure and function Level 1 Myeloid to erythroid ratio (M:E)/erythroid to granulocyte ratio (E:G) Erythropoiesis Granulopoiesis Megakaryopoiesis Non-hematopoietic cells Cellularity: fat (yellow marrow) to cell (red marrow) ratio	Liver (Structure, blood flow, function) Lymph nodes (Structure, blood flow, function) Thymus (Structure, blood flow, function) State the physical findings commonly present in hematologic disease Level 2 Splenomegaly Hypersplenism Hepatosplenomegaly Lymphadenopathy Bone Marrow Tissue List indications for performing bone marrow examination Level 1 Describe bone marrow collection techniques Level 1 Aspiration Core biopsy Prepare and stain bone marrow smears Level 2 Romanowsky polychrome stain Prussian Blue (Iron) Stain Describe preparation and/or process specimen for specialized testing Level 2 Flow cytometry Molecular assays Cytogenetics Fluorescent *in-situ* hybridization (FISH) Describe key terms used to assess bone marrow structure and function Level 2 Myeloid to erythroid ratio (M:E)/erythroid to granulocyte ratio (E:G) Erythropoiesis Granulopoiesis Megakaryopoiesis Non-hematopoietic cells

Aplastic marrow Hypo/Hyperplastic marrow	Cellularity: fat (yellow marrow) to cell (red marrow) ratio Aplastic marrow Hypoplastic marrow Hyperplastic marrow Describe concepts related to the assessment of iron stores and sideroblast population in the bone marrow Level 2 Type I Type II Type III

Additions/Deletions –

MLS ELC Hematology/Coagulation

Added and Deleted items

Additions:

State the physical findings commonly present in hematologic disease
Describe the preparation of bone marrow smears and stains used
Describe terms used to assess bone marrow structure and function
Describe concepts related to the assessment of iron stores in bone marrow
Perform differential counts on normal specimens
Distinguish between normal and abnormal hematopoietic elements found within the peripheral blood
Correlate complete blood count findings with peripheral blood smear evaluation
List and define components of commonly used stains
Acceptable stain quality
Describe the distinctive features used to characterize developing cells
List the maturation sequence of developing erythrocytes
Distinguish nucleated erythrocyte precursors from other hematopoietic elements
List nutritional and regulatory factors with associated with erythropoiesis
Describe the purpose of the metabolic pathways used by erythrocytes
Identify the effect various conditions can have on an oxygen disassociation curve
Removed ‘Standard operational’ from procedures
Discuss the automated hemogram parameters used for erythrocyte evaluation
Calculate red blood cell indices when provided appropriate data
Perform standard reticulocyte assays
Determine the appropriate area of a peripheral blood smear to evaluate red blood cell morphology
Distinguish between normal and abnormal red blood cell morphology
Differentiate band neutrophils, segmented neutrophils, eosinophils, and basophils
Determine if a granulocyte is mature or immature
Discuss the clinical utility of the absolute neutrophil count

Agranulocytes changed to lymphocytes and monocytes
List the maturation sequence of monocytes and macrophages
List the maturation sequence of lymphocytic cells
Describe monocyte and macrophage function
Identify and classify normal white blood cells on a properly stained Romanowsky blood smear
Associate quantiative and qualitiative leukocyte disorders with expected results
Identify morphologic changes in neutrophils that may accompany nonmalignant neutrophilic disorders
State characteristic abnormalities and clinical features for the qualitative/functional disorders of neutrophils
Identify abnormal lipid accumulations within monocytes and macrophages
*Be it noted that this objective succinctly achieves what the above deletions aimed to accomplish.
Identify causes of non-neoplastic disorders of lymphocytes and plasma cells.
Differentiate between reactive and resting lymphocytes on Romanowsky stained smears
Identify the causes of reactive lymphocytosis
State the clinical signs and symptoms of anemia
List the categories used in a morphological classification of the anemias
Describe the expected laboratory results seen in the various pathophysiologic classifications of anemia
Explain sources of error of the red blood cell indices
Define common words used to describe red cell morphology
Differentiate between normal and abnormal RBC morphology
Associate a given red blood cell morphology with routinely encountered conditions
- Iron defieincy/alterations in iron metabolism
- Vitamin B12/Folate deficiency
- Thalassemia
- Sickle Cell Disease/Trait/other hemoglobinopathies
- Malaria

Hereditary membrane abnormalities (spherocytosis, elliptocytosis, ovalocytosis, etc)
- RBC Enzyme abnormalities (G6PD and PK deficiencies)
- Extracorpuscular (immune and non-immune) mediated RBC defects

Describe changes in the bone marrow and peripheral blood with polycythemia
List the causes of hypochromic anemias
Discuss tests methods commonly used to assess megaloblastic anemia
Describe the clinical features and laboratory findings of red cell membrane defects
Describe the utility of flow cytometry in assessing red cell membrane defects
Describe the clinical and laboratory features of red cell enzyme abnormalities
Non-immune and immune mediated hemolytic anemias were merged into one category for all hemolytic anemias.
Describe the clinical and laboratory findings of hemoglobinopathies
Describe the etiology of anemia of acute blood loss
List the clinical symptoms of acute blood loss
Identify the laboratory findings of acute blood loss
Describe the clinical features and laboratory findings associated with nonhematologic disorders
Identify major systems used to classify neoplastic disorders of leukocytes
Incorporation of WHO system into Acute Leukemia objectives and removal of FAB system from myelodysplastics
Removal of pathophysiology, etiology, and treatment objectives from Acute leukemia objectives
No expectation that MLT students would perform acute leukemia differentials at the entry level
Describe the clinical and laboratory findings commonly found in MPD

The hematology educators felt that knowing immunophenotypic profiles of chronic lymphocytic neoplasms was not appropriate at the MLT level.
Describe the principle of the platelet function assay
Perform procedures to evaluate erythrocytes and their physical properties using patient blood and quality control samples
Describe procedures to evaluate erythrocytes and their physical properties using patient blood and quality control samples
Perform and interpret calculations associated with reticulocyte assays
*Be it noted that this was simply a learning extension but is now a learning objective
Remove III from Antithrombin III
Interpret results of erythrocyte sedimentation rates
Recognize situations when results may be falsely high or low
Calculate absolute and relative white blood cell values
Greater than 20% (WHO)
Primary myelofibrosis (PMF)
Discuss the role of the vasculature in normal hemostasis

Deletions

Associate physical findings with the presence of hematologic disease
Prepare and stain bone marrow smears
Cytochemical stains deleted from bone marrow stains
Describe terms and apply concepts to assess bone marrow
Describe key terms and apply concepts to assess iron stores in bone marrow
Perform differential counts
Correlate bone marrow findings with peripheral blood evaluation
Good stain Quality
Research new concepts and emerging technologies
Describe therapeutic use of growth factors and stem cells to stimulate hematopoietic recovery
Discuss bone marrow/stem cell transplant to treat hematologic disease
Discuss molecular biologic techniques in hematology analysis
Identify distinctive features used to characterize developing cells
List and identify stages of the maturation sequence of erythrocytes
Associate nutritional and regulatory factors with erythropoiesis
List hormones associated with erythropoiesis
Describe metabolic pathways used for red cell ATP
Graph and interpret shifts to the oxygen disassociation curve when altered
Discuss automated hemogram parameters
Calculate MCV, MCH, and MCHC
Perform standard procedures to evaluate reticulocytes
Perform standard operational procedures in peripheral smear examination for red cell morphology
List the maturation sequence and identify distinguishing morphology for stages of developing blood granulocytes using Romanowsky stained smears, photographs, electronic images, or kodachrome slides
Deletion of all kodachrome slide references
Determine differential cell counting using automated methods
Identify and classify white cells on a properly Romanowsky stained blood smear
Characterize granulopoietic alterations

Discuss pathophysiology , causes and conditions quantiative and qualitiative leukocyte disorders with expected results
Identify on Romanowsky stained smears, photographs, electronic images or kodachrome slides morphologic changes in neutrophils that may accompany nonmalignant neutrophilic disorders
Review and compare characteristic abnormalities and clinical features for the qualitative/functional disorders of neutrophils
List the defect, substance accumulated, and clinical features for the major disorders characterized by an accumulation of lipids in monocytes and macrophages

- Gaucher's disease
- Neimann-Pick disease
- Tay-Sachs disease
- Mucopolysaccharidoses
- Sea-blue histiocytosis

Identify from Romanowsky stained smears, photographs, electronic images, or kodachrome slides of the bone marrow

- Gaucher's cells
- Neimann-Pick cells
- Sea-blue histiocytes

Appraise non-neoplastic disorders of lymphocytes and plasma cells
Identify reactive/variant lymphocytes on Romanowsky stained smears, photographs, electronic images, or kodachrome slides of peripheral blood
Evaluate among benign causes of lymphocytosis
Perform infectious mononucleosis evaluation

- Presence of reactive/variant lymphocytes
- Positive serologic tests
- Cytomegalovirus (CMV)
- Toxoplasmosis
- Pertussis (whooping cough)
- Infectious lymphocytosis
- Viral hepatitis

List the major immune deficiencies in relation to T and B cell development
Recognize hematologic alterations in acquired immune deficiency syndrome (AIDS)

- Lymphocytopenia (T cell CD4 and CD 8 ratio)
- Leukopenia
- Anemia
- Thrombocytopenia

Identify the clinical signs ,symptoms of hematologic findings of anemia
Describe the categories used in a morphological classification of the anemias
Describe the pathophysiologic classification of the anemias
Define and calculate RBC indices; explain sources of errors
Interpret results and relate results to physiologic conditions
State the criteria that define
Recognize and quantiatively/qualitatively evaluate red cells

- Normal size erythrocytes
- Microcytes
- Macrocytes

State the criteria that define variations in color

- Normal

Hypochromic
Polychromatic

State the criteria that define poikilocytosis

Microscopically, identify alterations in red cell distribution

Rouleaux
Agglutination

Describe the composition and morphology, methods to identify, and list the possible pathologic inclusions

Correlate clinical conditions associated with the abnormal changes in size, shape, color, distribution, and inclusions

Identify and describe changes in the bone marrow and peripheral blood with polycythemia

Discuss the etiology and pathophysiology

Iron deficiency anemia
Sideroblastic anemia
Anemia of chronic disease
Hemochromatosis/ Hemosiderosis
Porphyrias
Thalassemia

Outline a laboratory approach to the evaluation of a patient's iron status

Discuss megaloblastic transformation

Mechanisms
Cell Changes

Outline a sequential approach to the differential diagnosis of megaloblastic anemia using the following laboratory procedures

Identify common factors associated with the development

Describe the possible pathophysiology

Define Congenital dyserythropoietic anemias (Types I, II, and III)

Describe the clinical features
Describe the laboratory findings

Describe the etiology, pathophysiology, clinical features, and laboratory findings of red cell membrane defects

Identify and correlate data from laboratory tests that are used to detect increased RBC destruction and production

Discuss the principle of the Sugar water (sucrose hemolysis) test

Describe the clinical features
Describe the laboratory findings
Perform /observe the procedure
Apply appropriate quality control procedures
Evaluate results

Discuss the principle of the acidified serum (Ham's) test

Describe the clinical features
Describe the laboratory findings
Perform /observe the procedure
Apply appropriate quality control procedures
Evaluate results

Describe the etiology, pathophysiology, and clinical features of red cell enzyme abnormalities

Describe the physiologic abnormalities and clinical findings

Describe the physiologic abnormality

Hemoglobin variants with altered oxygen affinity
Unstable hemoglobins
Methemoglobinemia

Describe the clinical features associated with different gene combinations in alpha and beta thalassemia

Describe the pathophysiology of alpha and beta thalassemia

Correlate screening test for sickling hemoglobin with peripheral blood morphology and electrophoretic patterns of hemoglobin

Describe the etiology and pathophysiology and identify laboratory findings associated with nonhematologic disorders

Read case studies of neoplastic disorders and apply knowledge and skills in interpreting laboratory results

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Correlate the diagnostic blood and bone marrow findings to the differential identification

Refractory anemia (RA)
Refractory anemia with ringed sideroblast (RARS)
Refractory anemia with excess blast (RAEB)
Chronic myelomonocytic leukemia (CMML)
Refractory anemia with excess blasts in transition (RAEB-t)

Describe characteristics of MDS

Epidemiology
Chromosomal association with pathogenesis
Clinical course with associated hematologic changes
Treatment options

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Correlate diagnostic criteria to these findings for the differential identification

Identify treatment options and recognize effects on peripheral blood white cells, red cell parameters, and platelets

Chemotherapy
Splenic irradiation/splenectomy
Phlebotomy
Bone marrow transplant

Apply diagnostic criteria to blood and bone marrow findings for the differential identification of chronic lymphoid leukemias

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Recognize and describe features associated with aggressive forms of the disease

Autoimmune hemolytic anemia (AIHA)
Chromosome abnormality--trisomy 12
Richter's syndrome

Name and compare systems used to stage disease severity and progress

Modified Rai
Binet

Describe the presence of lymphoma cells on permanently stained blood and body fluid smears, photographs, kodachromes, or electronic images

Perform a bleeding time test

Differentiate between disorders of the vasculature

Acquired purpura
Henoch-Schölein purpura
Hereditary hemorrhagic telangiectasia
hlers-Danlos syndrome
Pseudoxanthoma elasticum

Deletion with no replacement

Learning extension under prepare and stain bone marrow smears:

Cytochemical stains (not used by all facilities)
Enzymatic techniques (esterase, myeloperoxidase)
Nonenzymatic techniques (PAS, Prussian blue (iron))
Describe and/or perform standard operational procedures to evaluate erythrocytes and their physical properties using patient blood and quality control samples
Perform differentials counts on normal bone marrow
Describe normal hemoglobin oxygen dissociation curve: ph, temperature, CO2, 2,3 DPG, Hb S Ect
Homochromatosis/Hemosiderosis
Porphyrias
Discuss the principle of Osmotic Fragility
Delta beta Thal
Hb Constant Spring
Apply knowledge of analytical testing to support healthcare profession engaged in genetic counseling
Review criteria used to classify nonmalignant leucocyte disorders:
Quantitative/Qualitative etc.
Sudan Black, PAS, LAP, TRAP
Recognize and describe features associated with aggressive forms of the disease: autoimmune hemolytic ect
Discuss treatment options : Splenectomy etc.
Apply diagnostic criteria to blood and Bone marrow findings : adult T, lymphoid and cell line etc. Reedsternberg, Rye Modified.

Hematology and Hemostasis MLT ELC Additions and Deletions

Additions:

State the physical findings commonly present in hematologic disease
Describe the preparation of bone marrow smears and stains used
Describe terms used to assess bone marrow structure and function
Describe concepts related to the assessment of iron stores in bone marrow
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Distinguish between normal and abnormal hematopoietic elements found within the peripheral blood
Correlate complete blood count findings with peripheral blood smear evaluation
List and define components of commonly used stains

Acceptable stain quality

Describe the distinctive features used to characterize developing cells
List the maturation sequence of developing erythrocytes
Distinguish nucleated erythrocyte precursors from other hematopoietic elements

List nutritional and regulatory factors with associated with erythropoiesis
Describe the purpose of the metabolic pathways used by erythrocytes
Identify the effect various conditions can have on an oxygen disassociation curve
Discuss the automated hemogram parameters used for erythrocyte evaluation
Calculate red blood cell indices when provided appropriate data
Perform standard reticulocyte assays
Determine the appropriate area of a peripheral blood smear to evaluate red blood cell morphology
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Differentiate band neutrophils, segmented neutrophils, eosinophils, and basophils
Determine if a granulocyte is mature or immature
Discuss the clinical utility of the absolute neutrophil count
Agranulocytes changed to lymphocytes and monocytes
List the maturation sequence of monocytes and macrophages
List the maturation sequence of lymphocytic cells
Describe monocyte and macrophage function
Identify and classify normal white blood cells on a properly stained Romanowsky blood smear
Associate quantiative and qualitiative leukocyte disorders with expected results
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*Be it noted that this objective succinctly achieves what the above deletions aimed to accomplish.

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Differentiate between reactive and resting lymphocytes on Romanowsky stained smears
Identify the causes of reactive lymphocytosis
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List the categories used in a morphological classification of the anemias
Describe the expected laboratory results seen in the various pathophysiologic classifications of anemia
Explain sources of error of the red blood cell indices
Define common words used to describe red cell morphology
Differentiate between normal and abnormal RBC morphology
Associate a given red blood cell morphology with routinely encountered conditions

Iron defieincy/alterations in iron metabolism
Vitamin B12/Folate deficiency
Thalassemia
Sickle Cell Disease/Trait/other hemoglobinopathies
Malaria
Hereditary membrane abnormalities (spherocytosis, elliptocytosis, ovalocytosis, etc)
RBC Enzyme abnormalities (G6PD and PK deficiencies)
Extracorpuscular (immune and non-immune) mediated RBC defects

Describe changes in the bone marrow and peripheral blood with polycythemia
List the causes of hypochromic anemias
Discuss tests methods commonly used to assess megaloblastic anemia

Describe the clinical features and laboratory findings of red cell membrane defects
Describe the utility of flow cytometry in assessing red cell membrane defects
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Non-immune and immune mediated hemolytic anemias were merged into one category for all hemolytic anemias.
Describe the clinical and laboratory findings of hemoglobinopathies
Describe the etiology of anemia of acute blood loss
List the clinical symptoms of acute blood loss
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Describe the clinical features and laboratory findings associated with nonhematologic disorders
Identify major systems used to classify neoplastic disorders of leukocytes
Describe the clinical and laboratory findings commonly found in MPD
Describe the principle of the platelet function assay

Deletions:

Associate physical findings with the presence of hematologic disease
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Cytochemical stains deleted from bone marrow stains
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Review and compare characteristic abnormalities and clinical features for the qualitative/functional disorders of neutrophils

List the defect, substance accumulated, and clinical features for the major disorders characterized by an accumulation of lipids in monocytes and macrophages

- Gaucher's disease
- Neimann-Pick disease
- Tay-Sachs disease
- Mucopolysaccharidoses
- Sea-blue histiocytosis

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Appraise non-neoplastic disorders of lymphocytes and plasma cells

Identify reactive/variant lymphocytes on Romanowsky stained smears, photographs, electronic images, or kodachrome slides of peripheral blood

Evaluate among benign causes of lymphocytosis

Perform infectious mononucleosis evaluation

- Presence of reactive/variant lymphocytes
- Positive serologic tests
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Recognize hematologic alterations in acquired immune deficiency syndrome (AIDS)

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Interpret results and relate results to physiologic conditions

State the criteria that define

Recognize and quantiatively/qualitatively evaluate red cells

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Microcytes
Macrocytes

State the criteria that define variations in color

Normal
Hypochromic
Polychromatic

State the criteria that define poikilocytosis

Microscopically, identify alterations in red cell distribution

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Iron deficiency anemia
Sideroblastic anemia
Anemia of chronic disease
Hemochromatosis/ Hemosiderosis
Porphyrias
Thalassemia

Outline a laboratory approach to the evaluation of a patient's iron status

Discuss megaloblastic transformation

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Cell Changes

Outline a sequential approach to the differential diagnosis of megaloblastic anemia using the following laboratory procedures

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Describe the clinical features
Describe the laboratory findings

Describe the etiology, pathophysiology, clinical features, and laboratory findings of red cell membrane defects

Identify and correlate data from laboratory tests that are used to detect increased RBC destruction and production

Discuss the principle of the Sugar water (sucrose hemolysis) test

Describe the clinical features
Describe the laboratory findings
Perform /observe the procedure
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Discuss the principle of the acidified serum (Ham's) test

Describe the clinical features
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Describe the etiology, pathophysiology, and clinical features of red cell enzyme abnormalities

Describe the physiologic abnormalities and clinical findings

Describe the physiologic abnormality

Hemoglobin variants with altered oxygen affinity
Unstable hemoglobins
Methemoglobinemia

Describe the clinical features associated with different gene combinations in alpha and beta thalassemia

Describe the pathophysiology of alpha and beta thalassemia

Correlate screening test for sickling hemoglobin with peripheral blood morphology and electrophoretic patterns of hemoglobin

Describe the etiology and pathophysiology and identify laboratory findings associated with nonhematologic disorders

Read case studies of neoplastic disorders and apply knowledge and skills in interpreting laboratory results

Incorporation of WHO system into Acute Leukemia objectives and removal of FAB system from myelodysplastics

Removal of pathophysiology, etiology, and treatment objectives from Acute leukemia objectives

No expectation that MLT students would perform acute leukemia differentials at the entry level

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Correlate the diagnostic blood and bone marrow findings to the differential identification

Refractory anemia (RA)
Refractory anemia with ringed sideroblast (RARS)
Refractory anemia with excess blast (RAEB)
Chronic myelomonocytic leukemia (CMML)
Refractory anemia with excess blasts in transition (RAEB-t)

Describe characteristics of MDS

Epidemiology
Chromosomal association with pathogenesis
Clinical course with associated hematologic changes
Treatment options

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Correlate diagnostic criteria to these findings for the differential identification

Identify treatment options and recognize effects on peripheral blood white cells, red cell parameters, and platelets

Chemotherapy
Splenic irradiation/splenectomy
Phlebotomy

Bone marrow transplant

Apply diagnostic criteria to blood and bone marrow findings for the differential identification of chronic lymphoid leukemias

Identify key morphologic features on permanently stained blood and bone marrow smears, photographs, kodachromes, or electronic images

Recognize and describe features associated with aggressive forms of the disease

Autoimmune hemolytic anemia (AIHA)

Chromosome abnormality--trisomy 12

Richter's syndrome

Name and compare systems used to stage disease severity and progress

Modified Rai

Binet

Describe the presence of lymphoma cells on permanently stained blood and body fluid smears, photographs, kodachromes, or electronic images

Perform a bleeding time test

Differentiate between disorders of the vasculature

Acquired purpura

Henoch-Schölein purpura

Hereditary hemorrhagic telangiectasia

hlers-Danlos syndrome

Pseudoxanthoma elasticum

Luebering-Rapoport