AMERICAN SOCIETY OF HEMATOLOGY

HEMATOLOGY CURRICULUM

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Introduction

The field of Hematology includes the study of blood forming elements, blood constituents, coagulation, and/or organs involved in, or that interact with, these physiologic functions. Continued progress in understanding normal and abnormal hematologic physiologic processes and in identifying new approaches to diagnosis and treatment combine to keep the specialty at the cutting edge of medicine. This continuous growth testifies to the validity of Hematology as a (sub)specialty as well as to its contributions to the understanding of the normal and abnormal physiology of numerous other organ systems (e.g. cardiovascular, renal).

As defined by the American Society of Hematology (ASH), "a hematologist is a physician who specializes in the diagnosis, treatment, prevention, and/or investigation of disorders of the hematopoietic, hemostatic, and lymphatic systems, and disorders of the interaction between blood and blood vessel wall." For fellowship programs in Hematology, the challenge is to provide education and experiences with enough breadth and depth so that the physician is well prepared for a professional career in Hematology. A curriculum template is needed to assure that specialty training in Hematology is inclusive of all relevant disciplines, but it should be general enough to allow individual programs to define the specific content of that training.

Although the American Board of Internal Medicine (ABIM) and the Accreditation Council on Graduate Medical Education (ACGME) present a basic structure for subspecialty training in Hematology, the ASH Executive Committee identified a need to provide more specific recommendations for the content of the Hematology curriculum. To this end, a subcommittee of the ASH Committee on Training Programs was created to develop curriculum guidelines for training in Hematology. It was decided that a curriculum should include education in basic science principles and techniques, pathophysiology of normal and abnormal hematologic processes, and the tools needed to diagnose and manage patients with hematologic disorders. Such an education is expected to require a combination of extensive mentorship, didactic lectures, hands-on procedure skill training, diverse clinical experiences, and a variety of supervised skill building and self-education activities. ASH has been actively updating and creating new education materials that should prove useful for all physicians, including trainees in Hematology. These include an Image Bank, Self-Assessment Program, an internet-based journal club, and Annual Meeting Educational Program books and CDs, among others.

Subspecialty training must provide the trainee with appropriate preparation and experiences for a career path of their choice. Certainly, individual training programs will have their strengths and weaknesses, but all are expected to provide the tools necessary for the physician to care for patients with hematologic disorders. This will necessitate exposure of the trainee to basic science concepts, clinical and basic science research, health care system models and available technology for diagnosis and management.

An important component of training a subspecialist is mentorship by experienced faculty. Trainees should be mentored in all of their clinical, educational and research activities. Mentors should be expected to educate, supervise and guide a trainee’s acquisition of knowledge and skills.

The ACGME is in the early phase of initiating "general competencies and outcome assessment" requirements for all accredited physician training programs. Specifically, training programs will be required to develop a curriculum that incorporates the teaching of the competencies and creates the evaluation tools necessary to assess and document a trainee's competence in these areas. The currently defined general competencies include: 1) patient care, 2) medical knowledge, 3) interpersonal and communication skills, 4) professionalism, 5) practice-based learning, and 6) systems-based practice.

The following goal-oriented Hematology curriculum recommendations attempt to incorporate specific areas of content with the expectation of competency for subspecialty training. We have

carefully and intentionally chosen the phrases that begin each knowledge or skill description in an attempt to emphasize the priority that we believe is appropriate for that topic area. This framework is also expected to contribute to the development of education materials for use by all physicians interested in Hematology and to identify areas that can interact with, and can take advantage of, ASH educational resources.

General Programmatic Recommendations

Each Hematology subspecialty training program will need to determine the structure of their educational program. This structure will require a variety of educational, clinical and research formats and settings. Based on current ACGME guidelines, and recommendations made by ASH to the ACGME, the following are important components of any Hematology training program.

1. It is recommended that fellows be exposed to diverse clinical experiences covering the areas of hematopoiesis disorders, immunohematology, transfusion medicine, hematologic malignancies, hemostasis and thrombosis, and bone marrow transplantation. Clinical expertise in these areas is best obtained when fellows function as consultants or team leaders with other health care professionals.
2. Since most of the field of Hematology is based in the outpatient setting, it is recommended that at least 25% of clinical training time be spent in an outpatient setting.
3. It is recommended that blood bank and palliative care (that might include hospice) rotations be provided.
4. It is recommended that all trainees spend between 25 to 50% of their subspecialty training time devoted to the conduct of meaningful research under the direction of a faculty mentor. The research activity should be tailored to the interest of each individual trainee and be related to basic, clinical, epidemiological, supportive care or behavioral aspects of Hematology. Such work should result in submission of abstracts to national meetings and submission of manuscripts to peer reviewed journals.
5. Mentorship is a critical component of training. Each trainee should be assigned a career mentor at the beginning of training and may switch, if indicated, during the progression of training. When on inpatient clinical services, the trainees should round on a regular (daily) basis with the supervising faculty. There must be at least one faculty member present in outpatient clinics available for supervision of the fellow during outpatient sessions.
6. A core didactic series covering key curricular topics should be provided.
7. Journal club and case-based presentations and discussion sessions are recommended.
8. Hematology trainees should be provided with venues and opportunities to present clinical cases to faculty groups to learn presentation and organizational skills.
9. Hematology trainees should participate in multidisciplinary tumor boards.
10. Hematology trainees should participate in clinical quality assurance activities (e.g. morbidity and mortality conferences).
11. Hematology training programs should have facilities for examination of pathology and morphologic samples.
12. Hematology trainees should be provided with dedicated work areas (i.e. desks) and computer terminals to prepare written documents, review clinical and research data, and access internet resources.
13. All Hematology trainees should be encouraged to become Associate members of ASH and attend at least one ASH meeting during the course of their fellowship training.

Curriculum

I. Basic Principles

A. Basic Laboratory Concepts and Techniques

1. The Hematology trainee should demonstrate a comprehensive working knowledge of what DNA, RNA and proteins are and what their general roles are in normal cellular processes. The trainee should understand basic concepts of transcription and translation as well as the normal cellular processes of cell cycle regulation and apoptosis.
2. The Hematology trainee should have a working knowledge of standard techniques to evaluate cellular processes at the DNA, RNA and protein level by understanding, in general terms, the laboratory procedures of Northern blot, Southern blot, Western blot, ELISA, polymerase chain reaction (PCR), immunoprecipitation, microarrays, colony forming unit (CFU) assays and other cellular assays.

B. Pharmacology

1. The Hematology trainee should demonstrate a working knowledge and practical competency of the pharmacokinetics, mechanism of action, metabolism, route of administration, appropriate indications and dosages, and long-term consequences and toxicities of pharmacologic and biologic agents used to treat hematologic disorders. The Hematology trainee should also have a working knowledge of the toxicities and interactions of these agents.
2. The Hematology trainee should have a general understanding of current experimental therapeutics, such as monoclonal antibodies, radioimmunotherapy, other immunotherapeutics, gene therapy, transcription therapy, small molecule inhibitors, farnesyltransferase inhibitors, multi-drug resistance modifiers, novel delivery systems, etc.
3. The Hematology trainee should have a working knowledge of the mechanism of new drug development and the Food and Drug Administration's (FDA's) approval process for new drugs. Education should include an understanding of pharmaceutical company responsibilities and ethics in the drug development and approval process.

C. Clinical Laboratory Techniques

1. The Hematology trainee should have a practical knowledge and understanding of a number of hematology clinical laboratory techniques, including:
   a. Automated complete blood count with white blood cell differential
   b. Hemoglobin electrophoresis
   c. Reticulocyte count
   d. Osmotic fragility
   e. Red blood cell (RBC) enzyme assays
   f. Specific techniques for microscopic identification of RBC parasites
   g. High pressure liquid chromatography (HPLC)
   h. Flow cytometry of peripheral blood, bone marrow, body fluids, lymph nodes and other tissues
   i. Cytogenetics, including fluorescence in-situ hybridization (FISH)
   j. Prothrombin time and activated partial thromboplastin time
   k. Coagulation factor and inhibitor assays
   l. Bleeding time

m. Platelet function studies
n. Heparin induced thrombocytopenia (HIT) assays
o. Tissue (e.g. HLA) typing
p. Southern blot
q. Polymerase chain reaction (PCR)
r. Reverse transcriptase – PCR (RT-PCR)
s. Serum and urine protein electrophoreses and immunoelectrophoreses and/or immunofixation
t. Hematopathology tissue assessment techniques, including standard morphologic evaluation and the use of immunostaining
u. Blood banking techniques of cross-matching, antibody identification, direct antiglobulin test and indirect Coomb's test
v. Apheresis, plasmapheresis, plateletpheresis, leukopheresis
w. Therapeutic phlebotomy
x. Exchange transfusion
y. Immunocytochemistry
z. Cytochemistry

D. Transfusion Medicine

1. The Hematology trainee should demonstrate a comprehensive working knowledge of the procedures used to collect, evaluate and prepare blood products for administration to patients.
2. The Hematology trainee should demonstrate a comprehensive working knowledge of the components of blood products typically administered to patients, including red blood cell (RBC) preparations, platelet preparations, granulocyte preparations, fresh frozen plasma and cryoprecipitate. This should include an understanding of various methods by which these blood products can be handled and prepared in response to specific clinical situations, including irradiation, washing and filtering techniques.
3. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of identifying the clinical indications for use of specific blood products and the clinical scenarios for which they are used.
4. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the potential risks associated with the administration of various blood products. This should include, but is not limited to, allergic (anaphylactic) reactions, graft versus host disease, rejection reactions, introduction of infectious organisms, alloimmunization, delayed transfusion reactions, hemolytic reactions, febrile reactions and others.
5. The Hematology trainee should demonstrate practical competency and understanding of alternatives to blood product therapies.
6. The Hematology trainee should demonstrate a comprehensive working knowledge of the indications and processes of assays typically performed in a Blood Bank. These should include cross matching, direct antiglobulin tests (direct Coomb's test), antibody screen (indirect Coomb's test), ABO and Rh typing of red blood cells, and other antibody identification procedures.
7. The Hematology trainee should demonstrate a comprehensive working knowledge of the mechanism by which apheresis can be used to isolate and collect specific blood components from individuals.

8. The Hematology trainee should demonstrate a comprehensive working knowledge of the use of emergent plasmapheresis (as used in TTP), leukapheresis (as used in AML) and RBC exchange (as used in sickle cell anemia).
9. The Hematology trainee should demonstrate a working knowledge of the methods used for peripheral blood stem cell collections.

E. Radiation Therapy
1. The Hematology trainee should demonstrate a working knowledge and understanding of the basic principles of radiation biology.
2. The Hematology trainee should have practical knowledge of the basic approaches of administering radiation therapy, including the different radiation source types (e.g. electron beam, external beam, brachytherapy).
3. The Hematology trainee should have an understanding of the short-term toxicities and the potential long-term consequences of radiation therapy (e.g. secondary malignancies, coronary artery disease).
4. The Hematology trainee should understand and be able to recognize interactions of radiation therapy with medications, including antineoplastic pharmacologic agents.

F. Diagnostic Imaging
1. The Hematology trainee should have a general understanding of the mechanics, indications, clinical utility and potential risks and toxicities of imaging techniques used in the diagnosis and management of patients with hematologic disorders. This includes, but is not limited to, ultrasound, nuclear medicine studies (e.g. bone scan, radioisotope-tagged RBC scans) computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), and combined CT/PET.

G. Geriatrics
1. The Hematology trainee should have a practical understanding of the effects of specific changes associated with aging and their impact on normal hematologic processes (e.g. hematopoiesis, hemostasis) and on the biology, natural history, diagnosis and management of hematologic diseases in the elderly person.
2. The Hematology trainee should have a working knowledge of the impact of age on the pharmacology, pharmacokinetics and side effect profiles of drugs used to treat hematologic disorders.
3. The Hematology trainee should have a working knowledge of how to perform and use a geriatric assessment in evaluating and managing their elderly patients.
4. The Hematology trainee should demonstrate experience assessing quality of life measures in their patients.
5. The Hematology trainee should be provided knowledge of areas of hematology in need of research in the geriatric population.

H. Pediatrics
1. The Hematology trainee should demonstrate practical knowledge of the change in peripheral blood counts from birth onward.
2. The Hematology trainee should demonstrate practical knowledge and practical competency of the heritable hematologic disorders (detailed in later sections of this document).

II. Hematopoietic System

A. Normal Hematopoiesis

1. The Hematology trainee should demonstrate a working understanding of hematopoiesis. This should include understanding the developmental processes of all hematopoietic cell lineages beginning with the pluripotential stem cell. This should also include:
   a. Stem cell plasticity, embryology and differentiation
   b. Erythropoiesis
   c. Leukocyte differentiation, maturation and trafficking
   d. Basics of lymphocyte biology
   e. Thrombopoiesis
2. The Hematology trainee should demonstrate an understanding of cell surface receptor and cell surface protein changes that occur in the normal development and differentiation of hematopoietic cells. There should also be an understanding of the role of growth factors and cytokines on the development and differentiation of these cells. The impact of gender, pregnancy and age on hematologic parameters and functions should be recognized.
3. The Hematology trainee should demonstrate a comprehensive working knowledge of hemoglobin synthesis, including the role of porphyrin proteins and the specific enzymes involved. The Hematology trainee should understand the genetics and basic mechanisms of hemoglobin gene expression from the stages of embryo to adult. The trainee should demonstrate a working knowledge of hemoglobin structure and function. The trainee should demonstrate a comprehensive working knowledge of iron metabolism and the role of iron in hemoglobin synthesis. The trainee should also demonstrate a comprehensive understanding of vitamin B12 and folic acid biochemistry and their roles in RBC production.
4. The Hematology trainee should demonstrate a comprehensive working knowledge of normal platelet development and the role of thrombopoietin and other platelet growth factors. The trainee should demonstrate an understanding of the role of platelet surface proteins and platelet granule physiology in normal platelet development and function and in disease. The trainee should demonstrate a working knowledge of platelet-endothelial cell interactions.

B. Red Blood Cell Disorders

1. Anemias
   a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms, diagnosis and therapy of anemias. This should include being able to use a complete blood count with RBC indices to categorize the likely causes of anemia. Likewise, trainees should understand what the RBC indices represent and what leads to their abnormality. Trainees should demonstrate the ability to interpret and recognize all morphologic variations of RBCs (on peripheral blood smear and bone marrow aspirate) and correlate these with their likely pathophysiological conditions. The trainee should also demonstrate a working knowledge and practical competency of the indications and interpretation of a bone marrow aspirate and biopsy in the evaluation of anemias.
   b. Production disorders

1) Nutritional deficiencies
    a) The Hematology trainee should demonstrate a comprehensive working knowledge of the physiology of iron, vitamin B12 and folate utilization, storage and transport.
    b) The Hematology trainee should demonstrate an understanding of gender- and age-related effects on RBC production.
    c) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the diagnostic criteria for nutritional deficiency anemias based on clinical presentations and laboratory analysis of the deficient states.
    d) The Hematology trainee should demonstrate practical competency for determining the appropriate replacement therapy for nutritional deficiency anemias. This includes demonstrating the ability to calculate the magnitude of the deficit and the proper replacement regimen.
2) Anemia of chronic disease
    a) The Hematology trainee should demonstrate a comprehensive working knowledge of the underlying causes of anemia of chronic disease.
    b) The Hematology trainee should demonstrate a working knowledge and practical competency of the diagnostic criteria, differential diagnosis, and management of anemia of chronic disease.
3) Red cell aplasia and hypoplasia
    a) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the underlying causes, diagnosis and management of red cell aplasia and hypoplasia. This should include understanding the direct toxicity to the bone marrow of infectious diseases, toxins and metabolic insults.
    b) The Hematology trainee should demonstrate a working knowledge of the role and utility of serologic studies and of bone marrow aspirate and biopsy interpretations for making the diagnosis and identifying the etiology of these disorders. A practical competency in managing these patients, should be demonstrated. This should include demonstrating an understanding of the role and use of immunologic modifier therapy (e.g. antithymocyte globulin, cyclosporine, glucocorticoids) and stem cell transplantation, among others.
4) Sideroblastic anemias
    a) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency in the genetics, pathophysiology, diagnosis pathophysiology, diagnosis (including interpretation of a bone marrow aspirate iron stain), and management of the sideroblastic anemias.

c. RBC destruction disorders (Hemolytic anemias)
1) Hemoglobinopathies
    a) Thalassemias
        i. The Hematology trainee should demonstrate a comprehensive working knowledge of the genetics and pre-natal diagnosis of the thalassemias.
        ii. The Hematology trainee should demonstrate the ability to make a diagnosis of thalassemia. This should include demonstrating the

ability to distinguish between the different "types" of thalassemia (i.e. α, β, major, minor, etc.).

iii. The Hematology trainee should demonstrate practical competency in managing the various types of thalassemia. This should include primary treatment as well as management of the clinical sequelae of these diseases, including iron overload, skeletal abnormalities and organomegalies.

b) Sickle cell anemia

i. The Hematology trainee should demonstrate a comprehensive working knowledge of the genetics and physical properties of hemoglobin S.

ii. The Hematology trainee should demonstrate practical competency for diagnosing sickle cell disease and for recognizing and diagnosing the clinical sequelae of sickle cell disease. Particular emphasis should be placed on the life-threatening aspects, such as acute chest syndrome, hemolytic and aplastic crises, risk of infections, sickle cell lung disease, and strokes.

iii. The Hematology trainee should demonstrate practical competency for the role of RBC transfusion therapy and for the perioperative management of patients with sickle cell disease.

iv. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for the role and use of fetal hemoglobin synthesis stimulators (e.g. hydroxyurea, butyrate) and stem cell transplantation in the management of sickle cell disease.

v. The Hematology trainee should demonstrate a working knowledge of the variant sickle cell syndromes (e.g. S/Thalassemia, SC disease, etc.), including their diagnosis, recognizing their clinical sequelae and their management.

vi. The Hematology trainee should demonstrate a working knowledge and practical competency for acute and chronic pain management in patients with sickle cell disease.

c) Other congenital hemoglobinopathies

i. The Hematology trainee should demonstrate a working knowledge and practical competency of the pathophysiology, diagnosis and management of the broad range of other structural and biochemical hemoglobinopathies (e.g. hemoglobin E, high and low oxygen affinity hemoglobins, unstable hemoglobins and methemoglobins).

2) Hemolytic anemias

a) Autoimmune hemolytic anemias

i. The Hematology trainee should demonstrate a comprehensive working knowledge of the etiologies of autoantibody development. This includes an understanding of primary autoantibody production and autoantibodies that develop as sequelae of other diseases (secondary causes).

ii. The Hematology trainee should demonstrate a comprehensive working knowledge of the different mechanisms by which

autoantibodies can lead to destruction of RBCs. This includes understanding how to distinguish between warm autoantibodies, cold autoantibodies, cryoglobulins and cold agglutinins in the etiology of hemolytic anemias.

iii. The Hematology trainee should demonstrate practical competency for evaluating, diagnosing and recognizing the clinical sequelae of the hemolytic anemias. This should include demonstrating an understanding of the direct and indirect antiglobulin (i.e. Coomb's) tests and of the methods used to identify and classify autoantibodies.

iv. The Hematology trainee should demonstrate practical competency in managing autoimmune hemolytic anemias. This should include demonstrating the ability to recognize indications for treatment, the use of glucocorticoids, IVIg, immunosuppressives, and RBC transfusions. In addition, the trainee should demonstrate the ability to recognize and manage the sequelae of autoimmune hemolytic anemias.

b) Metabolic enzyme deficiency hemolytic anemias

i. The Hematology trainee should demonstrate a comprehensive working knowledge of RBC metabolic deficiencies that lead to hemolysis. This includes an understanding of deficiencies of glucose-6-phosphate-dehydrogenase (G6PD) and pyruvate kinase (PK), among others, and the conditions that aggravate these deficiencies. The trainee should demonstrate an understanding of the biochemical pathways affected by these enzyme deficiencies.

ii. The Hematology trainee should demonstrate practical competency in diagnosing and managing the metabolic enzyme deficiency hemolytic anemias.

c) Paroxysmal nocturnal hemoglobinuria (PNH)

i. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for the pathophysiology, diagnosis and management of PNH and its associated complications.

d) RBC membrane disorders

i. The Hematology trainee should demonstrate a comprehensive working knowledge of the relationship between structure and function of the RBC membrane and how mutations in the different membrane components lead to hemolytic syndromes.

ii. The Hematology trainee should demonstrate practical competency for differentiating between these disorders, recognizing microscopic morphologic presentations of these disorders, managing these different disorders and their associated clinical sequelae, and counseling patients about their disease and associated complications.

e) Microangiopathic hemolytic anemias (MAHA)

i. The Hematology trainee should demonstrate a comprehensive working knowledge of the pathophysiology of the different causes of MAHA. This should include demonstrating the ability to

differentiate between thrombotic thrombocytopenic purpura (TTP) and hemolytic uremic syndrome (HUS), among others.

ii. The Hematology trainee should demonstrate practical competency for diagnosing and managing TTP, HUS, disseminated intravascular coagulation (DIC) and the other MAHA.

f) Non-autoimmune, acquired hemolytic anemias

i. The Hematology trainee should demonstrate a working knowledge and practical competency of the pathophysiology, diagnosis and management of a variety of other acquired etiologies of hemolytic anemia. These etiologies should include physical (traumatic) fragmentation, infectious diseases, chemicals and toxins, physical agents (e.g. burns), and the impact of disorders of other organ systems.

2. Erythrocytosis

a. The Hematology trainee should demonstrate a working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms, diagnosis and therapy of disorders that cause an increase in RBC number and/or mass. These include polycythemia rubra vera (see Section IV.C.2.) and secondary causes. The trainee should be able to differentiate between primary (polycythemia rubra vera) and secondary causes of erythrocytosis.

b. The Hematology trainee should demonstrate a working knowledge of the physiology and role of erythropoietin in erythropoiesis and of the practical application and interpretation of measured erythropoietin levels. The trainee should be familiar with the American Society of Clinical Oncology (ASCO)/ASH evidence-based clinical practice guidelines for the use of erythropoietin in cancer patients.

3. Porphyrias

a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency in making the diagnosis of specific porphyria diseases and identifying the enzyme abnormality that has led to the associated clinical presentation.

b. The Hematology trainee should demonstrate practical competency for the treatment of patients with porphyria diseases. Specifically, this includes the identification of particular pharmacologic agents that may precipitate clinical symptoms and signs, and that should be avoided. The trainee should also demonstrate an understanding of the indications and proper use of hematin.

C. Hemochromatosis

1. The Hematology trainee should demonstrate a comprehensive working knowledge of the basic molecular and pathophysiologic mechanisms that lead to the development of hemochromatosis. This should include identifying risk factors and the common genetic mutations that are associated with an increased risk of a person developing hemochromatosis.

2. The Hematology trainee should demonstrate practical competency for recognizing the presentation and making the diagnosis of hemochromatosis. This should include the ability to use and interpret molecular diagnosis assays, including those that identify the C282Y and H63D mutations of the hemochromatosis gene (HFE).

3. The Hematology trainee should demonstrate the ability to recognize the clinical sequelae and complications of hemochromatosis on systemic organ systems.
4. The Hematology trainee should demonstrate practical competency for managing patients with hemochromatosis. This should include understanding the indications for the initiation and choice of therapy and the expected outcome and toxicities of phlebotomy and iron chelation therapies.

D. White Blood Cell Disorders
   1. Granulocyte Dysfunction Disorders
      a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic pathophysiologic mechanisms, diagnosis and therapy of qualitative granulocyte dysfunction disorders, including enzyme deficiencies, enzyme storage disorders, Chediak Higashi syndrome, chronic granulomatous disease and leukocyte adhesion deficiency. In order to accomplish this understanding of granulocyte disorders, a basic understanding of normal white blood cell development, differentiation, migration and trafficking should be acquired by the trainee.
   2. Granulocytopenia
      a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the pathophysiologic mechanisms that lead to generation of a differential diagnosis of granulocytopenia and understanding the diagnostic approach to identifying the etiology of granulocytopenia and agranulocytosis. Specifically, the role of drugs and environmental toxins, infiltrative disorders, immune mediated destruction, infections, bone marrow failure states and HIV infection should be understood.
      b. The Hematology trainee should demonstrate a comprehensive working knowledge of the risks associated with granulocytopenia.
      c. The Hematology trainee should demonstrate an understanding of the indication and role of cytokines (e.g. G-CSF, GM-CSF) in management of patients with granulocytopenia and agranulocytosis.
   3. Lymphopenia and Lymphocyte Dysfunction Syndromes
      a. The Hematology trainee should demonstrate a basic comprehension of B and T lymphocyte differentiation and development. There should also be a basic understanding of the genetics and pathophysiological mechanisms of B and T lymphocyte functional and numerical deficiencies including the pathophysiology of HIV-associated disease.
      b. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of recognizing, diagnosing and managing specific diseases that consist of lymphocyte dysfunction. This includes common variable immunodeficiency, severe combined immunodeficiency, adenosine deaminase deficiency, Wiskott-Aldrich syndrome, ataxia-telangiectasia, DiGeorge anomaly, selective immunoglobulin deficiencies, Omenn syndrome, reticular dysgenesis and others.
      c. The Hematology trainee should demonstrate an understanding of the impact of immune-suppressive therapy, chemotherapy and monoclonal antibody therapy on lymphocyte number and function, and on the immune system in general. The trainee should also demonstrate practical competency of how to prevent complications from these effects.

d. The Hematology trainee should demonstrate a basic understanding of the therapy of acquired and inherited immune deficiency syndromes.

4. Leukocytosis
   a. The Hematology trainee should demonstrate a working knowledge and a practical competency of the basic molecular and pathophysiologic mechanisms that can lead to leukocytosis. This includes understanding those processes that lead to increases in the different specific types of leukocytes (e.g. neutrophilia, lymphocytosis, hypereosinophilia).
   b. The Hematology trainee should be able to generate a differential diagnosis and develop a diagnostic approach to identifying the etiology of the leukocytoses. This should include recognizing primary (e.g. leukemia, idiopathic) versus secondary (e.g. drugs, infection, reactive) causes of leukocytosis.
   c. The trainee should be able to describe the clinical consequences of leukocytosis, including clinical scenarios where such consequences may be demonstrated (e.g. leukostasis, leukemias, eosinophilias and organ damage).
   d. The Hematology trainee should demonstrate a working knowledge and practical competency of the indications and approaches for interfering with increased white blood cell production by pharmacologic agents, biologic agents, and mechanical methods (i.e. leukopheresis) to transiently decrease the elevated leukocyte number. The indications, pharmacologic agents, and dosages and toxicities of these agents and approaches should be understood.

E. Platelet and Megakaryocyte Disorders
   1. Hereditary Platelet Disorders
      a. The Hematology trainee should demonstrate an understanding of the various inherited platelet disorders and their underlying pathophysiologic mechanisms. These include von Willebrand's disease, Bernard-Soulier syndrome (glycoprotein Ib-IX deficiency or defect), platelet collagen receptor deficiency, Glanzmann thrombasthenia (glycoprotein IIb-IIIa deficiency), gray platelet syndrome (α-granule deficiency, α-storage pool disease), dense granule deficiency (δ-storage pool disease), primary secretion defects and platelet procoagulant activity disorders, among others.
      b. The Hematology trainee should demonstrate the ability to identify and interpret the appropriate studies needed to diagnose patients with hereditary platelet disorders, including platelet aggregation assays and platelet antigen identification assays.
      c. The Hematology trainee should demonstrate the ability to manage the hereditary platelet disorders, including the appropriate administration of blood products, select coagulation factor products, apheresis, procoagulants and others.
   2. Acquired Platelet Function Disorders
      a. The Hematology trainee should demonstrate a working knowledge and practical competency of the basic pathophysiologic mechanisms, diagnosis and therapy of acquired platelet function disorders. These should include, but are not limited to, the effects of pharmacologic and biologic agents on normal platelet function, systemic conditions that are associated with platelet dysfunction (e.g. uremia, cardiopulmonary bypass surgery, and autoimmune disorders), and hematologic disorders that are associated with platelet dysfunction (e.g. chronic

myeloproliferative disorders, dysproteinemias, leukemias, myelodysplastic syndromes, etc.).

b. The Hematology trainee should understand and be able to interpret platelet aggregation assays and distinguish between the pathophysiological implications of stimulation with different agents.

3. Thrombocytopenia
   a. Decreased Platelet Production
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the differential diagnosis, basic molecular and pathophysiologic mechanisms, approach to diagnosis, and therapy of diseases that result in decreased production of platelets. This should include an understanding of specific diseases and clinical situations that can be associated with platelet production, including bone marrow failure states, aplastic anemia, myelodysplastic syndromes, infiltrative bone marrow disorders, immune etiologies, underproduction of thrombopoietin, drug effects and infections.
   b. Increased Destruction or Consumption of Platelets
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the differential diagnosis, basic molecular and pathophysiologic mechanisms, approach to diagnosis, and therapy of diseases that result in an increased rate of destruction or consumption of platelets. This should include an understanding of specific diseases and clinical situations that can lead to increased platelet destruction or consumption including hypersplenism, immune etiologies, drug effects, heparin-induced thrombocytopenia, microangiopathic disorders, disseminated intravascular coagulation (DIC), infections, bleeding and cardiopulmonary bypass.
   c. The Hematology trainee should be familiar with the ASH guidelines for the diagnosis and management of patients with immune thrombocytopenic purpura (ITP).
   d. The Hematology trainee should have an understanding of the assessment of the bleeding risk for a given level of thrombocytopenia. This should include the appropriate use and interpretation of the bleeding time, platelet number, platelet function (aggregation) studies, heparin-induced thrombocytopenia antibody assays and recognizing the contribution of other relevant underlying medical disorders.
4. Thrombocytosis
   a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms that lead to thrombocytosis. This should include recognizing the potential causes of thrombocytosis, including primary (e.g. essential thrombocythemia; see Section IV.C.4.) and secondary (e.g. reactive, iron deficiency) etiologies.
   b. The Hematology trainee should recognize the consequences associated with thrombocytosis that may range from bleeding to thrombosis and the trainee should understand how to assess the associated risks of thrombocytosis to individual patients.
   c. The Hematology trainee should demonstrate an understanding of the approach to diagnosis of the cause of thrombocytosis and should demonstrate practical competency for the use of pharmacologic agents, biologic agents, and mechanical

methods in the treatment of thrombocytosis. The trainee should understand the mechanism of action, dosing and toxicities of these agents.

5. Anti-platelet function drugs
   a. The Hematology trainee should understand the mechanism of actions, pharmacokinetics, toxicities, indications, dosages and interactions of all classes of anti-platelet drugs (i.e. aspirin, ticlopidine/clopidogrel, dipyridamole, GP IIb/IIIa inhibitors, etc).

F. Bone Marrow Failure States

1. The Hematology trainee should be able to list and describe the clinical characteristics of the inherited and congenital forms of bone marrow failure states. The trainee should demonstrate a basic working knowledge and practical competency of diagnosing and managing these disorders.
2. The Hematology trainee should demonstrate the ability to provide a differential diagnosis and the acquisition of practical knowledge of the role of medications, other drugs and environmental pathogens (including chemicals and infectious diseases) in the development of bone marrow failure states. An understanding of the approach to diagnosis and management of these disorders should be demonstrated.
3. The Hematology trainee should demonstrate the acquisition of specific knowledge about the following acquired bone marrow failure states:
   a. Aplastic Anemia
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the diagnosis and therapy of aplastic anemia. An understanding of the indications and risks of various treatment approaches (including stem cell transplantation, anti-thymocyte globulin, cyclosporine, other immune mediators) should be demonstrated by the trainee.
   b. Pancytopenia
      The Hematology trainee should be able to generate a differential diagnosis of the causes of pancytopenia. The trainee should demonstrate a working knowledge of the approach to diagnosis of the etiology of pancytopenia.

III. Hemostasis

A. Normal Mechanisms of Hemostasis

1. The Hematology trainee should understand the basic mechanisms and components of normal hemostasis and thrombosis. This should include a practical knowledge of the function and interactions of procoagulant and anticoagulant proteins, cellular contributions and interactions between these components as well as with vascular endothelium.

B. Bleeding Disorders

1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms of hemostasis. In particular, the trainee should understand the various genetic and acquired causes and contributors of bleeding disorders.
2. The Hematology trainee should demonstrate an understanding of the pathophysiologic abnormalities associated with the different types of von Willebrand's disease and should demonstrate the ability to recognize the clinical presentation, diagnose and

characterize the different types of von Willebrand's disease. The Hematology trainee should have knowledge of the clinical implications of the different types of von Willebrand's disease and should demonstrate practical competency in the treatment of these disorders. The correct use of replacement therapy, desmopressin (DDAVP) and blood products should be demonstrated.

3. The Hematology trainee should demonstrate a working knowledge of the cause of hemophilias A and B, and other inherited factor deficiency states. The trainee should demonstrate practical competency for diagnosing and managing patients with these disorders. The trainee should also be able to identify and diagnose patients with coagulation factor inhibitors and should demonstrate practical competency for treating these patient's bleeding and skeletal complications. This includes demonstration of knowledge of the different types of factor replacement and "bypass" products.
4. The Hematology trainee should demonstrate a working knowledge and practical competency of the genetics, pathophysiology, diagnosis and management of other factor deficiencies, such as factors XI and VII, as well.
5. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for recognizing and diagnosing acquired bleeding disorders. This should include recognizing the effects of systemic diseases (e.g. liver disease, renal failure) on hemostasis, disorders caused by the acquisition of coagulation factor antibodies (inhibitors), platelet disorders (see above), and effects of medicinals. The trainee should demonstrate the ability to diagnose the etiology of bleeding disorders and the ability to manage these patients.
6. The Hematology trainee should understand the role of vascular abnormalities in the etiology of specific bleeding disorders.
7. The Hematology trainee should demonstrate practical competency using various diagnostic tools, and interpreting their results, in patients with bleeding disorders, including platelet function studies, bleeding time, coagulation factor assays, and coagulation factor inhibitor screens and assays.

C. Thrombotic Disorders

1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular pathophysiologic mechanisms, diagnosis and therapy of diseases that lead to thrombosis. This should include recognizing the role of trauma and vascular injury, systemic disorders, altered balance of bleeding/thrombosis factors, pharmacologic agents and the role of genetics in the etiology of thrombotic disorders. The trainee should demonstrate practical competency of the diagnostic approach for identifying the cause of thrombosis in patients as well as recognizing inherited and acquired risk factors. There should be demonstrated knowledge of the specific genetic abnormalities that are associated with increased risk of thrombosis, including Factor V Leiden, Prothrombin G20210A and other potentially clinically relevant genetic abnormalities.
2. The Hematology trainee should be familiar with methods for prophylaxis, diagnosis, and treatment of venous thrombosis, including the proper use of anticoagulant therapies. The trainee should be familiar with prophylaxis strategies in medical and surgical populations, with diagnostic considerations for the evaluation and management of recurrent deep vein thrombosis, and with the evaluation and treatment of thrombosis that is refractory to standard anticoagulation.

3. The Hematology trainee should be familiar with the indication, approaches to and limitations of genetic testing to assess risk factors for thrombosis. The trainee should also demonstrate practical experience in the pre-test and post-test counseling for patients and their families with inherited or acquired risks of developing thromboses.
4. Heparin-Induced Thrombocytopenia
    a. The Hematology trainee should demonstrate a comprehensive working knowledge of the clinical presentation, pathogenic mechanism, diagnosis and management of heparin-induced thrombocytopenia. The trainee should demonstrate practical competency in the proper use of anticoagulant therapies in heparin-induced thrombocytopenia. The trainee should also demonstrate an understanding of the risk and consequences of thrombosis in these patients.
5. Antiphospholipid Syndrome
    a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for diagnosing and managing the manifestations of antiphospholipid syndrome. This should include a comprehensive working knowledge of the different antibodies that can be assayed and used in the diagnosis of this syndrome and a practical competency for the use of prophylaxis for those patients at risk of thrombosis. The trainee should also demonstrate practical competency for recognizing and managing the clinical manifestations associated with antiphospholipid syndrome, including the implications and risks associated with pregnancy and surgery.

D. Pharmacologic Manipulation of Bleeding and Thrombosis
1. The Hematology trainee should demonstrate practical competency with the use of the various classes of antithrombotics and anticoagulants that are available. These include heparins, warfarin, anti-thrombins, anti-platelet agents (see Section II.E.5.), fibrinolytic agents, and others. The trainee should be able to recognize the various classes, their mechanisms of action, indications and appropriate dosing for various clinical situations. The trainee should demonstrate a general understanding of the pharmacology dosing and administration of these agents as well as of their toxicities and potential interactions with other medications and other factors, such as diet and relevant co-morbidities. The trainee should demonstrate practical competency in understanding how to monitor the degree of anticoagulation with these anticoagulants as well as having an understanding of the factors to consider when determining the appropriate duration of anticoagulant therapy in patients with thrombotic disease.
2. The Hematology trainee should demonstrate practical competency with various factor replacement products, inhibitor “bypass” products, antifibrinolytic agents, and the role of blood products for the management of bleeding disorders. The trainee should demonstrate a general understanding of the pharmacology dosing and administration of these agents as well as of their toxicity and potential interactions with other medications and factors.

IV. Hematologic Neoplastic Disorders

A. Introduction

The hematologic neoplastic disorders have historically been categorized with a wide variety of formal classification schemes based on a broad range of criteria. The most recently described World Health Organization (WHO) Classification of Tumours system,

which has gained widespread acceptance and use, attempts to provide a classification system of human hematopoietic neoplasms that is based on their hematopathological and genetic features and that has worldwide relevance. This section of the curriculum uses the WHO classification system as the organizational template.

Likewise, a number of classification schemes have been described specifically for lymphomas. For the purposes of this curriculum, the lymphomas are organized according to the WHO classification scheme. However, the trainee is encouraged to also be familiar with the Revised European-American Lymphoma (REAL) classification scheme that was proposed by the International Lymphoma Study Group.

B. Cancer Biology
   1. The Hematology trainee should demonstrate a general knowledge of the mechanics and kinetics of tumor cell growth as well as of the mechanisms of tumorigenesis and immortalization. The trainee should also understand the basic concepts of angiogenesis, cell invasion and metastasis.
   2. The Hematology trainee should demonstrate a basic understanding of the role of telomeres and senescence in the malignant process.

C. Chronic Myeloproliferative Diseases
   1. Chronic Myelogenous Leukemia
      a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology and basic molecular and pathophysiologic mechanisms of the development of chronic myelogenous leukemia (CML). This should include an understanding of the role of the *bcr/abl* translocation (Philadelphia chromosome) in the development of the disease.
      b. The Hematology trainee should demonstrate a comprehensive working knowledge of the "phases" of CML disease progression and the associated prognoses associated with these.
      c. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for making a diagnosis of CML. This should include use of cytogenetic and molecular assays evaluating for the bcr/abl translocation, leukocyte alkaline phosphatase (LAP) “scores,” and morphologic characteristics of peripheral blood and bone marrow that represent the various “phases” of disease.
      d. The Hematology trainee should demonstrate practical competency for the treatment of CML. Specifically, the trainee should understand the role of specific therapies for the different "phases" of disease. This should include knowledge of the pharmacologic agents (including tyrosine kinase inhibitors), immunologic agents and biologic agents (e.g. interferon-α) used in the treatment of CML. The indications, mechanism of action, expected outcome, dosage, toxicities and mechanisms of resistance of these agents should be known by the trainee. In addition, the appropriate indications and role of stem cell transplantation in the management of CML should be understood. Finally, the trainee should demonstrate practical competency with diagnosis and management of refractory and relapsed CML.
   2. Polycythemia Rubra Vera

a. The Hematology trainee should demonstrate a comprehensive working knowledge of the diagnostic and staging criteria for polycythemia rubra vera. In addition, the trainee should demonstrate an understanding of the epidemiology, risk factors and natural history associated with the disease.
b. The Hematology trainee should demonstrate practical competency in making the diagnosis of polycythemia rubra vera and of choosing therapy for the disease. In particular, the trainee should demonstrate an understanding of the role of phlebotomy, pharmacologic agents and radioactive phosphorous in the treatment of polycythemia rubra vera. The trainee should also demonstrate an understanding of the indications, pharmacology, risks and toxicities associated with each of these therapies.

3. Chronic Idiopathic Myelofibrosis (Agnogenic Myeloid Metaplasia/Myelofibrosis)
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, risk factors, clinical presentation and natural history of patients with chronic idiopathic myelofibrosis.
   b. The Hematology trainee should demonstrate practical competency of making the diagnosis and choosing therapy for chronic idiopathic myelofibrosis.
   c. The Hematology trainee should demonstrate practical competency with the prognosis and long term outlook for patients with chronic idiopathic myelofibrosis.
4. Essential Thrombocythemia
   a. The Hematology trainee should demonstrate practical competency in the diagnosis and natural history of essential (primary) thrombocythemia (ET). The trainee should also demonstrate a comprehensive understanding of the risks associated with ET, including the risks of bleeding and thrombosis.
   b. The Hematology trainee should demonstrate a comprehensive understanding and practical competency in identifying the indications for initiating therapy for ET. This should include an understanding of the role of platelet pheresis, hydroxyurea, and anagrelide in the management of ET. In addition, the pharmacology, dosing, administration and associated toxicities of these therapies should be known.

D. Acute Myeloid Leukemias
1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms that underlie acute myelogenous leukemia (AML). This should include recognizing the molecular events that define biologic and prognostic subgroups of patients along with basic concepts regarding their respective mechanisms of leukemogenesis. This includes a basic understanding of how specific gene products function in hematopoiesis and in control of differentiation, proliferation and survival.
2. The trainee should demonstrate a comprehensive working knowledge and practical competency in the classification of AML as per the WHO (and the historically used FAB) classification. This should include the ability to interpret, and knowledge of, technical procedures used in establishing the diagnosis within this framework including morphologic analysis, immunohistochemical stains, cytogenetics, flow cytometry, fluorescence in situ hybridization (FISH), RT-PCR and real-time PCR. The trainee should demonstrate an understanding of the weaknesses and limitations of the classification schemes and how disease is further subdivided into prognostic groups according to the presence of molecular markers and abnormalities.

3. The Hematology trainee should demonstrate the ability to distinguish between primary and secondary AML. The trainee should demonstrate knowledge of pharmacologic and environmental agents associated with an increased risk for developing AML, the recognition of cytogenetic events associated with specific exposures and the prognostic implications of these findings.
4. The trainee should demonstrate practical competency in understanding the prognosis associated with the different classifications of AML and be able to integrate prognostic signs, including classification, cytogenetics, age, primary versus secondary etiology and genetics, to generate an accurate assessment of the patient's status and optimal therapeutic plan.
5. The Hematology trainee should demonstrate practical competency in the treatment of AML. This should include, but is not limited to, an understanding of the role, spectrum of action and toxicities of anthracyclines and cytarabine chemotherapy agents. The trainee should demonstrate practical competency in recognizing the indications, roles and indications of induction therapy, consolidation therapy and maintenance therapy in AML for each sub-type and prognostic groups of AML. Also, the trainee should demonstrate experience and knowledge of the role of other agents used to modify standard regimens or that form part of biological, radiotherapeutic and immunological therapies. The trainee should demonstrate a working understanding of how to monitor minimal residual disease and correlate those findings with the risk of relapse of disease.
6. The Hematology trainee should demonstrate practical competency in the recognition and treatment of acute promyelocytic leukemia (APL) including the proper use of all-trans retinoic acid, arsenic trioxide, anthracyclines and cytarabine, as well as the design of induction, consolidation and maintenance phases of treatment. The trainee should demonstrate practical competency in the optimal techniques and scheduling for monitoring of minimal residual disease and in the interpretation of these results. The trainee should be able to distinguish classical and non-classical APL and to recognize, prevent and treat retinoic acid syndrome. The trainee should demonstrate practical competency in the recognition and management of coagulopathy and its complications in patients with APL.
7. The trainee should have practical knowledge of the modalities of stem cell transplantation indicated for the treatment of AML, the proper indications for their inclusion in the therapeutic plan, and the anticipated complications. The trainee should be aware of the impact of graft-versus-leukemia effect of allogeneic transplantation and on the concomitant potential use of donor lymphocyte infusion and graft-versus-host disease.
8. The trainee should gain experience and demonstrate practical competency in the diagnosis and treatment of relapsed and refractory AML disease. The trainee should demonstrate practical competency in the diagnosis, prognosis and special treatment considerations of this subgroup as well as in the palliation of associated medical complications.
9. The Hematology trainee should demonstrate a working understanding of the role of growth factors (e.g. G-CSF, GM-CSF, etc.) in the management of patients with AML.
10. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for diagnosing and treating infections in patients with AML. This should include an understanding of the infectious diseases that may be typical as

a co-morbidity and the role and use of prophylactic anti-microbial pharmacologic agents in these patients.

11. The Hematology trainee should demonstrate a working knowledge of the issues relevant to the treatment of AML in the elderly patient. This includes an understanding of the biologic and etiologic differences of AML in elderly, compared with that seen in younger, patients. In addition, the trainee should demonstrate practical competency in choosing appropriate therapy for these patients and should demonstrate awareness of associated toxicities of disease and treatment that are of particular concern in the elderly patient. The trainee should demonstrate an understanding that the goals of therapy may be different in an older patient and should be able to identify appropriate supportive and palliative care resources that may be appropriate for the care of these patients.

E. Myelodysplastic Syndrome (MDS) Disorders

1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of basic molecular and pathophysiologic mechanisms, diagnosis, natural history and therapy of MDS disorders. This should include an understanding of the WHO, French/American/British (FAB), and International Prognosis and Staging System (IPSS) classifications of MDS; genetic abnormalities associated with MDS; the utility of cytogenetics in the diagnosis, management and assessment of prognosis in patients with MDS; and indications and approaches to treatment. The trainee should demonstrate an understanding of the specific pharmacologic and biologic agents, experimental approaches and the role of stem cell transplantation in the management of these patients.

F. B-cell Neoplasms

1. B-Lymphoblastic Leukemia/Lymphoma
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the basic molecular and pathophysiologic mechanisms that lead to development of B-Lymphoblastic Leukemia/Lymphoma (ALL). The trainee should understand the classification system of ALL. The Hematology trainee should understand the use of morphologic analysis, immunohistochemical stains, cytogenetics, flow cytometry, FISH and RT-PCR in the classification of ALL. The trainee should have a comprehensive understanding of the association of the development of ALL with specific genetic (inherited) disorders. There should also be a practical understanding of the role of cytogenetics in determining the prognosis of patients with ALL. This should include the impact of the *bcr/abl* translocation (Philadelphia chromosome).
   b. The Hematology trainee should demonstrate practical competency in the diagnosis of ALL. The Hematology trainee should demonstrate practical competency in recognizing the therapeutic and prognostic implications of ALL. There should be an understanding of the risk of central nervous system involvement with this disease and the impact of the diagnostic evaluation on the choice of therapy demonstrated.
   c. The Hematology trainee should demonstrate practical competency for treating ALL, including the use of pharmacologic agents and the various combination chemotherapy regimens that are used. The trainee should demonstrate an understanding of the need for prolonged therapy consisting of multiple phases of treatment. The trainee should demonstrate an understanding of the pharmacology,

mechanism of action, indications, dosing, administration and toxicities of the pharmacologic agents and regimens used for treating ALL. The trainee should also demonstrate a practical understanding of the role of stem cell transplantation in managing patients with ALL.

d. The Hematology trainee should demonstrate practical competency for diagnosing and treating patients with refractory or relapsed ALL.
e. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for diagnosing and treating infections in patients with ALL. This should include an understanding of the infectious diseases that may be typical as a co-morbidity and the role and use of prophylactic anti-microbial pharmacologic agents in these patients.

2. Lymphoplasmacytic Lymphoma (Waldenström's Macroglobulinemia)
   a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for the presentation, diagnosis and treatment of Waldenström's macroglobulinemia. This should include recognizing expected histopathologic findings on bone marrow aspirate smear and biopsy. The trainee should demonstrate practical competency in recognizing, diagnosing and managing complications associated with the disease, including hyperviscosity syndromes. The trainee should also demonstrate practical competency for treating the disease and understanding the indications and proper use of pharmacologic agents in the treatment of this disease.
3. Chronic Lymphocytic Leukemia/Small Lymphocytic Lymphoma
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, risk factors, and staging systems (e.g. Rai and Binet), for chronic lymphocytic leukemia/small lymphocytic lymphoma (CLL/SLL). The trainee should demonstrate a comprehensive working knowledge of the role and use of cell surface marker analysis (e.g. flow cytometry, immunohistochemical stains) in the diagnosis and differential diagnosis of CLL/SLL and entities that are often confused with CLL/SLL (e.g. hairy cell leukemia, marginal zone lymphoma, splenic lymphoma with villous lymphocytes, large granular lymphocyte proliferative disorder, adult T-cell leukemia/lymphoma, prolymphocytic leukemia, and others).
   b. The Hematology trainee should demonstrate practical competency for recognizing the clinical presentation and making a diagnosis of CLL/SLL. This should include an understanding, and demonstration of the ability to recognize and manage the paraneoplastic events that often accompany CLL/SLL.
   c. The Hematology trainee should demonstrate practical competency in the treatment of CLL/SLL. This should include demonstrating knowledge of the pharmacologic and biologic agents (including monoclonal antibodies) that are useful in the treatment of CLL/SLL. Knowledge of the indications, expected outcomes, pharmacology, dosage, administration and potential toxicities and interactions of these interventions should be demonstrated. The trainee should also be aware of investigational approaches, including stem cell transplantation, for the treatment of CLL.
4. Hairy Cell Leukemia
   a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the epidemiology, diagnosis, clinical presentation and prognosis of hairy cell leukemia. Specifically, the trainee should demonstrate an

understanding of the use of morphologic analysis, flow cytometry, immunohistochemistry staining and, specifically, tartrate resistant alkaline phosphatase (TRAP) staining for making the diagnosis of hairy cell leukemia.

b. The Hematology trainee should demonstrate practical competency of the indications of the various therapeutic options for treating hairy cell leukemia. This should include understanding the role of purine analogs and other pharmacologic agents, interferon-α, and splenectomy in the modern treatment of this disease. Specifically, the trainee should demonstrate an understanding of the indications, expected outcomes, pharmacology, dosage, administration, and potential toxicities and interactions of the pharmacologic and biologic agents used in the treatment of this disease. The trainee should also demonstrate comprehensive knowledge of alternative therapies for refractory or relapsed disease.

5. Plasma Cell Disorders

a. Plasma Cell Myeloma (Multiple Myeloma), Plasmacytomas and Other Plasma Cell Disorders

1) The Hematology trainee should demonstrate a comprehensive working knowledge of the biology of plasma cell development and differentiation, the disorders that can result in the production of monoclonal proteins and the diseases that are considered plasma cell dyscrasias.

2) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the clinical presentation, diagnosis, therapy and complications associated with plasma cell disorders.

3) Hematology trainees should demonstrate a comprehensive working knowledge and practical competency of the implications, prognosis, diagnostic criteria and management of patients with monoclonal gammopathy of unknown significance. This should include an understanding of the risk of developing multiple myeloma or other clinically significant diseases.

4) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic molecular and pathophysiologic mechanisms, diagnosis, staging and epidemiology of multiple myeloma. This should include identification of significant prognostic factors and the possible role of genetics and infectious diseases in the etiology of these diseases.

5) The Hematology trainee should demonstrate practical competency in the diagnosis and management of patients with multiple myeloma, including the selection and use of pharmacologic and biologic therapies that are available for treating these diseases. In addition, the trainee should demonstrate a working knowledge of the indications for stem cell transplantation and of the role of radiation therapy in the management of patients with multiple myeloma. Competency in other aspects of supportive care of the patient with multiple myeloma should also be demonstrated by the trainee, including the use of bisphosphonates.

6) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the pathophysiologic mechanisms, diagnosis and therapy of less common plasma cell disorders including, but

not limited to, nonsecretory multiple myeloma, plasma cell leukemia and POEMS syndrome.

b. Amyloidosis
    1) The Hematology trainee should demonstrate a comprehensive working knowledge of the basic biology, and molecular and pathophysiologic mechanisms of amyloid proteins, their tissue deposition and the clinical disorders that they can cause. This should include demonstrating an understanding of the natural history and epidemiology of the various amyloidoses as well as the characterization of the variety of amyloid proteins.
    2) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the presentation, diagnosis, clinical course, prognosis and treatment of the various amyloid diseases. This should include demonstrating an understanding of the diagnostic techniques that are used to make the diagnosis, including general and specific immunohistochemical staining that differentiates between different types of amyloid. The trainee should demonstrate a comprehensive working knowledge of the natural history and the typical response to therapy of the different types of amyloid. The trainee should demonstrate the ability to identify the indications for initiating treatment and to select appropriate therapy. An understanding of the pharmacology, dosage, administration and toxicities of those therapeutics commonly used should be demonstrated. The trainee should demonstrate an understanding of the role of stem cell transplantation in the treatment of these diseases.

c. Castleman's Disease
    1) The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic pathophysiologic mechanisms, presentation, diagnosis and treatment of Castleman's disease. This should include knowledge of the various forms of Castleman's disease and their expected clinical course and prognosis.

6. B-cell Lymphomas
    a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, natural history of disease course, genetics, risk factors, staging systems, and classification and grading systems for the B-cell lymphomas. The trainee should be aware of the various classification systems that have been used historically and should have a comprehensive working knowledge of the WHO classification scheme. The trainee should be familiar with the REAL and other historically used classification schemes. The trainee should demonstrate a comprehensive knowledge of the presentation, prognosis and expected outcomes of patients with the various types of B-cell lymphoma.
    b. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the morphologic, genetic, etiologic, diagnostic, and prognostic characteristics of the various specific B-cell lymphomas. In addition, the trainee should demonstrate practical competency in the management implications associated with each of the specific B-cell lymphomas (some of which are described in detail elsewhere in Section IV of this curriculum). These should include precursor B-lymphoblastic leukemia/lymphoma, splenic marginal zone lymphoma including mucosa-associated lymphoid tissue (MALT) lymphoma, nodal marginal zone B-cell lymphoma, follicular lymphoma, mantle

cell lymphoma, diffuse large B-cell lymphoma, mediastinal (thymic) large B-cell lymphoma, intravascular large B-cell lymphoma, primary effusion lymphoma, Burkitt's lymphoma/leukemia, angiocentric lymphoma, and anaplastic large cell lymphoma.

c. The Hematology trainee should demonstrate practical competency in diagnosing, staging and classifying the risks of patients with B-cell lymphomas. The trainee should understand the role of the bone marrow aspirate and biopsy in diagnosing and staging patients. The trainee should also demonstrate a comprehensive working knowledge of the role of imaging studies (e.g. CT, MRI, PET, gallium scans, and others), molecular diagnostics, and cytogenetics in making diagnostic and prognostic predictions in patients with B-cell lymphomas.

d. The Hematology trainee should demonstrate practical competency in defining the goals of therapy based on expected outcomes and prognosis of the various B-cell lymphomas.

e. The Hematology trainee should demonstrate practical competency in the management of the various types of B-cell lymphomas. Specifically, the trainee should demonstrate a comprehensive understanding of the indications and role of pharmacologic agents, biologics, immunotherapy and radioimmunotherapy agents in the treatment of the B-cell lymphomas. The trainee should demonstrate a comprehensive working knowledge of the indications, dosage, administration, potential toxicities and expected outcomes for each of these agents. In addition, the trainee should understand the role and use of radiation therapy, surgery and stem cell transplantation in the treatment and management of B-cell lymphomas. The trainee should also have a general understanding of investigational therapies for these diseases.

f. The Hematology trainee should demonstrate practical competency in the evaluation and management of patients with relapsed or refractory B-cell lymphomas.

g. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency in the diagnosis and management of primary central nervous system (CNS) lymphomas. This includes demonstrating the ability to formulate a differential diagnosis, selecting and interpreting appropriate imaging studies, and recommending diagnostic procedures. The trainee should demonstrate the ability to select appropriate treatment, taking into account the role of surgery, radiation therapy, chemotherapy and investigational therapies. In addition, the trainee should demonstrate an understanding of the associated co-morbidities and risks associated with the location of the disease as well as with diagnostic and therapeutic approaches.

G. B-cell Proliferations of Uncertain Malignant Potential

1. Post-transplantation Lymphoproliferative Disorders

a. The Hematology trainee should demonstrate a comprehensive working knowledge of the risk factors, natural history and biology of the post-transplantation lymphoproliferative disorders (PTLDs). This should include demonstrating an understanding of the role of immunosuppressive therapies and viruses in the etiology of these diseases.

b. The Hematology trainee should demonstrate practical competency in diagnosing and staging PTLDs. This should include an understanding of the histologic and

clonal versus non-clonal variants of PTLD, the prognostic implication of these variants, the role of imaging studies in diagnosis and staging, and the implications of the type of transplant on prognosis and epidemiology.

c. The Hematology trainee should demonstrate practical competency in the management of PTLDs. This should include demonstrating an understanding of the role and selection of reducing immunosuppressive therapy, antivirals, chemotherapy, radiation therapy, biologic therapies (e.g. interferon-α), and investigational therapeutic approaches. The trainee should also demonstrate a working knowledge of the implications of PTLD and its treatment on the transplanted organ.

H. T-cell and NK-cell Neoplasms

1. Adult T-cell Leukemia/Lymphoma
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, presentation and risk factors associated with adult T-cell leukemia/lymphoma (ATLL). The trainee should be aware of the role of HTLV-I in the pathogenesis of this disorder.
   b. The Hematology trainee should demonstrate practical competency for making the diagnosis of ATLL and for recognizing the pathognomonic morphologic and phenotypic characteristics of the disease on a peripheral blood smear, by flow cytometry and on molecular studies.
   c. The Hematology trainee should demonstrate practical competency in the general approach to management of patients with ATLL. This should include a general awareness of the investigational therapies that are being used for the treatment of this disease.
2. Mycosis Fungoides, Sezary Syndrome and Cutaneous T-cell Lymphoma
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, presentation and biology of mycosis fungoides (MF), Sezary syndrome (SS) and cutaneous T-cell lymphoma (CTCL).
   b. The Hematology trainee should demonstrate practical competency in the diagnosis and therapy of MF, SS, and CTCL. Specifically, the trainee should demonstrate knowledge regarding the use of pharmacologic agents, biologic agents, and the use of PUVA and other nonpharmacologic therapies in the treatment of these diseases. Practical experience with a multidisciplinary approach, including participation of Dermatologists, to the diagnosis and management of these diseases is encouraged.
3. T-cell Large Granular Lymphocytic Leukemia
   a. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, presentation and biology of T-cell large granular lymphocytic leukemia (T-cell LGL).
   b. The Hematology trainee should demonstrate practical competency in the diagnosis and treatment of T-cell LGL. This should include ability to identify and manage the associated affects on hematopoiesis, presumed to be due to cytokines.
4. T-cell Lymphomas
   a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the epidemiology, natural history of disease course,

genetics, risk factors, staging systems, classification and grading systems, diagnosis, prognostic characteristics and management of the T-cell Lymphomas.

b. The Hematology trainee should be specifically familiar with peripheral T-cell lymphoma, angio-immunoblastic T-cell lymphoma, precursor T-lymphoblastic leukemia/lymphoma, nasal T/NK-cell lymphoma, intestinal T-cell lymphoma and anaplastic large cell lymphoma.

I. Hodgkin's Disease

1. The Hematology trainee should demonstrate a comprehensive working knowledge of the epidemiology, risk factors and natural history of Hodgkin's disease. The trainee should also demonstrate comprehensive knowledge of the classification of the various forms of Hodgkin's disease and their associated clinical presentations, clinical courses and prognoses. The trainee should also demonstrate a comprehensive understanding of the origin and role of the Reed Sternberg cell in the malignant process.
2. The Hematology trainee should demonstrate knowledge of the historical approaches to diagnosing and managing patients with Hodgkin's disease. Specifically, the trainee should be aware of the historical and current role of staging laparotomy with splenectomy in patients with Hodgkin's disease. This should include understanding the associated advantages, risks and morbidity associated with this procedure.
3. The Hematology trainee should demonstrate practical competency in diagnosing and staging Hodgkin's disease. This should include demonstrating a working knowledge of the use of hematopathology techniques to diagnose and to classify the type of Hodgkin's disease as well as the role of the bone marrow aspirate and biopsy for staging.
4. The Hematology trainee should demonstrate practical competency in applying the Ann Arbor staging system.
5. The Hematology trainee should demonstrate a comprehensive working knowledge of the goals of therapy in patients with Hodgkin's disease and should demonstrate the practical knowledge of how to use these goals in the choice of therapy.
6. The Hematology trainee should demonstrate practical competency in the treatment of patients with Hodgkin's disease. Specifically, the trainee should understand the indications and role of pharmacologic agents for the treatment of Hodgkin's disease. This should include understanding the indications, pharmacology, dosage, administration, toxicities, interactions and expected outcome of these pharmacologic agents. In addition, the trainee should demonstrate practical competency in identifying the indications and role of radiation therapy and stem cell transplantation in the treatment of Hodgkin's disease. This includes the indications and application of combined modality therapy with pharmacologic agents and radiation therapy for some patients.
7. The Hematology trainee should demonstrate practical competency in the diagnosis, evaluation and treatment of patients with refractory or relapsed Hodgkin's disease.

J. Histiocytic and Dendritic Cell Neoplasms

1. The Hematology trainee should demonstrate a comprehensive working knowledge of the basic, molecular and pathophysiologic mechanisms and biology of normal histiocyte function.

2. The Hematology trainee should demonstrate a working knowledge and practical competency of the clinical presentation, diagnosis and therapy of Langerhans cell histiocytosis and the other histiocyte disorders.

K. Mastocytosis
   1. The Hematology trainee should demonstrate a comprehensive working knowledge of mast cell biology, including the granule content of the mast cell.
   2. The Hematology trainee should demonstrate practical competency in recognizing the clinical presentation, making the diagnosis and managing systemic mast cell disease. This should include demonstrating knowledge of the indications and use of tissue biopsies, including bone marrow aspiration and biopsy, for making the diagnosis and understanding the role of immunohistochemical staining in making the diagnosis. This should also include demonstrating practical knowledge of the use of pharmacologic and biologic agents for treating the symptoms and signs that result from released granule contents and for treatment of the underlying mast cell disease.

L. Complications of Hematologic Malignancies
   1. Febrile Neutropenia
      a. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the pathophysiologic mechanisms and implications of neutropenia in the febrile neutropenic patient. This should include demonstrating an understanding of the likely microorganisms that the patient is at risk of acquiring infection from, the risks to the patient's overall well-being, and an assessment of those risks.
      b. The Hematology trainee should demonstrate practical competency for managing patients with febrile neutropenia. This should include demonstrating the ability to assess the severity and anticipated duration of neutropenia, to use and select antimicrobial therapy both for recognized infections and for empiric treatment, and of identifying the indications and proper use of cytokines (i.e. G-CSF and GM-CSF).
   2. Tumor Lysis Syndrome
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for anticipating, diagnosing and managing the tumor lysis syndrome. The trainee should demonstrate practical competency for the use of prophylactic measures (including the use of fluids and pharmacologic agents) that might lessen the severity and/or impact of the tumor lysis syndrome.
   3. Disseminated Intravascular Coagulation (DIC)
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the pathophysiologic mechanisms, diagnosis, clinical implications and management of DIC. This should include an understanding of the proper role and use of blood products in the management of DIC. The trainee should develop skills to recognize and diagnose underlying disorders that may lead to development of DIC.
   4. Superior Vena Cava (SVC) Syndrome
      The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the pathophysiologic mechanism, diagnosis and management of SVC syndrome. This should include an understanding of the potential hemodynamic and systemic consequences of SVC syndrome. Practical competency

for managing SVC syndrome, including an understanding of the role of glucocorticoids, radiation therapy and pharmacologic agents, should be demonstrated.

5. Spinal Cord Compression
   The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the diagnosis, clinical consequences and management of spinal cord compression. This should include an understanding of the role of glucocorticoids, radiation therapy, surgery and pharmacologic agents in the treatment of spinal cord compression. In addition, the trainee should demonstrate an understanding of the neurologic consequences and prognosis of spinal cord compression.

M. Paraneoplastic Disorders
   1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for recognizing, evaluating and managing paraneoplastic disorders that result from hematologic diseases.

V. Pregnancy

A. The Hematology trainee should demonstrate a comprehensive working knowledge of the hematologic changes that are associated with pregnancy. This includes changes in peripheral blood counts, coagulation factors and the associated risks of hemostasis and thrombosis, and the changes in the pregnant woman that might predispose to development of hematologic disorders.

B. The Hematology trainee should demonstrate a comprehensive working knowledge of the impact of hematologic disorders on pregnancy. The trainee should demonstrate practical competency for diagnosing and managing the potential risks and consequences of these disorders in the context of the pregnancy.

C. The Hematology trainee should demonstrate a comprehensive knowledge of the expected potential impact of therapies for hematologic disorders on a pregnancy. The trainee should also demonstrate practical competency in selecting treatments that are most compatible with pregnancy.

VI. Palliative Care

A. Pain Management
   1. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of managing pain in patients with hematologic disorders.
   2. The Hematology trainee should demonstrate practical competency in the indications, choice and use of pharmacologic agents in managing pain. This includes demonstrating an understanding of the pharmacology, indications, dosage, administration, potential toxicities and potential interactions of these agents. A practical knowledge of dose conversions for changing narcotic agents or the route of administration of narcotics should be demonstrated.
   3. The Hematology trainee should demonstrate practical competency in the indications and use of nonpharmacologic methods for treating pain in patients with hematologic diseases.

B. Nutrition
   1. The Hematology trainee should demonstrate practical competency for the role of nutrition in the care of patients with hematologic disorders. The trainee should understand the physical and psychological significance, and limitations, of nutrition in hematologic disease.

C. Hospice/End-of-Life Care
   1. The Hematology trainee should demonstrate practical competency in discussing and delivering end-of-life care and counseling to those patients whose hematologic diseases are leading to the patient's death. This should include discussions about quality of life, continued care environments (i.e. home versus institution), assessment of nursing needs and the role (if any) of hospice.
   2. The Hematology trainee should demonstrate practical competency in discussing and providing resuscitation and other level of care intervention options to the patient. This should include demonstrating skills and competency for communicating with patients and their families regarding these matters, taking into account cultural, ethnic and religious biases of the patient and their family.
   3. The Hematology trainee should demonstrate an understanding of the types of end-of-life care that can be delivered by different health care models, including in-home hospice, residential hospice and other nursing services and settings.

VII. Bone Marrow Transplantation (BMT)/Stem Cell Transplantation (SCT)

A. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the basic, cellular and molecular biology of hematopoiesis and BMT/SCT. In addition, the trainee should demonstrate an understanding of tumor immunology and the biologic and immunologic relationships between a donor's hematopoietic cells and the host.

B. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the indication and role of autologous, full intensity allogeneic, low intensity allogeneic and tandem BMT/SCT in the management of hematologic diseases. The trainee should also be familiar with the role of the National Marrow Donor Program (NMDP) in identifying unrelated stem cell donors.

C. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the preparative regimens used in anticipation of autologous and allogeneic BMT/SCT.

D. The Hematology trainee should demonstrate practical experience in (or alternatively observe and understand) the method of collecting and handling bone marrow and peripheral stem cells for transplantation. This should include demonstrating an understanding of the approaches used to mobilize hematopoietic stem cells to the peripheral blood.

E. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency of the process of performing autologous and allogeneic BMT/SCT.

F. The Hematology trainee should demonstrate an understanding and practical competency of the need for prophylactic and supportive care measures in the management of patients undergoing BMT/SCT. These should include an understanding of the pharmacologic and environmental approaches to preventing infectious diseases, the use of immunosuppressive therapies to prevent or decrease graft-versus-host disease, the effects of different approaches of "pre-treating" the stem cells (e.g. T-cell depletion) prior to transplantation, and the proper use of blood products while awaiting engraftment of the transplanted hematopoietic stem cells.

G. The Hematology trainee should demonstrate an understanding and practical competency of recognizing the presentation, making the diagnosis, and managing the complications that can occur post-transplant, including marrow engraftment failure, acute and chronic graft-versus-host disease, opportunistic infections, veno-occlusive disease, and others.

VIII. Hematologic Manifestations of Infectious Diseases

A. Human Immunodeficiency Virus (HIV)

1. Infection by HIV can lead to a number of hematologic disorders in the infected person. The Hematology trainee should be familiar with the broad range of hematologic disorders that can occur in these patients, including:

a. Anemia

The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for recognizing the clinical presentation, establishing a diagnosis and evaluating for possible coincident contributors to the etiology of anemia in these patients. The trainee should understand the role and use of erythropoietin in the management of these anemias.

b. Leukocytopenia

The Hematology trainee should demonstrate a comprehensive working knowledge of the possible etiologies of leukocytopenia in this population. These should include lymphocytopenia that results directly from HIV infection as well as neutropenia and other leukocytopenias that may result from medications or from infiltration of bone marrow by infectious diseases or malignancies. An understanding of the prognostic significance of the $CD4^+$ (helper) T cell in prognosis should be demonstrated.

c. Thrombocytopenia

The Hematology trainee should demonstrate practical competency in diagnosing and managing immune thrombocytopenic purpura (ITP) and other causes of thrombocytopenia in the HIV infected patient. Specifically, the trainee should understand the role of antiretroviral therapy in the treatment of ITP in this patient population and the complications that may occur in these patients with modalities commonly used to treat ITP in non-HIV-infected patients.

d. Coagulation Abnormalities

The Hematology trainee should demonstrate an understanding of the coagulation abnormalities that can result as a direct result of HIV infection or as a result of a co-morbidity associated with HIV infection.

e. Lymphadenopathy

The Hematology trainee should demonstrate practical competency and a basic understanding of recognizing the differential diagnosis, the diagnostic approach and management issues related to lymphadenopathy that can occur with HIV infection. This should include an understanding of the lymphadenopathy syndrome that is seen following HIV infection as well as the risk of the lymphadenopathy representing a hematologic malignancy.

f. Malignancies

The Hematology trainee should demonstrate practical competency in recognizing the presentation, diagnosing and managing hematologic malignancies that occur in HIV patients. Specifically, the trainee should be aware of those malignancies for which HIV infection is recognized as a risk factor. The Hematology trainee should also demonstrate a practical understanding of confounding issues that may influence treatment decisions for these patients' malignancies, including the impact of co-morbidities on the ability to tolerate therapy and possible increased risk of other toxicities. The role of cytokine support, possible chemotherapy dosage modification and the anticipated level of bone marrow tolerance for chemotherapeutic agents in the treatment of these patients should be demonstrated. The Hematology trainee should demonstrate practical competency for differentiating primary CNS lymphomas from other CNS mass lesions (e.g. infectious diseases) and for determining the proper treatment approaches for these patients.

g. Opportunistic Infections

The Hematology trainee should recognize the spectrum of opportunistic infections that might affect hematologic processes in the HIV patient. This includes an understanding of those infectious agents that might infiltrate or infect the bone marrow.

2. Other Infectious Diseases

a. The Hematology trainee should demonstrate a comprehensive working knowledge of the pathophysiologic mechanisms of the hematologic disorders caused by infectious organisms.

b. The Hematology trainee should demonstrate a comprehensive working knowledge and practical competency for recognizing the clinical presentation, establishing a diagnosis and managing hematologic disorders that are associated, or caused by, infectious organisms. This should include bacteria (e.g. E. coli 0197, clostridia), viruses (e.g. Epstein Barr Virus, B19 Parvovirus, Ebola virus), parasites (e.g. Plasmodium species, babesiosis), and other microorganisms (e.g. mycobacteriae, fungi, etc.).

IX. Multidisciplinary Care

A. The Hematology trainee should gain practical appreciation of the cooperative nature of the common interactions and interdependence of the hematologist with allied health professionals such as physician's assistants, nurse practitioners and nurses. The trainee should demonstrate an appreciation of the strengths and weaknesses/limitations of these colleagues, and learn how to integrate efforts with them, in caring for patients.

B. The Hematology trainee should demonstrate a practical understanding of the role of a multidisciplinary approach to caring for patients with hematologic diseases. This should

include demonstrating an understanding of the types of resources available, (e.g. physicians, nurses, pharmacists, rehabilitation therapists, social workers, nutritionists, clergy, home care services, and others) and understanding their individual roles for delivering care to patients. Trainees should gain practical experience by participating in the development of multidisciplinary patient management plans.

X. Psychosocial Issues

A. The Hematology trainee should gain practical experience for recognizing potential psychosocial problems or matters that may impact the treatment and outcome of hematologic disorders in their patients. For example, this might include the impact of a patient's personal economic factors in their ability to comply with a recommended treatment.

B. The Hematology trainee should gain a practical appreciation of the impact of hematologic disorders on patients' quality of life and relationships with family and friends.

C. The Hematology trainee should gain practical appreciation of the effects of culture, ethnic and religious background on patients' approaches and attitudes towards decision making pertaining to their disease and treatment.

D. The Hematology trainee should develop attitudes and coping skills that are appropriate and necessary in caring for critically ill patients.

XI. Ethics

A. The Hematology trainees' curriculum should provide a practical understanding of the ethical issues that face patients, their families and caregivers as it pertains to treatment options and treatment outcome. This should include, but is not limited to, end-of-life and resuscitation issues.

B. The Hematology trainee should gain experience in recognizing and dealing with a variety of ethical issues related to the delivery of health care. This should include issues related directly to patient care, delivering the care in a variety of health care settings, and interacting with members of the health care service environment and external entities (e.g. pharmaceutical companies and their representatives, hospital lawyers).

C. The Hematology trainee should gain experience in recognizing and dealing with a variety of ethical issues related to their relationships with pharmaceutical and other health care industry companies and the representatives of these companies. The trainee should be able to recognize conflicts of interest and acquire skills to avoid them. The trainee should learn and demonstrate proper and appropriate conduct in their patient care, research and educational activities that might be influenced by their interactions, and relationships, with pharmaceutical and other health care industry companies.

D. The Hematology trainee should demonstrate practical comprehension of the ethical conduct of clinical trials. This should include matters related to the enrollment of patients in clinical trials and the complexities of informed consent.

XII. Clinical Investigation and Research Skills

A. The Hematology trainee should demonstrate a working knowledge of the purposes, goals and characteristics of different phases (e.g. Phase I, II, III) of clinical trials. In addition, the trainee should demonstrate an understanding of the significant differences, advantages and disadvantages between single and multi-institutional clinical trials.

B. The Hematology trainee should demonstrate a working knowledge of biostatistics that will allow the trainee to interpret the published literature and to critically discriminate the impact of such work to their clinical practice.

C. The Hematology trainee should demonstrate a working knowledge of the basic elements of proper clinical trial design including identification of target populations, statistical power, proper statistical tools and ethical concerns.

D. The Hematology trainee should demonstrate a working knowledge of the purpose and function of the Institution Review Board and other regulatory bodies that oversee the conduct of clinical investigations.

E. The Hematology trainee should demonstrate a working knowledge of the purpose, content and design of informed consent documents. The trainee should demonstrate the ability to obtain informed consent. The trainee should also demonstrate an understanding of the ethics related to conducting clinical trials, including issues of industry sponsorship and conflict of interest (as discussed above).

F. The Hematology trainee should demonstrate the ability to manage a patient on a clinical trial. This should include the ability to evaluate a patient's eligibility for participation in a specific clinical trial; obtaining the necessary baseline studies; writing the treatment orders as directed in the protocol; following a trial's calendar for assuring that required patient encounters, therapy, diagnostic studies and data collection are performed at the appropriate times; and assessing and reporting responses and adverse events appropriately.

G. The Hematology trainee should demonstrate a general working knowledge of what "translational research" is, how it is performed and what its value is.

H. The Hematology trainee is encouraged to participate in, or have, didactic training in the clinical trial process. This should include having the opportunity to be involved in the processes of designing research protocols, writing clinical protocols, obtaining regulatory approval for a clinical trial, enrolling patients into clinical trials, performing data analysis, manuscript writing and making formal presentations of data collected.

I. The Hematology trainee should demonstrate the ability to seek out the existence and details of available clinical trials available at their institution and elsewhere in the course of caring for their patients.

J. The Hematology trainee should demonstrate a general working knowledge of where funding resources for research studies can be found.

XIII. Consultation Skills

A. The Hematology trainee should demonstrate the skills appropriate and necessary to provide medical recommendations and care for a patient with a hematologic disorder in the role of a consultant. This should include demonstrating an understanding of appropriate means of communicating with a referring physician and assuming an appropriate level of responsibility for the care of the patient.

XIV. Procedural Skills

The ability to perform a number of noninvasive and invasive procedures in patients with hematologic diseases is an important component of the training of a subspecialist in Hematology. For this reason, adequate training and supervision to establish competency in performing these procedures is an important component of the Hematology trainee's education. The procedural skills that are recognized as being typically used in the practice of Hematology include:

A. Preparation of peripheral blood smear

B. Interpretation of peripheral blood smear

C. Bone marrow aspirate and biopsy

D. Interpretation of bone marrow aspirate smear

E. Measurement of lymph node and tumor mass sizes

F. Administration of chemotherapy via indwelling vascular access devices and via implanted central nervous system access devices

G. Lumbar puncture for diagnosis and for intrathecal administration of chemotherapy

H. Management of indwelling vascular access devices

I. Therapeutic phlebotomy

In addition, Hematology trainees are encouraged to be able to recognize the typical morphologic characteristics of normal and abnormal bone marrow and lymph nodes on biopsy samples.

Conclusion

The above is a detailed description of a curriculum intended to guide the training of subspecialists in Hematology. This curriculum is intended to be goal-oriented in an attempt to address the current "competency-based" expectations of the ACGME. The organizational format of this curriculum attempts to use the most recent and widely accepted classification systems in use today.

In any given training program, it is expected that the contents of this curriculum will be delivered to trainees in a variety of educational environments including inpatient and outpatient clinical experiences, didactic sessions, and numerous other settings such as tumor boards, case conferences and journal clubs. Clearly, the Hematology trainee will need guidance, supervision and mentoring as they acquire the knowledge, skills and attitudes to become a subspecialist in the broad field of Hematology.