

Recommended Curriculum for Teaching Hematopathology to Subspecialty Hematopathology Fellows

Sherrie L. Perkins, MD, PhD,^{1*} Vishnu B.V. Reddy, MD,^{2*} Kaari K. Reichard, MD,³ Mary Ann Thompsen, MD, PhD,⁴ and Cherie H. Dunphy, MD,^{5*} for the Society for Hematopathology Education Committee

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Abstract

The performance and interpretation of clinical hematology and hematopathology laboratory tests and diagnosis of benign or malignant hematolymphoid disorders present unique challenges to hematopathology fellow trainees. To assist hematopathology fellowship program directors in preparing trainees to meet these challenges, a task force of pathologists with expertise in hematopathology developed a suggested training curriculum that includes a comprehensive list of topics in the areas of analytic hematology, bone marrow pathology, lymph node pathology, splenic pathology, lymphoma diagnostics, cytogenetics, and molecular diagnostics. This report also includes recommendations for training experiences that will facilitate the transition of subspecialty residents to practicing consultants in hematopathology.

Fellowship training in hematopathology requires wide exposure to evaluation of benign and malignant hematolymphoid disorders involving blood, bone marrow (BM), lymph nodes, spleen, and other tissues. Morphologic features, laboratory testing, and ancillary immunophenotypic, molecular, and cytogenetic findings all have a role in the diagnosis of hematopathologic processes and require the integration of various diagnostic techniques and ancillary studies. As a result, hematopathology represents a significant discipline to master, whether in an academic or private practice setting. Interpretation and understanding of the tools used in diagnostic hematopathology are essential to the correct diagnosis of hematolymphoid diseases, monitoring of responses to therapy, and prediction of prognosis.

A proposal for curriculum reform in clinical pathology residency training, the Graylyn Report, was put forward in 1995 by the Conjoint Task Force on Clinical Pathology Residency Training, a collaborative effort of the Academy of Clinical Laboratory Physicians and Scientists, the American Society for Clinical Pathology (ASCP), the Association of Pathology Chairs, and the College of American Pathologists (CAP)¹ and provided an early model for development of specific training curricula to ensure that pathology trainees receive comprehensive training to ensure competence. Since that time, specific recommendations have been published for training in transfusion medicine,² molecular pathology,³ management,³ and informatics,⁴ but there are no publications defining critical topics, listing key resources, or describing training experiences for the complex area of hematopathology. Therefore, the members of the education committee of the Society for Hematopathology developed a list of curriculum topics in hematopathology for subspecialty fellowship

trainees that will help ensure coverage of major topics in hematopathology and will be of use to directors of hematopathology fellowship programs in development of their training programs.

Curriculum Content and Design

Concepts integral to hematopathology that impact all laboratory medicine disciplines include the selection of appropriate methods (ie, flow cytometry, immunohistochemistry, or enzyme cytochemistry, various cytogenetic techniques, and a variety of molecular techniques) in the evaluation of diverse specimens (ie, peripheral blood, body fluids, BM specimens, and tissue specimens) for benign and malignant disease states. Hematopathology trainees should have a central role at all stages in the evaluation of these specimens. For example, a trainee may be responsible for the preliminary evaluation of BM specimens on a particular case (ie, BM aspirate and/or core biopsy specimen) to determine triaging of specimens for flow cytometry, appropriate cytogenetic studies, and molecular studies. In addition, if special stains, including immunohistochemical stains, are indicated based on the clinical history or findings within the BM aspirate smear or BM core touch preparation, trainees may be responsible for ordering the appropriate stains. Likewise, trainees may be given responsibility for directly processing or supervising the processing of fresh tissue specimens submitted for “lymphoma workup” and determination of allocation of tissue for ancillary studies (ie, flow cytometry, cytogenetic studies, and/or molecular studies).

Other topics unique or especially important to hematopathology include analytic hematology and review of peripheral blood smears and body fluid preparations; evaluation of special hematology test results, including hemoglobin electrophoreses; BM pathology; lymph node pathology; splenic pathology; evaluation of various types of tissue for lymphomatous involvement; molecular hematopathology; cytogenetics; and coagulation testing. The level of responsibility given to trainees may be graduated to reflect experience of the supervising fellow and institutional policies.

Hematopathology fellowships vary in length of training, although only 1 year of training is required for subspecialty certification by the American Board of Pathology. Most programs offer a 1- or 2-year training experience. In addition to acquisition of knowledge and competency in the diagnosis of clinical hematopathologic processes, the Accreditation Commission for Graduate Medical Education (ACGME) also requires trainee exposure to research, education, and laboratory management and administration. Thus, fellowship training should include exposure to all these aspects of hematopathology, although significant research experience may require longer fellowship training.

Most of the time, 1-year hematopathology subspecialty training programs focus on clinical disease states of blood, BM, lymph node, and spleen and evaluation of various extranodal and extramedullary tissue specimens for involvement by hemolymphoid diseases. Ancillary tools, such as flow cytometry and immunohistochemistry, are generally included in the evaluation of these various types of specimens. However, if flow cytometry and/or immunohistochemistry is not incorporated into the general evaluation of these specimen types, experience in interpretation of these diagnostic techniques should be attained through separate rotations in these fields. In addition, cytogenetic and molecular studies are also generally incorporated into the final hematopathology diagnostic reports, and trainees should have ample exposure to cytogenetic and molecular testing that applies to diagnostic hematopathology. Likewise, subspecialty residents should be given the opportunity to have training time in special hematology, analytic hematology, and coagulation to be familiar with the technical and interpretative testing in these areas.

Clinically, residents generally require 4 to 8 weeks of training to gain sufficient confidence to answer consultative questions.⁵ Peripheral smear review, request for BM for evaluation of acute leukemia or immune thrombocytopenic purpura, or a tissue evaluation for a possible high-grade lymphoma are common topics for routine and after-hours consultations in hematopathology, and exposure to these areas should occur early in the program and be reinforced by actual consultative experiences. Fellow presentations on aspects of hematopathology can be integrated into sign-out sessions or existing hematopathology or multidisciplinary conferences to encourage integration of didactic material from a variety of sources and to encourage trainees to use the literature in approaching a specific clinical problem.

Fellowship trainees should be given the opportunity to reinforce and explore clinical learning through participation in research projects and should be strongly encouraged to have scholarly productivity. These activities may include a variety of formats, including clinical case reports, assisting in preparation of book chapters, more extensive clinical-pathologic correlative projects, method development or comparisons, test validation, and translational studies and basic bench research, depending on the length of the fellowship and availability of appropriate mentors. Some trainees may develop a stronger interest in one aspect of hematopathology, such as cytogenetics or molecular genetics. Research and additional training in these areas should be encouraged through additional laboratory, clinical, or research training in these areas.

Research training should focus on use and interpretation of the current literature, study design, and data interpretation and presentation no matter what research format is chosen by the trainee. In addition, appropriate training in the logistics of research, including ethical conduct of research, institutional

research board or animal use approval, and protection of protected patient information should be addressed. For research to be carried out during the relatively limited training programs in most institutions, care must be taken to identify research projects early in training to allow trainees sufficient time to develop and carry out an appropriate research project during times of lighter clinical service loads or during elective months designated for research activities. Trainees should also be encouraged to present research at an appropriate national meeting.

Training in hematopathology necessarily uses a variety of teaching formats. A carefully crafted series of directed readings and/or didactic lectures should be supplemented by practical experiences such as direct observation or performance of certain procedures, case-focused rounds in the laboratory and/or the clinical unit, microscopic sign-out of cases, on-call responsibility for hematology and hematopathology problems and consultations, and participation in laboratory and interdepartmental quality improvement activities and conferences. The importance of role models—faculty actively engaged in the practice of hematopathology who interact with clinicians and laboratory professionals—cannot be overemphasized. Similarly, graded responsibility, beginning with carefully supervised activities and progressing to consultations and front-line on-call responsibility (with appropriate attending physician backup), is essential to reinforce knowledge and develop professionalism. Participating in a call rotation with responsibility for after-hours laboratory and clinical consultations reinforces didactic lessons.

In addition, hematopathology fellow trainees have a crucial role in the training of pathology residents or medical students as they rotate through the hematopathology service, and teaching of less experienced trainees will help solidify the fellow trainee's knowledge base. Hematopathology fellow trainees should have extensive contact with lower level resident trainees or medical students and work with them to review and work up difficult cases. Fellow trainees should allow lower level residents the opportunity to review cases independently and be available for additional informal discussion or teaching about the case, before review by the attending hematopathologist. In addition, most programs require hematopathology fellow trainees to teach in a more formal setting, by lecturing to other residents, attending physicians, or medical students or by presenting conferences. Fellows may also be asked to run microscopic or case presentation sessions that require appropriate discussion of salient microscopic morphologic features, ancillary testing, and the diagnostic entity. These more formal teaching experiences will allow evaluation of the trainee's teaching efficacy and style. Documentation and formal evaluation of teaching activities by hematopathology attending physicians and by students and residents who have been exposed to teaching by the fellow trainee should be maintained by the program director.

Laboratory management, particularly as it pertains to hematopathology, should be included in the curriculum (see the following section), and trainees should be encouraged to participate in laboratory administrative duties including quality assurance (QA), laboratory regulatory issues, and laboratory inspections.

Hematopathology Curriculum Topics

As noted, hematopathology fellowship trainees are required to learn about a broad range of topics and testing modalities to ensure competence in the area of hematopathology. General areas that should be addressed in the curriculum of a hematopathology fellowship to ensure adequate training, meet with ACGME requirements, and allow trainees to be prepared for the American Board of Pathology subspecialty examination in hematology are given in the following list. This listing reflects general subject areas that should be addressed during training according to the methods most suitable to the specific training program and may not be all-inclusive.

Hematology Laboratory

Trainees must be familiar with the instrumentation and interpretation of testing from hematology analyzers and interpretation of peripheral blood smears and body fluid specimens.⁶⁻⁹ This requires familiarity with morphologic appearances of a variety of disorders and understanding of basic clinical-pathologic use of data generated in evaluation and use of appropriate reference intervals.¹⁰⁻¹³ Pediatric and adult specimens should be addressed.^{4,14,15} In addition, performance, quality control (QC), and interpretation of special hematology-related staining for characterization of hemolymphoid processes in blood or BM should be included.^{4,7,10,16} Suggested topics should include the following:

- I. Hematology analyzers
 - A. Sources of age-appropriate reference intervals for peripheral blood characteristics of an ideal automated hematology analyzer for pediatric and adult specimens
 - B. Use of quantitative nucleated RBC counts and reticulocyte counts
 - C. Interpretation of RBC indices to characterize anemias
 - D. Limitations and uses of automated WBC differentials
- II. Morphologic analysis of blood and fluid preparations
 - A. Appearance of the following conditions or features on cytocentrifuge preparations from body fluid specimens
 1. Acute leukemia or blasts (lymphocytic and myeloid)
 2. Malignant lymphoid cells
 3. Remote cerebrospinal fluid (CSF) hemorrhage
 4. CSF shunt changes

5. Central nervous system tissue: neuroglia, choroid plexus, and ependymal cells
 6. BM contamination of CSF
 7. Chylothorax in a neonate
 8. Malignant vs reactive tissue and mesothelial cells in ascitic and pleural fluids
- B. Recognition of features associated with the following disorders by examination of peripheral blood morphologic features
1. Chédiak-Higashi syndrome
 2. May-Hegglin anomaly
 3. Pelger-Huët anomaly
 4. Alder-Reilly anomaly
 5. Glucose-6-phosphate dehydrogenase (G6PD) deficiency
 6. Pyruvate kinase deficiency and other erythrocytopenopathies
 7. Hereditary spherocytosis
 8. Hereditary elliptocytosis and poikilocytosis
 9. Southeast Asian ovalocytosis
 10. Sickle cell disease
 11. Hemoglobinopathies other than sickle cell disease
 12. Thalassemia
 13. Iron deficiency anemia
 14. Megaloblastic anemias (vitamin B₁₂ or folate deficiency)
 15. Hemolytic anemias
 16. Malaria
 17. Immune thrombocytopenic purpura
 18. Thrombotic thrombocytopenic purpura (TTP)
 19. Leukoerythroblastic blood picture
 20. Myelodysplastic syndromes (MDSs)
 21. Hairy cell leukemia
 22. Acute lymphocytic leukemia
 23. Acute myeloid leukemia (AML)
 24. Chronic myeloid leukemia
 25. Chronic myelomonocytic leukemia
 26. Chronic lymphocytic leukemia (CLL) and prolymphocytoid transformation
 27. Prolymphocytic leukemia
 28. Peripheralization of malignant lymphoma cells
 29. Myeloid shift to immaturity
 30. Artifacts: pseudothrombocytopenia due to clumping and platelet satellitosis
 31. Abnormal platelet morphologic features (eg, May-Hegglin and gray platelet syndrome)

III. Special hematology procedures

It is recognized that not all training programs will have laboratories that perform all special hematology procedures and stains on a routine basis; however, trainees should understand the theory, performance, interpretation, and testing limitations for the listed tests.

- A. Enzyme cytochemical staining
 1. Acid phosphatase and tartrate resistant acid phosphatase
 2. Nonspecific esterases
 3. Chloroacetate esterase
 4. Myeloperoxidase
 5. Sudan black B
 6. Leukocyte alkaline phosphatase stain
 7. Periodic acid–Schiff stain
 8. Terminal deoxynucleotidyl transferase staining
 9. Giemsa staining for malaria and other organisms
- B. Heinz body stain
- C. G6PD enzyme testing
- D. Hemoglobin electrophoreses and high-pressure liquid chromatography analysis
- E. Osmotic fragility
- F. Serum viscosity
- G. Unstable hemoglobin by heat stability

Bone Marrow

BM evaluation is fundamental to hematopathology practice and covers wide areas of benign, reactive, and overt malignant conditions. The goal for trainees is to recognize morphologic abnormalities and subtle diagnostic clues in the blood, marrow aspirates, and BM biopsy specimens and incorporate appropriate ancillary test data in formulating the differential and final diagnoses. A BM “knowledge base” is crucial for recognizing and diagnosing a wide array of hematopathologic conditions such as myeloproliferative syndromes, dysplastic conditions, lymphoproliferative syndromes, leukemias, metastatic lesions, BM failure syndromes, posttreatment BM assessment, and anemias and reactive conditions.¹⁷⁻²²

It is very important for trainees to be involved in all aspects of BM examination, including gathering of pertinent clinical information; performing procedures on patients; initially evaluating CBC counts and peripheral blood specimens, BM aspirates, biopsy specimens; and triaging BM specimens for ancillary testing (eg, cytogenetics, flow cytometry, special histochemical or immunohistochemical stains, microbiology studies and molecular pathology tests) as deemed necessary based on the clinical context and initial BM findings.

There is considerable regional variability in whether pathologists or hematologists perform BM procedures, but it is important for hematopathology fellowship trainees to develop competency in performance of these procedures. The Society for Hematopathology Education Committee suggests performance of between 5 and 10 BM aspirate and trephine biopsy procedures on adult patients under appropriate clinical supervision to establish fellow trainee competency. The ultimate determination of competency is at the discretion of the fellowship program director and may require close interaction with clinical colleagues when pathologists are not directly

involved in the biopsy procedure. It is recognized that the total numbers of BM procedures will vary widely between institutions based on individual trainees, institutional policies, and numbers of BM procedures performed. Observation of pediatric BM procedures is also encouraged, but it is realized that there may be reluctance to have trainees perform these procedures.

In addition to collection of BM specimens, trainees should also be responsible for morphologic assessment of Wright-Giemsa–stained BM smears or touch imprints from BM cores and H&E-stained sections of the biopsy specimens and performance or review of BM aspirate differential counts. Trainees are expected to work up the case, consult clinical colleagues, and come up with clinical correlations and incorporate additional test results from the clinical laboratory (eg, lactate dehydrogenase and serum protein levels); specific ancillary testing, such as flow cytometry and molecular diagnostics, should also be considered and incorporated into the diagnostic workup. When appropriate, trainees should present these BM cases during clinical sign-out sessions and at inter-departmental conferences.

Diagnostic entities and BM curriculum topics include BM manifestations and workup of a variety of neoplastic and nonneoplastic disorders including the following:

- I. Reactive and nonneoplastic conditions
 - A. Anemias, not otherwise specified
 - B. Iron deficiency, vitamin B₁₂ or folate deficiency, hemolytic anemia, and anemia of chronic disease
 - C. Erythrocytosis and secondary polycythemia
 - D. Leukocytosis, leukemoid reaction, toxic changes
 - E. Reactive BM shift to immaturity and postchemotherapy or post–BM transplantation BM recovery
 - F. Growth factor effects
 - G. Eosinophilia, basophilia, monocytosis, and lymphocytosis
 - H. Reactive viral and parasite and organism identification in peripheral blood and BM
 - I. HIV-associated changes and granulomatous conditions (eg, sarcoid)

- J. Bone changes and fibrosis associated with hyperparathyroidism and renal disease
- K. Megakaryocytic numbers and morphologic features in association with thrombocytosis or thrombocytopenia
- L. BM failure syndromes
- II. Neoplastic conditions¹⁸ ■ **Table 1**
 - A. Myeloproliferative syndromes
 - B. Overlap myelodysplastic/myeloproliferative conditions
 - C. MDS
 - D. AML
 1. AML with recurrent cytogenetic abnormalities
 2. AML with multilineage dysplasia
 3. AML and MDS, therapy-related
 4. AML, not otherwise categorized
 - E. Acute leukemia of ambiguous lineage¹⁸ ■ **Table 2**
 - F. Lymphoid neoplasms¹⁸ ■ **Table 3**
 1. Precursor B- and T-cell neoplasms
 2. Mature B-cell neoplasms
 3. Posttransplantation lymphoproliferative disorder
 4. Mature T- and natural killer (NK)-cell neoplasms
 - G. Neoplasms of uncertain lineage and stage of differentiation: blastic NK-cell lymphoma
 - H. Hodgkin lymphoma
 - I. Histiocytic and dendritic-cell neoplasms¹⁸ ■ **Table 4**
 - J. Mastocytosis¹⁸ (Table 4)
 - K. Other conditions
 1. Metastatic tumors
 2. BM necrosis (secondary to tumor, leukemia, or embolic events)

Lymph Node/Extranodal Tissues

Evaluation of lymph nodes and tissues other than BM for involvement by lymphoma or other hematolymphoid processes is usually a significant training challenge for hematopathology fellowship trainees owing to the wide variety of benign and neoplastic processes seen in hematopathology and the need to integrate morphologic with immunophenotypic, clinical,

■ **Table 1**
Neoplastic Myeloid Disorders

MPDs	Overlap MDS/MPDs	MDSs	AML
CML	CMML	Refractory anemia	AML with recurrent cytogenetic abnormalities
Polycythemia vera	Atypical CML	Refractory anemia with ringed sideroblasts	AML with multilineage dysplasia
Essential thrombocythemia	Juvenile myelomonocytic leukemia	Refractory cytopenias with multilineage dysplasia	AML and MDS, therapy-related
Chronic idiopathic myelofibrosis	MDS/MPD, unclassified	Refractory anemia with multilineage dysplasia and ringed sideroblasts RAEB, RAEB-1, and RAEB-2 MDS, unclassified MDS associated with isolated del(5q)	AML, not otherwise categorized

AML, acute myeloid leukemia; CML, chronic myelogenous leukemia; CMML, chronic myelomonocytic leukemia; MDS, myelodysplastic syndrome; MPD, myeloproliferative disorder; RAEB, refractory anemia with excess blasts.

Table 2
Acute Leukemia of Ambiguous Lineage

- Undifferentiated acute leukemia
- Bilineal acute leukemia
- Biphenotypic acute leukemia

and, sometimes, molecular or cytogenetic data for a precise diagnosis.^{18,23} To optimize trainees' involvement in the workup and diagnosis of tissue-based hematolymphoid disorders, it is optimal to involve them in the gross examination and triage of specimens for appropriate ancillary testing (eg, cultures, flow cytometry, and cytogenetic and molecular testing).²³ Trainees should also follow the specimen through to diagnosis, integrating the data collected with the clinical manifestations, gross pathologic features, and morphologic impression, and have responsibility for reporting the diagnosis with incorporation of all ancillary data used in formulation of the final reported diagnosis. This will necessarily require development of a knowledge base that includes the clinical entities, ancillary testing (ie, flow cytometry, immunohistochemical and special stains, and cytogenetic and molecular studies), and morphologic features of a large number of benign and malignant processes. It is anticipated that as training proceeds, trainees will develop the knowledge base to allow for additional responsibility in the triaging of specimens, ordering of ancillary testing, and diagnostic decision making. Important curriculum topics that should be addressed include the following:

I. Lymph node

- A. Benign nodal lymphadenopathies
 1. Reactive lymphadenopathies
 2. Infectious lymphadenitides
 - a. Viral lymphadenitides, including manifestations of AIDS
 - b. Bacterial lymphadenitides
 - c. Mycobacterial lymphadenitides
 - d. Fungal lymphadenitides
 - e. Protozoal lymphadenitides
 3. Lymphadenopathies associated with clinical syndromes
 - a. Kimura lymphadenopathy
 - b. Sinus histiocytosis with massive lymphadenopathy
 - c. Kikuchi-Fujimoto lymphadenopathy
 - d. Sarcoidosis lymphadenopathy
 - e. Systemic lupus lymphadenopathy
 - f. Rheumatoid lymphadenopathy
 - g. Dermatopathic lymphadenopathy
 - h. Castleman lymphadenopathy
 - i. Hemophagocytic syndrome
 4. Iatrogenic lymphadenopathies (drug-induced)
 5. Vascular lymphadenopathies
 6. Foreign body lymphadenopathies
 - a. Lymph node inclusions
- B. Recognition of lymphomas¹⁸ (Table 3)
 1. Classical Hodgkin lymphoma and subtypes
 2. Lymphocyte-predominant Hodgkin lymphoma
 3. Precursor B- and T-cell neoplasms

Table 3
Lymphoid Neoplasms

Precursor B- and T-Cell Neoplasms	Mature B-Cell Neoplasms	Mature T- and NK-Cell Neoplasms	Hodgkin Lymphoma
Acute lymphoblastic leukemia/lymphoma	Chronic lymphocytic leukemia/small lymphocytic lymphoma B-cell prolymphocytic leukemia/Richter transformation Lymphoplasmacytic lymphoma Marginal zone lymphomas Hairy cell leukemia Plasma cell neoplasms, including primary amyloidosis, multiple myeloma, monoclonal gammopathy of uncertain significance, and solitary plasmacytoma bone Follicular lymphoma Mantle cell lymphoma Diffuse large B-cell lymphoma Mediastinal (thymic) large B-cell lymphoma Intravascular B-cell lymphoma Primary effusion lymphoma Burkitt lymphoma/leukemia Lymphomatoid granulomatosis	T-cell prolymphocytic leukemia T-cell large cell granular lymphocytic leukemia Aggressive NK-cell leukemia Hepatosplenic T-cell lymphomas ($\gamma\delta$ and $\alpha\beta$ subtypes) Extranodal NK/T-cell lymphoma, nasal type Enteropathy-type T-cell lymphoma Adult T-cell leukemia/lymphoma Mycosis fungoides/Sézary syndrome Angioimmunoblastic lymphomas Peripheral T-cell lymphoma, not otherwise specified Anaplastic large cell lymphoma	Nodular lymphocyte predominant Hodgkin lymphoma Classical Hodgkin lymphoma

NK, natural killer.

4. Mature B-cell neoplasms
5. Mature T-cell and NK-cell neoplasms
6. Granulocytic, histiocytic, and dendritic-cell neoplasms¹⁸ (Table 4)
7. Mastocytoses
8. Recognition of lymphoproliferative disorders associated with immune deficiency
 - a. Congenital immune deficiencies
 - b. Post-organ transplantation
 - c. Acquired immunodeficiency: recognition of spindle cell, vascular, and metastatic neoplasms in lymph nodes

Because hematolymphoid malignancies may involve extranodal sites and some of these malignancies actually have an increased propensity for extranodal involvement or manifestation (eg, extranodal marginal zone lymphomas, enteropathy-associated T-cell lymphomas, NK/T-cell [nasal] type lymphomas, subcutaneous panniculitis-like T-cell lymphoma, primary cutaneous lymphomas, posttransplantation lymphoproliferative disorders, granulocytic sarcomas), it is essential that subspecialty hematopathology residents be knowledgeable of the evaluation of extranodal tissues for hematolymphoid malignancies.¹⁸

Splenic pathology also forms an area that requires special attention to recognize disease processes specific to the spleen, as well as secondary involvement by other hematolymphoid processes.²⁴ As in lymph nodes, fellow trainees should be involved with gross pathology, selection of histologic sections, and triaging of tissue for ancillary studies initially. The correlation of gross, microscopic, immunophenotypic, and, perhaps, molecular or cytogenetic findings in reaching a diagnosis is essential, as in nodal and other extranodal sites. Knowledge of normal splenic architecture²⁴ and the spectrum of disease entities that may involve the spleen should be taught to ensure that trainees will recognize abnormal (pathologic) changes seen in hematolymphoid disorders and reactive processes^{25,26} and other primary and metastatic tumors that involve the spleen.²⁷⁻³²

Diagnostic entities and pathologic processes that involve the spleen that should be included in the curriculum include the following:

- II. Spleen
 - A. Hypersplenism and hyposplenism
 - B. Extramedullary hematopoiesis
 - C. Disorders of the white pulp
 1. Reactive lymphoid hyperplasia
 2. Granulomatous disorders
 3. Hodgkin lymphoma
 4. Lymphomatous involvement of the spleen: primary and secondary
 5. Plasma cell dyscrasias and related disorders
 6. Primary amyloidosis
 - D. Disorders of the red pulp
 1. Splenic pathology in nonneoplastic disorders of erythrocytes, granulocytes, and platelets
 2. Disorders of the monocyte-macrophage system
 3. Storage diseases
 - a. Ceroid histiocytosis
 - b. Gangliosidosis
 4. Hemophagocytic syndrome
 5. Leukemias
 - a. AML
 - b. Precursor T- and B-cell neoplasms
 - c. Chronic myelogenous leukemia
 - d. Chronic myelomonocytic leukemia
 - e. B-cell CLL and variants
 - f. T- and B-cell polymphocytic leukemia
 - g. Hairy cell leukemia
 - h. Large granular lymphocytic leukemia
 - i. Adult T-cell leukemia/lymphoma
 - E. Systemic mastocytosis
 - F. Chronic myeloproliferative disorders
 1. Chronic myelogenous leukemia
 2. Chronic idiopathic myelofibrosis
 - G. Nonneoplastic vascular lesions
 - H. Splenic cysts, nonhematopoietic tumors, and tumor-like lesions

Table 4
Other Neoplasms

Histiocytic and Dendritic-Cell Neoplasms	Mastocytosis	PTLDs	Other Conditions
Histiocytic sarcoma	Indolent systemic mastocytosis	Reactive plasmacytic hyperplasia	Metastatic tumors to the marrow
Langerhans cell histiocytosis/sarcoma	Systemic mastocytosis with associated clonal, hematologic non-mast cell lineage disease	Infectious mononucleosis-like polymorphic PTLD	Marrow or lymph node necrosis (secondary to tumor, leukemia, or embolic events)
Interdigitating dendritic cell sarcoma/tumor	Aggressive systemic mastocytosis	Monomorphic PTLD and T-cell PTLD	
Follicular dendritic cell sarcoma/tumor	Mast cell leukemia/sarcoma	Hodgkin lymphoma and Hodgkin lymphoma-like PTLD	

PTLD, posttransplantation lymphoproliferative disorder.

I. Metastatic neoplasms

Thymic pathology is another area that often spans the border between surgical pathology and hematopathology, but it is important that fellow trainees be aware of the precursor lymphoid lesions and tumors^{33,34} that may involve or arise in the thymus, as well as reactive disorders of the thymus.^{18,35} As in other tissue sites, fellow trainees should be involved in the selection of testing and correlation of results with morphologic features in reaching a final diagnosis. Topics for the thymus include the following:

III. Thymus

A. Diagnosis of lymphomas involving the thymus and differentiation from thymoma, reactive processes, and thymic hyperplasia

B. Recognition of thymic hyperplasia

Cutaneous non-Hodgkin lymphoma (NHL) is also an area that may overlap among hematopathology, dermatopathology, and surgical pathology, reflecting different approaches to these tumors in practice. It is important that fellow trainees recognize and understand the workup of cutaneous lymphomas, including the somewhat unique approaches that have been proposed by the dermatopathology community in contrast with the World Health Organization classification and be familiar with the World Health Organization–European Organization for Research and Treatment of Cancer classification of cutaneous lymphoma.³⁶

IV. Skin lymphomas

A. Cutaneous T-cell lymphomas

1. Mycosis fungoides and variants
2. Sézary syndrome
3. Adult T-cell leukemia/lymphoma
4. Primary CD30+ lymphoproliferative disorders
5. Subcutaneous panniculitis-like T-cell lymphoma
6. Extranodal NK/T-cell lymphoma
7. Primary cutaneous peripheral T-cell lymphomas, not otherwise specified

B. Primary cutaneous B-cell lymphomas

1. Primary cutaneous marginal zone lymphoma
2. Primary cutaneous follicle center lymphoma
3. Primary cutaneous diffuse large B-cell lymphoma, leg type
4. Primary cutaneous large B-cell lymphoma, other, including intravascular lymphoma

C. Precursor hematologic neoplasm: CD4+/CD56+ hematodermic neoplasm (blastic NK-cell lymphoma)

D. Secondary involvement of skin by NHL

Pediatric Hematopathology

Diseases of the blood, BM, and lymphoid tissues in children display different frequencies from those in adults, and some diseases are unique to the pediatric population.³⁷⁻⁴⁴ Exposure to these disease processes is highly desirable to

ensure that hematopathology fellow trainees are able to recognize and diagnose these diseases or form appropriate diagnostic differentials to provide insight that reference values appropriate for children are often different from those used for adults.^{14,45} Trainees should be aware of the association of specific diseases with a wide range of congenital disorders, such as trisomy 21, Fanconi anemia, and hereditary immunodeficiencies.^{42,44,46} It is also necessary to provide training in hereditary hematologic disorders that are most commonly first recognized in children.^{44,47} Although it is unlikely that the volume of pediatric pathologic materials will be sufficient to allow exposure to all disease entities in most training programs, directed readings or lectures and pathologic study sets may be used to supplement primary case materials. Suggested topics include the following:

I. Blood and BM

A. Hereditary BM failure syndromes

B. Acquired aplastic anemia

C. Hereditary RBC cell disorders

1. Hemoglobinopathies

2. RBC membrane disorders

3. RBC enzymopathies

4. Hereditary sideroblastic anemias

D. Immune hemolysis

1. Maternal-fetal incompatibility

2. Autoimmune hemolytic anemias

3. Infection-related hemolytic anemias

E. Other anemias

1. Transient erythroblastopenia

2. Parvovirus infection

3. Nutrient deficiencies (eg, iron, vitamin B₁₂, and folate)

F. Hereditary leukocyte disorders

1. Functional disorders of leukocytes

2. Leukocyte-related BM failure syndromes

3. Immunodeficiency disorders

G. Platelet disorders

1. Functional platelet disorders

2. Amegakaryocytic BM disorders

H. Phagocytic system

1. Hereditary and acquired hemophagocytic syndromes

2. Hereditary storage disorders

I. Neoplastic disorders of blood and marrow

1. Acute lymphoblastic leukemias

2. AML

3. Infantile leukemias

4. Juvenile myelomonocytic leukemia

5. Chronic myelogenous leukemia

6. Myelodysplasia

7. Transient myeloproliferative disorder associated with Down syndrome

8. Langerhans cell histiocytosis and histiocytic neoplasms

9. Mastocytosis

II. Lymph nodes and extranodal lymphoid tissues

A. Reactive lymphadenitis

B. Neoplastic disorders

1. NHLs (Table 3)

2. Hodgkin lymphoma (Table 3)

3. Histiocytic neoplasms (Table 4)

Ancillary Studies: Immunophenotyping

Diagnostic hematopathology relies heavily on combining cytomorphic and histologic studies with ancillary techniques that provide additional information that allows a diagnosis to be made. Immunophenotyping, by flow cytometric analysis or immunohistochemical analysis on paraffin-embedded tissue samples, is the most commonly used ancillary technique in hematopathology.⁴⁸ Immunophenotypic data often define specific disease entities in hematopathology, and it is essential that hematopathology fellow trainees be familiar with methods of immunophenotyping, interpretation of data, and the immunophenotypic patterns associated with hematologic disorders. Appropriate choice of testing dependent on specimen type and handling and insight into pitfalls associated with testing are important topics that help ensure that trainees are able to effectively collect and use immunophenotypic data in arriving at a diagnosis.

I. Flow cytometry

Flow cytometric immunophenotyping (FCI) is a useful tool in diagnostic hematopathology.⁴⁹ FCI allows for the definition of distinct cell populations by size (forward light scatter) and granularity (side light scatter), gates dead cells out of the analysis, detects even weakly expressed surface antigens, and provides a relatively noninvasive diagnostic evaluation of body fluids and fine-needle aspiration (FNA) specimens, possibly obviating tissue biopsy. Multicolor (2-, 3-, and 4-color) analysis allows for an accurate definition of the surface antigen profile of specific cells and the detection of 2 simultaneous hematologic malignancies within the same tissue site.

The following are important applications of flow cytometry for hematopathology trainees to master, as well as advantages and limitations of FCI and use with FNA:

- A. Diagnosis and subclassification of NHLs
- B. Distinguishing between follicular hyperplasia and follicular lymphoma
- C. Subtyping B-cell lymphomas/leukemias composed predominantly of small cells
- D. Identifying prognostic markers in CLL
- E. Immunophenotyping B-cell lymphomas/leukemias
- F. Distinguishing between hematogones and neoplastic lymphoblasts
- G. Detection of the lack of surface immunoglobulin or light chain expression by a significant number of B cells, indicating malignancy

- H. Differentiating plasma cell dyscrasia from NHLs of B-cell origin
- I. Differentiating NHL from Hodgkin lymphoma and T-cell from B-cell NHLs
- J. Identifying composite lymphomas
- K. Distinguishing between T-cell lymphoblastic lymphoma and thymoma
- L. Immunophenotyping T-cell lymphomas/leukemias and NK-cell lymphoproliferative disorders: criteria for diagnosis of Sézary syndrome in blood
- M. Immunophenotyping posttransplantation lymphoproliferative disorders
- N. Differentiating NHL from leukemic infiltrates (granulocytic/monocytic sarcomas, including leukemia cutis) and nonhematopoietic neoplasms
- O. Immunophenotypic analysis of acute myelogenous leukemias, acute lymphoblastic leukemias, and MDSs
- P. Advantages of FCI
 1. Rapid immunophenotypic analysis
 2. Increased antigen detection sensitivity over immunohistochemical analysis of fixed tissue samples
 3. Increased antigen repertoire in myeloid, monocytic, and lymphoid antigens compared with immunohistochemical analysis
 4. Ability to detect small populations of neoplastic cells for minimal residual disease and in partial involvement
 5. Ability to identify aberrant expression patterns on a single cell population by multiparametric analysis
 6. Ability to detect 2 simultaneous hematolymphoid malignancies (ie, CLL and AML).
- Q. Limitations of FCI
 1. Fresh tissue required
 2. Limited use in sclerotic BM that yields too few cells or is difficult to create adequate cell suspension
 3. Possibly too few cells for analysis in markedly hypercellular or "packed" BM
 4. Loss of architectural relationships
 5. Possible lack of detection of a small population of monoclonal B cells in a T cell-rich or lymphohistiocytic-rich B-cell lymphoma
 6. Possible lack of detection of T-cell lymphomas that do not have an aberrant immunophenotype
 7. Observation of an aberrant T-cell immunophenotype (ie, absence or down-regulation of pan-T-cell antigens, particularly CD7) that does not necessarily indicate malignancy and may be infectious mononucleosis, reactive dermatoses, and inflammatory disorders
 8. Possible false-negative results from sampling differences owing to focal/partial tissue involvement by lymphoma or poor tumor preservation
 9. Inability to detect/diagnose Hodgkin lymphoma

owing primarily to the low number of neoplastic cells normally present in this disease

10. Frequent underestimation of the percentage of plasma cells, large cell lymphoma cells, and blasts owing to tumor cell fragility, processing of samples, hemodilution, and sampling

R. Criteria for FNA diagnosis of lymphoma: When is FNA with flow cytometric data sufficient for diagnosis of lymphoma, and when should a biopsy be recommended?

It is essential to provide training in the interpretation and correlation of FCI data. FCI data should always be correlated with light microscopy and other testing, even if no FCI abnormalities are detected. Immunohistochemical analysis may need to be performed in selected cases in which morphologic correlation is required for diagnosis.

II. Paraffin immunohistochemical analysis

Immunohistochemical analysis provides an important cornerstone for diagnosis in hematopathology, and knowledge of immunohistochemical techniques, staining patterns, and interpretation is essential for hematopathology trainees.^{50,51} As with flow cytometry, it is important that trainees be competent in the selection of immunohistochemical stains to make a diagnosis, interpretation of staining patterns, and pitfalls in the use of immunohistochemical staining. Advantages of immunohistochemical analysis include the preservation of architectural relationships and the ability to detect a relatively low number of neoplastic cells, such as in Hodgkin lymphoma or a T cell–rich large B-cell lymphoma. In addition, some antibodies may be better evaluated in paraffin-embedded tissue samples (ie, CD15 in Reed-Sternberg cells, bcl-6, cyclin D1, and anaplastic lymphoma kinase-1).

The following represent the unique applications of paraffin immunohistochemical analysis that should be included in the training curriculum and lists pitfalls:

- A. Differentiation of various forms of B-cell hyperplasia from B-cell lymphoma
- B. Subtyping B-cell lymphomas
- C. Defining a plasma cell dyscrasia
- D. Differentiating T-cell NHL from B-cell NHL
- E. Immunophenotyping of T-cell NHL and T/NK-cell lymphoproliferative disorders
- F. Detection of a composite lymphoma
- G. Diagnosis of Hodgkin lymphoma and differentiation from various forms of diffuse large B-cell lymphoma and T-cell lymphomas
- H. Immunophenotyping T-cell lymphoma
 - I. Differentiating NHL from leukemic infiltrates
 - J. Diagnosing, immunophenotyping, and follow-up of primary BM disorders (eg, acute leukemias and myelodysplasias) when the BM is not suitable for flow cytometric analysis
 - K. Differentiating acute leukemia from nonhematopoietic malignancies, especially small blue cell tumors

- L. Diagnosis of primary BM disorders that are not generally defined by FCI (ie, multiple myeloma and systemic mast cell disease)
- M. Evaluating BM for lymphomatous or other metastatic disease involvement
- N. Pitfalls of immunohistochemical analysis
 1. Difficulty detecting surface light chain expression and weakly expressed antigens in paraffin-embedded tissue samples
 2. Variability in tumor preservation and fixation
 3. Lack of some markers for use in paraffin-embedded tissue samples (ie, CD13, CD14, CD19, and CD33)

Ancillary Studies: Cytogenetics

Cytogenetics has become increasingly important as an ancillary study in hematopathology as disease entities are defined by specific cytogenetic findings (eg, chronic myelogenous leukemia, acute promyelocytic leukemia, and mantle cell lymphoma).⁵²⁻⁵⁵ It is essential that hematopathology trainees be familiar with general cytogenetic procedures including standard karyotyping analysis and fluorescent in situ hybridization (FISH) and more specialized techniques.^{56,57} Trainees should understand the uses and limitations of standard karyotyping and FISH and be familiar with the implications of demonstration of common cytogenetic findings in hematologic disorders.^{52,53,57} Topics in cytogenetics include the following:

- I. Methods, procedures, and interpretation of cytogenetic tests and when each test is appropriately ordered
 - A. Fresh tissue used for karyotyping, FISH analysis
 - B. Fixed tissues appropriate for FISH analysis
- II. Cytogenetics of myeloid disorders
 - A. Acute myelogenous leukemias and leukemias defined by recurrent cytogenetic abnormalities
 - B. Cytogenetic findings in myeloproliferative disorders and MDSs
 - C. Prognostically important cytogenetic findings in myeloid disorders
- III. Cytogenetics of lymphoid disorders
 - A. Cytogenetic findings in diagnosis of B- and T-cell lymphoproliferative disorders
 - B. Cytogenetic findings and prognostic impact in acute and chronic lymphoid leukemias
 - C. Cytogenetic findings and importance in plasma cell dyscrasias

Ancillary Studies: Molecular Pathology

Many aspects of hematopathology diagnosis are rapidly moving toward molecular testing to diagnose or define a disease entity.^{52,53,57} Thus, it is indispensable for trainees to have a basic understanding of molecular pathologic tests and their uses, limitations, and costs. In addition, trainees should rotate

through a molecular pathology laboratory (2-4 weeks minimum) and be familiarized with processing of specimens, handling of fresh and fixed specimens, and determining quality of extracted DNA and RNA and with molecular tests such as polymerase chain reaction (PCR), reverse transcription-PCR, real-time PCR, FISH, and PCR product detection (gel or capillary electrophoresis).⁵⁸⁻⁶⁰ Trainees should be responsible for incorporation of appropriate molecular pathology data and results in the final versions of BM, lymph node, and tissue pathology reports. Trainees should be aware of false- and false-positive results of molecular biology procedures.⁶⁰ Also, during this rotation, refreshing basic molecular biology concepts that are pertinent to practice of hematopathology is highly recommended.⁵⁸ Topics to be addressed during training in molecular hematopathology include the following:

- I. Basic concepts in molecular biology and pathology
 - A. Structure of nucleic acids
 - B. DNA
 1. Single-copy DNA
 2. Repetitive DNA
 - C. RNA
 1. Messenger RNA
 2. Ribosomal RNA
 3. Transfer RNA
 - D. Basic gene structure and function
 1. Promoters and enhancers
 2. Pseudogenes
 3. Transcription
 4. Polyadenylation
 5. RNA editing
 6. Translation and amino acid synthesis
 7. Frame shift mutations
 8. Epigenetic effects
 9. Methylation of DNA
 10. Histones
- II. Molecular pathology tests pertinent to hematopathology
 - A. Southern blot (eg, immunoglobulin heavy chain, T-cell receptor β , bcl-6, and Epstein-Barr virus clonality)
 1. Sample requirements: fresh or frozen tissue
 2. Restriction enzymes and digestion
 3. Probes, electrophoresis, and novel band detection
 - B. PCR analysis (B- and T-cell clonality screening, immunoglobulin heavy chain, κ , T-cell receptor γ)
 1. Fresh and formalin-fixed tissue specimens
 2. Sample preparation, quality of DNA
 3. Inhibitors of PCR
 4. PCR setup
 5. PCR product detection (gel or capillary electrophoresis)
 - C. PCR for infectious agents
 1. Viral (human T-lymphotropic virus-1, parvovirus, B19)

2. Bacterial (*Bartonella henselae*)
 3. Fresh and fixed tissue specimens
 4. PCR product detection
 - D. Reverse transcription-PCR analysis (eg, BCR/ABL)
 1. Sample preparation
 2. PCR setup
 3. PCR product detection (gel or capillary electrophoresis)
 - E. QA and QC of molecular tests
 1. False-positive results
 2. False-negative results
- III. Other emerging techniques and technologies
- A. Real-time PCR
 1. Operating principles and role in diagnostic laboratory
 2. Interpretation of data, use of standard curves
 3. Use in minimal residual disease testing
 - B. Mutation detection: Flt3, hemochromatosis mutation (C282Y and H63D), JAK2 mutation, GATA-1 mutations
 - C. Gene-chip arrays: general concepts and interpretation of the data matrix

Coagulation

Hematopathology trainees require training in coagulation—in integration of clinical data and interpretation of coagulation laboratory test results.⁶¹⁻⁶⁴ It is optimal that trainees have the opportunity for “coagulation rounds” with clinical colleagues, visit patients, and participate in patient interviews if these activities are available at the training site. In this manner, trainees will learn to gather pertinent clinical data from charts and clinicians to allow workup and diagnosis of a coagulation disorder. Trainees should be involved in interpretation of routine tests of hemostasis (prothrombin time [PT], partial thromboplastin time [PTT], and thrombin time), workup of abnormal PTT, thrombosis risk testing (lupus anticoagulant, activated protein C), disseminated intravascular coagulation workup, hemophilia factor replacement issues, and diagnosis of TTP. Optimally, trainees should be involved in generating interpretative test reports for thrombophilia profiles, platelet aggregation studies, and coagulation and factor deficiency states.⁶⁵

- I. Review of hemostasis and routine test results: PT, PTT, thrombin time, and reptilase time
- II. Workup of abnormal PTT and PT results
- III. Hemophilia factor replacement issues and inhibitors
- IV. von Willebrand disease
- V. Platelet disorders
 - A. Aspirin-like defects
 - B. Alpha and dense granule deficiencies
 - C. Platelet aggregation and release histograms
 - D. Heparin-induced thrombocytopenia
- VI. Thrombosis risk testing
 - A. Lupus anticoagulant
 - B. Activated protein C resistance
 - C. Factor V Leiden

- VII. Disseminated intravascular coagulation and fibrinolytic profiles and testing
- VIII. Complex acquired bleeding disorders
 - A. Renal
 - B. Liver
 - C. TTP
- IX. Anticoagulant monitoring
 - A. Warfarin
 - B. Heparins (fractionated and unfractionated)

Laboratory Management

Laboratory management is an important component of hematopathology fellowship training, and trainees should be expected to participate in a variety of management-related activities throughout training.^{4,6,66,67} Participation in a variety of activities and conferences will enhance the expertise in laboratory management of subspecialty residents in hematopathology. The level of additional instruction required is dependent on previous laboratory management exposure of trainees. Minimally, laboratory management topics should be integrated with clinical services and rotations during hematopathology fellowship training and would involve participation of the fellow in the following:

- I. Hematology, flow cytometry, coagulation, and other appropriate laboratory section meetings and conferences
- II. QA/QC data analysis through QA peer review of randomly selected cases for diagnosis and reporting
- III. QA/QC via consensus conferences and multidisciplinary conferences
- IV. Internal and external QC through second opinions from internal and external reviewers
 - V. External proficiency testing (via the CAP)
- VI. Mock CAP inspections
- VII. Participation in quarterly Check Path Samples from ASCP

In addition, hematopathology trainees may require didactic or practical instruction in a number of laboratory management issues that may include (but are not limited to) the following:

- Preanalytic and analytic factors that may be optimized to enhance evaluation of hematopathology specimens
- Resources for finding a laboratory that can perform a test not available in larger reference laboratories
- Timely and effective communication of laboratory results, including selection of critical values
- Ethical considerations regarding patients as research subjects
- Effective communication with clinicians regarding test menus, report formats, and appropriate expectations for turnaround time
- Effective communication with laboratory staff and hospital administrative staff regarding laboratory service

- needs of hematology and oncology patients
- Billing and reimbursement issues, including appropriate *Current Procedural Terminology* coding

Competency in Hematopathology

The ACGME has mandated that educational programs for all medical specialties include detailed performance measures to assess trainees' competency in 6 areas: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice (www.acgme.org/outcome). The education committee of the Society of Hematopathology considers the process of graded responsibility described a means of achieving competency in these areas. Performance as a consultant in hematopathology will develop competency in the areas of patient care, interpersonal and communication skills, professionalism, and systems-based practice. In becoming an effective consultant, trainees will necessarily develop skills in acquiring medical knowledge and in practice-based learning and improvement. Therefore, measurement of competency in hematopathology could include documented exposure to the topics listed and formal assessment of trainees' skill in providing diagnostic hematopathology services, specifically, evaluations of peripheral blood smears and body fluid preparations, BM diagnostics, and evaluations of various types of specimens for lymphomatous involvement or teaching for one or more of these topics in the context of sessions with pathology residents or other pathology and multidisciplinary conferences. Specific hematopathology competencies in these areas could include the following:

Patient Care

1. Gather essential and accurate information regarding patients being evaluated, including clinical history and previous results of diagnostic biopsies
2. Make informed decisions regarding appropriate triaging of BM and fresh tissue specimens
3. Inform clinicians, pathology residents, and hematology and oncology trainees of appropriate testing and triaging
4. Inform clinicians of diagnostic findings, and educate pathology residents, hematology and oncology trainees, and clinicians of the significance of findings
5. Efficiently and effectively solve problems with any aspect of the hematopathology service (eg, obtaining extra slides from outside cases, clarifying clinical history, and procuring blocks for molecular studies)
6. Use good judgment as to when to ask for help in the evaluation of peripheral smear reviews, body fluid reviews, and BM and lymph node examinations

Medical Knowledge

1. Successfully complete a program of instruction in hematopathology as defined by the program director
2. Identify and use key text and electronic resources for the selection and interpretation of hematology and hematopathology laboratory data
3. Appropriately respond to questions posed by clinicians, pathology residents, or during sign-out sessions regarding hematology and hematopathology tests, results, and clinical significance
4. Take the initiative to know and research the answers to unknown posed hematopathology questions
5. Give microscopy teaching sessions to pathology residents, and be knowledgeable about additional questions that arise during the presentation of cases at these sessions
6. Be knowledgeable about cases presented at multidisciplinary conferences
7. Performance on an objective test of knowledge and diagnostic skills in hematopathology

Practice-Based Learning and Improvement

1. Use appropriate texts and information technology to support clinical consultations and diagnostic decision making in hematopathology
2. Understand the use and limitations in hematopathology of ancillary diagnostic tools
3. Identify clinical and laboratory medicine consultants who can provide assistance with questions in hematopathology
4. Demonstrate graduated expertise in the performance and evaluation of studies related to hematopathology
5. Show a gradual increase in the fund of knowledge in hematopathology, and show improvement in competence, efficiency, and confidence in all areas of hematopathology

Interpersonal and Communication (Oral and Written) Skills

1. Communicate effectively with hematology and oncology clinical colleagues by demonstrating a knowledge of and experience with hematology and hematopathology laboratory testing needs to support patient-focused care
2. Communicate effectively with hematology and oncology colleagues by demonstrating a knowledge of the significance of the reported diagnostic findings and clearly explain the morphologic results to clinicians, students, and trainees
3. Willingly and actively review slides with interested clinicians, providing accurate assessment of disease processes
4. Use listening skills to identify opportunities to improve

- laboratory medicine services for hematology and oncology clinicians and hematology and oncology patients
5. Communicate effectively with hospital and laboratory administrative staff to provide appropriate laboratory support for hematology and oncology patients
6. Actively participate in the teaching of hematology and hematopathology to laboratory personnel, physicians, students, and trainees
7. Evaluate all cases (including BM differential counts) and, if required, record results on report forms before sign-out, write or correct the report during sign-out, and proofread the final typed copy

Professionalism

1. Demonstrate respect, compassion, integrity, and responsiveness to the needs of hematology and oncology patients and their health care providers
2. Demonstrate a knowledge of and commitment to the ethical principles pertaining to patient care and the conduct of clinical research in hematology and oncology
3. Demonstrate proper respect for technologists, clinicians, medical students, and all other staff

Systems-Based Practice

1. Partner with health care providers and managers to assess, coordinate, and improve hematology and oncology health care
2. Demonstrate a sensitivity to hematology and hematopathology laboratory testing requirements in deliberations regarding the selection of laboratory methods and equipment, cost analysis/benefit ratios, and timeliness of results

Discussion

Hematopathology fellowship training requires trainees to accumulate an extensive knowledge base in the interpretation and diagnosis of hematologic disorders in adults and children. Training must include broad exposure to the spectrum of disorders seen in hematopathology and training in performance, interpretation, and incorporation of ancillary testing modalities into diagnostic impressions and prognostic evaluations. Trainees are expected to provide hematology and hematopathology consultations and may be required to select laboratory equipment and analytic methods; determine which tests will be provided on a stat basis, in-house, or sent to a referral laboratory; and develop appropriate QA/QC activities, requiring adequate training in laboratory management.

Through development of a curriculum that addresses the broad base of knowledge that is necessary to develop diagnostic skills in hematopathology, the hematopathology training

programs should be able to provide fellow trainees with sufficient ability to diagnose most hematopathologic disorders, use primary and ancillary testing appropriately, and function in providing hematopathologic services. The incorporation of a broad list of subjects, such as suggested herein, will ensure that trainees are exposed to the range and will have an adequate knowledge base to be eligible for subspecialty certification by the American Board of Pathology. As noted, subspecialty training in hematopathology should involve a variety of teaching methods and increasing responsibility for trainees in workup of specimens, ordering of tests, and interpretation of test results to ensure that on graduation, trainees are equipped to practice hematopathology competently.

From the Departments of Pathology, ¹University of Utah, Salt Lake City; ²University of Alabama, Birmingham; ³University of New Mexico, Albuquerque; and ⁴Vanderbilt University Medical Center, Nashville, TN; and ⁵Department of Pathology and Laboratory Medicine, University of North Carolina, Chapel Hill.

Address reprint requests to Dr Perkins: Dept of Pathology, University of Utah Health Sciences Center, 30 North 1900 East, Salt Lake City, UT 84132.

** Drs Perkins, Reddy, and Dunphy contributed equally to the development and writing of this article.*

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