Location: Mayo D219
Duration: Three months
Rotation Director: Michael Linden, MD, PhD. – phone: 612-273-5629 (pager: 899-8102)
Other Faculty: Elizabeth Courville, MD, Bartosz Grzywacz, MD, Robert McKenna, MD, Pawel Mroz, MD, PhD, Sarah Williams, MD, Sophia Yohe, MD

General Description:
As a part of the clinical pathology requirements, residents are required to complete up to five months of Hematopathology, including the initial three month rotation, which typically occurs in the first or second year of residency (this rotation applies to all residents whether they are on an AP-CP, AP-only, or CP-only track). This rotation occurs at the University of Minnesota Medical Center in the Hematopathology Division located in the second floor of the Mayo Medical Building (D219). The goals of the first Hematopathology rotation are to learn the morphologic, diagnostic characteristics, and pathophysiology of neoplastic and non-neoplastic hematologic disorders in the blood, bone marrow and lymphoid tissues. This rotation is also designed to educate the residents on efficient and cost effective use of ancillary studies in conjunction with morphology to making appropriate diagnoses in Hematopathology. The residents may also have opportunities to observe or perform bone marrow biopsies or lymph node work ups.

Goals and Objectives:
The learning objectives below reference the corresponding ACGME core competencies: Patient Care (PC), Medical Knowledge (MK), Professionalism (Prof), Communication Skills (CS), Practice Based Learning and Improvement (PBLI), and Systems-Based Practice (SBP).

Objectives: The general expectations below are expected throughout the rotation. At the end of the first Hematopathology rotation (three months), residents are expected to meet/exceed the goals and objectives of each of the subsequent subheadings:

**General**
- Timely attendance is expected at all conferences; we expect that rare late arrivals and/or absences will occur, but it is essential to communicate with the fellows and staff if you will be late/absent.
- Attendance and participation at the daily Hematopathology Consensus Conference at 9 AM in the multi-headed scope room (Prof, MK, CS); typically the rotation begins at 8 AM with time from 8-9 AM to review cases, gather clinical histories, perform differential counts.
- Attendance, and possible presentation, at Adult and Pediatric Hematology Malignancy Conferences (Prof, MK, CS, PC) – these occur two-three times per month.
- Attendance and participation at the monthly Pediatric Hematopathology Conference (Prof, MK, CS, PC).
- Attendance and presentation at the weekly Clinical Pathology (CP) conference at 12:00 on Tuesdays (Prof, MK, CS, PC).
- Attendance and participation/previewing unknowns during the Tuesday and Thursday Hematopathology didactic lectures and unknown sessions (Prof, MK, CS, PC).
- Demonstration of respect for fellow trainees and Hematopathology technicians and staff (Prof, CS).

**Automated Hematology**
- Understand the principles of complete cell counts (CBCs) including the principles by which the instrument arrives at a WBC differential (PC, MK).
- Understand the importance of absolute versus relative counts. Also, understand the clinical utility of the absolute neutrophil count (ANC), as well as the problems associated with neutrophil band counts (PC, MK).
- Understand RBC indices, including their derivation (PC, MK).
- Correctly interpret CBC data (PC, MK).
• Understand the effects of clots, hemolysis, and lipidemia on automated CBC results (PC, MK).
• Understand the principles of automated reticulocyte enumeration (PC, MK).

Peripheral Blood (PB) Smear Analysis
• Review available medical records, CBC data, and indications for peripheral blood smear (PC, MK).
• Understand how peripheral blood is collected for PB smears and how PB smears are prepared and stained. Be able to describe the basic features of a well-prepared PB smear (PC, MK).
• Recognize normal RBC, WBC, and platelet morphologies. Be able to estimate high or low counts (PC, MK).
• Capable of performing an accurate manual white blood cell differential (MK).
• Interpret abnormal CBC data and recognize abnormal RBC, WBC, and platelet morphologies. Formulate differential diagnoses and provide recommendations for appropriate follow-up or ancillary studies (PC, MK, CS).
• Identify micro-organisms (parasites, bacteria, and fungi), and provide recommendations for appropriate confirmatory studies (PC, MK, CS).
• Efficiently prepare a preliminary report with a final diagnosis, comment (if appropriate), clinical history/indication, and results section. Report should be free from spelling and grammatical errors and contain correct clinical and laboratory data (Prof, MK, PC).
• Capable of communicating the PB smear findings and interpretations to the attending staff (Prof, MK, CS).

Leukocyte Disorders
• Understand the principles of cytochemical stains including their utility, evaluation, and interpretation (PC, MK).
• Understand and interpret abnormal leukocyte morphology or cell counts, develop a differential diagnosis, and interpret the findings in the provided clinical context (PC, MK).

Erythrocyte Disorders
• Understand the pathophysiology and morphologic characteristics of major RBC disorders including nutritional anemias, anemias of chronic disease, hemolysis, hemoglobinopathies, and thalassemias (PC, MK).
• Understand the principles of hemoglobin electrophoresis (ELP) as well as the ELP patterns for the diagnoses of major qualitative and quantitative hemoglobin disorders (Sickle cell anemia, Hgb E, Hgb C, SC disease, and alpha and beta thalassemias) (PC, MK).
• Know the typical morphologic and laboratory characteristic and be able to interpret the available laboratory studies in the evaluation of microcytic, normocytic, and macrocytic anemias, formulate differential diagnoses, and recommend appropriate ancillary or follow-up studies (PC, MK, CS).
• Interpret laboratory studies and PB smear morphology in the evaluation of hemolysis, and recommend appropriate ancillary or follow-up studies (PC, MK, CS).
• Understand the principles of a DAT, osmotic fragility test, Heinz body, and Kleihauer-Betke analyses (PC, MK).
• Know the causes and pathophysiology of elevated hemoglobin and be able to recommend appropriate ancillary studies (PC, MK, CS).

Platelet Disorders
• Know the major differentials and pathophysiology for thrombocytopenia and thrombocytosis (PC, MK).
• Understand the principles of platelet numeration by automated hematology analyzers (MK).

Bone Marrow/Hematopathology
• Review available medical records, CBC data, and indications for bone marrow biopsy (PC, MK).
• Understand how a trephine core and a marrow aspirate is collected and processed. Understand the utility of the different components of the bone marrow biopsy evaluation and the characteristics of an adequate or inadequate biopsy/aspirate (PC, MK).
Recognize normal morphologies for erythroid precursors, granulocyte precursors, histiocytes, plasma cells, and megakaryocytes (PC, MK).

Capable of performing accurate marrow differentials and marrow cellularity assessments (PC, MK).

Interpret abnormal CBC data and recognize abnormal RBC, WBC, and platelet morphologies. Formulate differential diagnoses and provide recommendations for appropriate follow-up or ancillary studies (PC, MK, CS).

Understand the utility and interpret special/cytochemical stains including MPO, NSE, iron stains (Dacie and Prussian), reticulin, AFB-FITE and GMS (PC, MK).

Demonstrate knowledge of CD markers and be able to form differential diagnoses of common hematolymphoid neoplasms (PC, MK, CS).

Understand the utility and interpret immunohistochemistry and in situ hybridization (PC, MK).

Know the immunohistochemical profile, cytogenetics or molecular findings along with the morphologic and clinical characteristics of common lymphoid and myeloid malignancies including, but not limited to (PC, MK):
- Acute lymphoblastic leukemias
- Mature B-cell leukemias/lymphomas
- Mature T/NK-cell leukemias/lymphomas
- Hodgkin lymphoma
- Plasma cell dyscrasias
- Myeloproliferative neoplasms
- Myelodysplastic syndromes
- Immunodeficiency and post-transplant lymphoproliferative disorders
- Therapy-related myeloid neoplasms

Recognize marrow involvement by storage disorders and non-hematopoietic neoplasms (PC, MK).

Understand the pathophysiology, clinical presentation, and diagnostic features of PNH (PC, MK).

Recognize the reactive changes in the marrow as well as changes as a result of infections, nutritional deficiencies, medications or chemotherapy (PC, MK).

Integrate PB and bone marrow biopsy findings and efficiently prepare a preliminary report with a final diagnosis, comment section with incorporation of flow cytometry findings or other laboratory data, clinical history/indication, and results section. Report should be free from spelling and grammatical errors and contain correct clinical and laboratory data (Prof, PC, MK).

Capable of communicating the PB smear, marrow aspirates, and trephine findings and interpretations to the attending staff (Prof, PC, MK, CS).

Assigned Reading:
- Robbings and Cotran, Pathologic Basis of Disease, Chapter 13 (Diseases of the White Blood Cells, Lymph nodes, Spleen, and Thymus) and Chapter 14 (Red blood Cell and Bleeding Disorders).

Optional Reading:
Call Duties: Residents may be assigned the lymph node pager to cover after hours lymph node workups.

During the rotation, the trainee is expected to join the following conferences:
- Clinical Pathology Conference: Tues 12:00-1:00 PM (weekly) – Mayo D175
- Resident Didactic Series: Wed 7:00-8:00 AM & 9:15-10:15 AM (weekly) – Mayo D175
- Lab Medicine/Pathology Grand Rounds: Wed 8:00-9:00 AM (weekly) – 450 MCRB
- Daily Hematopathology Consensus Conference: M, T, Th, and F 9-10:00 AM – Mayo D219
- Hematopathology Didactic Series: Tues and Thurs 10:00 AM or TBD – Mayo D219
- Adult Hematology Malignancy Conference: 2nd and 4th Mon of the month 4:15 PM – Mayo D175
- Pediatric Hematopathology Conference: 1st Friday of every month 7:30 AM or TBD – Mayo D219
- Pediatric Hematology Conference: Once a month, 6th floor MCRB

Other Requirements:
- May be asked to participate or contribute to Adult or Pediatric Hematology Malignancy Conference
- May be asked to perform lymph node workups and/or carry the lymph node pager to cover after hour workups

Assessment methods:
Resident performance on this rotation will be assessed by:
- Global performance assessment completed by Hematopathology attending physicians
- Formative feedback will be provided by Hematopathology attending physician
- End of rotation multiple choice question exam (including practical slide review)