

## General structure of curriculum:

Designed to provide complete training in all major areas of anatomic and clinical pathology

- Flexible to accommodate diverse career goals in community, private practice, academia, or other settings
- Anatomic and clinical pathology rotations integrated throughout the 4-year AP/CP curriculum to allow continuous exposure to both components

## *Anatomic Pathology Rotations*

### Frozen section

As you may be aware, the Mayo Clinic has a unique way of signing out its surgical specimens received from the operating rooms. The great majority of surgical specimens received from the ORs are signed out at the frozen section lab within minutes. This translates into a huge number of frozen sections performed each day. On a typical day, 300-500 frozen section slides will be evaluated at each of the two frozen section labs. The frozen section method was developed at Mayo and has been utilized successfully for more than a century. The advantages of evaluating specimens at frozen section are many, and include rapid diagnosis thereby allowing further treatment plans to be formulated the following day, immediate evaluation of surgical margins thereby avoiding unnecessary subsequent operations, and proper triage of specimens for appropriate ancillary studies. It is important to note, though, that this unique process applies only to specimens obtained during surgery. Most cases evaluated within our department and the vast majority of cases you will see during your residency will not come from the frozen section lab and will therefore be processed in a traditional manner.

Nonetheless, your time spent in the Mayo frozen section labs will represent a formative experience of your overall training. The frozen section model offers a unique opportunity for residents to enhance their gross and microscopic examination skills in a way that would not be possible anywhere else. As a junior resident, you will learn the critical importance of gross-histopathologic correlation through the repetitive and instant correlation of gross and microscopic features. Of paramount importance, you will also learn how to accurately convey relevant information to the rest of your frozen section team and the OR team. The frozen section team consists of the pathology resident, a staff consultant, a surgical pathology fellow, two to three pathologist's assistants, and numerous technologists. Under the mentorship of the more experienced members of your team, you will gradually take on increasing levels of responsibility, including gross examination, frozen section interpretation, communication with the OR, and case write-up. During your first month, you will work closely with the pathologist's assistants to learn basic gross examination skills until you are comfortable handling most common specimens. If you ever need help handling a specimen, the entire team is immediately available. During your subsequent rotations, you will sit for short periods of time in the "hot seat" directly beside the staff consultant who will mentor you in the fundamentals of interpreting frozen sections and communicating with surgeons. As you progress in your gross and histopathological examination skills, you will sit for longer periods of time in the "hot seat" and take greater responsibility for all aspects of a case. By your final rotation in the frozen section lab, you will effectively function as an experienced surgical pathology fellow, arriving at a diagnosis, communicating that diagnosis to the OR, writing up the case with all relevant prognostic information, and requesting any additional ancillary studies.

Specimens are grossed in the fresh state as soon as they arrive from the operating rooms, and are distributed among the resident and the pathologist's assistants. This typically leads to a steady but manageable stream of work throughout the day. Residents are generally excused from the frozen section lab between 5 and 7 pm (although rarely grossing responsibilities extend later into the evening). This means there is usually time for reading or other pursuits at the end of the day. On alternating days, known as "file days," you will spend the day reviewing the confirmatory H&E permanent sections of the previous day's frozen sections. On "file days", you will also review any ancillary studies (immunohistochemistry, special stains, flow cytometry and molecular studies) ordered previously.

Residency applicants often have questions about the frozen section laboratory and its impact on resident training. The simple answer is that the frozen section lab will enhance your surgical pathology skills in a way that could not be achieved anywhere else. The frozen section lab rotations represent an important portion of your overall surgical pathology training. We have tried to answer some of the more common questions about the frozen section lab in the "[Frequently Asked Questions](#)" section.

## **SR Biopsy**

Complementing the frozen section rotation, the biopsy rotation provides additional training in general surgical pathology, with an emphasis on learning the histopathology of prostate, breast and head and neck biopsies. During this rotation, the resident has primary responsibility for in-house clinic biopsies from the above mentioned specialties. As noted above, these specimens are not processed through the frozen section lab. On a typical day, the resident may see up to 30 biopsies. As the primary pathologist for these specimens, the resident is responsible for writing up a preliminary diagnosis, ordering any special stains, obtaining any intra-departmental consults, and communicating with clinicians. The residents double scope the cases with the subspecialty consultants of each individual working group (breast, urologic, head and neck). Residents have found this to be a very rewarding rotation and some have likened the Biopsy rotation experience to "running your own small private practice."

## **Autopsy**

The autopsy service at Mayo is one of the busiest hospital autopsy services in the country. Approximately 800-900 autopsies are performed each year. Residents are given responsibility for both forensic and medical autopsies, and all of our residents are able to reach the minimum number of 50 autopsies required for AP board eligibility. Our autopsy service is staffed by 9 consultants, including two board-certified forensic pathologists. The autopsy service is also staffed by a laboratory supervisor, 7 full-time autopsy technicians and 10 rotating pathology assistants. The physical facilities are modern and spacious and include two autopsy rooms, a separate gross dissection room, an x-ray room, a resident work area, digital photography equipment, storage freezers, and heart/lung perfusion fixation apparatus. During the first month of autopsy, new residents will be paired with a supervising pathologist's assistant and will be taught standard autopsy dissection techniques. Gross and microscopic autopsy findings will be reviewed with the staff consultant. By the end of the rotation, the resident will be comfortable formulating a complete autopsy report, incorporating relevant clinical information, autopsy findings, and supplemental studies. The autopsy rotation is an excellent rotation to learn systemic pathology, gross anatomic pathology, and histopathology.

## **Cytology**

Residents spend a total of 3 blocks on this rotation during the course of residency. The cytology service is one of the busiest services a resident will encounter, processing approximately 110,000 specimens each year. Of course, you will focus on reviewing the abnormal and challenging specimens, such as abnormal thin preps pap smears, urine cytology, pulmonary cytology, body fluids and fine needle aspirates. An important educational feature of the cytology rotation is that gynecologic biopsies and core needle biopsies are also signed out in cytology, thereby allowing immediate cyto-histologic correlation. During the first week on the cytology service, the resident will be trained in basic cytopathology by cytopathology education specialists and staff cytopathologists. As the comfort level increases, the resident will take more responsibility for the case load, previewing cases prior to consultant review and, when necessary, gathering applicable clinical data and patient history. Throughout the three rotations in cytology, the resident will also participate in a structured, progressive curriculum of one-on-one teaching sessions with the director of our cytotechnologist training program. The first rotation is focused on learning gynecological cytology, primarily normal and abnormal Pap smears. The second rotation is focused on learning non-gynecological cytology, primarily pulmonary, body fluid and urine cytology. The third rotation is focused on learning FNA interpretation and emerging molecular cytology techniques. Additionally, the resident attends a weekly cytology-histology correlation conference.

Extensive teaching files are also available for resident study. Hands-on FNA of thyroid nodule experience is provided through collaboration with our clinical colleagues in Endocrinology.

## **Dermatopathology**

The resident experience in dermatopathology is centered in a rotation in the Department of Dermatology. Their faculty includes several board certified dermatopathologists who sign out nearly 30,000 skin biopsies per year. The case load has an excellent mix of "bread and butter" cases along with rare and challenging cases from both the intramural practice and external consultations. Part of the resident's training includes attendance of lectures given in the Department of Dermatology regarding both pathology and clinical topics. Moreover, the dermatopathology sign-out area is located adjacent to the clinical exam room area and the pathology group routinely breaks during sign-out to examine interesting patient presentations and correlate the gross findings with pathology results. This emphasis of clinicopathologic correlation in a multidisciplinary manner greatly enhances the resident's learning experience and most residents find their time in dermatopathology to be very high-yield.

## **GI Pathology**

The required rotation in gastrointestinal pathology serves primarily as an introduction to upper and lower endoscopic biopsies. The breadth of pathology seen while on this rotation spans the entire spectrum of gastrointestinal disease, and includes inflammatory bowel disease, celiac disease, infectious disease, microscopic colitis, dysmotility disorders, neoplastic disease and rare genetic syndromes. On a typical day the resident will preview approximately 30 biopsies in the morning which will then be signed out with a consultant in the afternoon. Sign-out occurs at a double-headed scope and is heavily focused on teaching residents key diagnostic features and pitfalls. Residents may also participate in the evaluation of liver biopsies that are received throughout the day, although many residents choose to complete an additional month of GI pathology focusing on liver pathology. At the end of the rotation, residents present an interesting case or project at the GI working group education meeting.

## **Medical Pathology**

The medical pathology rotation encompasses two blocks in which residents will be exposed to various areas of medical pathology. This includes renal pathology, cardiovascular pathology, placental pathology, liver pathology and pulmonary pathology. The experiences in this rotation include the signing out of actual cases, didactic sessions, and grossing experience under guidance of consultant experts in their respective areas. Self-study teaching tools, such as slide sets, are also made available.

## **MCIC**

The required rotation abbreviated as MCIC stands for Mayo Clinic Internal Consults. This service is considered a senior resident rotation, in which residents are responsible for reviewing outside pathology cases for patient's coming to the Mayo Clinic for additional care. Cases across many specialties are represented including neuropathology, bone and soft tissue pathology, cytopathology, gynecologic pathology, breast pathology, head neck pathology, gastrointestinal pathology, urologic pathology and dermatopathology. Approximately 30 cases are seen per day. This includes surgical excision specimens and biopsies. The resident is responsible for reviewing the slides and preparing reports with all necessary details for sign-out. The resident reviews the cases with the sign-out consultant, and also is responsible for seeking consultation with other subspecialty working groups as needed.

## **Neuropathology**

The neuropathology rotation gives comprehensive exposure to neoplastic and non-neoplastic diseases involving the CNS under the guidance of our neuropathology section experts. The resident will gain firsthand exposure to a large volume of excisions and biopsies of tumors involving the brain and spinal cord, in both the adult and pediatric populations. In addition, the residents will gain exposure to a broad spectrum of gross neuropathology through weekly autopsy brain cutting sessions, including neurodegenerative and forensic neuropathology.

## ***Clinical Pathology Rotations***

### **Hematopathology, including Lymph Node pathology**

Peripheral blood and bone marrow examination are the focus of the initial three blocks of this rotation. The fourth block consists of rotations through the molecular and metabolic hematopathology labs. The lymph node portion (one block) of hematopathology is most often done as a third year rotation. Residents perform a requisite number of bone marrow biopsies and have additional opportunities to improve their proficiency with this procedure as time and interest allow. Residents review smears, aspirates, and biopsies independently each morning and then sign out completed cases with staff consultants later in the day. As a major center for Hematology/Oncology, the volume of material encountered in the Mayo Clinic hematopathology lab is tremendous. Residents receive graduated responsibilities as they progress to review an average of 10 bone marrow cases each day. This volume, along with substantial referral sources also allows for in-depth exposure to flow cytometry, molecular genetic modalities, and other ancillary and esoteric tests.

## **Transfusion Medicine**

Residents have often found the transfusion medicine rotation to be one of the busiest, but also one of the most rewarding clinical pathology rotations, largely due to the close interactions required with the clinical services. Residents spend a total of 4 blocks on the transfusion medicine service. The first block is devoted exclusively to education and is comprised of didactic sessions, practical labs hands-on, and various seminars. After completing this preliminary rotation, residents assume the transfusion medicine "hot seat" acting as a liaison between clinicians and the transfusion medicine service. Residents manage utilization and inventory of blood components, donor eligibility issues, donation-related reactions, coordination of apheresis treatments, and other special problems that may arise. The resident rotating on the transfusion medicine service is on-call every other week, alternating with a transfusion medicine fellow and other pathology residents. The on-call responsibility is by pager and most trainees handle calls from their homes. An on-call transfusion medicine fellow or transfusion medicine consultant is always available should challenging issues arise that require more expert assistance.

## **Clinical Chemistry**

The Clinical Chemistry rotation consists of required rotations through the Central Clinical Laboratory (3 weeks), Cardiovascular Laboratory Medicine (1 week), Protein Lab (1 week), Renal Lab (1 week), and Toxicology Lab (2 weeks) followed by 4 weeks of elective time. Residents complete 3 weeks in the Central Clinical Laboratory and one week in toxicology (Chem 1) during their second year, and complete the remaining rotations (including elective time) during the third year of residency (Chem 2). For their elective time, residents may choose to rotate through the Antibody Immunology, Drug Monitoring, Metals, Endocrine, Nucleotide Polymorphism, Biochemical Genetics, Metabolic Hematopathology, Neuroimmunology, or Immunodeficiency labs. During their elective time, residents often undertake a project, such participation in the validation of a new assay, or learning about test methodology, for example. Throughout the rotation, residents also participate in the administrative activities of the laboratory directors. Supplemental lectures and interactive problem-based sessions occur throughout the rotation, with the weekly CP core seminar series containing much of the core didactic content in clinical chemistry. Many esoteric tests are performed in the clinical chemistry laboratories with a large enough volume to allow significant interpretive experience if a resident desires to focus on a particular area. For example, a resident interested in porphyrias could complete an elective in the Biochemical Genetics Laboratory which performs more tests for porphyrias than any other laboratory in the world. During the rotation, residents periodically take clinical chemistry call. Calls are directed to residents from our core laboratory, and also from Mayo Lab Inquiry, the customer service branch of Mayo Medical Laboratories. These calls deal with interpretive and diagnostic dilemmas faced by community pathologists and laboratorians around the country, and provide an excellent means to supplement learning in clinical chemistry. Weekly call rounds allow residents to learn from these calls throughout the clinical chemistry rotation.

## **Microbiology**

The Microbiology rotation consists of 8 weeks of rotations through each of the major microbiology labs, including bacteriology, virology, parasitology, hepatitis and HIV, and tuberculosis/mycology. The resident will be introduced to the basic and advanced methods used for microbe identification in each lab. The pathology resident will also spend 1 week with the clinical Infectious Diseases team. Towards the end of the rotation, each resident will also get a week-long "day call" experience fielding questions from the microbiology labs and from outside clients. Throughout the rotation, residents will also give informal talks on selected topics in microbiology. The department has particular expertise in the development of new molecular assays for microbe identification utilizing methods, such as real-time PCR, ribosome sequencing, mass spectrometry, and in situ hybridization.

## **Cytogenetics**

This rotation is designed as an orientation to the field of cytogenetics, including both neoplastic and congenital diseases, with an emphasis on principles of different techniques used in the laboratory. The rotation is very structured, with lectures and seminars in the morning and case sign-out in the afternoon. Educational specialists in the laboratory guide residents through a lecture series, as well as through the practical exercises that include karyotyping using different staining techniques, fluorescent in-situ hybridization (FISH) signal analysis, cell culturing techniques, and data analysis. A particular hands-on exercise that residents have found exciting is the optional karyotyping of their own chromosomes.

Residents give two 20-minute seminars on selected topics (one on congenital abnormalities and one on tumor markers) for the department.

## Coagulation

The Coagulation rotation consists of 4 weeks spent between the special coagulation laboratory and the coagulation clinic. The Coagulation service at Mayo is run cooperatively between the Departments of Hematology and Laboratory Medicine and is staffed by clinical hematologists and clinical pathologists. Typically, the pathology resident will rotate along with hematology fellows, although the pathology resident will focus on the interpretation of special coagulation studies. The rotation is organized by an education specialist who teaches test profile interpretation until the resident is able to independently provide a written interpretation of coagulation study profiles. A typical day consists of seeing patients in the morning at the coagulation clinic followed by a didactic lecture on selected coagulation topics given by the attending hematologist or pathologist. The afternoon is spent previewing special coagulation study profiles, writing interpretations, and signing out profiles with the assigned Coagulation consultant for that day. The spectrum of disease seen by the pathology resident is very wide, and includes inherited coagulation factor deficiencies, specific coagulation factor inhibitors, lupus anticoagulants, acquired and inherited thrombophilias, heparin-induced thrombocytopenia, and rare inherited platelet disorders.

## Molecular Genetics

The clinical molecular genetics laboratory rotation is an outstanding and well-organized 2-month course. The activities of this rotation include developing a thorough understanding of molecular genetic techniques, applying those techniques to render a diagnosis, and experience working with our clinical genetic counselors. Additionally, residents participate in molecular pathology journal clubs, prepare lectures on particular molecular genetic topics, develop an understanding of how statistics play a role in assessing risk in genetic diseases, and participate in sign-out with molecular genetics consultants. Residents learn to interpret results from both our in-situ hybridization laboratory (such as the evaluation of head and neck cancers for HPV) as well as our molecular anatomic pathology laboratory, which performs PCR-based tests for the presence of particular translocations in solid tumors (such as synovial sarcoma or alveolar rhabdomyosarcoma).

## Electives

Residents can choose from a wide variety of electives which also include lab directorship rotations and research (up to 6 blocks in accordance with ABP policy). Electives are available nearly every area of Laboratory Medicine and Pathology and include bone/soft tissue pathology, breast pathology, cardiovascular pathology, endocrine pathology, gynecologic pathology, head and neck pathology, immunodermatopathology, immunohistochemistry laboratory, genomics, ophthalmic pathology, pulmonary pathology, renal pathology, and urologic pathology. Residents are welcome to return to many required rotations such as clinical chemistry, coagulation, dermatopathology, hematopathology, microbiology, and transfusion medicine for electives.

## Research

Residents may choose to engage in basic, translational or clinical research depending on the level of their interest, research background, and time availability. Translational research and new test development is a focus area for our department. Research is encouraged but not required. Many residents also present at the USCAP, CAP or ASCP meeting each year. Recent residents and fellows have won prestigious awards at the USCAP meeting including the Stowell-Orbison award, the Gastrointestinal Pathology Society award, the international society of Urology Pathology award and the Society for Cardiovascular Pathology award. For those who wish to have extended time for research during residency, a fully funded physician-scientist research track and an institutional [Clinical Investigator Training Program](#) is available.

## Calls

Residents take microbiology call, weekend autopsy call, transfusion medicine call and chemistry call. Microbiology call only includes day call during the rotation. Weekend autopsy rotations begin in the first year during your scheduled autopsy blocks. Transfusion medicine and clinical chemistry call consists of after-hours at-home pager call one week at a time, as well as day call during assigned rotations. There is no frozen section call.