Cornell University

Residency training guidelines for Clinical Pathology

This is a 3 year residency training program, designed to give thorough training in veterinary clinical pathology and prepare the resident for board certification in clinical pathology by the American College of Veterinary Pathologists (ACVP). In the first 2 years, the resident shall train under board-certified (or board eligible) clinical pathologists. Training will continue into the 3rd year (senior resident), however the resident should have substantial autonomy by this stage, to the extent that they can perform diagnostic cytology and hematology responsibilities with minimal supervision.

Knowledge in Clinical Pathology

During this training program, the resident will attain skills in the different disciplines of clinical pathology indicated below. These skills will be attained in various ways during the training program, including rotation through laboratory sections, by completion of designated tasks, by participation in daily cytology/hematology read-out sessions, by interacting with the clinical pathologist on duty, laboratory technicians, students and clinicians, by inclusion in troubleshooting and laboratory operations, by teaching other Cornell University Hospital for Animals (CUHA) residents and students, by performing clinical pathologic-related research studies, by participation in journal clubs and pathology meetings, through regular meetings with the clinical pathologists, and through self-study. These are common expectations for these disciplines:

1. Knowledge of test methodology, including different instrumentation, if relevant.
2. Identifying test abnormalities from instrument data.
3. Identifying abnormalities from smears.
4. Knowledge of the effect of interferences and other variables, e.g. age-related artifacts, on the laboratory data.
5. Interpreting laboratory data with and without the context of a case.
6. Troubleshooting instrument problems.
7. Knowledge of all species, including avian and exotic species.
8. Knowledge of quality performance, including reference intervals, confidence intervals, test validation, method comparison, Westguard rules, Levy-Jennings charts etc.

Hematology:

The hematology guidelines endorsed by the American Society of Veterinary Clinical Pathology (ASVCP) (see Guidelines for resident training in veterinary clinical pathology II. Hematology, VCP, 35: 382, 2006 - pubmed) will be followed. The resident will learn how to prepare, stain, coverslip and examine blood smears, perform packed cell volume determinations and plasma appearance. They will have familiarity with the method of operation of the hematology analyzer with no expectation for running the instrument, and knowledge of how fibrinogen by heat precipitation is measured, with no expectation of performing the test. The resident will also learn the following:

1. Knowledge of test methodology, techniques of analysis, and result interpretation of different instrumentation including impedance and laser-based analyzers, and quantitative buffy coat analysis.
2. The resident will learn how to perform blood smear examination, including the ability to identify abnormalities in the smear, decide their clinical relevance, and estimate leukocyte, erythrocyte and platelet counts from smears without knowledge of the actual counts.

Clinical chemistry:
The clinical chemistry guidelines endorsed by ASVCP (see Guidelines for resident training in veterinary clinical pathology I. Clinical chemistry, VCP, 32: 202, 2003 - pubmed) will be followed. The resident should be familiar with the method of operation of the chemistry analyzer, blood-gas analyzer and back-up instrumentation (e.g. chloridometer) with no expectation for running the instruments.

Cytology:
The hematology guidelines endorsed by ASVCP (see Guidelines for resident training in veterinary clinical pathology III. Cytopathology and surgical pathology, VCP, 38: 281, 2009 - pubmed) will be followed. The resident will learn how to prepare, stain, coverslip and examine cytology smears of all types, including buffy coat smears, bone marrow smears, and cytospins, perform total protein determination, nucleated and erythrocyte counts on fluids with the Z2 analyzer, and perform special stains, specifically gram and Prussian blue stains. The resident will learn about the basis and types of assays available for immunophenotyping, histochemistry and cytochemistry and how to interpret the results. They are not expected to perform these assays, but should be familiar with the test methodology.

Urinalysis:
The resident will learn how to prepare and examine urine smears, perform dipstick analysis and dissolution experiments for crystal identification. They should be familiar with the method of operation of the urine analyzer, but are not expected to operate it.

Flow cytometry and immunocytochemistry:
The resident with learn the principles of flow cytometry and immunocytochemistry and will be expected to be familiar with the available markers for animal tissues, but are not expected to perform the assays. Emphasis will be placed on antibody selection and interpretation of results.

Immunology:
The resident should understand the principles and be able to examine and interpret the results of the following techniques, but are not expected to perform the assays: agarose gel electrophoresis, ANA, LE preps, Coombs testing, and immunoglobulin quantification. The resident will be able to perform and interpret results of crossmatching (including

mare/foal incompatibility) and will provide this service on an on-call basis to the clinicians of the CUHA.

Coagulation:
The resident should be familiar with all coagulation tests and techniques, including optical, magnetic and mechanical clot detection methods. The resident will learn to interpret all hemostasis-related test results. This aspect of resident training will be done in cooperation with the Comparative Coagulation Laboratory.

Endocrinology:
The resident should be familiar with all endocrine tests, including stimulatory tests and tests for antibodies against hormones, and techniques, including radioimmunoassay, ELISA etc. The resident will learn to interpret endocrinologic-related test results through independent study, case discussions within the clinical pathology group and consultation/interaction with the endocrinology department as needed.

Surgical pathology:
The resident will learn how to examine, describe and interpret surgical biopsy specimens. This will be accomplished through designated rotations through the surgical pathology service in all years of the clinical pathology residency. Furthermore, the resident can participate in other surgical biopsy readout sessions with the agreement of the pathologist on duty. Cytology-histology correlate sessions are also held regularly in clinical pathology. Residents are responsible for obtaining histologic results from CUHA cytology specimens, for collating the slides (cytology and histology) and scheduling a pathologist for these sessions.

Research

1) Research
   The resident will perform clinical pathologic-related research under the direction of the clinical pathologists, beginning in the first year. The intention is to publish the results in a peer-reviewed journal. The research can be retrospective or prospective in nature, however one study of the latter is required. This research requirement does not include publication of single case reports or "What's your diagnosis?" These are considered additional (but desirable) publications, if the opportunity arises.

2) Presentations
   Second and third year residents will present an abstract (oral or poster) or ASVCP mystery slide presentation at the annual meeting of the ACVP.

3) Publications
   A minimum of one research publication is expected during the residency program.

4) Grants
   Residents are expected to apply for relevant grants to support their research studies, e.g. ASVCP Share the Future grants.

Teaching

1) Senior students on pathology rotation
   Students attend twice weekly 1-1.5 hour small group clinical pathology discussions around the multi-headed microscope in Clinical Pathology. Starting at some stage during the first year (depending on the confidence and skills of the resident), the resident will lead these discussions with or without the clinical pathologist in attendance.

2) Opportunity block students and other residents
   Residents may audit the training of these students and other residents. Although not required to directly supervise in this training, residents may be asked to participate by acting as a resource (ex. reviewing slides and cases with students and visiting residents).

3) Clinical Pathology Distribution Course
   First year and second year residents will help prepare and teach in the laboratories, and attend the lectures and case discussions. Second year residents will give one lecture during the course and by their third year, in addition to 1 or 2 lectures, residents will potentially lead a discussion session with the students.

4) Clinical Pathology Rounds
   Residents will help organize twice monthly clinical pathology rounds, presenting the cases of interest from the preceding weeks to clinicians, residents and students. This task will include digitizing case slides and preparing power point presentations to display case material.

5) Foundation course III laboratories
   Residents will assist in the teaching of these laboratories (2 x hematology and 1 x chemistry), starting in year 1.

6) Pathology club
   Residents will participate in or lead teaching sessions organized by the pathology club, particularly in the second or third year.

7) Other rounds/seminars
   Residents are encouraged to present topics and/or case related materials at other college-wide rounds or seminars such as: Tumor Board, Infectious Disease Forum, and Wildlife Rounds.

Organization of the Program

1) The resident will attend, on arrival, the relevant pathology and CUHA orientation sessions.

2) Rotations through the clinical pathology laboratory
   Residents will rotate through the different sections of the clinical pathology laboratory, to learn about the techniques and become familiar with the instrumentation and method of operation (of the instrumentation and laboratory). This will include quality control procedures that are performed daily in the laboratory. The length of time that the resident will rotate through the sections may differ depending on the section, i.e. less time may be spent in chemistry, than in hematology/cytology.

3) Hematology and cytology training
   In the first few months of the training program, the clinical pathologists will conduct microscope training sessions with the resident on hematology and basic cytology to familiarize the trainee with normals, specific abnormalities and species differences. Lectures on different aspects of hematology (e.g. infectious agents, red and white cell morphology) and cytology will also be given by faculty during this orientation period.

4) Participation in daily cytology/hematology read-out sessions (diagnostic service duty)
   a) *First year*: the resident will attend these daily sessions. This will be the basis of cytology and an extension of hematology training. It is anticipated that at least two weeks a month will be occupied with the resident on service duty. Starting in the first year of the program, residents may be expected to review the smears before the clinical pathologist on duty, if possible. The conclusions reached by the resident will then be reviewed by the clinical pathologist on duty.
   b) *Second year*: Residents are expected to review and write up case descriptions and interpretations prior to the clinical pathologist, whenever possible.
   c) *Third year*: The resident will examine and report out cytology and hematology results independently for at least one week a month, without a required review by the clinical pathologist on duty. However, a clinical pathologist will always be available for consultation, as desired by the resident. This shift to independence will be dictated by the skill level of the trainee and will be determined by the clinical pathologists.

5) Case follow-up
   Residents will print reports of all diagnostic cytology and selected hematology cases for case follow-up, within 1-2 weeks of service duty. The resident will search the online medical record of all CUHA and selected Diagnostic Lab cases

and will provide the case outcome to the clinical pathologist. This is used both as a learning tool and to select cases for cytology-histology correlate sessions and clinical pathology rounds.

6) Out of hours service
Residents will cover out of hours calls for the clinicians of CUHA daily from 5pm to 8am and on weekends. Services provided include: cytology, crossmatching, and hematology (blood smear exams only). Residents will contact the on-call clinical pathologist as needed to complete these tasks. Holiday out of hours service will be covered by medical technologists.

7) Rotations through other laboratory sections of the College
Residents will rotate through the pathology (Appendix A) and the coagulation (Appendix B) sections of the AHDC and College. Optional rotations include toxicology (Appendix C), virology, serology, bacteriology, parasitology (Appendix D) and endocrinology (Appendix E). During these rotations, they will learn basic information on test methodology etc, and will be given tasks or cases to interpret. The resident will not be required to run instrumentation but must have a good working knowledge of testing principles and variables impacting results.

8) Rotations through clinical sections of the College
Residents may choose to rotate through one or more of the following: large animal medicine, small animal medicine, exotic animal medicine and oncology sections (Appendix F) of CUHA.
    a) These will generally be 2 week rotations.
    b) The resident will be placed on email lists providing information of clinical rounds, journal clubs and board preparation review. Attendance and presentation at these rounds is encouraged.

9) Directed learning of clinical pathology
    a) Tasks
    In order to learn basic laboratory principles, disease processes etc, the resident may be given tasks by the clinical pathologists, e.g. learning how to establish reference intervals for clinical pathologic-related variables, interpretation of a case.
    b) Weekly meetings within the clinical pathology group
        i. Monday morning mystery slides: These are cytology, hematology or surgical biopsy cases given to the residents ahead of time to describe and interpret. They are initially designed to familiarize the resident with classic cases and writing board-style descriptions. During the resident's third year these cases should be timed and used as practice cases for board exam preparation.

ii. Cytology-histology correlates: Residents pull and present interesting cytology or hematology cases which have corresponding histopathology. These seminars occur on Wednesday mornings whenever an anatomic pathology resident or faculty member can participate.
iii. Clinical chemistry cases: Clinical chemistry cases are given to the residents in advance to interpret. During the resident's third year these cases should be timed and used to as practice cases for board exam preparation. These seminars usually occur on Wednesday mornings (in rotation with cytology-histology correlates).
iv. Task review/journal club: Each member of the clinical pathology team (residents and clinical pathologists) will take turns selecting a topic for discussion once a week. These could be the tasks given above, journal review, quality assurance issues etc.

10) Course work

It is required that all residents take one statistics course during their residency. Other courses may be audited or taken for credit with the approval of the course instructor and resident supervisor.

11) Journal clubs/seminars/rounds

a) Pathology Journal club and seminars
Whenever possible, the resident will attend pathology journal clubs and Tuesday morning surgical pathology seminars.
b) College/University seminars
Residents may attend college or university-wide seminars (these are offered daily) of interest, however prior approval must be obtained from the clinical pathologist on duty if these seminars conflict with teaching or daily readout sessions.

12) ASVCP meeting

The clinical pathology laboratory will support the attendance of the resident to the ACVP annual meeting. However, the expectation is that the resident will present an abstract (in oral or poster format) of a research-related topic or a mystery slide case at the meeting in the second or third year of their residency. Abstracts and cases are generally due by June 1 and July 1, respectively.
Residents are expected to take representative images of the mystery slide cases from the meeting and incorporate within a powerpoint presentation for future residents.

13) Recommended reading

Residents are required to read and be thoroughly familiar with information from many sources including relevant chapters of textbooks and clinical pathologic-related journal articles. A list of recommended reading for the clinical pathology

board examination is available on the ACVP website and can be accessed via this link. Additional reading may be assigned by the clinical pathologists to supplement and enrich resident training.

Board examination preparation

In the fall (typically in late September) following completion of the residency program residents will certify with the ACVP by writing a comprehensive 3-day board examination. Residents will apply to sit the examination by mid-December (post deadline is usually around January 10th) in their third year and require sponsorship by a board certified clinical pathologist. Details on the examination are available on the ACVP website and can be accessed via this link. The structured residency program at Cornell prepares candidates well for the examination which includes the following sections:

1) Cytology: Multiple choice, case slides and projected images
2) Hematology: Multiple choice, case slides and projected images
3) General Pathology: Multiple choice
4) Clinical chemistry: Multiple choice, cases

The following aspects of the clinical pathology residency at Cornell prepare residents for successful completion of the board examination:

- Residents are taught to develop a consistent, thorough method of slide review and written description for cytology and hematology case slides. This is facilitated by the Monday morning mystery slide sessions as well as instruction during diagnostic service duty throughout the residency.
- Residents are taught to develop a consistent, thorough method of interpreting and reporting clinical chemistry, coagulation and endocrinology data. This is facilitated by clinical chemistry cases that are given to residents throughout the training program.
- Residents are encouraged to participate in general pathology journal club with the anatomic pathology residents as well as engage in independent study in order to adequately prepare for the general pathology section of the examination. Resources, such as example questions and study guides, are available to further facilitate this preparation.
- A large image database is available for residents to aid in preparation for the projected image section of the examination. Residents are expected to add to this database during their training to improve and update this resource for future residents in the program.
- Structured sessions such as the task review/journal club help reinforce important concepts and cover major points of journal articles relevant to all section of the examination.
- If desired, the clinical pathologists will prepare a Mock board exam to be given to the resident during the third year of their program.

Appendix A

Surgical pathology rotation

1) In the first year of their residency, Clinical Pathology residents will rotate through the Anatomical Pathology Service. The initial 3-week rotation will start on the second or third week of July and will coincide with the new pathology residents. It will only include surgical biopsies. The Pathology faculty on duty will be responsible of the supervision of these trainees.

2) During the remainder of their residency, we recommend (but do not require) residents to either take some surgical pathology duty (for no more than 1 week at a time) or sit in on biopsy read-out sessions with the pathologists, after obtaining permission from the pathology faculty on duty.

3) Throughout the year the residents are encouraged to attend the seminars offered by the Anatomic Pathology Section:
   a) Tuesday Seminar (Tuesday, 8 am)
   b) Veterinary and General Pathology Journal Club (Wednesday, 8 am)
   c) Wildlife Pathology Rounds (one Friday per month, 8 am)

Neuropathology Rounds (one Friday per month, 8am)
Tumor Board (one Friday per month, 8am)

4) The resident can, at their discretion, attend AFIP Seminars (Monday, 12 noon) and Necropsy Rounds (Show and Tell, Friday, 12 noon).

5) After the first training period and, depending on case availability, they may have the opportunity to work under the oversight of Pathology faculty on the pathological examination of genetically modified mice, sentinel animals, wildlife and avian species, and other research animals of interest.

Appendix B

Comparative Coagulation rotation

1) In the first or second year of the program, the resident will rotate for 1 week through the Comparative Coagulation section of the Animal Health Diagnostic Center. During this time, the resident will observe the operation of the instrumentation of the laboratory and also analyze and interpret results. This will occur in fall semester (usually December).

2) It is recommended that the resident attend hemostasis-related lectures and laboratories during the first and second year of the residency. These include:
   a) Block 2: Genetic testing for hemostatic disorders
   b) Block 3: 2 lectures on hemostasis: Pathophysiology and cases
   c) Block 5: 2 lectures on hemostasis: Diagnosis of bleeding disorders and transfusion medicine

3) Opportunities also exist for the resident to observe and participate in hemostasis related-research projects.

Appendix C

Toxicology rotation

1) The resident will have the opportunity to rotate for 1 week through the toxicology section of the Animal Health Diagnostic Center. During this time, the resident will observe the operation of the instrumentation of the laboratory, perform bench top testing, analyze and interpret results, and assist the toxicologist in working up cases, answer calls from veterinarians and writing reports.
    a) Instrumentation includes X-ray fluorescence, ELISA, thin layer HPLC, atomic absorption.

The resident can audit VTMED 6328 Veterinary Clinical Toxicology distribution course in spring semester in the first year of their program, if desired.

Appendix D

AHDC Rotations
(bacteriology, serology, virology, parasitology)

Virology

The resident will have the opportunity to rotate through the virology section of the Animal Health Diagnostic Center, if desired. This will be organized at an appropriate time (for the resident and faculty) with Dr. Dubovi. During this time, the resident will learn methods involved in virus isolation and identification.

Parasitology

The resident can also rotate through the parasitology section of the AHDC for one week. During this time, the resident will observe different methods for detecting parasites, including ELISA, Knott's techniques and fecal flotations. Most of the time will be spend in parasitology in the afternoon (from 1 pm onwards), but there will be some flexibility in this and the resident will be available in the morning if something interesting arises in the morning. There will be additional opportunity to interact with the parasitology section if interesting cases arise at other times of the year.

Appendix E
Endocrinology Rotation

1) The first year resident can rotate for 1-2 weeks through the Endocrinology section of the Animal Health Diagnostic Center. During this time, the resident will observe the operation of the instrumentation of the laboratory, any troubleshooting of the equipment that may occur, and analyze and interpret results.

2) The resident may wish to attend endocrinology-related lectures given by Dr. Randolph during block V (spring semester) before attending this rotation.

3) Consultation with the endocrinology staff on interesting cases is not restricted to this rotation, but can occur throughout the year. Residents can also wander down to Endocrinology at any time to observe operations of the laboratory etc.

Appendix F
Oncology rotation

1) The clinical pathology resident can have a 2 week rotation during their residency.

2) The resident can attend at their discretion the following rounds associated with the oncology service:
   a) Oncology Resident Rounds - held once weekly (Monday, 8 am). These focus on cancer biology, radiation therapy topics and clinical aspects of veterinary oncology. For cancer biology sessions, presenters utilize the main texts that have been suggested for preparing for the Oncology Certifying Examination in addition to review articles found in the current literature. For tumor topics, presenters use the main veterinary oncology textbooks as well as perform a search of the current literature. The presentation provides background information including epidemiology, etiology, pathology, diagnosis and treatment. Clinical Pathology Residents generally present a topic or journal article at these rounds once or twice a year.
   b) Internal Medicine Rounds - weekly internal medicine rounds to prepare house officers for ACVIM board preparation.
   c) Morbidity and Mortality rounds - once monthly case presentations to all house officers and faculty.
   d) Weekly Cancer Case Rounds - once weekly meeting with oncology faculty and house officers to discuss ongoing cases and review charts of patients undergoing radiation therapy.

3) The resident may attend the following oncology-related courses
   a) VTMED 6500 – Veterinary Clinical Oncology. This lecture-based course presents the most common cancers affecting small and large animals. Emphasis is placed on etiology, biologic behavior and patient management. Surgery, chemotherapy, and radiation therapy as important methods to treat cancers in veterinary patients are discussed.
   b) VTMED 6558 – Advanced Small Animal Clinical Oncology. Spring. This is an elective course designed to complement the required course VTMED 6500. This advanced course emphasizes the biologic behavior and patient management of cancers in dogs and cats more thoroughly than addressed in VTMED 6500. Additionally, molecular and cytogenetic methodologies that are likely to affect cancer diagnosis and management in the future are discussed. Finally, students are provided with the skills necessary to critically read and evaluate clinically-based publications in the professional literature.