

LEARNING OBJECTIVES AND EXPECTATIONS

Flow cytometry/Cytogenetics

DURATION: 1 month

FACULTY: Nitin Karandikar, M.D., Ph.D. (Rotation Director, flow cytometry)
Yin Xu, M.D., Ph.D. (hematopathology and flow cytometry)
Robert McKenna, M.D. (hematopathology)
Kathleen Wilson, M.D., Ph.D. (cytogenetics)

PREREQUISITES:

A prior hematopathology rotation is highly desirable.

OBJECTIVES: See core competencies below.

FELLOW RESPONSIBILITIES

Orientation – on the first day of rotation, the fellow will meet with the Laboratory Director or Laboratory Manager for a general overview of the rotation.

Immunophenotyping of Leukemias and Lymphomas – The fellow will begin by observing the process of data analysis performed by the attending or fellow for one to several days. This will be followed by independent analysis of a teaching set of normal specimens. This set is maintained on the flow lab server, and is accompanied by step-by-step instructions for the analysis of each tube. Finally, the fellow will begin to independently analyze clinical cases in real time. The fellow will work closely with the covering pathologist in selecting antibody panels for specimen testing, interpretation and write-up of analyzed cases, photographing cases, relaying approved interpretations to the requesting physicians, and learning the basics of data analysis using Paint-a-Gate software. The level of responsibility assigned to the fellow will increase as competence is demonstrated.

CD34(+) cell quantification – the covering pathologist will review with the fellow representative cases submitted for CD34(+) cell quantification.

Lymphocyte subset enumeration--the covering pathologist will review with the fellow representative cases submitted for CD34(+) cell quantification.

Technical procedures – the fellow will coordinate with technologists to observe all technical aspects of flow cytometry laboratory testing, reviewing the procedure manuals as procedures are observed. A checklist of procedures will be provided. This should start during the first few days of the rotation in order to ensure that all procedures are observed.

CONFERENCES

Residents will be expected to attend the following conferences:

- Mon-Friday sign-out with Drs. McKenna, Kroft, and Xu at the multi-headed microscope, South or North Campus, 8:00am unless otherwise specified.
- Biweekly Tuesday “Updates in Pathophysiology”
- 2nd Tuesday of each month CMC tumor board, 4:30pm
- Wednesday CP Rounds, HG.102, 11:00am*
- Thursday Heme-Onc Rounds, NC8-212, 7:30am
- Friday multimodality tumor board (when applicable), NC8-212, 7:30am.
- Friday Flow Cytometry Case Reviews, NB6.132, 10:00am**

*The fellow will be expected to present periodically and to actively participate in this conference

**The fellow may be asked to assist the flow fellow, who has primary responsibility for compiling cases and presenting at this conference.

LEARNING RESOURCES

“Information for Residents” notebook – contains the basic information about flow cytometry, relevant articles, instructions for analyzing and writing up cases and examples of interesting cases.

Projection slide file – using the lab’s slide viewer, the fellow can quickly review a large number of cases by looking at the morphology and immunophenotype depicted in the projection slides for each case, formulating a diagnosis, and then checking the diagnosis against the copy of the report in the report binder.

“Picture Page Box” – this contains the recent positive cases, which may be reviewed each day by the fellow. The fellow may bring to the pathology fellow or covering pathologist any case that the fellow wishes to discuss.

RECOMMENDED TEXTS FOR REFERENCE

Practical Flow Cytometry, 4rd edition. Shapiro HM. Available at resident desk.

Flow Cytometry in Clinical Diagnosis, 3rd edition. Keren et al. Available at resident desk.

Flow Cytometry in Hematopathology. Nguyen. Available in Dr. Karandikars’s office.

CORE COMPETENCIES – Flow Cytometry

1. Patient care.

(A.) Procedural skills.

(1.) Objective: None

(B.) **Interpretive skills.**

(1.) **Objectives:** Interpret flow cytometry histograms in the context of clinical history and morphologic review.

(2.) **Plan:** On the first one to several days of the rotation, fellows observe the fellows and faculty performing analysis and interpretation of flow cytometry histograms. Once they are familiar with the overall approach and the use of the painting software, they proceed through a set of teaching cases (retained on the flow cytometry lab server with detailed, step by step analysis instructions) that illustrate the major panels for normal specimens. After they have worked through the normal teaching cases, they proceed to analyze patient cases in real time. This is done with a fellow or attending available to answer ongoing questions during the period of analysis. The resident is expected to generate his or her own interpretation of the case during the analysis period. When the analysis is complete, it will be reviewed in detail with the fellow or faculty to assess the accuracy and completeness of the analysis and the interpretation. Corrections and constructive criticism will be provided at this time, after which the fellow will be expected to create a draft report. The attending will review the draft report, edit, and sign. Any major corrections to the draft report will be discussed with the fellow.

(3.) **Assessment:** The fellow performance will be assessed in several ways: 1) direct observation during the process of case real-time case work-up by rotation director, flow cytometry faculty, and hematopathology fellows.; 2) oral quizzes in the context of weekly flow conference; 3) analysis of challenging flow cytometry teaching cases (maintained on flow lab server); and 4) written quizzes (presently under development).

2. **Medical knowledge.**

(A.) **Objectives:** The fellow is expected to understand the basic technical principles of flow cytometry. The fellow is expected to gain familiarity with the immunophenotypic features, and to a lesser extent the morphologic features, of various types of hematologic neoplasia encountered routinely in the flow cytometry laboratory. The fellow should also understand the basic applications of lymphocyte subset analysis and stem cell analysis.

(B.) **Plan:** This knowledge will be acquired through ongoing exposure to case material, attendance at weekly flow cytometry conference, attendance at daily hemepath consult sign-out, ongoing reading on a case by case basis, and an introductory lecture by the rotation director or designee on the basic principles of flow cytometry. In addition, relevant articles dealing with major diagnostic issues and technical considerations in flow cytometry will be included in the fellow rotation book, with the expectation that the fellow read these articles during his/her rotation. The fellow will also learn about technical issues in flow cytometry through the bench rotations and review of procedures.

(C.) **Assessment:** Medical knowledge will be assessed through: direct observation by rotation director, flow cytometry faculty, and hematopathology fellows; oral quizzing during weekly flow conference; and hematopathology consult sign-out.

3. **Practice-based learning and improvement.**

(A.) Objectives: Appreciate the application of literature review, journal club, interdepartmental conferences, and peer review of cases.

(B.) Plan: Residents on flow cytometry are expected to attend the monthly hematopathology journal club in order to participate in a literature-based discussion of cutting edge information relevant to the practice of hematopathology (to include flow cytometry). During the work-up of difficult cases, the fellow may at times be asked to perform a literature search on a topic in order to facilitate accurate and timely diagnosis. Residents also attend joint conferences with the hematology/oncology division and other services, in which the pathology results (including flow cytometry) are included in the decision making process regarding the overall management of the patient. These conferences also allow one to keep abreast of progress in patient management and basic and translational research that may impact on the pathology practice. Finally, the fellows will participate in the peer review process in the flow cytometry laboratory, whereby randomly selected cases signed out by each faculty person are re-reviewed by another faculty person.

(C.) Assessment: Direct observation by rotation director, flow cytometry faculty, and hematopathology fellows.

4. **Interpersonal and communication skills.**

(A.) Objectives: The fellow is expected to learn sufficient communication skills to be able to effectively gather information, provide test results, and communicate his/her own thought processes in arriving at diagnostic conclusion.

(B.) Plan: In the process of working up a case, the fellow is expected, when necessary, to contact referring pathologists and clinicians to obtain additional historical information. In addition, the fellow is also expected to orally provide test results to the ordering physician and provide consultative input into the interpretation of the results in the clinical context. Residents also are expected to craft the flow cytometry report in order to most efficiently and effectively convey important diagnostic information (to be critiqued by the attending or fellow). Finally, through the process of orally discussing cases in weekly flow conference, the fellow should obtain experience verbally expressing the decision-making process he or she is employing in the assessment of a case.

(C.) Assessment: Direct observation by rotation director, flow cytometry faculty, hematopathology fellows, and medical technologists..

5. **Professionalism.**

(A.) Objectives: The fellow should learn how to communicate with other pathologists, clinicians, technologists, and support staff in a courteous and professional manner, and appreciate how such professionalism is essential to the effective practice of pathology.

(B.) Plan: The fellow will learn professionalism through ongoing interaction with referring pathologists, clinicians, medical technologists, and support staff.

(C.) Assessment: Direct observation by rotation director, flow cytometry faculty, and hematopathology fellows.

6. **Systems-based practice.**

(A.) Objectives: The fellow should learn how to select the most efficient and effective testing approach for a given sample. The fellow should also gain familiarity with basic laboratory management issues, such as quality assurance, resource management, laboratory logistics, and long-term strategic planning. The fellow should understand the contribution of ancillary laboratory services such as flow cytometry in the global diagnostic work-up of a patient. Finally, the fellow should understand how the results he or she is generating are used by clinicians in formulating a management plan.

(B.) Plan: Each specimen undergoes an initial triage process, in which the fellow will participate along with an attending or fellow. This requires an assessment of morphologic and clinical data to select the testing panel that will most efficiently assure the highest level of patient care. At times, the assessment results in the conclusion that flow cytometric analysis is not indicated, and the fellow will participate in the communication of this assessment to the ordering physician. After interpretation of the initial flow cytometry results, the fellow will participate in the process of determining the necessity for additional flow analysis and, if necessary, the selection of additional markers to be tested. In addition, the fellow will participate in determining the necessity, through consultation with the ordering physician, the necessity of additional diagnostic testing in other laboratories, such as molecular analysis or fluorescence in situ hybridization. The latter requires appreciation of the necessity of incorporating information from a variety of sources into the final diagnostic decision making process. This is further reinforced in daily hematopathology consult sign-out. Finally, through attendance at joint conferences with clinical services, the fellow will learn to appreciate the role of diagnostic testing in patient management and the role of the pathologist as a clinical consultant.

The fellow will be exposed to quality assurance issues during sessions at the bench with the medical technologists, in which quality control procedures will be directly demonstrated and discussed. The fellow will also participate in interpreting proficiency testing (PT) survey materials with the responsible attending, as well as review the PT results with the medical director. In addition, the fellow will review with the medical director reagent crosschecks, compensation parameters, and other ongoing quality assurance assessments in the laboratory. Finally, the fellow will attend weekly management meetings between the medical director, the chief technologist, and the quality assurance coordinator, at which ongoing technical, logistical, and quality assurance issues are discussed.

(C.) Assessment: Direct observation by rotation director, flow cytometry faculty, hematopathology fellows, and technologists.

CORE COMPETENCIES-CYTOGENETICS

1. Patient care.

(A.) Procedural skills.

(1.) Objective:

- a. Perform all aspects of culture and analysis of one (their own or another's) peripheral blood specimen, including culture initiation, harvest, slide preparation, staining, microscope analysis, and karyotype preparation.
- b. Observe and participate, where appropriate, in specimen processing and evaluation of each specimen type: amniotic fluids, stimulated peripheral bloods, bone marrow aspirates and leukemic bloods, solid tumors and non-neoplastic tissue specimens.
- c. Observe and participate in all aspects of the fluorescence in situ hybridization (FISH) procedure, including probe and slide preparation, hybridization and detection procedures, fluorescence microscopy and computer analysis.

(2.) Plan:

- a. Procedural skills are taught by actual performance of various cytogenetic techniques and/or observation. These skills are taught by cytogenetic technologists and faculty in cytogenetics.
- c. Level of responsibility and supervision, and documentation.

It is the fellow's responsibility to complete these exercises. This is documented by a Procedural Skills Checklist (Appendix I) signed off by a senior technologist who is directly supervising these fellow activities.

(3.) Assessment:

Procedures are supervised and skills assessed by direct interaction, observation, verbal and written assessment by the senior cytogenetics technologists and faculty in cytogenetics.

(B.) Interpretive skills.

(1.) Objective:

Appreciation of the G-banded karyotype.

- a. Familiarity with scoring patient specimens evaluated by fluorescence in situ hybridization (FISH).

(2.) Plan:

1. Completing one's own karyotype
2. Cutting and analyzing normal and abnormal karyotypes
3. Review of Audio-Visual Slide Set:
Preparation of the Normal Giemsa-Trypsin-Banded Karyotype
(See Appendix II: Audio-Visual Material)
4. Participation in fluorescence microscopy and interpretation with cytogenetics faculty and staff.

The fellow is responsible for completion of these exercises and is supervised by senior cytogenetic technologists and faculty in cytogenetics.

(3.) Assessment:

Interpretive skills are assessed by direct daily interaction and interaction at weekly didactic teaching sessions, verbal and written assessment by the senior cytogenetic technologists and faculty in cytogenetics.

2. Medical knowledge.

(A.) Objectives:

Fellows participate in scheduled teaching conferences during their rotation. These sessions include, review of selected cases that are representative of various cytogenetic disorders. Topics covered include constitutional chromosome disorders, myeloid and lymphoid malignancies, solid tumors, and fluorescence in situ hybridization (FISH). Following these conferences with the teaching faculty, the fellow is expected to become proficient with the appropriate indications and specimen requirements for cytogenetic evaluation of each disorder discussed. Fellows will be able to discuss the conventional and molecular cytogenetic findings in the context of the clinical presentation of patients with the various disorders, relevant physical examination findings, natural history and implications for family members.

(B.) Plan:

a. Basic Reading is organized into five Teaching Modules covered over a four week time period (See Appendices III and IV):

-Week One: Constitutional Disorders (Module 1)

-Week Two: Myeloid Disorders and FISH (Modules 2 and 3)

-Week Three: Lymphoid Disorders (Module 4)

-Week Four: Solid Tumors (Module 5)

b. Computer Resources:

Fellows will become familiar with computer resources that pertain to cytogenetic disorders. They are required to locate Online Mendelian Inheritance in Man on the Internet and use it as a resource for the teaching conferences.

(<http://www.ncbi.nlm.nih.gov/Omim/>) and also, Atlas of Genetics and Cytogenetics in Oncology and Haematology at

(<http://www.infobiogen.fr/services/chromcancer/>)

(1.) Teaching conferences

Weekly didactic sessions with cytogenetics faculty

Clinical Pathology Lecture Series

Clinical Pathology Rounds

Adult Hematology/Oncology Clinical Case Conference

Pediatric Hematology/Oncology Leukemia Conference (contact Janine Dezee at 214-456-2806)

Clinical Genetics Conference (<http://www3.swmed.edu/cgi-bin/Calcium35?CalendarName=McDermottCenter>)

Maternal/Fetal Medicine Clinical Conference

(C.) Assessment:

- (1.) Assessment occurs at weekly didactic teaching sessions with cytogenetics faculty
- (2.) Objective assessment by written exam at the end of rotation (See Appendices V- VIII.)

3. **Practice-based learning and improvement.**

(A.) Objectives: Application of the medical literature, research and statistical methods, and data management technology for self-evaluation and improvement.

Fellows review the majority of all actual cases completed during that month.

"Quiz" questions will be attached to a selected number of these current cases.

The fellow is responsible for answering and discussing the answers to the quiz questions at the teaching conferences.

(B.) Plan: How does the fellow achieve the objectives of practice-based learning and improvement?

- (1.) Practice-based learning and improvement is incorporated into the fellow's daily routine
 - a. Daily review of cases.
 - b. Morphologic and clinical correlation for cases which pose diagnostic challenges.
 - c. Attendance at Cytogenetics Section Meetings (See Appendix IX.)
- (2.) Informal exercises, formal conferences (e.g. journal clubs, peer review conferences), and lectures exist on this rotation to facilitate practice-based learning and improvement
 - a. Daily Cytogenetics Intake Meetings.
 - b. Weekly Cytogenetics Section Meetings (See Appendix IX.)
 - c. Monthly Cytogenetics Laboratory Meetings.

(C.) Assessment:

Assessment is through daily interactions with faculty and staff.

4. **Interpersonal and communication skills.**

(A.) Objectives: What interpersonal and communication skills are the fellows expected to develop and use on this rotation?

- (1.) Presentation of appropriate cases at selected case conferences throughout the rotation month. Cases with cytogenetic findings of interest are discussed with the teaching faculty, recent relevant literature is reviewed, and the fellow presents the case.

(2.) Appropriate interaction with cytogenetics faculty and staff, clinicians, hospital staff, other UTSW faculty which demonstrate effective exchange of information.

(B.) Plan: How does the fellow learn the skills necessary for effective personal interaction and communication?

(1.) How are interpersonal and communication skills incorporated into the fellow's service work?

Daily interaction with faculty and staff.

(2.) What informal conferences and formal presentations and reports exist on this rotation to facilitate the development of communication skills?

Presentations at Clinical Genetics Conference.

Weekly Didactic Teaching sessions with faculty.

(C.) Assessment: How are the fellow's interpersonal and communication skills assessed and by whom?

Communication skills are assessed by daily interactions with faculty and staff, presentations at conferences, and didactic teaching sessions. Assessment is in writing from cytogenetics faculty and staff.

5. Professionalism.

(A.) Objectives:

(1.) Team-building.

(2.) Adherence to ethical principles.

(3.) Sensitivity to a diverse patient population and work environment.

(4.) Commitment to carrying out professional responsibilities.

(B.) Plan:

(1.) Development and review of all conference presentations with cytogenetics faculty.

(2.) All fellows contribute to the common teaching materials while on the service. This may include development of cases for additional teaching exercises, identification of recent literature resources, online resources, or technology developments. This exercise provides for consistent improvement of the educational experience for subsequent fellows.

(3.) Attendance at daily cytogenetics intake rounds and all weekly section meetings.

(C.) Assessment:

Professionalism is assessed by daily interactions within the laboratory, presentations at conferences and didactic teaching sessions. Professionalism is assessed in writing by cytogenetics faculty and staff.

6. Systems-based practice.

(A.) Objectives:

(1.) Awareness and responsiveness to the larger context of the health care system and as it pertains to submission of cytogenetic specimens and cytogenetic diagnoses.

(2.) Ability to call on system resources to provide optimal cytogenetic evaluation.

(B.) Plan:

(1.) Attendance at Daily Cytogenetics Intake Meeting, Weekly Section Meetings, and Monthly Laboratory Meetings

(2.) Daily interaction with other pathology services (Flow Cytometry, Diagnostics, Immunohistochemistry) and other UTSW departments (OB/GYN, Hematology/Oncology Services, Pediatrics) in obtaining important clinical or laboratory information to perform the appropriate cytogenetic test or assist in accurate interpretation of a cytogenetic result, interaction and utilization of the knowledge base of individuals from other services rotating (often concurrently) on the cytogenetics rotation.

Services which rotate:

UT Southwestern Adult Hematology/Oncology fellows

UT Southwestern Clinical Genetics Training Program (residents)

UT Southwestern Dermatopathology fellows

UT Southwestern Hematopathology fellows

UT Southwestern Pediatric Hematology/Oncology fellows

UT Southwestern Pathology residents (entire program)

Baylor Medical Center Pathology residents (entire program)

(3.) Resource access within the system in order to optimize the value of pathology services: The fellows's educational experience is integrated with computer and library resources, hospital information systems, and the cytogenetics database.

(C.) Assessment:

Written assessment by cytogenetics faculty and staff.