GOALS AND OBJECTIVES
MOLECULAR PATHOLOGY
CHEO

Molecular Lab – 3 weeks; Cytogenetic Lab – 1 week

Overall goals and training

☐ The overall goal of the Molecular Pathology Section is to teach residents and fellows how to safely handle tissue samples for molecular and cytogenetic analysis, to learn basic techniques at the laboratory bench, and to learn how to analyze results critically, including an appreciation of the limitations of each technique.
☐ Training is provided by didactic lecture, by hands-on bench experience, and in data review conferences.

CanMEDS ROLE SPECIFIC OBJECTIVES

MEDICAL EXPERT

The resident will be able to describe and discuss:

• The cytogenetic and molecular mechanisms resulting in:
  o Mitosis and Meiosis
  o Somatic mutation
  o Loss of Heterozygosity
  o Mosaicism
  o Clonal evolution

• The techniques used in direct and indirect genetic diagnostic testing including:
  o DNA extraction
  o PCR amplification
  o Restriction enzyme digestion/ RFLP analysis
o Cycle sequencing
o Next-generation sequencing
o Genomic and expression microarray analysis
o Bone marrow, lymphocyte, solid tumour and lymph node culture and cell harvesting
o G-banding
o Standard metaphase analysis
o Interphase FISH for the detection of chromosome abnormalities involved in hematologic malignancies

• The indications, contraindications, limitations, sensitivities and specificities of various molecular and cytogenetic technologies.

• The appropriate methodologies for genetic testing in a given patient situation.

• The principles of molecular mutation and cytogenetic nomenclature.

• Databases used in molecular and cytogenetics.

• The nature, prognosis and treatment of conditions currently assessed by cytogenetic and molecular genetic technologies.

• Recommendations for additional cytogenetic and/or molecular genetic investigations to clarify the etiology and prognosis of various neoplastic disorders.

• Types and relative frequency of various chromosomal abnormalities in hematologic disorders.

• The basic techniques of nucleic acid handling, including proper storage of tissue samples and the extraction of DNA from tissue, blood samples and paraffin-embedded tissues.

• The electrophoresis methods for analysis of DNA, including agarose gel electrophoresis and capillary electrophoresis.

• How to identify trinucleotide repeat expansions/contractions and understand how this analysis applies to the investigation of microsatellite instability.

• How to digest DNA using restriction endonucleases and how restriction fragment length polymorphisms analysis can be used for targeted mutation detection.

• How to detect genomic deletions and gains using appropriate technology and how these molecular and cytogenetic techniques complement each other.

• How to assess heterozygosity of polymorphic loci and how this applies to analysis of “loss of heterozygosity” in neoplasias.

• How to select appropriate controls for molecular based assays.

• How to analyze and interpret sequencing data.
• The basic methods of tissue culture, and harvesting.

• How chromosomes are stained and understand how different staining methodologies can be used to assess chromosomes.

• How metaphases are analyzed and how karyotypes are prepared for a G-band study.

• How to distinguish between an interphase and metaphase FISH study and understand when each study is appropriate.

• Appropriate uses of molecular cytogenetic FISH, and how to apply/interpret the different types of probes for the investigation of chromosome abnormalities in neoplasias.

• The difference between “constitutional” and “somatic” genetic aberrations.

• The different types of chromosome rearrangements that can contribute to balanced and unbalanced karyotypes and mechanisms involved.

• The difference between chromosome rearrangements that contribute to neoplastic transformation by formation of gene-fusions versus juxtaposition of genes next to novel regulatory elements.

The resident will demonstrate the ability to:

• Interpret and report cytogenetic and molecular test results using standard nomenclature.

COMMUNICATOR

The resident will demonstrate the ability to:

• Effectively communicate at a level appropriate to referring clinicians and other health care professionals the indications for, methodologies used in, and results of, a variety of cytogenetic and molecular pathology tests, including any related uncertainties.

• Provide the referring clinician with an understandable written summary of the result.

• Communicate effectively with the members of the molecular and cytogenetics laboratories, including the laboratory director, technologists and support staff.

COLLABORATOR
The resident will demonstrate the ability to:

- Respect and consult effectively with the clinical laboratory director, technologists, and support staff to provide optimum patient care.
- Where appropriate, be able to assume a leadership role in team settings.
- Consult and work cooperatively with research scientists and other disciplines, where applicable, to advance knowledge of molecular pathology, cytogenetics and patient care.
- Recognize the importance of collaboration between Pathology and Molecular Oncology Laboratories for establishing appropriate samples for molecular testing.

**MANAGER**

The resident will demonstrate the ability to:

- Allocate molecular pathology and cytogenetics test resources wisely.
- Utilize information technology to optimize interpretation of test results.
- Utilize resources effectively to balance laboratory and learning needs.
- Balance personal and professional demands on activities of daily living.
- Promote quality assurance as it relates to laboratory results.
- Maintain complete and accurate laboratory records.

**HEALTH ADVOCATE**

The resident will be able to describe and discuss:

- How health care governance influences resource allocation for molecular and cytogenetic laboratory testing at a local, provincial, regional, and national level.
- The roles of national and international agencies in the determination of guidelines for genetic testing.

The resident will demonstrate the ability to:

- Recognize and respond to those issues where advocacy for molecular
pathology or cytogenetic testing is appropriate.

- Refer molecular or cytogenetic test inquiries to the appropriate laboratory, community and national resources.

**SCHOLAR**

The resident will demonstrate the ability to:

- Use case encounters as a stimulus to further reading and review of the current literature.
- Critically assess the genetics literature, applying epidemiological and biostatistical principles where relevant.
- Develop, implement and monitor a personal continuing education strategy.
- Apply and enhance teaching skills in the education of medical students, other residents and other health care professionals about molecular and cytogenetic tests.

**PROFESSIONAL**

The resident will demonstrate the ability to:

- Recognize the limitations of their expertise and skills and seek help whenever indicated.
- Recognize his/her own cultural biases that may influence or impede ethical decision-making.
- Recognize and demonstrate his/her obligation to effective teaching.
- Understand, recognize and respect the role of genetic counsellors, clinical laboratory geneticists, technologists, support staff and researchers.
- Display personal and professional attitudes consistent with a consulting physician.
- Understand the duty of confidentiality and the difficulties it can pose in the interpretation and reporting of genetic test results.

*Revised April 2016*