CCMG Cytogenetics Training Guideline and Specialty Requirements

Preamble
The aim of the Cytogenetics Training Program is to produce scientific specialists who are competent to effectively function as an independent clinical cytogeneticist. Competence implies the individual has the knowledge, skills and attitudes to:
1) Identify and interpret chromosomal abnormalities.
2) Participate in the management of patients and their families with chromosomal disorders.
3) Assume the day-to-day responsibilities for the operation and standards of a cytogenetic laboratory.

The Cytogeneticist will have a thorough grounding in the theory, methodology and techniques of cytogenetics, and will be familiar with a broad spectrum of disorders representing all modes of inheritance and indications typically encountered in the cytogenetic setting.

Trainees are expected to participate fully in all aspects of laboratory medicine as it relates to cytogenetics, multi-disciplinary case discussion, rounds, seminars and meetings related to cytogenetics. There is increasing responsibility over the 2 year training period to include more independence in result interpretation, test development, lab management, quality assurance and other competencies as outlined here in the Training Guideline.

The CCMG training guidelines are modeled after the CanMEDS framework. This framework includes the competencies required of specialists and the role of the specialist beyond that of the specialty medical expert. The other roles of the specialist are that of communicator, collaborator, manager, health advocate, scholar, and professional. The detailed objectives describe minimal standards and in no way exclude the necessity for mastery of additional knowledge, skills or attitudes necessary for the practice of cytogenetics.

Required Background
Trainees must have a PhD and/or an MD degree.

A candidate’s PhD must have a strong genetics content. The required educational experience would approximate that required for an MSc in genetics and cytogenetics. If this experience is lacking, the trainee must gain this knowledge through suitable courses and/or private study.
PhD trainees must have successfully defended and submitted the final version of their PhD thesis before beginning CCMG training. The start date for training can not be before submission of the final version, with all revisions (if any) approved by the relevant university officer(s). Individuals with an MD degree must have completed at least 3 years of residency training in a program accredited by the Royal College of Physicians and Surgeons of Canada (RCPSC) and/or Collège des Médecins du Québec (CMQ).

Administrative Aspects

1. Supervisory committee:
   a. Each trainee’s program will be supervised by a committee, headed by a Fellow of the CCMG in Cytogenetics who takes primary responsibility for the training (a.k.a. supervisor).
   b. The committee will consist of the head and a minimum of two additional members. Other members might consist of clinical geneticists and molecular geneticists. The structure of the committee will vary depending on the background of the trainee.
   c. The program director or supervisor on behalf of the committee ensures the trainee is registered with the CCMG Credentials Committee by submitting a registration form to the CCMG Secretariat within the first three months of commencing training.
   d. The committee takes responsibility for ensuring the training program is meeting the needs of the trainee and is in keeping with CCMG guidelines, including graduation of responsibility in the laboratory and clinical setting. The committee must submit an outline of completed and planned training with the trainee’s application for credentialing.
   e. The committee meets every six months with the candidate, and ensures that in-training evaluation forms (ITER; one for each rotation and one for every 6 months for longer rotations) are completed and discussed with the trainee. If remedial work is needed by the trainee, the committee must ensure that this is provided.
   f. The committee completes and submits the Final In-Training Evaluation Report (FITER) to the CCMG secretariat prior to oral examination. Please note that the FITER is additional to the ITER covering the last 6 months of training. The committee must also submit a Completion of Training form, if the FITER does not coincide with the completion of training.

2. Location of training
   a. Cytogenetics training must take place in a centre accredited by the CCMG for training in Cytogenetics.
   b. Elective training may be done at non-accredited centres at the discretion of the supervisory committee.
   c. In the event that accreditation of a centre is terminated during the candidate’s training, the trainee will be allowed a maximum of six months to move to an accredited center for completion of training.

3. Training in foreign centres
a. Training in American centres accredited by the American Board of Medical Genetics (ABMG) is recognized by the CCMG.
b. As the ABMG and CCMG have different credentialing requirements, it is the responsibility of the trainee to ensure completion of all requirements of the CCMG.

4. Part-time training
a. Part-time training is recognized by the CCMG, provided it conforms to all requirements in this document and the trainee spends a minimum of 50% of time in the program.
b. The total amount of time must equal two complete years in training.

5. Second specialty training
CCMG fellows currently certified in another laboratory specialty who want to certify in Cytogenetics must complete a minimum of 12 months full time training in a CCMG-accredited laboratory that provides cytogenetic diagnostic services. All training as outlined below in Mandatory training item 1 must be completed. The Supervisory Committee may recommend additional training depending upon previous training and experience.

6. Credentialing
Candidates are advised to review the Credentialing requirements on the CCMG website early in their training to facilitate Credentials submission and review.

Content of Training
Two year program, including:
Mandatory training:
1. Minimum of 12 months in a CCMG-accredited laboratory that provides cytogenetic diagnostic services. Training sites must ensure compliance with their laboratory accreditation programs. This may require bench work performed by a trainee be performed using non-clinical samples or under supervision of appropriately certified individuals at the discretion of the training center and supervised result reporting (co-signed) or the use of archival cases.

It is recognized that not all training centres will be able to provide a fully-comprehensive training program. Those responsible for training at a given center must identify any ‘gaps’ and encourage trainees to obtain the appropriate training at other CCMG- or ABMG-accredited centres to meet the overall training objectives of the program.

Training will include:
a. Technical skills: Hands-on experience with all wet and dry bench cytogenetics tasks, with a logbook recording 100 cases in which there was significant participation of the trainee in the laboratory. Cases may include wet bench (culture, harvest, slide preparation in tandem with qualified laboratory personnel, microarray processing) and/or dry bench (microscopic analysis, digital image capture and karyotyping, microarray analysis) involvement. It is the
responsibility of the local fellowship committee to determine if the trainee requires more cases to become familiar with all technical aspects.

b. **Interpretative and consultative skills**: Experience in interpretation and communication of results, with a logbook recording involvement in **200 cases** (though it is likely that more than 200 cases will be reviewed). It is the sole responsibility of the local fellowship committee to determine the total number of cases to be reviewed by the candidate to ensure a high level of competence. The candidate is required to request special stains as appropriate, review karyotypes and/or FISH data, write the correct ISCN nomenclature, and write the interpretation.

**Case distribution**: The cases documented must cover all current cytogenetic and molecular-cytogenetic technologies. The representation of each tissue type amongst the 200 cases is as follows: prenatal (amniocentesis and CVS); tissue (skin biopsy and/or products of conception and/or fetal autopsy); oncology (unstimulated blood and/or bone marrow and/or soft tumor); and peripheral blood leukocytes (pediatric and adult samples). A **minimum of 30 cases is required in each category**.

**Abnormal/Illustrative cases**: At least 120 of the cases must represent abnormal results (e.g. pathogenic, technical artefact, rare variant of unknown clinical significance). A minimum of 20 cases from each tissue type is required and no more than 2 of each abnormal/illustrative scenario per tissue type may be used. Illustrative scenarios may include: maternal cell contamination; contamination of cell cultures; handling of mislabelled specimens; level I mosaicism; and acrocentric polymorphism. In order to meet the abnormal/illustrative minimums in each category, archival material (inactive cases illustrative of a rare abnormal that is unlikely to be seen during the training period) may be used (to a maximum of 40 archival cases). A complete cytogenetic interpretation (including ISCN nomenclature and report) of all of the abnormal cases should be performed. However, only the ISCN karyotype need be submitted. Abnormal results observed during technical experience can also be logged.

c. **Management skills**: Experience in management of a cytogenetic diagnostic laboratory.

2. Rotations in other medical genetics specialties, including:
   a. **Molecular Genetics laboratory training**: a minimum of **three months** to be spent in a CCMG-accredited laboratory providing molecular diagnostic services.
   b. **Clinical genetics training**: a minimum participation in **25 patient encounters** (counseling sessions), with a CCMG/ABMG certified clinical geneticist or CAGC/ABMG certified genetic counselor, but not necessarily in a CCMG-accredited centre. This rotation can occur as a block or throughout the training program. The trainee should keep a logbook recording participation in a minimum of 25 counselling sessions, representing at least 4 of the following clinical scenarios: prenatal, pediatric, adult, metabolic, cancer and neurogenetic. Participation must include developing an
understanding of the issues through researching the literature and discussions with clinical colleagues.

3. Courses/conferences
   a. Participation in educational events and courses prescribed by the trainee’s supervisory committee is to be documented in an education logbook.
   b. Documented attendance at one local (e.g. departmental annual research day, a research institute research day), national or international genetics meeting during the training period.

4. Research training
   a. **The trainee must participate in clinical or laboratory-based research for a period equivalent to 6 months full time research**; this may be accomplished through a dedicated 6 month block of time or distributed throughout the training period. Training may be obtained at the training centre or another hospital or university centre in Canada or abroad as approved by the candidate’s supervisory committee and Program Director. The research can be applied or translational in nature such as development of a new test, test validation, test improvement, quality improvement, case follow up and cost-benefit analysis.
   b. A research supervisor must be identified and the proposed research objectives and methodology are to be submitted to the supervisory committee for review and approval. The research supervisor is responsible for completing an evaluation (ITER) of the trainee. The trainee is responsible for a written summary of completed research to be submitted to Program director and dissemination to the appropriate audience (laboratory staff, clinicians, publication).

5. Logbooks
   CCMG Logbook templates available on the CCMG website **must** be used. Patient confidentiality must be guarded. Therefore, before submitting to the CCMG, cases must have all identifiers removed so as not to be traceable. Each Logbook is in an Excel format with tabs for documentation of:
   a. Technical cases and consultative cases (tab: Technical and Consultative Log)
   b. Clinical experience (tab: Clinical Log)
   c. Education experience (tab: Education Activities)
   d. Research experience (tab: Research Activities)
   e. Training program (tab: Training Outline)

A logbook should not only be viewed as a mechanism for tracking the number of cases/experiences accumulated but as a means for documenting learning, illustrative cases and approaches/troubleshooting undertaken that can be reflected upon and recalled as you study for the CCMG exam and as you start your career as a laboratory geneticist. The logbook should be reviewed regularly and discussed by the supervisor and trainee to ensure they represent the breadth of testing required and acquisition of competencies.
**Elective training** provides additional training opportunities in related areas of interest to the trainee. Elective training must be approved by the supervisory committee.

1. Rotations in related fields, such as biochemical genetics, embryopathology, developmental genetics, oncology, haematology, pathology and relevant aspects of obstetrics.
2. Rotations in other cytogenetic diagnostic service laboratories or CCMG training centres.
Cytogenetics Specialty Requirements

Key and Enabling Competency Statements

Note:
The 7 Roles are the thematic groups of competencies that organize the CanMEDS format (Medical Expert, Communicator, Collaborator, Manager, Health Advocate, Scholar, Professional).

The Key Competencies are the overall culminating objectives of training. They are meant to be summative and cumulative, while also being observable and measurable.

The Enabling Competencies are the skills that allow the Key Competencies to be achieved. The Enabling Competencies break-down the Key Competencies into observable and measurable statements.

MEDICAL EXPERT

Key Competencies

By the end of training, Cytogenetics Trainees will demonstrate the ability to:
1. Explain advanced concepts in human cytogenetics, molecular biology and medical genetics;
2. Define the pathobiology of human genetic disorders and their cytogenetic causes;
3. Relate cytogenetic testing for acquired disorders to other cytogenetic testing applications including cancer cytogenetics;
4. Demonstrate expertise with standard and advanced cytogenetic techniques;
5. Demonstrate the ability to implement effective cytogenetic testing.

Enabling Competencies

1. Explain advanced concepts in human cytogenetics, molecular biology and medical genetics.
   To achieve this, the Cytogenetics Trainee will be able to:
   1.1. Discuss the general concepts of medical genetics outlined in the CCMG General Knowledge Guidelines.
   1.2. Describe general concepts of cytogenetics and genetics;
       1.2.1. Historical development of clinical cytogenetics;
       1.2.2. Chromosome and DNA structure and function;
       1.2.3. Fundamental concepts of mitosis, meiosis, including behaviour and segregation of normal and structurally altered chromosomes;
       1.2.4. Cytogenetic techniques used in gene mapping, and their limitations;
       1.2.5. Principles of population genetics, patterns of inheritance, genetic variation and polymorphisms;
1.2.6. Theories relating to the origin of numerical and structural anomalies;
1.2.7. Gametogenesis and fertilization;
1.2.8. Oocyte and sperm contributions to genetic and cytogenetic abnormalities;
1.2.9. Basic embryology;
1.2.10. Genetic basis of sex-determination and X inactivation;
1.2.11. Chromosome breakage/instability syndromes and fragile sites;
1.2.12. Genetics and cytogenetics of carcinogenesis;
1.2.13. Imprinting and uniparental disomy;
1.2.14. Evolution of human chromosomes (in broad terms);
1.2.15. Mosaicism.

1.3. Describe fundamental molecular genetic principles:
   1.3.1. The interrelationship between cytogenetic and molecular genetic based testing.

1.4. Describe the molecular basis of gene silencing including the role of chromatin, histone
and DNA modifiers, transcription factors and other trans-acting factors, promoters,
enhancers, locus control regions, etc. as it applies to:
   1.4.1. Imprinted regions of the genome
   1.4.2. X-inactivation
   1.4.3. Heterochromatin

1.5. Describe mechanisms of DNA repair and provide examples of disorders resulting from
defects in DNA repair genes;

1.6. Describe the identification of human disease genes and susceptibility factors including
the role of positional cloning, aCGH, exome and genome sequencing, and functional
studies.

2. Define the pathobiology of human genetic disorders and their cytogenetic causes;
   To achieve this, the Cytogenetics Trainee will be able to:
   2.1. Explain the aetiology (including stage or parent of origin and mechanism of formation)
of:
       2.1.1. Aneuploidies and polyploidies;
       2.1.2. Structural chromosome anomalies of all types (including translocations,
deletions, inversions, markers, microduplication/deletions etc);
   2.2 Describe the incidence, clinical phenotypes, natural history, reproductive consequences
and recurrence risks of :
       2.2.1. Aneuploidies;
       2.2.2. Well characterized, cytogenetically visible, unbalanced structural anomalies
(such as 5p-, 4p-, iso12p etc);
       2.2.3. Recurring microdeletion and microduplication syndromes
       2.2.4. Fragile sites;
       2.2.5. Chromosome breakage/DNA repair defect syndromes.
   2.3. Describe the reproductive consequences, recurrence risks and the potential imbalances
arising during meiotic segregation/gametogenesis in carriers of structural anomalies;
2.4. Recognition and interpretation of cytogenetic polymorphisms/heteromorphisms including those found with molecular cytogenetic methodology;

2.5. The differential diagnoses of non-cytogenetic conditions that may phenotypically resemble specific chromosomal anomalies (phenocopies);

3. Relate cytogenetic testing for acquired disorders to other cytogenetic testing applications including cancer cytogenetics;

To achieve this, the Cytogenetics Trainee will be able to:

3.1. Describe the classification and differential diagnoses of haematological malignancies;

3.2. Describe the classification and the differential diagnoses of those solid tumours in which cytogenetic analysis is of clinical use;

3.3. Describe the chromosomal anomalies that are of diagnostic and prognostic importance in cancer and the cytogenetic and molecular techniques used to detect them as well as the advantages and limitations of the techniques;

3.4. Describe the interrelationship between cytogenetic and molecular testing as it applies to cancer diagnosis and management;

4. Demonstrate expertise with standard and advanced cytogenetic techniques;

To achieve this, the Cytogenetics Trainee will be able to:

4.1. Understand the methodological basis and demonstrate proficiency with standard cytogenetic techniques including but not limited to:
   4.1.1. Reagent preparation, storage and handling
   4.1.2. Tissue culture, harvesting, fixing and banding of metaphases;
   4.1.3. Karyotype and identify normal and abnormal chromosome complements, both under the microscope and by analysis of prints of G-banded chromosomes at all band levels;
   4.1.4. Computerized karyotyping;
   4.1.4. Special staining.

4.2. Understand the methodological basis and demonstrate proficiency with advanced cytogenetic techniques including but not limited to:
   4.2.1. Fluorescence in situ hybridization (FISH) including probe types, selection, hybridization, washing, detection and fluorescence microscopy;

4.3. Understand the methodological basis and demonstrate proficiency with genomic techniques including but not limited to:
   4.3.1. Array comparative genomic hybridization and SNP microarrays (including sample preparation, hybridization, data analysis and interpretation);
   4.3.2. Bioinformatic tools for the interpretation of rare variants, including understanding the inherent biases of disease and control population databases.

4.4. Recognize the limitations of each cytogenetic and molecular cytogenetic techniques;

4.5. Troubleshoot standard and advanced cytogenetic techniques.

5. Demonstrate the ability to implement effective cytogenetic testing.
To achieve this, the Cytogenetics Trainee will be able to:
5.1. Describe the indications for performing cytogenetic analysis. This should be evidence-based and best practice, taking into consideration current CCMG guidelines and scientific literature;
5.2. Recommend the appropriate cytogenetic technique based on the clinical indication and interpret the results for:
   5.2.1. Prenatal testing (including amniocentesis, CVS and maternal blood);
   5.2.2. Tissue testing (skin biopsy and/or products of conception and/or fetal autopsy);
   5.2.3. Oncology (unstimulated blood and/or bone marrow and/or soft tumor);
   5.2.4. Peripheral blood leukocytes (pediatric and adult samples);
   5.2.5. Chromosomal breakage disorders
5.3. Recognize and interpret artifacts or unusual results in cytogenetic test results and conduct appropriate investigations;
5.4. Design, validate and utilize methods for cytogenetic follow-up.
5.5. Describe the diagnostic approach to chromosomal mosaicism in all tissue types, especially in prenatal diagnosis, including criteria for inclusion and confidence levels for exclusion;
5.6. Be familiar with the interpretation and reporting of array CGH results including the use of primary databases;
5.7. Assign correct cytogenetic nomenclature according to currently approved CCMG Guidelines (ISCN rules);
5.8. Recommend other genetic/non-genetic laboratory testing that would be of clinical benefit;
5.9. Use the medical/scientific literature when compiling a report;
5.10. Develop and validate a diagnostic test according to accreditation standards using standard test development procedures. This will include the appropriate interpretation of results during the course of test development, planning for subsequent experiments, and documentation of all experiments in a final report according to a standard laboratory format.

COMMUNICATOR

Key Competencies

By the end of training, Cytogenetics Trainees will demonstrate ability to:
1. Provide consultation for cytogenetic cases to health care providers, laboratory staff, patients and others;
2. Integrate clinical and laboratory information to assist with result interpretation and decision making for appropriate cytogenetic test utilization;
3. Report results and interpretation of cytogenetic testing to relevant individuals.

Enabling Competencies
1. Provide consultation for cytogenetic diagnostic cases to other health care providers, laboratory staff, patients and others.
   
   To achieve this, the Cytogenetics Trainee will be able to:
   1.1. Communicate with referring health care providers or other individuals to compile information required to assess appropriate cytogenetic investigations for clinical cases;
   1.2. Convey relevant information regarding cytogenetic testing possibilities to relevant individuals.

2. Integrate clinical and laboratory information to assist with result interpretation and decision making for appropriate cytogenetic test utilization;
   
   To achieve this, the Cytogenetics Trainee will be able to:
   2.1. Recognize the importance of clinical or other laboratory information for cases referred for cytogenetic diagnostic testing;
   2.2. Communicate effectively with relevant health care providers to obtain required information;
   2.3 Utilize clinical and other laboratory information to make decisions regarding appropriate cytogenetic diagnostic testing to be performed.

3. Report results and implications of cytogenetic testing to relevant individuals.
   
   To achieve this, the Cytogenetics Trainee will be able to:
   3.1. Correlate results with clinical or other laboratory information;
   3.2. Communicate cytogenetic diagnostic results and implications in both oral and written forms;
   3.3. Use appropriate ISCN nomenclature and include clinically relevant comments in cytogenetic reports;
   3.4. Maintain patient confidentiality and privacy in the reporting of results;
   3.5. Provide consultative services regarding implications of cytogenetic testing results and additional recommended investigations.

**COLLABORATOR**

**Key Competencies**

By the end of training, Cytogenetics Trainees will demonstrate ability to:
1. Participate effectively as a team member with relevant health care providers in collaborative decision-making for cytogenetic cases;
2. Mediate decision-making in inter-professional teams;
3. Contribute effectively to other interdisciplinary team activities.

**Enabling Competencies**

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CCMG Cytogenetic Training Guidelines
Revised with Board approval: June 2014
Effective: July 1st, 2014
Archived date:
1. Participate effectively as a team member with relevant health care providers in collaborative decision making.  
   *To achieve this, the Cytogenetics Trainee will be able to:*  
   1.1. Describe the role and responsibilities of a clinical cytogenetics professional to health care providers;  
   1.2. Develop rapport, trust and ethical relationships with the health care team;  
   1.3. Participate as a team member in activities related to cytogenetic testing, including education, research and clinical care;  
   1.4. Demonstrate respect for other health care professionals and their role in health care teams;  
   1.5. Network with other cytogenetic diagnostic laboratories.

2. Mediate decision-making in interprofessional teams.  
   *To achieve this, the Cytogenetics Trainee will be able to:*  
   2.1. Demonstrate appropriate conflict resolution skills;  
   2.2. Facilitate communication within inter-professional teams to prevent and resolve conflicts.

3. Contribute effectively to other interdisciplinary team activities.  
   *To achieve this, the Cytogenetics Trainee will be able to:*  
   3.1. Participate in an interdisciplinary team meeting, and demonstrate the ability to consider and respect the opinions of other team members, while contributing cytogenetic-specific expertise him/herself;  
   3.2. Communicate effectively with the members of an interdisciplinary team in the resolution of conflicts, provision of feedback, and where appropriate, be able to assume a leadership role.

**MANAGER**

**Key Competencies:**

*By the end of training, the Cytogenetics Trainees will demonstrate the ability to:*  
1. Understand and apply the essential elements of Quality Management system within the laboratory;  
2. Utilize cytogenetic testing resources effectively;  
3. Manage staff and equipment to work effectively and efficiently in a health care organization;  
4. Manage time effectively and prioritize required activities;

**Enabling Competencies**

1. Understand and apply the essential elements of a Quality Management system within the laboratory.
To achieve this, the Cytogenetics Trainee will be able to:

1.1. Explain the concepts of laboratory quality assurance programs, including methods of implementation and monitoring;
1.2. Understand the principles of quality control (including, but not limited to, statistical quality control), and be able to develop an effective quality control program, to interpret quality control data and to recommend appropriate corrective action;
1.3. Demonstrate understanding of Lab standards and guidelines such as external proficiency programs, turnaround times, etc.;
1.4. Understand the administrative, legal and physical requirements for the operation of a hospital cytogenetics laboratory including:
   1.4.1. The provincial requirements for accreditation of cytogenetic laboratories and general hospital laboratories;
   1.4.2. The cytogenetic requirements for CCMG-accreditation of centres.
1.5. Maintain complete and accurate records of cytogenetic testing.
   1.5.1. Describe methods to implement and maintain an efficient system to manage laboratory information, data and reports;
   1.5.2 Maintain complete records for all cases, including written, electronic and oral information;
   1.5.3 Demonstrate knowledge of laboratory information systems for patient tracking and record maintenance;
   1.5.4 Maintain confidentiality for all cases, including both oral and written communication;
   1.5.5. Explain the medico-legal implications in the practice of cytogenetics and appropriate use of medical records.
1.6. Understand the importance of Continuous Quality Improvement (CQI) as it applies to lab policies, processes and procedures;
1.7. Describe issues in quality assurance that are unique to cytogenetic testing.
1.8. Demonstrate the ability to respond effectively to laboratory-related complaints.

2. Utilize cytogenetic testing resources effectively.

To achieve this, the Cytogenetics Trainee will be able to:

2.1. Use cytogenetic testing resources in a manner that balances costs with potential implications of results;
2.2. Organize multiple cytogenetic investigations in an appropriate concurrent or sequential manner;
2.3. Coordinate cytogenetic testing with other diagnostic investigations;
2.4. Determine what constitutes an unacceptable or suboptimal specimen or result;
2.5. Determine what constitutes the most appropriate specimen for a specific diagnostic question and how such a specimen should be procured and processed in the cytogenetics laboratory;
2.6. Recognize the sensitive nature of genetic samples and act to minimize potential harms;
2.7. Advise on the principles of establishing new technologies in the cytogenetics laboratory including but not limited to the cost/benefit ratio, sensitivity and specificity of the test and the validation of the test method and the results;
2.8. Demonstrate knowledge of the CCMG Cytogenetics Practice Guidelines.

3. Manage staff and equipment to work effectively and efficiently in a health care organization.
   To achieve this, the Cytogenetics Trainee will be able to:
   3.1. Describe equipment and supplies used in cytogenetic testing and their costs;
   3.2. Demonstrate the ability to prepare a laboratory budget;
   3.3. Demonstrate familiarity with bids and service contracts for laboratory equipment;
   3.4. Explain the technical training requirements for laboratory technologists;
   3.5. Develop appropriate laboratory protocols for laboratory staff;
   3.6. Demonstrate the ability to effectively prioritize the work of laboratory staff;
   3.7. Describe the Workplace Hazardous Materials Information System (WHMIS) biohazard regulations and safe laboratory operating procedures;
   3.8. Demonstrate understanding of the process of staff recruitment and interview skills;
   3.9. Demonstrate understanding of the accreditation process and understand the process for responding to reviewers recommendations.

4. Manage time effectively and prioritize required activities.
   To achieve this, the Cytogenetics Trainee will be able to:
   4.1. Set, prioritize and manage time to balance required activities;
   4.2. Recognize critical aspects of certain activities and allocate time appropriately.

HEALTH ADVOCATE

Key Competencies

By the end of training, Cytogenetics Trainees will demonstrate the ability to:
1. Describe specific public health practices or policies that affect provision of cytogenetic testing services;
2. Respond to the health care needs of individuals, communities and populations served by cytogenetic testing.

Enabling Competencies

1. Describe specific public health practices or policies that affect provision of cytogenetic testing services.
   To achieve this, the Cytogenetics Trainee will be able to:
   1.1. Explain how health care governance influences resource allocation for cytogenetic services at the local, regional, provincial and national level;
1.2. Describe the roles of national and international organizations in the determination of guidelines affecting cytogenetic diagnostic testing;
1.3. Participate in discussion regarding public policy and decision-making processes with respect to current and future cytogenetic testing (i.e. introduction of new tests, new platforms).

2. Respond to the health care needs of individuals, communities and populations served by cytogenetic diagnostic testing.
   To achieve this, the Cytogenetics Trainee will be able to:
2.1. Recognize and respond to those medical genetic issues where advocacy is appropriate;
2.2. Become informed about community resources and related patient support groups for individuals and families served by cytogenetic testing;
2.3. Liaise effectively with individuals, communities and populations on issues applicable to cytogenetic testing.
2.4. Act as a resource and information source regarding cytogenetic testing for individuals, communities and populations.

**SCHOLAR**

**Key Competencies**

By the end of training, Cytogenetics Trainees will demonstrate the ability to:
1. Conduct ongoing learning activities to maintain and advance professional knowledge;
2. Facilitate the learning of other health care professionals, students, laboratory staff, the public and others regarding cytogenetic testing;
3. Conduct research projects and publish findings for the advancement of knowledge.

**Enabling Competencies**

1. Conduct ongoing learning activities to maintain and advance professional knowledge.
   To achieve this, the Cytogenetics Trainee will be able to:
   1.1. Critically assess the literature as related to human genetics, cytogenetics and diagnostics;
   1.2. Demonstrate commitment to continuing education events, including conferences, rounds, clinical and research seminars, patient conferences;
   1.3. Recognize limitations of current knowledge base and seek appropriate continuing educational activities;
   1.4 Be aware of and maintain accreditation through ongoing CME programs (eg RCPC / CCMG MOC program).
2. Facilitate the learning of other health care professionals, students, laboratory staff, the public and others regarding cytogenetic diagnostic testing.  
*To achieve this, the Cytogenetics Trainee will be able to:*
   2.1 Demonstrate the willingness and ability to enhance and apply teaching skills in the education of colleagues, undergraduate and postgraduate trainees, and other health care professionals;  
   2.2. Deliver effective lectures and presentations on human genetics and cytogenetic concepts;  
   2.3. Present concise and audience appropriate summaries of cytogenetic diagnostic methodologies, clinical situations related to cytogenetic testing and case reports or presentations.  

3. Conduct research projects for the advancement of the field of cytogenetic diagnostics.  
*To achieve this, the Cytogenetics Trainee will be able to:*
   3.1. Plan and conduct a minimum six month research project related to human cytogenetic diagnostics;  
   3.2. Summarize results in a format suitable and present the results to an appropriate audience (e.g. publication in a refereed journal, presentation at a conference or rounds, presentation to laboratory staff);  
   3.3. Identify personal limitations with respect to previous research experience and recognize that an additional year of research may be beneficial in certain situations for promotion and career development.  

**PROFESSIONAL**  

**Key Competencies**  

*By the end of training, Cytogenetics Trainees will demonstrate the ability to:*
  1. Demonstrate ethical practices and a sense of responsibility in cytogenetic testing;  
  2. Demonstrate appropriate respectful behaviour consistent with the role of a clinical cytogenetic diagnostician.  

**Enabling Competencies**  

1. **Demonstrate ethical practices in cytogenetic diagnostic testing.**  
   *To achieve this, the Cytogenetics Trainee will be able to:*
   1.1. Demonstrate understanding of the regulatory framework governing the practice of medicine. These include the Legal system as well as local Medical Advisory Councils, or Appointment Boards, Provincial and Territorial licensing bodies and Federal guidelines;  
   1.2. Maintain confidentiality and ensure appropriate release and protection of cytogenetic samples, data and reports;
1.3. Recognize ethical issues in cytogenetic testing, including but not limited to the process of consent, the needs of the patient vs. the family, the impact of cultural and personal beliefs, end of life decisions, testing of minors, impact of cytogenetic results on extended family members, testing for late onset disorders, prenatal testing and the use of human subjects for research;

1.4. Identify personal limitations and the necessity of seeking the opinions of colleagues or other professionals when required;

1.5. Identify technical laboratory limitations requiring referral to other laboratories.

2. **Demonstrate appropriate respectful behaviour consistent with the role of a clinical cytogenetic diagnostician.**

*To achieve this, the Cytogenetics Trainee will be able to:*

2.1. Demonstrate a professional attitude to clinical and laboratory colleagues, to laboratory staff, students and trainees, and patients;

2.2. Respect the opinions of fellow consultants and referring physicians in the management of patients and be willing to accept differences of opinion;

2.3. Demonstrate the ability to recognize and respond appropriately to abuse, gender bias, discrimination, intimidation, and disrespect;

2.4. Demonstrate the knowledge of how to sustain career satisfaction.

**REFERENCE**