

TECHNOLOGIST IN CYTOGENETICS,CG(ASCP)

EXAMINATION CONTENT GUIDELINE

This document should serve as a useful guide for examination preparation. The Board of Certification criterion-referenced examinations are constructed to measure the competencies described in the Certification Levels Definitions. These competency statements are specified into task definitions, linked to each of the content outlines, and measured by the test items.

It should be noted that for the technologist, the Certification Levels Definitions refer to skills and abilities expected at career entry, not those that may be acquired with subsequent experience.

TECHNOLOGIST LEVEL

Knowledge

The technologist has an understanding of the underlying scientific principles of laboratory testing as well as the technical, procedural, and problem-solving aspects. The technologist has a general comprehension of the many factors which affect health and disease, and recognizes the importance of proper test selection, the numerous causes of discrepant test results (patient and laboratory), deviations of test results, and ethics including result confidentiality. The technologist correlates abnormal laboratory data with pathologic states, determines validity of test results, and need for additional tests. The technologist understands and enforces safety regulations, uses statistical methods and applies business and economic data in decision making. The technologist has an appreciation of the roles and interrelationships of paramedical and other health related fields and follows the ethical code of conduct for the profession.

Technical Skills

- *Performs full range of cytogenetic laboratory procedures.*
- *Participates in the evaluation of new techniques and procedures in the laboratory.*

The technologist is capable of performing and interpreting standard, complex, and specialized tests. The technologist has an understanding of quality assurance sufficient to implement and monitor quality control programs. The technologist is able to participate in the introduction, investigation and implementation of new procedures and in the evaluation of new instruments. The technologist evaluates computer-generated data and troubleshoots problems.

The technologist understands and uses troubleshooting, validation, statistical, computer, and preventative maintenance techniques to insure proper laboratory operation.

Problem Solving and Analytical Decision Making

- *Evaluates and solves problems related to collection and processing of biological specimens for analysis.*
- *Differentiates and resolves technical, instrument, physiologic causes of problems or unexpected test results.*

The technologist has the ability to exercise initiative and independent judgment in dealing with the broad scope of procedural and technical problems. The technologist is able to participate in, and may be delegated, the responsibility for decisions involving: quality control/quality assurance programs, instrument and methodology selection, preventive maintenance, safety procedures, reagent purchases, test selection/utilization, research procedures, and computer/statistical data.

Communication

- *Provides administrative and technical consulting services on laboratory testing.*

The technologist communicates technical information such as answering inquiries regarding test results, methodology, test specificity and sensitivity and specific factors that can influence test results to other health professionals and consumers. The technologist develops acceptable criteria, laboratory manuals, reports, guidelines, and research protocols.

Teaching and Training Responsibilities

- *Incorporates principles of educational methodology in the instruction of laboratory personnel, other health care professionals and consumers.*

The technologist provides instruction in theory, technical skills, safety protocols, and application of laboratory test procedures. The technologist provides continuing education for laboratory personnel and maintains technical competence. The technologist may participate in the evaluation of the effectiveness of educational programs.

Supervision and Management

- *Gives direction and guidance to technical and support personnel.*

The technologist has an understanding of management theory, economic impact and management functions. The technologist participates in and takes responsibility for establishing technical and administrative procedures, quality control/quality assurance, standards of practice, safety and waste management procedures, information management and cost effective measures. The technologist supervises laboratory personnel.

THE EXAMINATION MODEL

The Board of Certification criterion-referenced examination model consists of three interrelated components:

COMPETENCY STATEMENTS describe the entry level skills and tasks performed and measured on the examination.

CONTENT OUTLINE delineates general categories or subtest areas of the examination.

TAXONOMY levels describe the cognitive skills required to answer the question.

- Level 1 - Recall:** Ability to recall or recognize previously learned (memorized) knowledge ranging from specific facts to complete theories.
- Level 2 - Interpretive Skills:** Ability to utilize recalled knowledge to interpret or apply verbal, numeric or visual data.
- Level 3 - Problem Solving:** Ability to utilize recalled knowledge and the interpretation/application of distinct criteria to resolve a problem or situation and/or make an appropriate decision.

EXAMINATION REPORTING MECHANISMS

After the examination has been administered and scored, a report is sent to the examinee. The Examinee Performance Report provides the scaled score on the total examination and pass/fail status for all candidates.

In addition, failing candidates receive scaled scores for each subtest. This information may help the examinee identify areas of strengths and weaknesses in order to develop a study plan for future examinations. A score of 400 on both Parts I and II on the same day is required to pass the examination. The subtest percentages for the CG examination are listed below:

CG PART I	
SUBTESTS	PERCENTAGE
Specimen Preparation, Culture, and Harvest	32%
Chromosome Banding and Staining Techniques	7%
Fluorescence In-Situ Hybridization (FISH)	6%
Microscope and Imaging Equipment Operation and Maintenance	10%
Chromosome Analysis	33%
Professional Laboratory Practice	12%
CG PART II	
SUBTESTS	PERCENTAGE
Metaphase Chromosome Display	50%
Karyotype Display	50%

COMPETENCY STATEMENTS

TECHNOLOGIST IN CYTOGENETICS

In regards to Laboratory Operations and the performance of laboratory tests involving Cytogenetic Techniques, the Technologist in Cytogenetics:

APPLIES KNOWLEDGE OF

- basic and special laboratory procedures
- sources of error
- fundamental characteristics of cytogenetic theory/cytogenetic biology
- theories and practice related to laboratory operations
- standard operating procedures
- fundamental theories of genetics

SELECTS APPROPRIATE

- course of action for method and test requested
- methods, instruments, reagents and controls
- routine and special laboratory procedures to verify tests results

PREPARES APPROPRIATE INSTRUMENTS, REAGENTS AND CONTROLS

CALCULATES RESULTS

ASSESSES TEST RESULTS BY CORRELATING LABORATORY DATA WITH

- clinical data
- quality control data
- physiologic processes to validate results and procedures

EVALUATES LABORATORY DATA TO

- recognize health and disease states
- make identifications
- verify test results for reporting
- resolve possible inconsistent results/sources or error
- check for procedural/technical problems
- determine appropriate instrument adjustments
- take corrective action
- assess test for procedural validity/accuracy
- recognize and report abnormal test results and/or the need for additional testing
- determine alternate test methods
- establish laboratory operational/testing procedures
- establish reference range criteria
- establish new testing procedures for alternate methods
- assure personnel safety

CONTENT OUTLINE

TECHNOLOGIST IN CYTOGENETICS

Refer to the Competency Statements for the competencies tested in each subtest.

PART I

I. SPECIMEN PREPARATION, CULTURE, and HARVEST (32%)

A. Select Appropriate Methods for Specimen Collection and Transport

1. Provide collection procedure parameters (e.g., phlebotomy, bone marrow aspiration, amniocentesis, skin biopsies)
2. Treat a sample using appropriate antibiotics
3. Transport a sample using appropriate
 - a. Containers and media
 - b. Conditions (e.g., temperature, time, sterility)
4. Assess and handle specimens by
 - a. Type
 - 1) Peripheral blood, cord blood, periumbilical blood (PUBS)
 - 2) Bone marrow and core biopsy
 - 3) Amniotic fluid
 - 4) Solid tissues (e.g., skin biopsies, products of conception)
 - 5) Chorionic villi
 - 6) Lymph nodes, tumors, malignant effusions
 - b. Quality
 - 1) Volume
 - 2) Viability
 - 3) Bacterial or fungal contamination
 - 4) Presence of clots
 - 5) Color
5. Troubleshoot compromised/unacceptable specimens
6. Notify appropriate authorities (e.g., supervisor/director) of compromised/unacceptable specimens
7. Split samples appropriately for multiple tests

B. Enter or Verify Appropriate Data

1. Confirm
 - a. Patient information (e.g., name, identification number, date of birth, sex, clinical history, indication for study, referring physician, billing information)
 - b. Specimen information (e.g., type of specimen, quality, date/time of collection)
2. Confirm appropriate test, priority status, and patient data based on reason for referral

C. Select Appropriate Culture System

1. Method type (e.g., suspension, in-situ, or monolayer)
2. Appropriate tissue for culture (e.g., products of conception, maternal vs. decidua)
3. Method for specimen preparation (e.g., mince, enzymatic)
4. Media selection and preparation
 - a. Prepare media and supplements (e.g., buffers, growth factors, fetal bovine serum, mitogens, essential amino acids, and antibiotics)
 - b. Perform tests to assess sterility and ability to support growth prior to use
5. Culture conditions/additives for
 - a. Routine tests
 - b. Special tests (e.g., breakage syndromes, B cell mitogens, growth factors)
6. Select/determine appropriate number of cultures and inoculation based on cell count and cellularity (e.g., leukemic specimens)
7. Select incubation period

D. Perform Aseptic Culture Techniques

1. Prevent microbial contamination (e.g., bacterial, fungal, or mycoplasma)
2. Prevent cross-contamination between cultures by using
 - a. Appropriate labeling techniques
 - b. Physical isolation techniques (e.g., handling single specimens)

E. Monitor and Document Cell Growth

1. Detect, identify, and control bacterial, fungal, and mycoplasma contamination (e.g., appearance, special stains, chemical tests)
2. Maintain cultures
3. Evaluate and subculture monolayer cells using enzymatic treatment (e.g., trypsin)
4. Select for harvest
5. Recognize and troubleshoot culture failures

F. Select Appropriate Techniques for Harvest

1. Harvest type
 - a. Suspension (e.g., direct, 24-hour, 72-hour)
 - b. In-situ (colonies)
 - c. Culture flask of an adherent cell population (monolayer)
2. Chromosome elongation
 - a. Synchronization and release agents (e.g., thymidine, MTX)
 - b. Intercalation agents (e.g., ethidium bromide, actinomycin D)
3. Mitotic inhibitors
4. Hypotonic solutions
5. Fixation process
6. Cell pellet storage

G. Prepare Slides

1. Assess slide quality by phase microscopy
 - a. Mitotic index
 - b. Chromosome morphology
 - c. Appropriate spreading (e.g., intact cells free of cytoplasm)
2. Age slides appropriately
3. Troubleshoot by adjusting
 - a. Ambient conditions
 - b. Cell concentrations

H. Evaluate Harvest

1. Assess harvest quality
2. Troubleshoot harvest errors associated with
 - a. Outdated or improperly prepared reagents
 - b. Missing or improper reagent steps
 - c. Mixed specimens

II. CHROMOSOME BANDING AND STAINING TECHNIQUES (7%)

A. Select and Process Slides

1. Perform G-banding using an enzyme (e.g., trypsin, pancreatin)
2. Choose appropriate mounting medium and coverslips
3. Store slides as required by regulation

B. Assess and Troubleshoot Banding/Staining Quality Regarding

1. Slide aging
2. Reagent exposure time (e.g., enzyme, stain)
3. Stain intensity
4. Environmental factors (e.g., temperature, humidity, pH)

III. FLUORESCENCE IN-SITU HYBRIDIZATION (FISH) (6%)

A. Prepare Slides and Perform FISH

1. Evaluate analysis type (e.g., interphase or metaphase)
2. Denature probe and target
3. Hybridize probe to target
4. Perform post-hybridization wash
5. Use appropriate counterstain

B. Analyze Slides, Target, and Control Signals

1. Select correct filter(s) for fluorescence microscopy
2. Score appropriate type and number of cells including
 - a. Interphase (e.g., prenatal, hematologic, tumor)
 - b. Metaphase (e.g., microdeletion, markers)
3. Capture and image cells of representative field

IV. MICROSCOPE AND IMAGING EQUIPMENT OPERATION AND MAINTENANCE (10%)

A. Operate and Maintain Microscopes (e.g., standard, compound, phase, fluorescence, inverted, stereo)

1. Identify microscope components
2. Achieve optimal resolution by
 - a. Establishing Köhler illumination
 - b. Using appropriate immersion oil
 - c. Selecting appropriate
 - 1) Magnification
 - 2) Cover glass thickness
3. Troubleshoot microscopy
4. Maintain microscope

B. Operate Imaging System

1. Capture images of optimal resolution
2. Enhance images
3. Troubleshoot image enhancement

V. CHROMOSOME ANALYSIS (33%)

A. Select and Analyze Suitable Metaphases in a Systematic Manner

1. Select analysis criteria including
 - a. Chromosome morphology (e.g., stain intensity, background staining, number of chromosome overlaps)
 - b. Suitable
 - 1) Banding level for referral diagnosis
 - 2) Number of metaphases to analyze
2. Review previous results when available
3. Analyze cells from the appropriate number of cultures
4. Document analysis including
 - a. Chromosome count
 - b. Chromosome analysis (e.g., band for band)
 - c. Vernier coordinates
 - d. Colonies for in-situ cultures and primary cultures for in-situ and non in-situ cultures
 - e. Metaphase identifiers (e.g., 12 o'clock chromosome)
5. Troubleshoot difficulties in analysis
6. Repeat culture after evaluating the need for additional studies

- B. Prepare Accurate Karyotypes from Images**
 1. Select good quality images
 2. Arrange chromosomes using approved format
 3. Prepare an appropriate number of karyotypes
 4. Provide permanent copy of final karyotype
- C. Identify and Document Constitutional or Acquired Chromosome Abnormalities Using a Variety of Techniques (e.g., G-, Q-, and C-banding, NOR, DA_DAPI, conventional staining) and Evaluate Clinical Implications for**
 1. Numerical
 2. Structural
 3. Mosaicism-vs-chimerism
 4. Cultural artifacts (e.g., pseudomosaicism)
 5. Marker chromosomes
 6. Normal variants
- D. Use Established Format for Recording Results**
 1. Record results using ISCN
 2. Report and document preliminary results
 3. Refer to previous studies and/or literature searches

VI. PROFESSIONAL LABORATORY PRACTICE (12%)

- A. Laboratory Practice**
 1. Prepare, label, and store reagents
 2. Operate and maintain laboratory equipment and instruments (e.g., record daily temperature, % CO₂, % O₂, humidity)
 3. Perform sterilization/decontamination procedures
 4. Follow appropriate cleaning procedures for laboratory instruments, equipment, and work surfaces
 5. Monitor adequate stocks and expiration dates of laboratory supplies and chemicals
- B. Laboratory Safety**
 1. Follow Standard Precautions for biological hazards using
 - a. Primary barriers (e.g., PPE)
 - b. Secondary barriers (e.g., biological safety cabinet)
 Follow
 - a. Material Safety Data Sheet guidelines
 - b. Emergency procedures (e.g., eye wash, spill clean-up)
 3. Use correct procedures to store, handle, and dispose of sharps and glass materials/waste
 4. Practice proper ergonomics (e.g., chair adjustment, posture)
 5. Document and investigate all laboratory accidents (e.g., needle sticks, spills, splashes)
 6. Document participation in required safety training

- C. Quality Management and Continuous Quality Improvement**
 1. Monitor equipment function and report deviations
 2. Perform preventative maintenance of equipment
 3. Maintain quality control records of
 - a. Culture failure/contamination
 - b. Growth support for media components
 - c. Reagent performance
 4. Record quality indicators as directed (e.g., band length, turn-around time)
 5. Participate in laboratory proficiency testing and accreditation site inspections
 6. Document training for competency assessment
 7. Verify accuracy and reproducibility results
- D. Professional Standards**
 1. Maintain patient confidentiality and security of patient records
 2. Identify and report a breach of professional ethics and/or standards (e.g., confidentiality, interpersonal interactions, integrity)
 3. Respond to inquiries regarding laboratory tests (e.g., methodology, specimen requirements, reference values, collection procedures)
 4. React to requests of on-site laboratory inspectors

PART II

Chromosome and karyotype displays representing the following may be used for the Part II examination:

I. METAPHASE CHROMOSOME DISPLAY (50%)

A. Group A-G

1. Identification
2. Orientation
3. Structural abnormalities
4. Numerical abnormalities

B. Sex Chromosomes

1. Identification
2. Orientation
3. Structural abnormalities
4. Numerical abnormalities

C. General

1. Karyotype identification using ISCN nomenclature
2. Chromosome classification
 - a. Metacentric
 - b. Submetacentric
 - c. Acrocentric
3. Band level
 - a. < 400
 - b. 450 – 550
 - c. 600 – 750
 - d. > 800
4. Constitutional abnormalities
5. Acquired abnormalities
6. Normal variants or marker chromosomes
7. Clinical implications of karyotype

II. KARYOTYPE DISPLAY (50%)

A. Group A-G

1. Identification
2. Orientation
3. Structural abnormalities
4. Numerical abnormalities

B. Sex Chromosomes

1. Identification
2. Orientation
3. Structural abnormalities
4. Numerical abnormalities

C. General

1. Karyotype identification using ISCN nomenclature
2. Chromosome classification
 - a. Metacentric
 - b. Submetacentric
 - c. Acrocentric
3. Band level
 - a. < 400
 - b. 450 – 550
 - c. 600 – 750
 - d. > 800
4. Constitutional abnormalities
5. Acquired abnormalities
6. Normal variants or marker chromosomes
7. Clinical implications of karyotype

All Board of Certification examinations use conventional units for results and reference ranges.

You will need to bring a non-programmable calculator with log function to the examination.

END OF CONTENT GUIDELINE