American Society for Clinical Pathology
Board of Certification

# TECHNOLOGIST IN CHEMISTRY, C(ASCP) and SPECIALIST IN CHEMISTRY, SC(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. Certification Levels are hierarchical and it is assumed that the specialist level encompasses knowledge and skills of the preceding technologist level.

## 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 chemical 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 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 troubleshooting problems. The technologist understands and uses troubleshooting, validation, statistical, computer, and preventive 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 education 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.

## SPECIALIST LEVEL

**Knowledge**

The specialist has knowledge of advanced scientific principles as well as the technical, procedural and research aspects of laboratory testing in the specialty area and of factors that influence disease processes and laboratory tests. The specialist has knowledge of the structure and function of the organization, principles of management and education as well as the roles of other members of the health care team.

**Technical Skills**

- *Performs and establishes laboratory procedures for the specialty area.*

The specialist is able to perform all laboratory tests and appropriate equipment maintenance in the specialty area. The specialist has the knowledge, ability and technical skill to research, develop, implement and evaluate new and existing methodologies, including instrumentation and quality assurance.

**Problem Solving and Analytical Decision Making**

- *Develops and implements plans to correct and prevent problems.*

The specialist is capable of implementing and delegating decisions regarding laboratory operation and exercising independent judgment in problem solving. The specialist is able to anticipate and respond to unique situations regarding patients and/or samples in a laboratory setting. The specialist can participate in policy decisions affecting laboratory performance or laboratory personnel in the specialty area.

**Communication**

- *Represents the specialty to the health care community and consumers.*

The specialist is able to communicate in depth with other health care personnel on the application and validity of laboratory data as well as the policies and operation of the specialty area. The specialist is capable of representing the specialty area to the community at large.

**Teaching and Training Responsibilities**

- *Designs and presents educational programs.*

The specialist has the ability to plan, implement, and evaluate effective educational programs and maintains technical competence.

**Supervision and Management**

- *Performs and directs administrative functions for the specialty area.*

The specialist is capable of planning, directing, controlling and evaluating the overall operation of the laboratory in the specialty area. Implicit is the capability to provide direct supervision of other personnel in that discipline.

## 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 total score of 400 is required to pass the examination. The subtest percentages for the C and SC examinations are listed below:

| SUBTEST | C and SC |
|---|---|
| General Chemistry (GC) | 15% |
| Protein and Enzymes (PE) | 15% |
| Acid-Base, Blood Gases and Electrolytes (EAB) | 15% |
| Hormones and Vitamins (HV) | 15% |
| Toxicology and Therapeutic Drug Monitoring (TT) | 10% |
| Instrumentation and Analytical Techniques (INST) | 10% |
| Laboratory Operations (LO) | 20% |

# COMPETENCY STATEMENTS
TECHNOLOGIST IN CHEMISTRY

*In regard to Laboratory Operations and the performance of laboratory tests involving General Chemistry, Proteins and Enzymes, Acid-Base, Blood Gases and Electrolytes, Hormones and Vitamins at career entry, the Technologist in Chemistry:*

**APPLIES KNOWLEDGE OF**
- principles of basic and special laboratory procedures
- sources of error
- fundamental biological characteristics
- theories and practice related to laboratory operations
- standard operating procedures

**SELECTS APPROPRIATE**
- type of sample and method for test requested
- instruments, reagents and controls
- routine and special procedures to verify test results

**PREPARES APPROPRIATE INSTRUMENTS, REAGENTS AND CONTROLS**

**CALCULATES RESULTS**

**ASSESSES TEST RESULTS BY CORRELATING LABORATORY DATA WITH**
- clinical data
- other laboratory data
- physiologic processes to validate results and procedures
- quality control data

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

# COMPETENCY STATEMENTS

SPECIALIST IN CHEMISTRY

*In regard to Laboratory Operations and the performance of laboratory tests involving General Chemistry, Proteins and Enzymes, Acid-Base, Blood Gases and Electrolytes, Hormones and Vitamins at career entry, the Specialist in Chemistry:*

**APPLIES KNOWLEDGE OF**

- principles of basic and special laboratory procedures
- sources of error
- fundamental biological characteristics
- theories and practice related to laboratory operations and management
- standard operating procedures
- theories and practice to clinical laboratory teaching and research and development

**SELECTS APPROPRIATE**

- type of sample and method for test requested
- instruments, reagents, controls and standards
- routine and special procedures to verify test results

**PREPARES APPROPRIATE**

- instruments
- reagents
- controls and standards
- educational materials

**CALCULATES RESULTS**

**ESTABLISHES**

- procedures to facilitate laboratory accreditation
- new reference ranges
- policies and procedures for laboratory operations and testing
- procedures for alternate test methodologies

**ASSESSES TEST RESULTS BY CORRELATING LABORATORY DATA WITH**

- clinical data
- other data to assess accuracy or to assess test methods
- physiologic processes to validate results and procedures
- quality control or other laboratory data

**EVALUATES LABORATORY DATA TO**

- recognize related health and disease states
- make identifications
- verify test results for reporting
- resolve possible inconsistent results/sources of error
- check for procedural/technical problems
- determine appropriate instrument adjustments
- take corrective action
- assess test for procedural validity/accuracy
- validate quality assurance
- assess new technology and scientific advancements for possible implementation
- recognize and report abnormal test results and/or the need for additional testing
- refine laboratory operational/testing procedures and policies
- measure the performance of clinical laboratory students
- determine alternate testing method

# CONTENT OUTLINE

## TECHNOLOGIST (C) AND SPECIALIST (SC) IN CHEMISTRY

*Refer to the C and SC Competency Statements for the competencies tested in each subtest.*

I. **GENERAL CHEMISTRY** (15%)
- A. **Carbohydrates**
  1. Biochemical theory and physiology
     - a. Metabolic pathways
     - b. Normal and abnormal states
     - c. Physical and chemical properties
  2. Test procedures
     - a. Principles
     - b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
     - c. Tolerance testing
     - d. Glycated proteins
  3. Test result interpretation
- B. **Lipids**
  1. Biochemical theory and physiology
     - a. Metabolic pathways
     - b. Normal and abnormal states
     - c. Physical and chemical properties
       - 1) lipoproteins
       - 2) phospholipids
       - 3) triglycerides
       - 4) cholesterol
       - 5) apolipoproteins
  2. Test procedures
     - a. Principles
     - b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
  3. Test result interpretation
- C. **Heme Derivatives**
  1. Biochemical theory and physiology
     - a. Metabolic pathways
     - b. Normal and abnormal states
     - c. Physical and chemical properties
       - 1) porphyrins
       - 2) hemoglobin
       - 3) bilirubin
       - 4) urobilinogen
  2. Test procedures
     - a. Principles
     - b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
  3. Test result interpretation

II. **PROTEINS AND ENZYMES** (15%)
- A. **Enzymes**
  1. Biochemical theory and physiology
     - a. Metabolic pathways
     - b. Normal and abnormal states
     - c. Physical and chemical properties
       - 1) LD
       - 2) CK
       - 3) AST/ALT
       - 4) GGT
       - 5) lipase
       - 6) amylase
       - 7) alkaline phosphatase
       - 8) other enzymes
  2. Test procedures
     - a. Principles
     - b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
  3. Test result interpretation
- B. **Proteins and Other Nitrogen Containing Compounds**
  1. Biochemical theory and physiology
     - a. Metabolic pathways
     - b. Normal and abnormal states
     - c. Physical and chemical properties
       - 1) proteins
       - 2) amino acids
       - 3) urea
       - 4) uric acid
       - 5) creatinine
       - 6) ammonia
       - 7) tumor markers
       - 8) viral proteins
       - 9) cardiac markers (e.g., troponin, myoglobin)
       - 10) other compounds
  2. Test procedures
     - a. Principles
     - b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
     - c. Clearances
  3. Test result interpretation

**III. ACID-BASE, BLOOD GASES AND ELECTROLYTES** (15%)

**A. Acid-Base Determinations (Including Blood Gases)**

1. Biochemical theory and physiology
   a. Henderson-Hasselbach equation
   b. pH and $H^+$ ion concentration
   c. $CO_2$ and $O_2$ transport
   d. Normal and abnormal states
2. Test procedures
   a. Analytical principles
   b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
3. Test result interpretation

**B. Electrolytes**

1. Biochemical theory and physiology
   a. Sodium, potassium, chloride, $CO_2$, bicarbonate
   b. Calcium, magnesium, phosphorus, iron, TIBC
   c. Trace elements (e.g., copper, selenium)
   d. Normal and abnormal states
2. Test procedures
   a. Principles
   b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
   c. Calculations (osmolality, anion gap)*
3. Test result interpretation

**IV. HORMONES AND VITAMINS** (15%)

**A. Endocrinology**

1. Biochemical theory and physiology
   a. Metabolic pathways
   b. Normal and abnormal states
   c. Mechanism of action
   d. Physical and chemical properties
      1) steroid hormones
      2) peptide hormones
      3) thyroid hormones
      4) other hormones
2. Test procedures
   a. Principles
      1) fluorescence
      2) immunoassay
      3) chromatography
      4) other methods
   b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
   c. Stimulation/suppression tests
3. Test result interpretation

**B. Vitamins and Nutrition**

1. Biochemical theory and physiology
   a. Metabolism and action
   b. Normal and abnormal states
   c. Properties
2. Test procedures
   a. Principles
   b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
3. Test result interpretation

**V. TOXICOLOGY AND THERAPEUTIC DRUG MONITORING** (10%)

**A. Therapeutic Drug Monitoring**

1. Pharmacokinetics
   a. Therapeutic states
   b. Toxic states
   c. Metabolism and excretion
2. Chemical and physical properties
   a. Aminoglycosides
   b. Cardioactive
   c. Anti-convulsants
   d. Anti-depressants
   e. Immunosuppressants
   f. Other drugs
3. Test procedures
   a. Principles
      1) immunoassay
      2) chromatography
      3) other methods
   b. Special precautions, specimen collection and processing, troubleshooting and interfering substances
4. Test result interpretation

**B. Toxicology**

1. Toxicokinetics
   a. Toxic effects, signs and symptoms
   b. Metabolism and excretion
2. Chemical and physical properties
   a. Alcohols
   b. Heavy metals
   c. Analgesics
   d. Drugs of abuse
   e. Other toxins
3. Test procedures
   a. Principles
      1) immunoassay
      2) chromatography
      3) other assays
   b. Special precautions, specimen collections and processing, troubleshooting and interfering substances
4. Test result interpretation

**Any commonly used formula is acceptable for examination purposes.*

**VI. INSTRUMENTATION AND ANALYTICAL TECHNIQUES** (10%)

- **A. Spectrophotometry and Photometry**
  1. Atomic absorption
  2. Photometry (ultraviolet to infrared)
  3. Fluorescence
  4. Nephelometry/turbidimetry
  5. Reflectance
- **B. Mass Spectrometry**
- **C. Osmometry**
- **D. Computers**
- **E. Automated Analytical Systems**
  1. General chemistry
  2. Immunoassays
  3. Other
- **F. Electrophoresis**
- **G. Chromatography**
- **H. Electrochemistry**
  1. Potentiometry (including blood gas analyzers)
     - a. pH
     - b. $pCO_2$
     - c. $pO_2$
     - d. Ion selective electrodes
     - e. Other applications
  2. Coulometry
- **I. Centrifuges and Balances**
- **J. Molecular Techniques**
- **K. Point-of-Care Testing (POCT)**

**VII. LABORATORY OPERATIONS FOR TECHNOLOGIST IN CHEMISTRY ONLY** (20%)

- **A. Mathematics**
  1. Reagents
  2. Graphs (Beers Law)
  3. Statistics
  4. Method evaluation
  5. Other calculations
- **B. Quality Assurance**
- **C. Safety**
- **D. Management**
- **E. Research and Development**
- **F. Education**

**VIII. LABORATORY OPERATIONS FOR SPECIALIST IN CHEMISTRY ONLY** (20%)

- **A. Mathematics**
  1. Reagents
  2. Graphs (Beers Law)
  3. Statistics
  4. Method evaluation
  5. Other calculations
- **B. Management and Quality Assurance**
  1. Planning
     - a. Setting goals and objectives
     - b. Budget development
     - c. Applied research and/or development
  2. Organizing
     - a. Personnel
     - b. Work flow
     - c. Computer operations
     - d. Interpersonal relations
     - e. Interdepartmental relations
  3. Staffing
     - a. Selection
     - b. Training
     - c. Evaluation
     - d. In-service education
  4. Directing
     - a. Communication (internal and external)
     - b. Productivity
     - c. Leadership
     - d. Motivation
  5. Controlling
     - a. Infection prevention and safety
     - b. Laboratory certification (including regulations)
     - c. Performance standards (QC)
     - d. Inventory and purchases

*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**