ASCP BOARD OF CERTIFICATION

VALID ONLY FOR MLS(ASCP) AND MLS(ASCP^i) TESTING DATES BEGINNING JANUARY 1, 2022

MEDICAL LABORATORY SCIENTIST, MLS(ASCP)
INTERNATIONAL MEDICAL LABORATORY SCIENTIST, MLS(ASCP^i)

EXAMINATION CONTENT GUIDELINE

EXAMINATION MODEL

The MLS(ASCP) and MLS(ASCP^i) certification examination is composed of 100 questions given in a 2 hour 30 minute time frame. All exam questions are multiple-choice with one best answer. The certification exam is administered using the format of computer adaptive testing (CAT).

With CAT, when a person answers a question correctly, the next test question has a slightly higher level of difficulty. The difficulty level of the questions presented to the examinee continues to increase until a question is answered incorrectly. Then a slightly easier question is presented. In this way, the test is tailored to the individual's ability level.

Each question in the test bank is calibrated for level of difficulty and is classified by content area. The content area aligns with the examination specific content outline. The examinee must answer enough questions correctly to achieve a measure above the pass point in order to successfully pass the certification examination. There is no set number of questions one must answer to pass, nor is there a set percentage one must achieve to pass. If at the end of the exam the examinee's score is above the pass point, then he or she passes the exam.

EXAMINATION CONTENT AREAS

The MLS exam questions encompass different content areas within Medical Laboratory Science: Blood Banking, Urinalysis and Other Body Fluids, Chemistry, Hematology, Immunology, Microbiology, and Laboratory Operations. Each of these content areas comprise a specific percentage of the overall 100-question exam. The content areas and percentages are described below:

CONTENT AREA	DESCRIPTION	EXAM PERCENTAGE
BLOOD BANKING	Blood products, blood group systems, blood group immunology, physiology and pathophysiology, serologic and molecular testing, transfusion practice	**17 – 22%**
URINALYSIS AND OTHER BODY FLUIDS	Physical and chemical testing, microscopic analysis, physiology, disease states	**5 – 10%**
CHEMISTRY	Carbohydrates, lipids, heme derivatives, enzymes, proteins and other nitrogen-containing compounds, acid-base determinations (including blood gases), electrolytes, endocrinology, vitamins and nutrition, therapeutic drug monitoring, toxicology	**17 – 22%**
HEMATOLOGY	Physiology, disease states, laboratory testing, hemostasis (including physiology, disease states, and laboratory determinations)	**17 – 22%**
IMMUNOLOGY	Principles of immunology, diseases of the immune system, transplantation, infectious disease serology, serologic procedures, test results	**5 – 10%**
MICROBIOLOGY	Preanalytic procedures; analytic procedures for bacteriology; analytic procedures for mycobacteriology, virology, parasitology, and mycology; postanalytic procedures	**17 – 22%**
LABORATORY OPERATIONS	Quality assessment/troubleshooting, safety, laboratory mathematics, manual/automated methodology and instrumentation, basic management principles, education principles	**5 – 10%**

For a more specific overview of the MLS exam, please refer to the **CONTENT OUTLINE** starting on page 2.

- **C. Antigen-Antibody Interactions**
  1. Principles
  2. Testing
     a. Principles
     b. Methods
- **D. Complement**
  1. Classical and alternative pathway mechanisms
  2. Biologic properties

IV. PHYSIOLOGY AND PATHOPHYSIOLOGY

- **A. Physiology of Blood**
  1. Circulation and blood volume
  2. Composition and function of blood
     a. Normal function
     b. Abnormal physiology
  3. Cell survival
  4. Cell metabolism
- **B. Hemostasis and Coagulation**
  1. Coagulation factors and disorders
  2. Platelet functions and disorders
- **C. Hemolytic Disease of the Fetus and Newborn**
  1. Pathophysiology
  2. Detection
  3. Treatment
  4. Prevention
- **D. Anemias**
  1. Congenital and acquired
     a. Pathophysiology
     b. Detection
     c. Treatment
  2. Immune hemolytic anemias: warm, cold, drug-induced
     a. Pathophysiology
     b. Detection
     c. Treatment
- **E. Transplantation**
  1. Solid organ
  2. Hematopoietic progenitor cell (HPC)

V. SEROLOGIC AND MOLECULAR TESTING

- **A. Routine Tests**
  1. Blood grouping tests
  2. Compatibility tests
     a. Antibody detection
     b. Crossmatch
  3. Antibody identification/clinical significance
  4. Direct antiglobulin testing
- **B. Reagents**
  1. Antiglobulin sera
  2. Blood grouping sera
  3. Reagent red cells
- **C. Application of Special Tests and Reagents**
  1. Enzymes
  2. Enhancement media
  3. Lectins
  4. Adsorptions
  5. Elutions
  6. Titrations
  7. Cell separations
  8. ELISA
  9. Molecular techniques
  10. Neutralization/inhibition
  11. Use of thiol reagents
  12. Immunofluorescence
  13. Solid phase
  14. Column agglutination test
  15. Chloroquine diphosphate
  16. EDTA glycine-acid
- **D. Leukocyte/Platelet Testing**
  1. Cytotoxicity
  2. Platelet testing
- **E. Quality Assurance**
  1. Blood samples
  2. Reagents
  3. Test procedures

VI. TRANSFUSION PRACTICE

- **A.** Indications for Transfusion
- **B.** Component Therapy
- **C.** Adverse Effects of Transfusion
  1. Immunologic reactions
  2. Nonimmunologic reactions
  3. Transfusion-transmitted diseases
- **D.** Apheresis and Extracorporeal Circulation
- **E.** Blood Administration and Patient Blood Management

6) Amylase
7) Alkaline phosphatase
8) Angiotensin converting enzyme

2. Test procedures
   a. Principles
   b. Special precautions, specimen collection and processing, troubleshooting, and interfering substances
3. Test result interpretation
4. Disease state correlation

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) Cardiac markers
2. Test procedures
   a. Principles
   b. Special precautions, specimen collection and processing, troubleshooting, and interfering substances
   c. Clearances
3. Test result interpretation
4. Disease state correlation

III. ACID-BASE, BLOOD GASES AND ELECTROLYTES

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
4. Disease state correlation

B. Electrolytes

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

IV. SPECIAL CHEMISTRY

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 (e.g., cortisol, estrogen, hCG)
      2) Peptide hormones (e.g., insulin, prolactin)
      3) Thyroid hormones
      4) Catecholamines
2. Test procedures
   a. Principles
      1) Fluorescence
      2) Immunoassay
   b. Special precautions, specimen collection and processing, troubleshooting, and interfering substances
   c. Stimulation/suppression tests
3. Test result interpretation
4. Disease state correlation

- **C. Platelets**
  1. Quantitative abnormalities
     - a. Thrombocytopenia
       1) Increased destruction (e.g., ITP, TTP, HIT)
       2) Decreased production
       3) Pseudothrombocytopenia
     - b. Thrombocytosis
  2. Qualitative defects
     - a. von Willebrand disease
     - b. Bernard-Soulier syndrome
     - c. Glanzmann thrombasthenia

III. HEMATOLOGY LABORATORY TESTING

- **A. Cell Counts (to include blood and body fluids)**
  1. Manual
  2. Automated
  3. Reticulocytes
  4. Spurious results
- **B. Differentials and Morphology Evaluation (to include blood and body fluids)**
- **C. Hemoglobin**
  1. Quantitative
  2. Qualitative
     - a. Electrophoresis
     - b. HPLC
     - c. Sickle solubility
- **D. Hematocrit**
- **E. Indices**
- **F. Hemolytic Indicators (e.g., haptoglobin, LD)**
- **G. Special Stains**
  1. Esterase
  2. Myeloperoxidase
  3. Prussian blue
  4. Kleihauer-Betke
- **H. Other Studies**
  1. ESR
  2. G-6-PD
  3. Heinz body
- **I. Flow Cytometry Immunophenotyping**
  1. Leukemia
  2. Lymphoma
  3. Lymphocyte subsets
  4. PNH
- **J. Molecular and Cytogenetic Testing**
  1. Recurring cytogenetic abnormalities (WHO classification)
  2. *BCR/ABL1*
  3. *JAK2*

IV. HEMOSTASIS

- **A. Physiology**
  1. Coagulation pathways
  2. Fibrinolytic pathway
  3. Vascular system
- **B. Disease States**
  1. Coagulation factor deficiencies
     - a. Acquired
     - b. Hereditary
  2. Inhibitors
  3. Fibrinolytic system
  4. Hypercoagulable states
  5. DIC
- **C. Laboratory Determinations**
  1. PT/INR
  2. APTT
  3. Fibrinogen
  4. D-dimer
  5. Thrombin time
  6. Mixing studies
  7. Platelet function (e.g., PFA)
  8. Inhibitor assays
  9. Factor assays
  10. von Willebrand assays
  11. Platelet aggregation
  12. Thromboelastography
  13. Hypercoagulability assessment
      - a. Assays (e.g., lupus anticoagulant, protein S, protein C, HIT studies)
      - b. Molecular (e.g., factor V Leiden, prothrombin 20210)
  14. Anti-Xa
  15. Direct thrombin inhibitors
  16. Heparin neutralization

IMMUNOLOGY

(5 – 10% of total exam)

I. PRINCIPLES OF IMMUNOLOGY

A. Immune System Physiology
1. Primary and secondary response
2. B and T cells, macrophages
3. Genetics

B. Immunoglobulins
1. Classes and subclasses
2. Structure
3. Biologic and physical properties

C. Antigen-Antibody Interactions
1. Principles
2. Testing
   a. Principles
   b. Methods

D. Complement
1. Classical and alternative pathway mechanisms
2. Biologic properties

II. DISEASES OF THE IMMUNE SYSTEM

A. Autoimmunity
1. Systemic (e.g., SLE)
2. Organ-specific (e.g., Graves disease)

B. Hypersensitivity
1. I, II, III, IV

C. Immunoproliferative Diseases
1. Monoclonal gammopathies (e.g., plasma cell myeloma, Waldenström macroglobulinemia)

D. Immunodeficiency
1. Hereditary (e.g., SCID)
2. Acquired (e.g., HIV)

III. TRANSPLANTATION

A. Graft-versus-host Disease

B. HLA Typing

C. Tumor Immunology

IV. INFECTIOUS DISEASE SEROLOGY

A. Clinical Significance and Epidemiology of Viral Pathogens (e.g., hepatitis [A, B, C], EBV, HIV, CMV, rubella, measles)

B. Stages of Infection of *Treponema pallidum* and *Borrelia burgdorferi*

C. Tuberculosis Infection (e.g., interferon-gamma release assay, PPD)

V. SEROLOGIC PROCEDURES

A. ANA

B. Thyroid Antibodies

C. Rheumatoid Factor

D. Labeled Immunoassays (e.g., ELISA)

E. Nontreponemal Syphilis Testing (e.g., RPR)

F. Treponemal Syphilis Testing (e.g., MHATP)

G. Cytokine Testing

H. Immunofluorescence

VI. TEST RESULTS

A. Interpretation

B. Confirmatory Testing

C. Disease State Correlation

MICROBIOLOGY

(17 – 22% of total exam)

I. PREANALYTIC PROCEDURES

A. Specimen Collection and Transport
1. Patient identification and specimen labeling
2. Specimen collection
3. Specimen transport systems and conditions for all organisms

B. Specimen Processing
1. Specimen prioritization and rejection criteria
2. Biosafety cabinet and personal protective equipment
3. Specimen preparation methods and applications
4. Media
5. Inoculation of media
6. Incubation conditions (e.g., temperature, atmosphere, duration)
7. Preparation methods for slides used for stains

C. Stains: Procedure, Principle, and Interpretation
1. Gram
2. Acid-fast
3. Modified acid-fast
4. KOH and calcofluor-white
5. Trichrome
6. Giemsa
7. Acridine orange

II. ANALYTIC PROCEDURES FOR BACTERIOLOGY

A. Blood and Bone Marrow

1. Specimen sources (e.g., peripheral, intravenous catheters)
2. Continuous-monitoring systems
3. Rapid identification/resistance detection methods
4. Species comprising skin flora and clinical significance
5. Colony morphology and identification of major pathogens (e.g., *Staphylococcus aureus*, other *Staphylococcus* spp. including coagulase-negative staphylococci, beta-hemolytic streptococci, *Enterococcus* spp., *Candida* spp*., Streptococcus pneumoniae, Acinetobacter baumannii, Enterobacteriaceae, Pseudomonas* spp.)
6. Common agents of endocarditis
7. Agents of bone marrow infection (e.g., *Brucella* spp., *Salmonella* spp.)
8. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

B. Cerebrospinal Fluid

1. Specimen sources (e.g., lumbar puncture, shunt, reservoir)
2. Colony morphology and identification of major pathogens associated with acute meningitis (e.g., *Streptococcus pneumoniae, Haemophilus influenzae*, *Neisseria meningitidis*, *Escherichia coli*, *Listeria monocytogenes*, *Enterobacteriaceae*, *Staphylococcus aureus*, beta-hemolytic streptococci)
3. Common agents of shunt infections (e.g., other *Staphylococcus* spp. including coagulase-negative staphylococci, *Corynebacterium* spp., *Propionibacterium* spp., *Cutibacterium* spp.)
4. Correlation with other laboratory results (e.g., glucose, protein, cell count)
5. Direct detection and molecular methods
6. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

C. Body Fluids from Normally Sterile Sites

1. Specimen sources (e.g., pleural, peritoneal, pericardial, vitreous and aqueous humor, synovial, amniotic)
2. Indigenous organisms associated with mucosal surfaces and skin
3. Colony morphology and identification of major pathogens (e.g., *Streptococcus pneumoniae*, *Haemophilus influenzae, Neisseria* spp*., Escherichia coli, Listeria monocytogenes, Enterobacteriaceae, Staphylococcus aureus,* beta-hemolytic streptococci, *Enterococcus* spp., *Pseudomonas aeruginosa*, *Acinetobacter* spp*., Clostridium perfringens, Bacteroides fragilis* group)
4. Molecular methods
5. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

D. Lower Respiratory

1. Specimen sources (e.g., sputum, endotracheal aspirate, bronchoalveolar lavage, bronchial wash, bronchial brush)
2. Significance of quantitative and semi-quantitative reporting of results
3. Species comprising oral flora colony and Gram stain morphology
4. Colony morphology and identification of major pathogens
5. Direct detection and molecular methods (e.g., *Streptococcus pyogenes*, *Bordetella pertussis*)
6. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

E. Upper Respiratory

1. Specimen sources (e.g., throat, nasopharynx, middle ear, sinus)
2. Indigenous flora colony and Gram stain morphology
3. Colony morphology and identification of major pathogens
4. Direct detection and molecular methods (e.g., *Streptococcus pyogenes*, *Bordetella pertussis*)
5. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

IV. MANUAL/AUTOMATED METHODOLOGY AND INSTRUMENTATION

- **A.** Basic Laboratory Equipment
- **B.** Spectrophotometry and Photometry
- **C.** Mass Spectrometry
- **D.** Osmometry
- **E.** Electrophoresis
- **F.** Chromatography
- **G.** Electrochemistry
- **H.** Fluorometry
- **I.** Nephelometry
- **J.** Flow Cytometry
- **K.** Molecular Methods
- **L.** Automated Microbiology Processors
- **M.** Hematology Instrumentation

V. BASIC MANAGEMENT PRINCIPLES

VI. EDUCATION PRINCIPLES

Examples provided (as indicated by e.g.) are not limited to those listed.

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

Ketones	< 5 mg/dL or negative	< 0.5 mmol/L or negative
Microscopic		
RBC	0 – 3/HPF	0 – 3/HPF
WBC	0 – 8/HPF	0 – 8/HPF
Casts	0 – 2 hyaline/LPF	0 – 2 hyaline/LPF
Epithelial cells	0 – 5/HPF	0 – 5/HPF

All values on the MLS exam can be interpreted using the reference ranges above. These reference ranges will not be given on the exam. Other reference ranges will be provided as needed on the exam.

END OF CONTENT GUIDELINE