

TECHNOLOGIST AND INTERNATIONAL TECHNOLOGIST IN MICROBIOLOGY, M(ASCP) AND M(ASCPⁱ) SPECIALIST AND INTERNATIONAL SPECIALIST IN MICROBIOLOGY, SM(ASCP) AND SM(ASCPⁱ) EXAMINATION CONTENT GUIDELINE

EXAMINATION MODEL

The M(ASCP), M(ASCPⁱ), SM(ASCP), and SM(ASCPⁱ) certification examinations are 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 exams are 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 M and SM exam questions encompass the following content areas within Microbiology: Preanalytic Procedures; Analytic Procedures for Bacteriology; Analytic Procedures for Mycobacteriology, Virology, Parasitology, and Mycology; 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
PREANALYTIC PROCEDURES	Specimen Collection and Transport, Specimen Processing, and Stains (Procedure, Principle, and Interpretation)	M: 10 – 15% SM: 5 – 10%
ANALYTIC PROCEDURES FOR BACTERIOLOGY	Blood and Bone Marrow, Cerebrospinal Fluid, Body Fluids From Normally Sterile Sites, Lower Respiratory, Upper Respiratory, Gastrointestinal, Skin/Soft Tissue/Bone, Genital Tract, Urine, Identification Methods, Antimicrobial Susceptibility Testing and Antibiotic Resistance, MRSA/MSSA, VRE, ESBL/CRE Screening, BSL-3 Pathogens and Select Agents (Bioterrorism)	M: 45 – 55% SM: 30 – 40%
ANALYTIC PROCEDURES FOR MYCOBACTERIOLOGY, VIROLOGY, PARASITOLOGY, AND MYCOLOGY	Specimen Sources, Major Pathogens, Disease States, Identification Methods, Antimicrobial Susceptibility Testing (SM ONLY), and Serology	M: 20 – 30% SM: 30 – 40%
LABORATORY OPERATIONS	Postanalytic Procedures, Quality Assessment/Troubleshooting, Safety, Laboratory Mathematics, Instrumentation, and Laboratory Administration (SM ONLY)	M: 10 – 15% SM: 20 – 25%

For a more specific overview of the M and SM exams, please refer to the **CONTENT OUTLINE** starting on page 2.

TECHNOLOGIST AND INTERNATIONAL TECHNOLOGIST IN MICROBIOLOGY, M(ASCP) AND M(ASCPⁱ) SPECIALIST AND INTERNATIONAL SPECIALIST IN MICROBIOLOGY, SM(ASCP) AND SM(ASCPⁱ) EXAMINATION CONTENT OUTLINE

Examination questions, which are related to the subtest areas outlined below, may be both theoretical and/or procedural. Theoretical questions measure skills necessary to apply knowledge, calculate results, and correlate patient results to disease states. Procedural questions measure skills necessary to perform laboratory techniques and follow quality assurance protocols. Additionally, regulatory questions are based on U.S. sources (e.g., AABB, FDA, CLIA, etc.).

I. PREANALYTIC PROCEDURES

(M: 10 – 15% of total exam)

(SM: 5 – 10% of total exam)

A. Specimen Collection and Transport

1. Patient identification and specimen labeling
2. Specimen collection
 - a. Sterile technique
 - b. Blood culture collection
 - c. Sites with flora (e.g., stool, wounds, sputum, throat)
3. Specimen transport systems and conditions for all organisms
 - a. Transport devices
 - b. Atmosphere
 - c. Time and temperature

B. Specimen Processing

1. Specimen prioritization and rejection criteria
2. Biosafety cabinet and personal protective equipment
3. Specimen preparation methods and applications
 - a. Concentration
 - b. Digestion/decontamination
 - c. Prevention of cross-contamination
 - d. Sterile technique
 - e. Tissue homogenization
 - f. DNA/RNA extraction
4. Media
 - a. Types (e.g., nutrient, selective, differential, enriched)
 - b. Components
 - c. Application/use
 - d. Selection for specific specimen types and organisms
 - e. Specialized media for recovery of specific, fastidious bacterial species

- f. Media for recovery of mycobacteria and fungi
5. Inoculation of media
 - a. Quantitative
 - b. Semi-quantitative
 - c. Automated plating instrument
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
8. Modified trichrome **(SM ONLY)**

II. ANALYTIC PROCEDURES FOR BACTERIOLOGY

(M: 45 – 55% of total exam)

(SM: 30 – 40% of total exam)

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* species 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* species including coagulase-negative staphylococci, *Corynebacterium spp., Propionibacterium spp., Cutibacterium spp.*)
4. Correlation with other lab 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
 - a. Community-associated pneumonia (e.g., *Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, Legionella pneumophila, Staphylococcus aureus*)
 - b. Healthcare-associated pneumonia (e.g., *Acinetobacter baumannii* complex, *Enterobacteriaceae, Pseudomonas spp., Stenotrophomonas maltophilia, Staphylococcus aureus*)
 - c. Cystic fibrosis (e.g., *Staphylococcus aureus, Pseudomonas spp., Haemophilus influenzae, Burkholderia cepacia* complex)
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
 - a. Pharyngitis (e.g., *Streptococcus pyogenes, Neisseria gonorrhoeae, Arcanobacterium spp., Corynebacterium diphtheria (SM ONLY), Bordetella pertussis (SM ONLY)*)
 - b. Otitis media and sinusitis (e.g., *Haemophilus influenzae, Streptococcus pneumoniae, Moraxella catarrhalis*)
4. Direct detection and molecular methods (e.g., *Streptococcus pyogenes, Bordetella pertussis*)
5. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

F. Gastrointestinal

1. Colony morphology and identification of major pathogens (e.g., *Salmonella* spp., *Shigella* spp., toxigenic *Escherichia coli*, *Campylobacter* spp., *Vibrio* spp., *Yersinia enterocolitica*, *Aeromonas* spp., *Plesiomonas shigelloides*)
2. Direct detection and molecular methods (e.g., *Clostridioides difficile*, Shiga toxin)
3. Serotyping of *Escherichia coli*, *Salmonella* spp., and *Shigella* spp.
4. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)
5. Detection methods for *Helicobacter pylori*

G. Skin, Soft Tissue, and Bone

1. Specimen sources (e.g., wound, abscess, biopsy)
2. Indigenous flora colony and Gram stain morphology
3. Colony morphology and identification of major pathogens
 - a. Skin (e.g., *Staphylococcus aureus*, beta-hemolytic streptococci, *Pseudomonas aeruginosa*)
 - b. Soft tissue (e.g., *Staphylococcus aureus*, beta-hemolytic streptococci, *Enterobacteriaceae*, anaerobes)
 - c. Bone (e.g., *Staphylococcus aureus*, beta-hemolytic streptococci, *Kingella* spp.)
 - d. Bite wound (e.g., *Pasteurella multocida*, *Eikenella corrodens*)
 - e. Zoonotic infections (e.g., *Bacillus anthracis*, *Brucella* spp., *Francisella tularensis*, *Yersinia* spp.)
4. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

H. Genital Tract

1. Specimen sources (e.g., vaginal, cervical, urethral, endocervical)
2. Indigenous organisms colony and Gram stain morphology
3. Methods for detection of pathogens associated with vaginitis (e.g., *Trichomonas vaginalis*, *Candida* spp., bacterial vaginosis)
4. Culture and/or molecular detection (e.g., *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, *Streptococcus agalactiae*, and *Mycoplasma* spp.)

5. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

I. Urine

1. Specimen source (e.g., mid-stream clean-catch, catheterized, suprapubic, nephrostomy)
2. Colony morphology and identification of major urinary pathogens (e.g., *Enterobacteriaceae*, *Enterococcus* spp., *Streptococcus agalactiae*, *Candida* spp., *Staphylococcus saprophyticus*)
3. Correlation of colony counts with clinical significance
4. Correlation of culture with urinalysis results

J. Identification Methods (Theory, Interpretation, and Application)

1. Colony morphology
2. Rapid tests used for presumptive identification (e.g., coagulase, catalase, oxidase, indole, PYR)
3. Conventional biochemical identification
4. Commercial kits
5. Automated methods
6. MALDI-TOF MS
7. Multiplex molecular methods
8. Sequencing (e.g., 16S)

K. Antimicrobial Susceptibility Testing and Antibiotic Resistance

1. Method, theory, interpretation, and application
 - a. Microbroth dilution
 - b. Disk diffusion
 - c. Gradient diffusion
2. Phenotypic detection of resistance (e.g., beta-lactamase, ESBL, inducible clindamycin resistance, carbapenamases)
3. Mechanisms of action of major antibiotic classes
4. Detection of genetic determinants of resistance (e.g., *mecA*, *vanA*, *bla_{KPC}*)
5. Intrinsic resistance patterns for common species
6. Antimicrobials appropriate for reporting by species and body site (**SM ONLY**)

L. MRSA/MSSA, VRE, ESBL/CRE Screening

1. Specimen sources
2. Culture methods
3. Molecular methods

**M. BSL-3 Pathogens and Select Agents
(Bioterrorism)**

1. Specimen source (e.g., blood, sputum, tissue, lymph node)
2. Colony morphology and rapid tests used for presumptive identification (e.g., *Bacillus anthracis*, *Yersinia pestis*, *Brucella* spp., *Francisella tularensis*)
3. Role of regional laboratory and Laboratory Response Network
4. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

B. Virology

1. Specimen sources
2. Major pathogens and disease states (e.g., etiology, epidemiology, transmission)
 - a. Respiratory (e.g., influenza virus, RSV, parainfluenza virus)
 - b. Vesicles and lesions (e.g., HSV, VZV)
 - c. Cervical cancer screening (e.g., HPV)
 - d. Meningitis (e.g., HSV, enterovirus)
 - e. Gastroenteritis (e.g., norovirus, rotavirus, adenovirus)
 - f. Immunocompromised host (e.g., CMV, HSV, EBV, BKV, JCV)
 - g. Hepatitis (e.g., HAV, HBV, HCV)
 - h. HIV
 - i. Other viruses (e.g., HTLV, West Nile, Zika, MERS, SARS, dengue, Ebola) **(SM ONLY)**

3. Direct detection of pathogens
4. Mechanisms of action and resistance for antiviral agents **(SM ONLY)**

C. Parasitology

1. Specimen sources (e.g., stool, respiratory, blood, tissue)
2. Major pathogens and disease states (e.g., etiology, epidemiology, transmission)
 - a. Blood and tissue protozoa (e.g., *Plasmodium* spp., *Trypanosoma* spp.)
 - b. Intestinal and urogenital protozoa (e.g., *Cryptosporidium* spp., *Entamoeba* spp., *Giardia* spp., *Trichomonas* spp.)
 - c. Intestinal and tissue helminths (e.g., *Ascaris* spp., *Enterobius* spp., hookworm, *Schistosoma* spp., *Strongyloides* spp., *Taenia* spp., *Diphyllobothrium* spp., *Trichinella* spp., *Trichuris* spp.)
 - d. Brain (e.g., *Toxoplasma* spp., *Naegleria* spp., *Acanthamoeba* spp.)
 - e. Insects and arthropods (e.g., ticks, mites, lice, bed bugs, scabies)
 - f. Additional parasites (e.g., filaria, flukes)
3. Microscopic and macroscopic identification
4. Direct and molecular detection
5. Culture (e.g., *Trichomonas* spp., *Strongyloides* spp.) **(SM ONLY)**

**III. ANALYTIC PROCEDURES FOR
MYCOBACTERIOLOGY, VIROLOGY,
PARASITOLOGY, AND MYCOLOGY
(M: 20 – 30% of total exam)
(SM: 30 – 40% of total exam)**

A. Mycobacteriology and *Nocardia* spp.

1. Specimen sources (e.g., lower respiratory, blood, soft tissue)
2. Acid-fast reaction, colony morphology, and growth characteristics
 - a. Major pathogens (e.g., *Mycobacterium avium intracellulare* (MAI), *M. kansasii*, *M. abscessus* group, *M. tuberculosis*, *M. marinum*, *Nocardia* spp.)
 - b. Common contaminant (e.g., *M. goodii*)
 - c. Less common Mycobacterium pathogens (e.g., *M. leprae*, *M. haemophilum*, *M. scrofulaceum*) **(SM ONLY)**
3. Identification methods (e.g., probes, sequencing, MALDI-TOF MS)
4. Direct detection by molecular methods
5. Antimicrobial therapy
 - a. *M. tuberculosis* (e.g., MDR, XDR)
 - b. MAI, *M. kansasii*, *M. marinum* **(SM ONLY)**
 - c. Rapid growers **(SM ONLY)**
6. Antimicrobial susceptibility testing **(SM ONLY)**
 - a. Broth microdilution
 - b. Critical concentration
 - c. Direct detection of resistance markers
7. Organism pathogenicity (e.g., etiology, transmission, virulence mechanisms)

D. Mycology

1. Specimen sources
 - a. Superficial (e.g., skin, hair, nails)
 - b. Deep and systemic (e.g., respiratory, bone, tissue)
 - c. Systemic (e.g., blood, bone marrow)
2. Major pathogens and disease states (e.g., etiology, epidemiology, transmission)
 - a. Yeasts (e.g., *Candida* spp., *Cryptococcus* spp., *Malassezia* spp.)
 - b. Dimorphic fungi (*Histoplasma capsulatum*, *Blastomyces* spp., *Coccidioides* spp., *Sporothrix schenckii*)
 - c. Dermatophytes (e.g., *Trichophyton* spp., *Microsporum* spp.)
 - d. Mucorales (Zygomycetes) (e.g., *Mucor* spp., *Rhizopus* spp.)
 - e. Hyaline molds (e.g., *Aspergillus* spp., *Fusarium* spp., *Penicillium* spp., *Scedosporium apiospermum* complex)
 - f. Dematiaceous molds (e.g., *Alternaria* spp., *Cladosporium* spp., *Fonsecaea* spp.) **(SM ONLY)**
 - g. *Pneumocystis jirovecii*
 - h. *Microsporidium* spp. **(SM ONLY)**
3. Colony morphology and growth characteristics of major pathogens (e.g., temperature, growth rate, length of incubation)
4. Microscopic identification of major pathogens
5. Direct and molecular detection
6. Other identification methods (e.g., biochemical, automated methods, MALDI-TOF MS)
7. Antifungal susceptibility testing **(SM ONLY)**
 - a. Manual and automated methods
 - b. Classes of antifungal agents
 - c. Intrinsic resistance patterns (e.g., *Candida krusei*)

E. Serology

1. Immunoglobulin response to infection (IgM, IgG, IgA)
2. Antigen-antibody interactions
 - a. Principles
 - b. Testing methods (e.g., latex agglutination, EIA, chemiluminescence, immunofluorescence, treponemal (MHATP), non-treponemal (RPR))

3. Serodiagnosis, clinical significance, and epidemiology of viral pathogens (e.g., hepatitis (A, B, C), EBV, HIV, CMV, rubella, measles)
4. Serodiagnosis, epidemiology, and vectors of transmission for agents of encephalitis (e.g., West Nile virus and other arboviruses) **(SM ONLY)**
5. Stages of infection and serodiagnosis of *Treponema pallidum* and *Borrelia burgdorferi*
6. Serodiagnosis of tuberculosis infection (e.g., interferon gamma release assay, PPD)

IV. LABORATORY OPERATIONS

(M: 10 – 15% of total exam)

(SM: 20 – 25% of total exam)

A. Postanalytic Procedures

1. Documentation practices
2. Urgent and critical value reporting
3. Result review and autoverification
4. Issuing corrected reports
5. Reporting to infection control/prevention and public health
6. Preparation of antibiogram **(SM ONLY)**
7. Antimicrobial stewardship **(SM ONLY)**

B. Quality Assessment/Troubleshooting

1. Preanalytical, analytical, postanalytical
2. Root-cause analysis
3. Quality control
4. Point-of-care testing (POCT)
5. Compliance
6. Regulation (e.g., proficiency testing, competency assessment, accreditation standards)

C. Safety

1. Safety programs and practices
 - a. Prevention of infection with bloodborne pathogens
 - b. Use of personal protective equipment (PPE)
 - c. Safe work practices
 - d. Safety data sheets (SDS) for chemicals and reagents
2. Emergency procedures (e.g., needlesticks, splashes to mucous membranes, fire)
3. Packaging and transportation of specimens and microorganisms

D. Laboratory Mathematics

1. Concentration, volume, and dilutions
2. Molarity, normality
3. Standard curves
4. Mean, median, mode, and confidence intervals
5. Sensitivity, specificity, and predictive value

E. Instrumentation

1. Microscope
2. Centrifuge
3. Spectrophotometer
4. Thermocycler
5. Continuous-monitoring blood culture system
6. MALDI-TOF MS
7. Automated antimicrobial susceptibility system

F. Laboratory Administration (SM ONLY)

1. Financial
 - a. Budgets
 - b. Capital equipment acquisition
 - c. Cost analysis, reimbursement
 - d. Purchasing, inventory
2. Operations
 - a. Customer service
 - b. Facility management (e.g., laboratory design, utilities)
 - c. Information technology
 - d. Data management (e.g., research, outcomes)
 - e. Test verification/validation
3. Personnel
 - a. Staffing and productivity
 - b. Performance standards (e.g., training, competency assessment)
 - c. Counseling, disciplinary action, and conflict resolution
4. Quality management
 - a. Continuous quality improvement
 - b. Individualized Quality Control Plan (IQCP)
 - c. Risk management/medical-legal issues

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.

END OF CONTENT GUIDELINE