ASCP BOARD OF CERTIFICATION

M AND SM PRACTICE ANALYSIS REPORT

For Development of

M(ASCP) & M(ASCP^{i})

and

SM(ASCP) & SM(ASCP^{i})

Content Guideline and Examinations

for Exam Publication July 1, 2020

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INTRODUCTION

The purpose of conducting a practice analysis (a.k.a. job analysis or job task analysis) is to provide the foundation of a certification examination by defining practice in a profession. The practice analysis provides evidence of content validation. It is required by psychometric standards and is considered best practices for high-stakes examination development. It also ensures the certification examination is fair, valid, job-related, and most importantly, legally defensible (Chinn and Hertz 2010)[1]. The ASCP Board of Certification (BOC) conducts a practice analysis approximately every five years in accordance with ASCP BOC Policy and requirements of the accrediting body, ANSI (American National Standards Institute), under ANSI/ISO/IEC 17024:2012.

A practice analysis is a formal process for determining or verifying the responsibilities of individuals in the job/profession, the knowledge individuals must possess, and the skills necessary to perform the job at a minimally competent level. The practice analysis process provides a complete and modern understanding of the duties and functions of practicing laboratory professionals. The results of the practice analysis inform the specifications and content of the ASCP BOC certification examinations. The practice analysis process ensures that the examinations are reflective of current practices. It also helps guarantee that individuals who become certified are current and up-to-date on the state of medical laboratory science practice and are competent to perform as certified laboratory professionals.

PRACTICE ANALYSIS PROCESS

ASCP BOC conducted a practice analysis survey to inform the following certification examination categories:

- Medical Laboratory Technician (MLT)
- Medical Laboratory Scientist (MLS)
- Technologist in Blood Banking (BB)
- Specialist in Blood Banking (SBB)
- Technologist in Chemistry (C)
- Specialist in Chemistry (SC)
- Technologist in Hematology (H)
- Specialist in Hematology (SH)
- Technologist in Microbiology (M)
- Specialist in Microbiology (SM)

The process for conducting a practice analysis consists of the following steps:

1. Survey Development
2. Demographics
3. Task Inventory – Knowledge and Skill Questions
4. Rating Criteria
5. Survey Construction
6. Pilot Testing and Revision
7. Survey Distribution
8. Survey Analysis
9. Committee Review and Discussion
10. Examination Content Guideline, Standard Setting, and Exam Publication

[1] Chinn, R.N., and N.R. Hertz. 2010. *Job Analysis: A Guide for Credentialing Organizations.* Lexington: Council on Licensure, Enforcement and Regulation (CLEAR).

SURVEY DEVELOPMENT

During the 2015 ASCP BOC examination committee meetings, the five categorical examination committees (Blood Banking [BB], Chemistry [C], Hematology [H], Microbiology [M] and Molecular Biology [MB]) provided the input and discussion to develop the practice analysis survey for ten certification categories including the generalist categories of MLT and MLS as well as the technologist categories (BB, C, H and M) and specialist categories (SBB, SC, SH and SM). Each committee created the sections of the survey corresponding to their respective disciplines. The Joint Generalist Committee (MLT & MLS), whose membership includes representatives (mainly educators) from each categorical examination committee, reviewed and approved a final version of the survey. The committee members (subject matter experts) collectively discussed all pertinent aspects of their profession to design a concise survey to extract useful feedback from field professionals while maximizing response rate. The survey had two main components: demographics and task inventory with appropriate rating scales for each.

DEMOGRAPHICS

The demographic questions asked about experience, education, gender, age, titles, work shift, type of facility, areas of lab work, work hours, etc. The purpose of these questions was to aid the committee in deciding whether the sample of respondents obtained was representative of the profession in general. The demographic data provided analytic categories that allowed refinement of the survey population to utilize only those responses from individuals at the targeted professional level.

TASK INVENTORY – KNOWLEDGE AND SKILL QUESTIONS

The survey was broken into two core areas: knowledge and skills. The categorical examination committees and the Joint Generalist Committee developed a series of knowledge areas and job-related task questions that formed the body of the survey.

This survey had eleven major sections:

- Laboratory Operations
- Blood Banking
- Microbiology
- Chemistry
- Hematology/Coagulation
- Molecular Biology
- Immunology/Serology
- Urinalysis
- Body Fluids
- Point-of-Care Testing
- Management/Supervision

Respondents only rated the tasks within the major sections in which they work. All respondents rated the tasks within the Laboratory Operations section. For example, if a respondent indicated they currently work in Microbiology and Molecular Biology, they rated tasks within those two sections and Laboratory Operations and did not see any other sections of the survey.

RATING CRITERIA

Different rating scales were used to assess the knowledge and skills on the survey. One rating scale was used for the knowledge-only tasks and asked respondents to assess the significance of having that knowledge to perform their job. The rating scale used for the skill-related tasks assessed whether respondents performed the specific task or not in their jobs.

SURVEY CONSTRUCTION

The practice analysis survey was created and delivered through Key Survey, an electronic survey vendor from Highroad Solution. Using an electronic tool allowed survey review and testing via the internet, email tracking of respondents using email addresses, and the ability to send email reminders for completion of the survey.

PILOT TESTING AND REVISION

The Joint Generalist Committee tested a pilot version of the survey. They reviewed and revised different aspects of the survey (e.g., information correctness, grammar/spelling errors, electronic glitches, correct survey branching, etc.). The pilot testing comments and edits informed the final version of the survey.

SURVEY DISTRIBUTION

The categorical and Joint Generalist Committees determined that the survey should be sent to all current generalist certificants (MLT and MT/MLS), categorical certificants (BB, C, H and M) and specialist certificants (SBB, SC, SH and SM) in the ASCP BOC Personify database. The survey was open for a five-week period between November 9, 2015 – December 14, 2015. ASCP BOC staff also directly emailed the survey to the categorical committees and encouraged the committee membership to disseminate the survey to their colleagues. Additionally, the survey link was posted on ASCP social media sites (e.g., Facebook and Twitter).

SURVEY ANALYSIS

The tasks were divided amongst eleven major sections (Laboratory Operations, Blood Banking, Chemistry, Microbiology, Hematology/Coagulation, Molecular Biology, Immunology/Serology, Urinalysis, Body Fluids, Point-of-Care Testing, and Management/Supervision). All respondents saw the Laboratory Operations category. Because respondents only rated the tasks within the other major categories in which they practice, the number of respondents vary for each of the other sections depending on the number of respondents who indicated that they currently work in that area.

To determine which of the eleven major survey sections were appropriate for the M and SM exams, the percentage of respondents currently working exclusively in Microbiology and each of the other sections was calculated. The data for any sections in which at least 20% of respondents were working in both Microbiology and that area, were included in the analysis. The other survey sections that scored above 20% and therefore were included in the M/SM analysis were Laboratory Operations, Molecular Biology, Immunology/Serology, Body Fluids, and Management/Supervision (for SM only). The committee determined that the specific tasks in the Body Fluids section were not appropriate for the M/SM exams and therefore it was not included on the exams.

Responses from individuals performing higher-level supervisory tasks were not appropriate for the entry-level Technologist in Microbiology certification category and were therefore excluded from the analysis. The responses from these individuals were included in the analysis for the Specialist in Microbiology exam category. Any individuals not currently practicing (e.g., retired, unemployed, or simply not working as a laboratory professional) were removed from the practice analysis survey.

COMMITTEE REVIEW AND DISCUSSION

During the 2016 examination committee meeting, the Microbiology Committee reviewed the practice analysis results. They agreed that the demographic results accurately reflected the M and SM populations **(Appendices A & C)**.

In general, tasks performed by at least 40% of the respondents were retained on the task list and considered valid to be on the examination. The committees reviewed all tasks performed by less than 40% of the respondents. If the committee determined that these tasks were critical to patient care and/or were up-and-coming in practice, then the task was retained on the task list and considered valid for the examination. If the task was considered outdated or too esoteric, then it was removed from the task list and the exam. Because only a small percentage of the M population reported performing management/supervisory tasks, the Management/Supervisory section did not provide useful data for this exam category. The committee's decisions were used to create the Final Task Lists for M and SM **(Appendices B & D)** which informed the exam content guideline and the content for the certification exams.

EXAM CONTENT GUIDELINE, STANDARD SETTING, AND EXAM PUBLICATION

The committee revised the M and SM exam content guideline to reflect the practice analysis results. They reviewed the exam content area percentages and decided where to set them based on the results of the practice analysis. The committee reviewed the exam databases according to the new content guideline and deleted or revised questions accordingly. They wrote new questions to fulfill the new content guideline, and reclassified questions according to the new guideline. After this work was completed, the committee set a new standard for each exam, and the new exam databases were published.

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Appendix A

TECHNOLOGIST IN MICROBIOLOGY (M)

DEMOGRAPHIC ANALYSIS

Total respondents: 7,122
Total usable: 654

Usable individual respondents met the following criteria:

- Currently employed as a medical laboratory professional in a clinical laboratory
- Currently working in microbiology
- Currently working as a non-supervisory technologist/MT/MLS

Summary:

- Certifications:
  - 86% are MLS certified
  - 8% are M certified
- Education:
  - 4% have an associate degree or lower
  - 86% have a baccalaureate degree or post-baccalaureate program certificate
  - 10% have a master's degree or higher
- Experience:
  - 45% have 10 years or less
  - 15% have 10 – 20 years
  - 40% have 20 or more years
- Geographic Distribution: there were respondents from across the U.S., including Washington D.C. and Puerto Rico, and states with the highest response rate include:
  - 7% from California
  - 6% from Texas
  - 5% each from Michigan, Ohio, and Colorado
  - 4% each from Wisconsin and Illinois
- Facility:
  - 83% work in hospitals
  - 8% work in independent labs
  - 9% work in other types of facilities
- Age:
  - 25% are younger than 30 years of age
  - 60% are 30 – 59 years of age
  - 15% are over 60 years of age
- Gender:
  - 84% are female
  - 14% are male
  - 2% chose not to answer this question

Appendix B

TECHNOLOGIST IN MICROBIOLOGY (M)

FINAL TASK LIST (TOPICS KEPT ON EXAM BASED ON PRACTICE ANALYSIS RESULTS)

LABORATORY OPERATIONS
SPECIMEN COLLECTION, PREPARATION, AND PROCESSING
1. Proper collection/procurement and labeling of specimens
2. Guidance/assistance to healthcare providers regarding test orders and procedures
3. Specimen processing (e.g., centrifuge, separate)
4. Specimen storage (e.g., time, temperature, light)
5. Specimen distribution (e.g., packaging to meet USPS, DOT and/or IATA regulations/requirements)
6. Specimen evaluation for acceptability
7. Corrective action for unsatisfactory specimens
REPORTING AND INTERPRETING RESULTS
8. Autoverification of patient results
9. Result reporting during LIS/computer downtime
10. Manual result entry (e.g., add interpretive comments, reference, or resource information to the report)
11. Correlation of test results with other data (e.g., clinical history, other lab results) and take corrective action as necessary
12. Critical result reporting according to protocol
13. Communication with healthcare providers regarding test results (e.g., report interpretation, amended results)
INSTRUMENTATION
14. Balances
15. Centrifuges (e.g., microhematocrit, cytocentrifuge)
16. Microscopes
17. Ocular micrometers
LABORATORY OPERATIONS
18. Reagent preparation, labeling, and storage
19. Reagent log maintenance
20. Temperature log maintenance
21. Calculations and unit conversions (e.g., dilutions, reagent preparation, graphs, statistics)
22. Instrument troubleshooting and repair
23. Instrument maintenance and calibration
24. Equipment (e.g., pipettes) maintenance and calibration
25. Evaluation/verification/validation of new instrumentation, methodologies, or assays
26. Safety activities (e.g., PPE, fume hoods, fire, safety data sheets, biosafety cabinet)
27. Hazard disposal, decontamination, and storage

28. Regulatory compliance (e.g., HIPAA, OSHA, EPA, homeland security, state, and local)
29. Quality control performance and review (e.g., IQCP)
30. Routine corrective action follow-up of 'Out of Control' results
31. Proficiency testing participation
32. Competency Testing Program participation
33. Quality Assurance Program participation
34. Training of new staff
35. Training of students, residents, and/or fellows
36. Appropriate notification of reportable diseases
37. Maintenance of patient records and laboratory database
38. Departmental policy/procedure writing, review, and revision
MOLECULAR BIOLOGY
KNOWLEDGE QUESTIONS
39. Nucleic acid chemistry and basic molecular theory (e.g., DNA structure, mutation, transcription)
40. Biochemical reagents (e.g., DNA ligase, polymerase enzymes)
41. Genetics (e.g., human, microbial)
42. Correlation of patient results with disease states
MOLECULAR TECHNIQUES
43. Specimen collection and/or handling protocols for molecular testing
44. Processing of specimens for molecular testing (e.g., extract RNA/DNA, evaluate quality/quantity of nucleic acid, store nucleic acid)
45. Nucleic acid amplification (e.g., PCR, PCR variations, SDA, TMA, NASBA, bDNA)
46. Hybridization methods (e.g., Southern Blot, array technology, FISH, colony blot)
47. Nucleic acid sequencing (e.g., Sanger sequencing, pyrosequencing, next-generation sequencing)
48. Prevention, detection, and removal of nucleic acid contamination
49. Bacterial identification by sequencing (e.g., 16S ribosomal RNA)
MOLECULAR TESTING **Infectious Disease**
50. Hepatitis (e.g., HCV, HBV)
51. HIV
52. Surveillance of immunocompromised patients (e.g, EBV, CMV, BK)
53. HSV
54. Chlamydia/N. gonorrheae
55. MRSA/MSSA
56. HPV
57. Respiratory pathogens (e.g., influenza, legionella, bordetella, adenovirus)
58. C. difficile
59. Gastrointestinal pathogens
60. Group B Strep

61. Mycobacteria
MICROBIOLOGY
GENERAL PROCESSING AND RAPID TESTING **Specimen Processing**
62. Routine bacteriology specimen processing (e.g., streaking plates, inoculating culture media, preparing slides for Gram stains)
63. Automated specimen processing (e.g., WASP, Kiestra, Previ)
64. Loading/unloading blood culture bottles on/from instrument
65. Direct specimen slide preparation for mycology (e.g., Calcofluor white, KOH)
66. Mycobacteriology specimen processing (e.g., digestion, decontamination, concentration, smear prep, media inoculation)
67. Parasitology specimen processing
Identify pathogens directly from specimens
68. Gram staining
69. Gram stain interpretation
70. Positive blood culture processing (e.g., Gram staining, streaking plates)
71. Direct molecular testing of positive blood cultures
72. Preliminary positive blood culture Gram stain result reporting
73. Interpretation of wet preparation smear (e.g., Trichomonas, calcofluor white)
74. Rapid antigen methods for bacteria (e.g., rapid Strep)
75. Rapid antigen methods for fungi (e.g., Cryptococcal antigen)
76. Rapid antigen methods for parasites (e.g., E. histolytica, Giardia, Malaria)
77. Rapid antigen methods for viruses (e.g., RSV, influenza)
78. Rapid molecular methods (e.g., BioFire, Nanosphere, Cepheid, Affirm VPIII)
ROUTINE BACTERIOLOGY (Including aerobes and anaerobes) **Identification/detection**
79. Identification of aerobes by automated methods (e.g., Microscan, Vitek, Phoenix)
80. Identification of aerobes by commercial nonautomated methods (e.g., RapID, API)
81. Identification of aerobes by rapid/spot biochemical methods (e.g., oxidase, indole, catalase)
82. Identification of aerobes by conventional biochemical methods (e.g., urea, KIA, TSI, OF-sugars)
83. Serotyping methods (e.g., Strep grouping, Salmonella/Shigella typing)
84. Chromogenic agar methods (e.g., MRSA)
85. MALDI-TOF
86. Identification of anaerobes by full biochemical testing (e.g., Vitek, API, RapID)
87. Identification of anaerobes by identification disc and/or spot testing
88. Antigen and/or toxin detection direct from specimen (e.g., C. difficile, Shiga toxin)
Antimicrobial susceptibility testing
89. Manual microdilution
90. Automated microdilution (e.g., Microscan, Vitek, Phoenix)
91. Disk diffusion method (i.e., Kirby Bauer)

92. E-Test gradient method
93. Enzyme detection (e.g., beta-lactamase)
94. Resistance mechanism detection (e.g., D test, modified Hodge, ESBL, PBP2a)
95. Molecular detection of resistance genes
96. Anaerobic antimicrobial susceptibility testing
MYCOLOGY/ACTINOMYCETES
Identification of Yeasts
97. Automated methods (Microscan, Vitek)
98. Commercial nonautomated methods (e.g., RapID, API)
99. Conventional methods (e.g., cornmeal tween 80, germ tube)
100. Chromogenic agar methods
101. MALDI-TOF
Identification of Molds
102. Stain method (e.g., lactophenol cotton blue)
103. Conventional methods (e.g., Trichophyton agars, urease)
104. MALDI-TOF
Identification of Actinomycetes
105. Genus determination by modified acid fast stain and lysozyme
106. MALDI-TOF
PARASITOLOGY
107. Pinworm preparation
108. Macroscopic parasite identification (e.g., larvae, ticks, worms)
109. Preparation of permanent stained smears (e.g., trichrome, iron hematoxylin)
110. Interpretation of permanent stained smears
111. Interpretation of direct exam from concentrate
112. Interpretation of blood films
113. Preparation and interpretation of stained smear for coccidians (e.g., *Isospora*, *Cryptosporidium*, *Cyclospora*)
114. Preparation and interpretation of stained smear for microsporidia
MYCOBACTERIOLOGY
Identification
115. Molecular methods directly from specimen (e.g., GeneXpert)
116. DNA probe
117. Sequencing and/or HPLC
118. MALDI-TOF
SPIROCHETES, OBLIGATE INTRACELLULAR BACTERIA and MYCOPLASMAS
119. Molecular methods directly from specimen (e.g., *Chlamydia*, *N. gonorrhoeae* NAAT)

IMMUNOLOGY
KNOWLEDGE QUESTIONS
120. Immune response (i.e., cellular and humoral / primary and secondary)
121. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
122. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)
SEROLOGICAL TECHNIQUES
123. Specimen collection and/or handling protocols for serology
124. Agglutination techniques (e.g., latex, particle)
125. Enzyme immunoassay
126. Chemiluminesence immunoassay
127. Immunofluoresence
VIRAL/MICROBIAL TESTING
128. Nontreponemal syphilis testing (e.g., RPR)
129. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
130. Immunity screening (e.g., rubella, measles, varicella zoster)
131. Hepatitis
132. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
133. CMV/EBV
134. Cytokine testing for tuberculosis (e.g., QuantiFERON)
135. Lyme disease testing

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Appendix C

SPECIALIST IN MICROBIOLOGY (SM)

DEMOGRAPHIC ANALYSIS

Total respondents: 7,122
Total usable: 467

Usable individual respondents met the following criteria:

- Currently employed as a medical laboratory professional in a clinical laboratory
- Currently working in microbiology
- Includes respondents who fit any of the following criteria:
    - Technologist/MT/MLS (supervisory, including senior/lead tech)
    - Technical specialist (non-supervisory)
    - Laboratory manager/director
    - Clinical educator
    - Quality/Compliance coordinator

Summary:

- Certifications:
    - 83% are MLS certified
    - 11% are SM certified
- Education:
    - 3% have an associate degree or lower
    - 74% have a baccalaureate degree or post-baccalaureate program certificate
    - 23% have a master's degree or higher
- Experience:
    - 13% have 10 years or less
    - 19% have 11 – 20 years
    - 68% have 20 or more years
- Geographic Distribution: there were respondents from across the U.S., including Puerto Rico, and states with the highest response rate include:
    - 9% from Texas
    - 7% from California
    - 5% from Minnesota
    - 4% from Wisconsin
- Facility:
    - 80% work in hospitals
    - 6% work in independent laboratories
    - 4% work in public health laboratories
    - 4% work in physician offices/clinics
    - 6% work in other facilities
- Age:
    - 5% are younger than 30 years of age
    - 74% are 30 – 59 years of age
    - 21% are over 60 years of age
- Gender:
    - 83% are female
    - 17% are male

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Appendix D

SPECIALIST IN MICROBIOLOGY (SM)

FINAL TASK LIST (TOPICS KEPT ON EXAM BASED ON PRACTICE ANALYSIS RESULTS)

LABORATORY OPERATIONS
SPECIMEN COLLECTION, PREPARATION, AND PROCESSING
1. Proper collection/procurement and labeling of specimens
2. Guidance/assistance to healthcare providers regarding test orders and procedures
3. Specimen processing (e.g., centrifuge, separate)
4. Specimen storage (e.g., time, temperature, light)
5. Specimen distribution (e.g., packaging to meet USPS, DOT and/or IATA regulations/requirements)
6. Specimen evaluation for acceptability
7. Corrective action for unsatisfactory specimens
REPORTING AND INTERPRETING RESULTS
8. Autoverification of patient results
9. Result reporting during LIS/computer downtime
10. Manual result entry (e.g., add interpretive comments, reference, or resource information to the report)
11. Correlation of test results with other data (e.g., clinical history, other lab results) and take corrective action as necessary
12. Critical result reporting according to protocol
13. Communication with healthcare providers regarding test results (e.g., report interpretation, amended results)
INSTRUMENTATION
14. Balances
15. Centrifuges (e.g., microhematocrit, cytocentrifuge)
16. Microscopes
17. Ocular micrometers
LABORATORY OPERATIONS
18. Reagent preparation, labeling, and storage
19. Reagent log maintenance
20. Temperature log maintenance
21. Calculations and unit conversions (e.g., dilutions, reagent preparation, graphs, statistics)
22. Instrument troubleshooting and repair
23. Instrument maintenance and calibration
24. Equipment (e.g., pipettes) maintenance and calibration
25. Evaluation/verification/validation of new instrumentation, methodologies, or assays
26. Safety activities (e.g., PPE, fume hoods, fire, safety data sheets, biosafety cabinet)
27. Hazard disposal, decontamination, and storage

28. Regulatory compliance (e.g., HIPAA, OSHA, EPA, homeland security, state, and local)
29. Quality control performance and review (e.g., IQCP)
30. Routine corrective action follow-up of 'Out of Control' results
31. Proficiency testing participation
32. Competency Testing Program participation
33. Quality Assurance Program participation
34. Training of new staff
35. Training of students, residents, and/or fellows
36. Appropriate notification of reportable diseases
37. Maintenance of patient records and laboratory database
38. Departmental policy/procedure writing, review, and revision
39. LIS implementation and maintenance
40. Billing and coding
MOLECULAR BIOLOGY
KNOWLEDGE QUESTIONS
41. Nucleic acid chemistry and basic molecular theory (e.g., DNA structure, mutation, transcription)
42. Biochemical reagents (e.g., DNA ligase, polymerase enzymes)
43. Genetics (e.g., human, microbial)
44. Correlation of patient results with disease states
MOLECULAR TECHNIQUES
45. Specimen collection and/or handling protocols for molecular testing
46. Processing of specimens for molecular testing (e.g., extract RNA/DNA, evaluate quality/quantity of nucleic acid, store nucleic acid)
47. Nucleic acid amplification (e.g., PCR, PCR variations, SDA, TMA, NASBA, bDNA)
48. Hybridization methods (e.g., Southern Blot, array technology, FISH, colony blot)
49. Nucleic acid sequencing (e.g., Sanger sequencing, pyrosequencing, next-generation sequencing)
50. Prevention, detection, and removal of nucleic acid contamination
51. Bacterial identification by sequencing (e.g., 16S ribosomal RNA)
MOLECULAR TESTING **Infectious Disease**
52. Hepatitis (e.g., HCV, HBV)
53. HIV
54. Surveillance of immunocompromised patients (e.g, EBV, CMV, BK)
55. HSV
56. Chlamydia/N. gonorrheae
57. MRSA/MSSA
58. HPV
59. Respiratory pathogens (e.g., influenza, legionella, bordetella, adenovirus)

60. C. difficile
61. Gastrointestinal pathogens
62. Group B Strep
63. Mycobacteria

MICROBIOLOGY

GENERAL PROCESSING AND RAPID TESTING **Specimen Processing**
64. Routine bacteriology specimen processing (e.g., streaking plates, inoculating culture media, preparing slides for Gram stains)
65. Automated specimen processing (e.g., WASP, Kiestra, Previ)
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71. Gram stain interpretation
72. Positive blood culture processing (e.g., Gram staining, streaking plates)
73. Direct molecular testing of positive blood cultures
74. Preliminary positive blood culture Gram stain result reporting
75. Interpretation of wet preparation smear (e.g., Trichomonas, calcofluor white)
76. Rapid antigen methods for bacteria (e.g., rapid Strep)
77. Rapid antigen methods for fungi (e.g., Cryptococcal antigen)
78. Rapid antigen methods for parasites (e.g., E. histolytica, Giardia, Malaria)
79. Rapid antigen methods for viruses (e.g., RSV, influenza)
80. Rapid molecular methods (e.g., BioFire, Nanosphere, Cepheid, Affirm VPIII)
ROUTINE BACTERIOLOGY (Including aerobes and anaerobes) **Identification/detection**
81. Identification of aerobes by automated methods (e.g., Microscan, Vitek, Phoenix)
82. Identification of aerobes by commercial nonautomated methods (e.g., RapID, API)
83. Identification of aerobes by rapid/spot biochemical methods (e.g., oxidase, indole, catalase)
84. Identification of aerobes by conventional biochemical methods (e.g., urea, KIA, TSI, OF-sugars)
85. Serotyping methods (e.g., Strep grouping, Salmonella/Shigella typing)
86. Chromogenic agar methods (e.g., MRSA)
87. MALDI-TOF
88. Identification of anaerobes by full biochemical testing (e.g., Vitek, API, RapID)
89. Identification of anaerobes by identification disc and/or spot testing

90. Antigen and/or toxin detection direct from specimen (e.g., C. difficile, Shiga toxin)
Antimicrobial susceptibility testing
91. Manual microdilution
92. Automated microdilution (e.g., Microscan, Vitek, Phoenix)
93. Disk diffusion method (i.e., Kirby Bauer)
94. E-Test gradient method
95. Enzyme detection (e.g., beta-lactamase)
96. Resistance mechanism detection (e.g., D test, modified Hodge, ESBL, PBP2a)
97. Molecular detection of resistance genes
98. Anaerobic antimicrobial susceptibility testing
MYCOLOGY/ACTINOMYCETES **Identification of Yeasts**
99. Automated methods (Microscan, Vitek)
100. Commercial nonautomated methods (e.g., RapID, API)
101. Conventional methods (e.g., cornmeal tween 80, germ tube)
102. Chromogenic agar methods
103. MALDI-TOF
Identification of Molds
104. Stain method (e.g., lactophenol cotton blue)
105. Conventional methods (e.g., Trichophyton agars, urease)
106. MALDI-TOF
Anti-fungal Susceptibility Testing:
107. Manual microdilution methods
108. Automated microdilution (e.g., Vitek)
109. Manual methods (e.g., Kirby Bauer, E-Test)
Identification of Actinomycetes
110. Genus determination by modified acid fast stain and lysozyme
111. MALDI-TOF
PARASITOLOGY
112. Pinworm preparation
113. Macroscopic parasite identification (e.g., larvae, ticks, worms)
114. Preparation of permanent stained smears (e.g., trichrome, iron hematoxylin)
115. Interpretation of permanent stained smears
116. Interpretation of direct exam from concentrate
117. Interpretation of blood films
118. Preparation and interpretation of stained smear for coccidians (e.g., *Isospora*, *Cryptosporidium*, *Cyclospora*)
119. Preparation and interpretation of stained smear for microsporidia

MYCOBACTERIOLOGY **Identification**
120. Molecular methods directly from specimen (e.g., GeneXpert)
121. DNA probe
122. Sequencing and/or HPLC
123. MALDI-TOF
Antimicrobial Susceptibility Testing
124. *M. tuberculous* mycobacteria antimicrobial susceptibility methods
125. Nontuberculosis mycobacteria antimicrobial susceptibility methods
SPIROCHETES, OBLIGATE INTRACELLULAR BACTERIA and MYCOPLASMAS
126. Molecular methods directly from specimen (e.g., *Chlamydia*, *N. gonorrhoeae* NAAT)

IMMUNOLOGY

KNOWLEDGE QUESTIONS
127. Immune response (i.e., cellular and humoral / primary and secondary)
128. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
129. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)
SEROLOGICAL TECHNIQUES
130. Specimen collection and/or handling protocols for serology
131. Agglutination techniques (e.g., latex, particle)
132. Enzyme immunoassay
133. Chemiluminesence immunoassay
134. Immunofluoresence
VIRAL/MICROBIAL TESTING
135. Nontreponemal syphilis testing (e.g., RPR)
136. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
137. Immunity screening (e.g., rubella, measles, varicella zoster)
138. Hepatitis
139. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
140. CMV/EBV
141. Cytokine testing for tuberculosis (e.g., QuantiFERON)
142. Lyme disease testing

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MANAGEMENT/SUPERVISORY ACTIVITIES
143. Supervision/direction of department staff in daily operations
144. Personnel management activities (e.g., hiring, discipline, job descriptions, evaluations, scheduling)
145. Infection control activities (e.g., hospital policies)
146. Reportable diseases activities (e.g., public health)
147. Epidemiologic information distribution and reporting (e.g., antibiogram, multi-drug resistance trending)
148. Inventory maintenance and ordering
149. Budgeting and purchasing decisions
150. Direct Laboratory Information System (LIS) development, implementation, and maintenance
151. Quality Assurance Program oversight (e.g., peer group QC evaluation, cross-functional teams, outcome measures, IQCP)
152. Evaluation of quality assessment/improvement activities (e.g., pre-analytical, analytical, and post-analytical)
153. Regulatory compliance and lab accreditation maintenance
154. Development and implementation of disaster or emergency procedures/preparedness
155. Development and implementation of training and educational programs (e.g., in-laboratory trainer, program faculty)
156. Development, implementation, and evaluation of a Competency Testing Program
157. Instrumentation/methodology evaluation, correlation, and application
158. Supervise/direct safety or training activities
159. Proficiency testing documentation and follow-up