ASCP BOC
ASCP
BOARD OF
CERTIFICATION

MLS AND MLT PRACTICE ANALYSIS REPORT

For Development of

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

and

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

Content Guidelines and Examinations

for Exam Publication January 1, 2019

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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 for MLT and MLS. 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 Chemistry and Hematology, 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).

In an effort to garner more responses from individuals working in blood centers, ASCP BOC staff also reached out to the Qualification in Apheresis Work Group and the AABB. These contacts distributed the DPT survey link to several blood centers and placed the link in an AABB newsletter.

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.

Responses from individuals performing higher-level supervisory tasks were not appropriate for an entry-level generalist or technologist certification categories were included for analysis with the specialist exam categories. 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 meetings, the Blood Banking, Chemistry, Hematology, and Microbiology Committees reviewed the practice analysis results. They agreed that the demographic results accurately reflected the MLT and MLS population **(Appendices A & C)**.

Each categorical exam committee reviewed the tasks within their area of expertise. In general tasks performed by at least 40% of the respondents would be retained on the task list and considered valid to be on the examination. These 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 would be removed from the task

list and the exam. Because only a small percentage of the MLS population reported performing management/supervisory tasks, the Management/Supervisory section did not provide useful data. The Joint Generalist Committee then reviewed the decisions made by the aforementioned committees and produced the Final Task Lists for MLT and MLS **(Appendices B & D)** which informed the exam content guidelines and the content for the certification exams.

EXAMINATION CONTENT GUIDELINE, STANDARD SETTING, AND EXAM PUBLICATION

The committees revised the MLT and MLS exam content guidelines 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 committees reviewed the exam databases according to the new content guidelines and deleted or revised questions accordingly. They wrote new questions to fulfill the new content guidelines, and reclassified questions according to the new guidelines. After this work was completed, the committees set a new standard for each exam, and the new exam databases were published.

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Appendix A

MEDICAL LABORATORY TECHNICIAN (MLT)

DEMOGRAPHIC ANALYSIS

Total respondents: 4,348
Total usable: 753

Usable individual respondents met the following criteria:

- Currently employed as a medical laboratory professional in a clinical laboratory or blood center
- Currently working as a non-supervisory technician/MLT

Summary:

- Certifications: nearly all (98%) are MLT certified
- Education:
  - 6% have less than an associate degree
  - 75% have an associate degree
  - 19% have a baccalaureate degree or higher
- Experience:
  - 58% have less than 10 years
  - 15% have 10 – 20 years
  - 27% have 20 or more years
- Geographic Distribution: there are respondents from all fifty U.S. states, Washington D.C. and Puerto Rico, and states with the highest response rate include:
  - 8% each from Minnesota and Texas
  - 7% from Ohio
  - 5% each from Illinois, Pennsylvania, and Wisconsin
  - 4% from Indiana, Michigan, and Missouri
- Facility:
  - 73% work in hospitals
  - 14% work in physician offices/clinics
  - 6% work in independent labs
  - 7% are employed in various types of facilities
- Age:
  - 22% are younger than 30 years of age
  - 71% are 30 – 59 years of age
  - 7% are over 60 years of age
- Gender:
  - 85% are female
  - 14% are male
  - 1% chose not to answer this question

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Appendix B

MEDICAL LABORATORY TECHNICIAN (MLT)

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. Chain of custody procedures
4. Specimen processing (e.g., centrifuge, separate)
5. Specimen storage (e.g., time, temperature, light)
6. Specimen distribution (e.g., packaging to meet USPS, DOT and/or IATA regulations/requirements)
7. Specimen evaluation for acceptability
8. Corrective action for unsatisfactory specimens
REPORTING AND INTERPRETING RESULTS
9. Autoverification of patient results
10. Result reporting during LIS/computer downtime
11. Manual result entry (e.g., add interpretive comments, reference, or resource information to the report)
12. Correlation of test results with other data (e.g., clinical history, other lab results) and take corrective action as necessary
13. Critical result reporting according to protocol
14. Communication with healthcare providers regarding test results (e.g., report interpretation, amended results)
INSTRUMENTATION
15. Balances
16. Centrifuges (e.g., microhematocrit, cytocentrifuge)
17. Microscopes
18. Digital imagers (e.g., IRIS, CellaVision)
LABORATORY OPERATIONS
19. Reagent preparation, labeling, and storage
20. Reagent log maintenance
21. Temperature log maintenance
22. Calculations and unit conversions (e.g., dilutions, reagent preparation, graphs, statistics)
23. Instrument troubleshooting and repair
24. Instrument maintenance and calibration
25. Equipment (e.g., pipettes) maintenance and calibration
26. Evaluation/verification/validation of new instrumentation, methodologies, or assays

27. Safety activities (e.g., PPE, fume hoods, fire, safety data sheets, biosafety cabinet)
28. Hazard disposal, decontamination, and storage
29. Regulatory compliance (e.g., HIPAA, OSHA, EPA, homeland security, state, and local)
30. Quality control performance and review (e.g., IQCP)
31. Routine corrective action follow-up of 'Out of Control' results
32. Proficiency testing participation
33. Competency Testing Program participation
34. Quality Assurance Program participation
35. Training of new staff
36. Training of students, residents, and/or fellows
37. Appropriate notification of reportable diseases
38. Maintenance of patient records and laboratory database
39. Departmental policy/procedure writing, review, and revision
MOLECULAR DIAGNOSTICS
KNOWLEDGE QUESTIONS
40. Nucleic acid chemistry and basic molecular theory (e.g., DNA structure, mutation, transcription)
41. Biochemical reagents (e.g., DNA ligase, polymerase enzymes)
42. Genetics (e.g., human, microbial)
43. Correlation of patient results with disease states
MOLECULAR TECHNIQUES
44. Specimen collection and/or handling protocols for molecular testing
45. Processing of specimens for molecular testing (e.g., extract RNA/DNA, evaluate quality/quantity of nucleic acid, store nucleic acid)
46. Nucleic acid amplification (e.g., PCR, PCR variations, SDA, TMA, NASBA, bDNA)
47. Separation techniques (e.g., electrophoresis)
48. Hybridization methods (e.g., Southern Blot, array technology, FISH, colony blot)
49. Prevention, detection, and removal of nucleic acid contamination
MOLECULAR TESTING
Infectious Disease
50. Chlamydia/N. gonorrheae
51. MRSA/MSSA
52. Respiratory pathogens (e.g., influenza, legionella, bordetella, adenovirus)
53. C. difficile
54. Gastrointestinal pathogens
55. Group B Strep
Hematology/Oncology
56. Leukemias/Lymphomas (e.g., CML, ALL, translocations)

MICROBIOLOGY

GENERAL PROCESSING AND RAPID TESTING

Specimen Processing

57. Routine bacteriology specimen processing (e.g., streaking plates, inoculating culture media, preparing slides for Gram stains)
58. Automated specimen processing (e.g., WASP, Kiestra, Previ)
59. Loading/unloading blood culture bottles on/from instrument
60. Direct specimen slide preparation for mycology (e.g., Calcofluor white, KOH)
61. Mycobacteriology specimen processing (e.g., digestion, decontamination, concentration, smear prep, media inoculation)
62. Parasitology specimen processing

Identify pathogens directly from specimens

63. Gram staining
64. Gram stain interpretation
65. Positive blood culture processing (e.g., Gram staining, streaking plates)
66. Direct molecular testing of positive blood cultures
67. Preliminary positive blood culture Gram stain result reporting
68. Interpretation of wet preparation smear (e.g., Trichomonas, calcofluor white)
69. Rapid antigen methods for bacteria (e.g., rapid Strep)
70. Rapid antigen methods for fungi (e.g., Cryptococcal antigen)
71. Rapid antigen methods for parasites (e.g., E. histolytica, Giardia, Malaria)
72. Rapid antigen methods for viruses (e.g., RSV, influenza)
73. Rapid molecular methods (e.g., BioFire, Nanosphere, Cepheid, Affirm VPIII)

ROUTINE BACTERIOLOGY (Including aerobes and anaerobes)

Identification/detection

74. Identification of aerobes by automated methods (e.g., Microscan, Vitek, Phoenix)
75. Identification of aerobes by commercial nonautomated methods (e.g., RapID, API)
76. Identification of aerobes by rapid/spot biochemical methods (e.g., oxidase, indole, catalase)
77. Identification of aerobes by conventional biochemical methods (e.g., urea, KIA, TSI, OF-sugars)
78. Serotyping methods (e.g., Strep grouping, Salmonella/Shigella typing)
79. Chromogenic agar methods (e.g., MRSA)
80. MALDI-TOF
81. Identification of anaerobes by full biochemical testing (e.g., Vitek, API, RapID)
82. Identification of anaerobes by identification disc and/or spot testing
83. Antigen and/or toxin detection direct from specimen (e.g., C. difficile, Shiga toxin)

Antimicrobial susceptibility testing

84. Automated microdilution (e.g., Microscan, Vitek, Phoenix)
85. Disk diffusion method (i.e., Kirby Bauer)
86. E-Test gradient method
87. Enzyme detection (e.g., beta-lactamase)
88. Resistance mechanism detection (e.g., D test, modified Hodge, ESBL, PBP2a)

89. Molecular detection of resistance genes
MYCOLOGY/ACTINOMYCETES
Identification of Yeasts
90. Automated methods (Microscan, Vitek)
91. Commercial nonautomated methods (e.g., RapID, API)
92. Conventional methods (e.g., cornmeal tween 80, germ tube)
93. Chromogenic agar methods
94. MALDI-TOF
Identification of Actinomycetes
95. MALDI-TOF
PARASITOLOGY
96. Pinworm preparation
97. Preparation of permanent stained smears (e.g., trichrome, iron hematoxylin)
98. Interpretation of permanent stained smears
99. Interpretation of direct exam from concentrate
100. Interpretation of blood films
SPIROCHETES, OBLIGATE INTRACELLULAR BACTERIA and MYCOPLASMAS
101. Molecular methods directly from specimen (e.g., *Chlamydia*, *N. gonorrhoeae* NAAT)
BODY FLUID TESTING
102. CSF analysis
103. Synovial fluid analysis (e.g., crystal analysis)
104. Serous body fluid (e.g., pericardial, peritoneal, pleural) analysis
105. Bronchoalveolar lavage (BAL) analysis
106. Gastric analysis (e.g., pH)
107. Semen analysis
108. Sweat test
109. Urine eosinophil testing
110. Occult blood testing
111. Fecal leukocyte testing
112. Automated cell counts
113. Manual cell counts
114. Cytospin prep

IMMUNOLOGY

KNOWLEDGE QUESTIONS

115. Immune response (i.e., cellular and humoral / primary and secondary)
116. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
117. Complement (i.e., mechanisms, biologic properties)
118. Lymphocyte subsets (e.g., CD4+ T helper cells)
119. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)

SEROLOGICAL TECHNIQUES

120. Specimen collection and/or handling protocols for serology
121. Agglutination techniques (e.g., latex, particle)
122. Enzyme immunoassay
123. Chemiluminesence immunoassay
124. Immunofluoresence

AUTOIMMUNITY

125. ANA/ENA/Anti-DNA
126. Thyroid antibodies (e.g., TSH receptor TG and/or TPO antibodies)
127. RF/anti-CCP
128. Celiac Antibodies
129. Parietal cell / intrinsic factor antibodies
130. Cryoglobulins

VIRAL/MICROBIAL TESTING

131. Nontreponemal syphilis testing (e.g., RPR)
132. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
133. Immunity screening (e.g., rubella, measles, varicella zoster)
134. Hepatitis
135. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
136. CMV/EBV

BLOOD BANKING

KNOWLEDGE QUESTIONS

Blood Group Systems

137. Molecular basis of blood group system (e.g., red cell genotyping, platelet genotyping)
138. Antigens and antibodies (e.g., red cell, HLA, platelet, granulocyte)
139. Recognition of the role of blood groups in transfusion (e.g., immunogenicity, antigen frequency)

Physiology and Pathophysiology
140. Physiology of blood (e.g., circulation and blood volume, composition and function of blood, abnormal physiology, cell survival, cell metabolism)
141. Hemostasis and coagulation (e.g., coagulation factors and disorders, platelet functions and disorders)
142. Hemolytic disease of the fetus and newborn (e.g., pathophysiology, detection, treatment, prevention)
143. Anemias (e.g., pathophysiology, detection, treatment)
144. Immune-hemolytic anemias: warm, cold, drug-induced (e.g., pathophysiology, detection, treatment)
145. Adverse effects of transfusion
146. Transplantation (e.g., testing and transfusion support of solid organ and stem cell recipients)
Blood Products
147. Recognition of anticoagulants and preservatives
General Immunology
148. Immune response (i.e., cellular and humoral / primary and secondary)
149. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
150. Complement (e.g., mechanisms, biologic properties)
151. Immunomodulatory medications (e.g., IVIg, monoclonal antibodies, steroids)
BLOOD PRODUCTS
Collecting Donor Blood
152. Determination of donor acceptability (e.g., health history questions and physical findings, hemoglobin screen, allogeneic and autologous donors)
153. Collection of donor blood/components by phlebotomy
154. Collection of donor blood/components by apheresis
155. Recognition and management of adverse donor reactions
Processing Donor Blood
156. Adherence to FDA/AABB requirements for testing donor blood (e.g., viral markers, NAT, ABO/Rh, antibody screen/ID)
157. Lookback and recall of donor products (e.g., positive test results, post-donation information)
158. Labeling of donor blood and blood products
Component Preparation
159. Preparation of blood components from whole blood (e.g., red cell, plasma, platelets, cryoprecipitate)
160. Special processing of blood components (e.g., washing, irradiating, freezing/deglycerolizing)
Quality Control of Blood Products
161. Maintenance of records from donor to final disposition
162. Blood product quality control
Storage and Transportation of Blood Products
163. Blood/component storage
164. Blood/component transportation
TRANSFUSION PRACTICE
165. Preparation of components for transfusion (e.g., storage, aliquoting, washing, thawing)
166. Monitoring component therapy (e.g., transfusion guidelines)
167. Selection and preparation of components for pediatric/neonatal/perinatal transfusion

168. Emergency/massive transfusion protocol
169. Platelet support for refractory patients
170. Therapeutic apheresis
171. Investigation of adverse effects of transfusion
172. Blood administration auditing
173. Blood product inventory management
174. Blood component issue and return
175. Plasma derivatives and factor concentrates issue (e.g., IVIG, factor VIII)
SEROLOGIC AND MOLECULAR TESTING
176. Manual serologic testing for ABO, Rh, and antibody detection (i.e., screening)
177. Automated serologic testing for ABO, Rh, and antibody detection (i.e., screening)
178. Antibody identification
179. Crossmatch/compatibility testing
180. Direct antiglobulin testing (DAT)
181. Phenotyping (e.g., K, S)
182. Antibody titration
183. Elutions
184. Adsorptions
185. Special techniques (e.g., enzyme testing, DTT)
186. Transfusion reaction work-up
187. Cell separations
188. Molecular RBC genotyping
189. Leukocyte and platelet testing
Hemolytic Disease of the Fetus and Newborn (HDFN) Work-up
190. Determination of candidacy for RhIG administration
191. Rosette test
192. Kleihauer-Betke test
CHEMISTRY
KNOWLEDGE QUESTIONS
193. Normal and abnormal physiology including metabolic pathways and disease states
194. The physical and chemical properties of analytes
ANALYTICAL TECHNIQUES
195. Spectrophotometry and photometry (e.g., photometry - UV or infrared, fluorescence, nephelometry/turbidimetry, reflectance, chemiluminescence)
196. Osmometry
197. Electrophoresis (e.g., traditional, capillary, isoelectric focusing)
198. Immunofixation

199. Electrochemistry (e.g., potentiometry, pH, *p*CO2, *p*O2, ion-selective electrodes)
CAROBOHYDRATES
200. Galactose and other reducing substances
201. Glucose including fasting, post-prandial, tolerance testing, insulin tolerance and gestational challenge
202. Tolerance testing to assess other carbohydrates (e.g., xylose, lactose)
203. Lactate
204. Ketones (e.g., beta-hydroxybutyrate)
205. Glycated hemoglobin/Hemoglobin A1c
206. Insulin and/or C-peptide
207. Fructosamine
LIPIDS
208. Cholesterol including total, HDL, LDL (calculated and/or direct)
209. Triglycerides
210. Apolipoproteins (A & B)
211. Chylomicron
HEME DERIVATIVES
212. Hemoglobins (e.g., electrophoresis)
213. Myoglobin
214. Bilirubin
215. Iron/TIBC
216. Ferritin
PROTEINS AND OTHER NITROGEN-CONTAINING COMPOUNDS
217. Total Protein (including albumin)
218. Urine albumin (high sensitivity, microalbumin)
219. Protein electrophoresis
220. Immunofixation electrophoresis
221. Newborn screening (e.g., amino acids, inborn errors of metabolism)
222. C3, C4
223. BNP
224. Ceruloplasmin
225. C-reactive protein/hsCRP
226. Haptoglobin
227. Immunoglobulins (IgG, IgA, IgM)
228. IgE
229. Transferrin
230. Urea
231. Uric acid
232. Creatinine/eGFR
233. Creatinine clearance

234. Ammonia
235. Routine tumor markers, (e.g., CEA, PSA, CA125)
236. Special tumor markers (e.g., AFP, thyroglobulin, CA15-3, CA19-9)
237. Fetal fibronectin
238. Troponin
239. Nutritional markers (e.g., prealbumin)
ENZYMES
240. Creatine kinase (CK-MB, CK-MM)
241. Lactate dehydrogenase (LD)
242. Alanine aminotransferase (ALT)
243. Aspartate aminotransferase (AST)
244. Alkaline phosphatase (ALP)
245. Gamma-glutamyl transferase (GGT)
246. Serum cholinesterase
247. Lipase/Amylase
248. Glucose 6-phosphate dehydrogenase (G-6-PD)
BLOOD GASES
249. *p*O2, *p*CO2, pH
250. Calculated blood gas parameters (e.g., p50, % saturation, base excess)
251. Carbon monoxide
ELECTROLYTES
252. Potassium, sodium, chloride, CO2, bicarbonate
253. Sweat test
254. Calcium
255. Magnesium
256. Phosphorus
257. Osmolality (measured and calculated)
258. Calculated electrolyte parameters (e.g., anion gap/osmolal gap)
HORMONES
259. TSH
260. Total T3
261. Free T3
262. Total and free T4
263. TSH stimulation
264. Cortisol
265. HCG (quantitative)
266. Luteinizing hormone (LH)/Follicle stimulating hormone (FSH)
267. Parathyroid hormone (PTH)
268. Estrogens

269. Progesterone
270. Testosterone
271. Prolactin
272. ACTH stimulation/dexamethasone suppression
273. Renin/aldosterone
274. 17-OH progesterone
275. Growth hormone/IGF-1
276. ADH (AVP)
VITAMINS
277. Vitamin D
278. Vitamin B12/Folate
279. Homocysteine
280. Miscellaneous vitamins (e.g., A, B6, C)
TOXICOLOGY
281. Ethanol
282. Volatiles (e.g., ethylene glycol, methanol, isopropanol)
283. Lead
284. Heavy metals (e.g., arsenic, mercury, bismuth)
285. Analgesics (e.g., acetaminophen, salicylates)
286. Drugs of abuse – class analyses/screening
287. Drugs of abuse – identification/confirmation/quantitation
288. Trace elements (e.g., copper, selenium)
THERAPEUTIC DRUG MONITORING
289. Aminoglycosides (e.g., gentamicin)
290. Cardioactive (e.g., digoxin)
291. Anti-convulsants (e.g., phenobarbital, diazepam, topiramate, levetiracetam)
292. Anti-depressants
293. Immunosuppressants (e.g., tacrolimus, sirolimus)

HEMATOLOGY

KNOWLEDGE QUESTIONS
294. Normal and abnormal physiology of erythrocytes, leukocytes, and platelets (e.g., production, destruction, function)
295. Physiology of hemostasis and thrombosis (e.g., pathways – extrinsic, intrinsic, common & fibrinolytic, vascular system)
296. Correlation of patient results with disease states of erythrocytes, leukocytes, and hemostasis

PERIPHERAL BLOOD EVALUATION
297. Automated cell counts and differentials
298. Peripheral blood smears for differentials (preparation and staining)
299. Manual differentials and peripheral smear evaluation (e.g., WBC, RBC, and platelet)
300. Manual cell counts (WBCs and platelets)
301. Estimation of leukocyte and platelet counts from a stained blood smear
302. Recognition of immature, reactive, malignant, or abnormal nucleated cells and leukocyte inclusions
303. Recognition of abnormalities that will interfere with automated results (e.g., platelet clumps, lipemia)
304. Correction of counts for the presence of nucleated red cells
305. Description and grading of red cells according to size, color, shape and inclusions
HEMATOLOGY TESTING
306. ESR (erythrocyte sedimentation rate)
307. Manual hematocrit
308. Fetal hemoglobin (Kleihauer Betke)
309. Hemoglobin F (quantitative)
310. Heinz body screen
311. Automated reticulocyte count
312. Reticulocyte count using microscopy
313. Sickle cell screen
314. Calculate/evaluate RBC indices including MCV, MCH, MCHC, RDW
315. Hemoglobin electrophoresis
316. RBC enzymes (e.g., G-6-PD, pyruvate kinase)
317. Blood parasite screens (e.g., malaria, Babesia)
318. Flow cytometric phenotyping
319. Molecular genetic testing (e.g., FISH, PCR)
HEMOSTASIS (COAGULATION) TESTING
320. Semi-automated coagulation analyzer
321. Automated coagulation analyzer
322. PT/INR
323. APTT
324. Thrombin time
325. Fibrinogen
326. D-dimer
327. Mixing studies
328. Factor assays
329. vWF assays
330. Heparin neutralization/adsorption (e.g., Hepzyme)
331. Heparin assay (anti-Xa assay)
332. Hypercoagulability tests (e.g., protein C, protein S, antithrombin)
333. Hypercoagulable molecular testing (e.g., Factor V Leiden, prothrombin gene mutation)
334. Platelet function screening tests (e.g., PFA-100TM)

URINALYSIS
KNOWLEDGE QUESTIONS
335. Normal and abnormal physiology of the urinary system
336. Correlation of patient results with disease states
URINALYSIS TASKS
337. Appearance (e.g., color, clarity)
338. Chemical exam (reagent strip)
339. Microscopic exam (e.g., casts, cells, crystals, artifacts)
340. Specific gravity by refractometer
341. Confirmatory testing for reducing substances (e.g., Clinitest)
342. Confirmatory testing for bilirubin (e.g., Ictotest)
343. Confirmatory testing for proteins (e.g., SSA)
344. Confirmatory testing for ketones (e.g., Acetest)
345. Osmolality
346. Qualitative pregnancy test
347. Automated urine reagent strip reading device
348. Automated urine sediment analyzer

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Appendix C

MEDICAL LABORATORY SCIENTIST (MLS)

DEMOGRAPHIC ANALYSIS

Total respondents: 4,348
Total usable: 2,004

Usable individual respondents met the following criteria:

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

Summary:

- Certifications: nearly 90% are MLS certified
- Education:
  - 3% have an associate degree or lower
  - 69% have a baccalaureate degree
  - 18% have a post-baccalaureate program certificate
  - 10% have a master's degree or higher
- Experience:
  - 45% have less than 10 years
  - 16% have 10 – 20 years
  - 39% have 20 or more years
- Geographic Distribution: there are respondents from all fifty U.S. states, Washington D.C. and Puerto Rico, and states with the highest response rate include:
  - 6% each from Texas and California
  - 5% each from Michigan and Wisconsin
  - 4% each from New York, Illinois, Florida, Ohio, Minnesota, and Pennsylvania
- Facility:
  - 81% work in hospitals
  - 8% work in independent labs
  - 4% work in physician offices/clinics
  - 7% are employed in various 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:
  - 83% are female
  - 16% are male
  - 1% chose not to answer this question

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Appendix D

MEDICAL LABORATORY SCIENTIST (MLS)

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. Chain of custody procedures
4. Specimen processing (e.g., centrifuge, separate)
5. Specimen storage (e.g., time, temperature, light)
6. Specimen distribution (e.g., packaging to meet USPS, DOT and/or IATA regulations/requirements)
7. Specimen evaluation for acceptability
8. Corrective action for unsatisfactory specimens
REPORTING AND INTERPRETING RESULTS
9. Autoverification of patient results
10. Result reporting during LIS/computer downtime
11. Manual result entry (e.g., add interpretive comments, reference, or resource information to the report)
12. Correlation of test results with other data (e.g., clinical history, other lab results) and take corrective action as necessary
13. Critical result reporting according to protocol
14. Communication with healthcare providers regarding test results (e.g., report interpretation, amended results)
INSTRUMENTATION
15. Balances
16. Centrifuges (e.g., microhematocrit, cytocentrifuge)
17. Microscopes
18. Ocular micrometers
19. Digital imagers (e.g., IRIS, CellaVision)
LABORATORY OPERATIONS
20. Reagent preparation, labeling, and storage
21. Reagent log maintenance
22. Temperature log maintenance
23. Calculations and unit conversions (e.g., dilutions, reagent preparation, graphs, statistics)
24. Instrument troubleshooting and repair
25. Instrument maintenance and calibration
26. Equipment (e.g., pipettes) maintenance and calibration

27. Evaluation/verification/validation of new instrumentation, methodologies, or assays
28. Safety activities (e.g., PPE, fume hoods, fire, safety data sheets, biosafety cabinet)
29. Hazard disposal, decontamination, and storage
30. Regulatory compliance (e.g., HIPAA, OSHA, EPA, homeland security, state, and local)
31. Quality control performance and review (e.g., IQCP)
32. Routine corrective action follow-up of 'Out of Control' results
33. Proficiency testing participation
34. Competency Testing Program participation
35. Quality Assurance Program participation
36. Training of new staff
37. Training of students, residents, and/or fellows
38. Training of point-of-care operators
39. Appropriate notification of reportable diseases
40. Maintenance of patient records and laboratory database
41. Departmental policy/procedure writing, review, and revision
MOLECULAR DIAGNOSTICS
KNOWLEDGE QUESTIONS
42. Nucleic acid chemistry and basic molecular theory (e.g., DNA structure, mutation, transcription)
43. Biochemical reagents (e.g., DNA ligase, polymerase enzymes)
44. Genetics (e.g., human, microbial)
45. Correlation of patient results with disease states
MOLECULAR TECHNIQUES
46. Specimen collection and/or handling protocols for molecular testing
47. Processing of specimens for molecular testing (e.g., extract RNA/DNA, evaluate quality/quantity of nucleic acid, store nucleic acid)
48. Nucleic acid amplification (e.g., PCR, PCR variations, SDA, TMA, NASBA, bDNA)
49. Separation techniques (e.g., electrophoresis)
50. Hybridization methods (e.g., Southern Blot, array technology, FISH, colony blot)
51. Nucleic acid sequencing (e.g., Sanger sequencing, pyrosequencing, next-generation sequencing)
52. Prevention, detection, and removal of nucleic acid contamination
53. Bacterial identification by sequencing (e.g., 16S ribosomal RNA)
MOLECULAR TESTING
Infectious Disease
54. Hepatitis (e.g., HCV, HBV)
55. HIV
56. Surveillance of immunocompromised patients (e.g., EBV, CMV, BK)
57. HSV

58. Chlamydia/N. gonorrheae
59. MRSA/MSSA
60. HPV
61. Respiratory pathogens (e.g., influenza, legionella, bordetella, adenovirus)
62. C. difficile
63. Gastrointestinal pathogens
64. Group B Strep
65. Mycobacteria
Hematology/Oncology
66. Leukemias/Lymphomas (e.g., CML, ALL, translocations)
Genetics
67. Coagulopathies (e.g., Factor V Leiden, prothrombin, MTHFR)
MICROBIOLOGY
GENERAL PROCESSING AND RAPID TESTING
Specimen Processing
68. Routine bacteriology specimen processing (e.g., streaking plates, inoculating culture media, preparing slides for Gram stains)
69. Automated specimen processing (e.g., WASP, Kiestra, Previ)
70. Loading/unloading blood culture bottles on/from instrument
71. Direct specimen slide preparation for mycology (e.g., Calcofluor white, KOH)
72. Mycobacteriology specimen processing (e.g., digestion, decontamination, concentration, smear prep, media inoculation)
73. Parasitology specimen processing
Identify pathogens directly from specimens
74. Gram staining
75. Gram stain interpretation
76. Positive blood culture processing (e.g., Gram staining, streaking plates)
77. Direct molecular testing of positive blood cultures
78. Preliminary positive blood culture Gram stain result reporting
79. Interpretation of wet preparation smear (e.g., Trichomonas, calcofluor white)
80. Rapid antigen methods for bacteria (e.g., rapid Strep)
81. Rapid antigen methods for fungi (e.g., Cryptococcal antigen)
82. Rapid antigen methods for parasites (e.g., E. histolytica, Giardia, Malaria)
83. Rapid antigen methods for viruses (e.g., RSV, influenza)
84. Rapid molecular methods (e.g., BioFire, Nanosphere, Cepheid, Affirm VPIII)

ROUTINE BACTERIOLOGY (Including aerobes and anaerobes)
Identification/detection
85. Identification of aerobes by automated methods (e.g., Microscan, Vitek, Phoenix)
86. Identification of aerobes by commercial nonautomated methods (e.g., RapID, API)
87. Identification of aerobes by rapid/spot biochemical methods (e.g., oxidase, indole, catalase)
88. Identification of aerobes by conventional biochemical methods (e.g., urea, KIA, TSI, OF-sugars)
89. Serotyping methods (e.g., Strep grouping, Salmonella/Shigella typing)
90. Chromogenic agar methods (e.g., MRSA)
91. MALDI-TOF
92. Identification of anaerobes by full biochemical testing (e.g., Vitek, API, RapID)
93. Identification of anaerobes by identification disc and/or spot testing
94. Antigen and/or toxin detection direct from specimen (e.g., C. difficile, Shiga toxin)
Antimicrobial susceptibility testing
95. Manual microdilution
96. Automated microdilution (e.g., Microscan, Vitek, Phoenix)
97. Disk diffusion method (i.e., Kirby Bauer)
98. E-Test gradient method
99. Enzyme detection (e.g., beta-lactamase)
100. Resistance mechanism detection (e.g., D test, modified Hodge, ESBL, PBP2a)
101. Molecular detection of resistance genes
102. Anaerobic antimicrobial susceptibility testing
MYCOLOGY/ACTINOMYCETES
Identification of Yeasts
103. Automated methods (Microscan, Vitek)
104. Commercial nonautomated methods (e.g., RapID, API)
105. Conventional methods (e.g., cornmeal tween 80, germ tube)
106. Chromogenic agar methods
107. MALDI-TOF
Identification of Molds
108. Stain method (e.g., lactophenol cotton blue)
109. Conventional methods (e.g., Trichophyton agars, urease)
110. MALDI-TOF
Identification of Actinomycetes
111. Genus determination by modified acid fast stain and lysozyme
112. MALDI-TOF
PARASITOLOGY
113. Pinworm preparation
114. Macroscopic parasite identification (e.g., larvae, ticks, worms)
115. Preparation of permanent stained smears (e.g., trichrome, iron hematoxylin)
116. Interpretation of permanent stained smears
117. Interpretation of direct exam from concentrate

118. Interpretation of blood films
119. Preparation and interpretation of stained smear for coccidians (e.g., *Isospora*, *Cryptosporidium*, *Cyclospora*)
120. Preparation and interpretation of stained smear for microsporidia
MYCOBACTERIOLOGY
Identification
121. Molecular methods directly from specimen (e.g., GeneXpert)
122. DNA probe
123. Sequencing and/or HPLC
124. MALDI-TOF
SPIROCHETES, OBLIGATE INTRACELLULAR BACTERIA and MYCOPLASMAS
125. Molecular methods directly from specimen (e.g., *Chlamydia*, *N. gonorrhoeae* NAAT)
BODY FLUID TESTING
126. CSF analysis
127. Synovial fluid analysis (e.g., crystal analysis)
128. Serous body fluid (e.g., pericardial, peritoneal, pleural) analysis
129. Bronchoalveolar lavage (BAL) analysis
130. Gastric analysis (e.g., pH)
131. Semen analysis
132. Amniotic fluid cell count
133. Sweat test
134. Urine eosinophil testing
135. Occult blood testing
136. Fecal leukocyte testing
137. Automated cell counts
138. Manual cell counts
139. Cytospin prep
IMMUNOLOGY
KNOWLEDGE QUESTIONS
140. Immune response (i.e., cellular and humoral / primary and secondary)
141. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
142. Complement (i.e., mechanisms, biologic properties)
143. Immunomodulatory medications (e.g., IVIg, monoclonal antibodies, steroids)
144. Lymphocyte subsets (e.g., CD4+ T helper cells)

145. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)
SEROLOGIC TECHNIQUES
146. Specimen collection and/or handling protocols for serology
147. Agglutination techniques (e.g., latex, particle)
148. Enzyme immunoassay
149. Chemiluminesence immunoassay
150. Immunofluoresence
AUTOIMMUNITY
151. ANA/ENA/Anti-DNA
152. Thyroid antibodies (e.g., TSH receptor TG and/or TPO antibodies)
153. RF/anti-CCP
154. Celiac Antibodies
155. Parietal cell / intrinsic factor antibodies
156. Cryoglobulins
VIRAL/MICROBIAL TESTING
157. Nontreponemal syphilis testing (e.g., RPR)
158. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
159. Immunity screening (e.g., rubella, measles, varicella zoster)
160. Hepatitis
161. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
162. CMV/EBV
163. Cytokine testing for tuberculosis (e.g., QuantiFERON)
164. Lyme disease testing
BLOOD BANKING
KNOWLEDGE QUESTIONS
Blood Group Systems
165. Molecular basis of blood group system (e.g., red cell genotyping, platelet genotyping)
166. Antigens and antibodies (e.g., red cell, HLA, platelet, granulocyte)
167. Recognition of the role of blood groups in transfusion (e.g., immunogenicity, antigen frequency)
Physiology and Pathophysiology
168. Physiology of blood (e.g., circulation and blood volume, composition and function of blood, abnormal physiology, cell survival, cell metabolism)
169. Hemostasis and coagulation (e.g., coagulation factors and disorders, platelet functions and disorders)
170. Hemolytic disease of the fetus and newborn (e.g., pathophysiology, detection, treatment, prevention)
171. Anemias (e.g., pathophysiology, detection, treatment)
172. Immune-hemolytic anemias: warm, cold, drug-induced (e.g., pathophysiology, detection, treatment)
173. Adverse effects of transfusion

174. Transplantation (e.g., testing and transfusion support of solid organ and stem cell recipients)
Blood Products
175. Recognition of anticoagulants and preservatives
General Immunology
176. Immune response (i.e., cellular and humoral / primary and secondary)
177. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
178. Complement (e.g., mechanisms, biologic properties)
179. Immunomodulatory medications (e.g., IVIg, monoclonal antibodies, steroids)
BLOOD PRODUCTS
Collecting Donor Blood
180. Determination of donor acceptability (e.g., health history questions and physical findings, hemoglobin screen, allogeneic and autologous donors)
181. Collection of donor blood/components by phlebotomy
182. Collection of donor blood/components by apheresis
183. Recognition and management of adverse donor reactions
Processing Donor Blood
184. Adherence to FDA/AABB requirements for testing donor blood (e.g., viral markers, NAT, ABO/Rh, antibody screen/ID)
185. Lookback and recall of donor products (e.g., positive test results, post-donation information)
186. Labeling of donor blood and blood products
Component Preparation
187. Preparation of blood components from whole blood (e.g., red cell, plasma, platelets, cryoprecipitate)
188. Special processing of blood components (e.g., washing, irradiating, freezing/deglycerolizing)
Quality Control of Blood Products
189. Maintenance of records from donor to final disposition
190. Blood product quality control
Storage and Transportation of Blood Products
191. Blood/component storage
192. Blood/component transportation
TRANSFUSION PRACTICE
193. Preparation of components for transfusion (e.g., storage, aliquoting, washing, thawing)
194. Monitoring component therapy (e.g., transfusion guidelines)
195. Selection and preparation of components for pediatric/neonatal/perinatal transfusion
196. Emergency/massive transfusion protocol
197. Platelet support for refractory patients
198. Therapeutic apheresis
199. Investigation of adverse effects of transfusion
200. Blood administration auditing
201. Blood product inventory management
202. Blood component issue and return
203. Plasma derivatives and factor concentrates issue (e.g., IVIG, factor VIII)

SEROLOGIC AND MOLECULAR TESTING
204. Manual serologic testing for ABO, Rh, and antibody detection (i.e., screening)
205. Automated serologic testing for ABO, Rh, and antibody detection (i.e., screening)
206. Antibody identification
207. Crossmatch/compatibility testing
208. Direct antiglobulin testing (DAT)
209. Phenotyping (e.g., K, S)
210. Antibody titration
211. Elutions
212. Adsorptions
213. Special techniques (e.g., enzyme testing, DTT)
214. Transfusion reaction work-up
215. Cell separations
216. Molecular RBC genotyping
217. Neutralization/inhibition
218. Leukocyte and platelet testing
219. Donath-Landsteiner testing
220. Thermal amplitude
Histocompatibility testing (e.g., HLA typing, HLA antibody screening)
221. Serologic
222. Molecular
Hemolytic Disease of the Fetus and Newborn (HDFN) Work-up
223. Determination of candidacy for RhIG administration
224. Rosette test
225. Flow cytometry
226. Kleihauer-Betke test
CHEMISTRY
KNOWLEDGE QUESTIONS
227. Normal and abnormal physiology including metabolic pathways and disease states
228. The physical and chemical properties of analytes
ANALYTICAL TECHNIQUES
229. Spectrophotometry and photometry (e.g., photometry - UV or infrared, fluorescence, nephelometry/turbidimetry, reflectance, chemiluminescence)
230. Mass spectrometry (e.g., GCMS, HPLC, tandem MS/MS, MALDI-TOF)
231. Osmometry
232. Electrophoresis (e.g., traditional, capillary, isoelectric focusing)
233. Immunofixation
234. Chromatography (e.g., thin layer, cation exchange)
235. Electrochemistry (e.g., potentiometry, pH, *p*CO2, *p*O2, ion-selective electrodes)

CARBOHYDRATES
236. Galactose and other reducing substances
237. Glucose including fasting, post-prandial, tolerance testing, insulin tolerance and gestational challenge
238. Tolerance testing to assess other carbohydrates (e.g., xylose, lactose)
239. Lactate
240. Ketones (e.g., beta-hydroxybutyrate)
241. Glycated hemoglobin/Hemoglobin A1c
242. Insulin and/or C-peptide
243. Fructosamine
LIPIDS
244. Cholesterol including total, HDL, LDL (calculated and/or direct)
245. Triglycerides
246. Apolipoproteins (A & B)
247. Chylomicron
248. Lipoprotein electrophoresis
249. Lp(a)
250. Lipid particle size analysis (e.g., VAP)
HEME DERIVATIVES
251. Hemoglobins (e.g., electrophoresis)
252. Myoglobin
253. Bilirubin
254. Porphyrin, precursors and derivatives (e.g., porphobilinogen, 5-aminolevulinic acid)
255. Iron/TIBC
256. Ferritin
PROTEINS AND OTHER NITROGEN-CONTAINING COMPOUNDS
257. Total Protein (including albumin)
258. Urine albumin (high sensitivity, microalbumin)
259. Protein electrophoresis
260. Immunofixation electrophoresis
261. Newborn screening (e.g., amino acids, inborn errors of metabolism)
262. Free light chains
263. Beta-2 microglobulin
264. Alpha-1 antitrypsin
265. C3, C4
266. BNP
267. Ceruloplasmin
268. C-reactive protein/hsCRP
269. Haptoglobin
270. Immunoglobulins (IgG, IgA, IgM)
271. IgE

272. Transferrin
273. Urea
274. Uric acid
275. Creatinine/eGFR
276. Creatinine clearance
277. Ammonia
278. Routine tumor markers, (e.g., CEA, PSA, CA125)
279. Special tumor markers (e.g., AFP, thyroglobulin, CA15-3, CA19-9)
280. Fetal fibronectin
281. Troponin
282. Procalcitonin
283. Nutritional markers (e.g., prealbumin)
ENZYMES
284. Creatine kinase (CK-MB, CK-MM)
285. Lactate dehydrogenase (LD)
286. Alanine aminotransferase (ALT)
287. Aspartate aminotransferase (AST)
288. Alkaline phosphatase (ALP)
289. Gamma-glutamyl transferase (GGT)
290. Serum cholinesterase
291. Lipase/Amylase
292. Glucose 6-phosphate dehydrogenase (G-6-PD)
BLOOD GASES
293. *p*O2, *p*CO2, pH
294. Calculated blood gas parameters (e.g., p50, % saturation, base excess)
295. Carbon monoxide
ELECTROLYTES
296. Potassium, sodium, chloride, CO2, bicarbonate
297. Sweat test
298. Calcium
299. Magnesium
300. Phosphorus
301. Osmolality (measured and calculated)
302. Calculated electrolyte parameters (e.g., anion gap/osmolal gap)
HORMONES
303. TSH
304. Total T3
305. Free T3
306. Total and free T4

307. TSH stimulation
308. Cortisol
309. HCG (quantitative)
310. Luteinizing hormone (LH)/Follicle stimulating hormone (FSH)
311. Parathyroid hormone (PTH)
312. Estrogens
313. Progesterone
314. Testosterone
315. Prolactin
316. ACTH stimulation/dexamethasone suppression
317. Renin/aldosterone
318. 17-OH progesterone
319. Growth hormone/IGF-1
320. ADH (AVP)
VITAMINS
321. Vitamin D
322. Vitamin B12/Folate
323. Homocysteine
324. Miscellaneous vitamins (e.g., A, B6, C)
TOXICOLOGY
325. Ethanol
326. Volatiles (e.g., ethylene glycol, methanol, isopropanol)
327. Lead
328. Heavy metals (e.g., arsenic, mercury, bismuth)
329. Analgesics (e.g., acetaminophen, salicylates)
330. Drugs of abuse – class analyses/screening
331. Drugs of abuse – identification/confirmation/quantitation
332. Trace elements (e.g., copper, selenium)
THERAPEUTIC DRUG MONITORING
333. Aminoglycosides (e.g., gentamicin)
334. Cardioactive (e.g., digoxin)
335. Anti-convulsants (e.g., phenobarbital, diazepam, topiramate, levetiracetam)
336. Anti-depressants
337. Immunosuppressants (e.g., tacrolimus, sirolimus)

HEMATOLOGY
KNOWLEDGE QUESTIONS
338. Normal and abnormal physiology of erythrocytes, leukocytes, and platelets (e.g., production, destruction, function)
339. Physiology of hemostasis and thrombosis (e.g., pathways – extrinsic, intrinsic, common & fibrinolytic, vascular system)
340. Correlation of patient results with disease states of erythrocytes, leukocytes, and hemostasis
PERIPHERAL BLOOD EVALUATION
341. Automated cell counts and differentials
342. Peripheral blood smears for differentials (preparation and staining)
343. Manual differentials and peripheral smear evaluation (e.g., WBC, RBC, and platelet)
344. Manual cell counts (WBCs and platelets)
345. Estimation of leukocyte and platelet counts from a stained blood smear
346. Recognition of immature, reactive, malignant, or abnormal nucleated cells and leukocyte inclusions
347. Recognition of abnormalities that will interfere with automated results (e.g., platelet clumps, lipemia)
348. Correction of counts for the presence of nucleated red cells
349. Description and grading of red cells according to size, color, shape and inclusions
HEMATOLOGY TESTING
350. ESR (erythrocyte sedimentation rate)
351. Manual hematocrit
352. Fetal hemoglobin (Kleihauer Betke)
353. Hemoglobin F (quantitative)
354. Heinz body screen
355. Automated reticulocyte count
356. Reticulocyte count using microscopy
357. Sickle cell screen
358. Calculate/evaluate RBC indices including MCV, MCH, MCHC, RDW
359. Hemoglobin electrophoresis
360. RBC enzymes (e.g., G-6-PD, pyruvate kinase)
361. Blood parasite screens (e.g., malaria, Babesia)
362. Flow cytometric phenotyping
363. Molecular genetic testing (e.g., FISH, PCR)
BONE MARROW EXAMINATION
364. Bone marrow procedure assistance
365. Bone marrows and/or biopsy material processing and staining
366. Bone marrow differentials (e.g., evaluate cellularity, classify various cell families, recognize abnormal and atypical cells and metastatic tumor cells)
367. Flow cytometry analysis (e.g., immunophenotyping)
368. Special stains: esterases, myeloperoxidase

369. Iron stain (e.g., Prussian blue)
370. Molecular studies (e.g., PCR, FISH, microarray)
371. WHO classification
372. FAB classification
HEMOSTASIS (COAGULATION) TESTING
373. Semi-automated coagulation analyzer
374. Automated coagulation analyzer
375. PT/INR
376. APTT
377. Thrombin time
378. Fibrinogen
379. D-dimer
380. Mixing studies
381. Factor assays
382. vWF assays
383. Heparin neutralization/adsorption (e.g., Hepzyme)
384. Lupus anticoagulant (e.g., dRVVT, phospholipid neutralization)
385. Factor VIII inhibitors/Bethesda titer
386. Heparin assay (anti-Xa assay)
387. Target-specific anticoagulant assays (e.g., dabigatran, rivaroxiban)
388. Hypercoagulability tests (e.g., protein C, protein S, antithrombin)
389. Hypercoagulable molecular testing (e.g., Factor V Leiden, prothrombin gene mutation)
390. Activated protein C resistance
391. Platelet function screening tests (e.g., PFA-100TM)
392. Platelet function/diagnostic tests (e.g., platelet aggregation)
393. Heparin induced thrombocytopenia (e.g., HIT studies)
394. Thromboelastography (TEG)

URINALYSIS

KNOWLEDGE QUESTIONS
395. Normal and abnormal physiology of the urinary system
396. Correlation of patient results with disease states
URINALYSIS TASKS
397. Appearance (e.g., color, clarity)
398. Chemical exam (reagent strip)
399. Microscopic exam (e.g., casts, cells, crystals, artifacts)
400. Specific gravity by refractometer
401. Confirmatory testing for reducing substances (e.g., Clinitest)
402. Confirmatory testing for bilirubin (e.g., Ictotest)

403. Confirmatory testing for proteins (e.g., SSA)
404. Confirmatory testing for ketones (e.g., Acetest)
405. Osmolality
406. Qualitative pregnancy test
407. Automated urine reagent strip reading device
408. Automated urine sediment analyzer