

# C AND SC PRACTICE ANALYSIS REPORT

For Development of

C(ASCP) & C(ASCP<sup>i</sup>)

and

SC(ASCP) & SC(ASCP<sup>i</sup>)

Content Guideline and Examinations

for Exam Publication July 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)<sup>1</sup>. 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

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<sup>1</sup> 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 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).

## **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 C and SC exams, the percentage of respondents currently working exclusively in Chemistry and each of the other sections was calculated. The data for any sections in which at least 20% of respondents were working in both Chemistry and that area, were included in the analysis. The other survey sections that scored above 20% and therefore were included in the C/SC analysis were Laboratory Operations, Immunology/Serology, Body Fluids, Point-of-Care Testing, and Management/Supervision (for SC only).

Responses from individuals performing higher-level supervisory tasks were not appropriate for the entry-level Technologist in Chemistry certification category and were therefore excluded from the analysis. The responses from these individuals were included in the analysis for the Specialist in Chemistry 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 Chemistry Committee reviewed the practice analysis results. They agreed that the demographic results accurately reflected the C and SC 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 C 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 C and SC **(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 C and SC 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.

## TECHNOLOGIST IN CHEMISTRY (C)

### DEMOGRAPHIC ANALYSIS

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Total respondents: 7,122

Total usable: 1,130

Usable individual respondents met the following criteria:

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

Summary:

- Certifications:
  - 90% are MLS certified
  - 3% are C 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:
  - 44% have less than 10 years
  - 16% have 10 – 20 years
  - 40% have 20 or more years
- Geographic Distribution: there are respondents from across the U.S., including Washington D.C. and Puerto Rico, and states with the highest response rate include:
  - 6% from Texas
  - 5% each from Michigan, Wisconsin, Florida, Illinois, and California
  - 4% each from Colorado, New York, and Pennsylvania
- Facility:
  - 83% work in hospitals
  - 6% work in independent labs
  - 5% work in physician offices/clinics
  - 6% work in other types of facilities
- Age:
  - 24% are younger than 30 years of age
  - 59% are 30 – 59 years of age
  - 17% are over 60 years of age
- Gender:
  - 82% are female
  - 17% are male
  - 1% chose not to answer this question

## TECHNOLOGIST IN CHEMISTRY (C)

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

<b>LABORATORY OPERATIONS</b>
<b>SPECIMEN COLLECTION, PREPARATION, AND PROCESSING</b>
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
<b>REPORTING AND INTERPRETING RESULTS</b>
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)
<b>INSTRUMENTATION</b>
15. Balances
16. Centrifuges (e.g., microhematocrit, cytocentrifuge)
17. Microscopes
<b>LABORATORY OPERATIONS</b>
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. Training of point-of-care operators
37. Appropriate notification of reportable diseases
38. Maintenance of patient records and laboratory database
39. Departmental policy/procedure writing, review, and revision

### **POINT OF CARE (WAIVED AND NON-WAIVED)**

40. Glucose
41. Electrolytes (e.g., I-Stat, NOVA)
42. Pregnancy test
43. Blood gases
44. Cardiac markers (e.g., troponin, myoglobin, CK-MB, BNP)
45. Lipids (e.g., total cholesterol)
46. Urine dipsticks
47. Lactate

### **CHEMISTRY**

#### **KNOWLEDGE QUESTIONS**

48. Normal and abnormal physiology including metabolic pathways and disease states
49. The physical and chemical properties of analytes

#### **ANALYTICAL TECHNIQUES**

50. Spectrophotometry and photometry (e.g., photometry - UV or infrared, fluorescence, nephelometry/turbidimetry, reflectance, chemiluminescence)
51. Mass spectrometry (e.g., GCMS, HPLC, tandem MS/MS, MALDI-TOF)
52. Osmometry
53. Electrophoresis (e.g., traditional, capillary, isoelectric focusing)
54. Immunofixation
55. Chromatography (e.g., thin layer, cation exchange)
56. Electrochemistry (e.g., potentiometry, pH,  $pCO_2$ ,  $pO_2$ , ion-selective electrodes)

### CARBOHYDRATES

- 57. Galactose and other reducing substances
- 58. Glucose including fasting, post-prandial, tolerance testing, insulin tolerance and gestational challenge
- 59. Tolerance testing to assess other carbohydrates (e.g., xylose, lactose)
- 60. Lactate
- 61. Ketones (e.g., beta-hydroxybutyrate)
- 62. Glycated hemoglobin/Hemoglobin A1c
- 63. Insulin and/or C-peptide
- 64. Fructosamine

### LIPIDS

- 65. Cholesterol including total, HDL, LDL (calculated and/or direct)
- 66. Triglycerides
- 67. Apolipoproteins (A & B)
- 68. Chylomicron
- 69. Lipoprotein electrophoresis
- 70. Lp(a)
- 71. Lipid particle size analysis (e.g., VAP)

### HEME DERIVATIVES

- 72. Hemoglobins (e.g., electrophoresis)
- 73. Myoglobin
- 74. Bilirubin
- 75. Porphyrin, precursors and derivatives (e.g., porphobilinogen, 5-aminolevulinic acid)
- 76. Iron/TIBC (move to electrolytes)
- 77. Ferritin

### PROTEINS AND OTHER NITROGEN-CONTAINING COMPOUNDS

- 78. Total Protein (including albumin)
- 79. Urine albumin (high sensitivity, microalbumin)
- 80. Protein electrophoresis
- 81. Immunofixation electrophoresis
- 82. Newborn screening (e.g., amino acids, inborn errors of metabolism)
- 83. Free light chains
- 84. Beta-2 microglobulin
- 85. Alpha-1 antitrypsin
- 86. C3, C4
- 87. BNP
- 88. Ceruloplasmin
- 89. C-reactive protein/hsCRP
- 90. Haptoglobin
- 91. Immunoglobulins (IgG, IgA, IgM)
- 92. IgE

93. Transferrin
94. Urea
95. Uric acid
96. Creatinine/eGFR
97. Creatinine clearance
98. Ammonia
99. Routine tumor markers, (e.g., CEA, PSA, CA125)
100. Special tumor markers (e.g., AFP, thyroglobulin, CA15-3, CA19-9)
101. Fetal fibronectin
102. Troponin
103. Procalcitonin
104. Nutritional markers (e.g., prealbumin)
<b>ENZYMES</b>
105. Creatine kinase (CK-MB, CK-MM)
106. Lactate dehydrogenase (LD)
107. Alanine aminotransferase (ALT)
108. Aspartate aminotransferase (AST)
109. Alkaline phosphatase (ALP)
110. Gamma-glutamyl transferase (GGT)
111. Serum cholinesterase
112. Lipase/Amylase
113. Glucose 6-phosphate dehydrogenase (G-6-PD)
<b>BLOOD GASES</b>
114. $pO_2$ , $pCO_2$ , pH
115. Calculated blood gas parameters (e.g., $p50$ , % saturation, base excess)
116. Carbon monoxide
<b>ELECTROLYTES</b>
117. Potassium, sodium, chloride, $CO_2$ , bicarbonate
118. Sweat test
119. Calcium
120. Magnesium
121. Phosphorus
122. Osmolality (measured and calculated)
123. Calculated electrolyte parameters (e.g., anion gap/osmolal gap)
<b>HORMONES</b>
124. TSH
125. Total T3
126. Free T3
127. Total and free T4

128. TSH stimulation
129. Cortisol
130. HCG (quantitative)
131. Luteinizing hormone (LH)/Follicle stimulating hormone (FSH)
132. Parathyroid hormone (PTH)
133. Estrogens
134. Progesterone
135. Testosterone
136. Prolactin
137. ACTH stimulation/dexamethasone suppression
138. Renin/aldosterone
139. 17-OH progesterone
140. Growth hormone/IGF-1
141. ADH (AVP)
<b>VITAMINS</b>
142. Vitamin D
143. Vitamin B12/Folate
144. Homocysteine
145. Miscellaneous vitamins (e.g., A, B6, C)
<b>TOXICOLOGY</b>
146. Ethanol
147. Volatiles (e.g. ethylene glycol, methanol, isopropanol)
148. Lead
149. Heavy metals (e.g., arsenic, mercury, bismuth)
150. Analgesics (e.g., acetaminophen, salicylates)
151. Drugs of abuse – class analyses/screening
152. Drugs of abuse – identification/confirmation/quantitation
153. Trace elements (e.g., copper, selenium) (move to electrolytes)
<b>THERAPEUTIC DRUG MONITORING</b>
154. Aminoglycosides (e.g., gentamicin)
155. Cardioactive (e.g., digoxin)
156. Anti-convulsants (e.g., phenobarbital, diazepam, topiramate, levetiracetam)
157. Anti-depressants
158. Immunosuppressants (e.g., tacrolimus, sirolimus)

## IMMUNOLOGY

### KNOWLEDGE QUESTIONS

- 159. Immune response (i.e., cellular and humoral / primary and secondary)
- 160. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
- 161. Complement (i.e., mechanisms, biologic properties)
- 162. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)

### SEROLOGICAL TECHNIQUES

- 163. Specimen collection and/or handling protocols for serology
- 164. Agglutination techniques (e.g., latex, particle)
- 165. Enzyme immunoassay
- 166. Chemiluminescence immunoassay
- 167. Immunofluorescence

### AUTOIMMUNITY

- 168. ANA/ENA/Anti-DNA
- 169. Thyroid antibodies (e.g., TSH receptor TG and/or TPO antibodies)
- 170. RF/anti-CCP
- 171. Celiac Antibodies
- 172. Parietal cell / intrinsic factor antibodies
- 173. Cryoglobulins

### VIRAL/MICROBIAL TESTING

- 174. Nontreponemal syphilis testing (e.g., RPR)
- 175. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
- 176. ASO
- 177. Immunity screening (e.g., rubella, measles, varicella zoster)
- 178. Hepatitis
- 179. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
- 180. CMV/EBV

## BODY FLUID TESTING

- 181. CSF analysis
- 182. Serous body fluid (e.g., pericardial, peritoneal, pleural) analysis
- 183. Sweat test

## SPECIALIST in CHEMISTRY (SC) DEMOGRAPHIC ANALYSIS

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Total respondents: 7,122

Total usable: 858

Usable individual respondents met the following criteria:

- Currently employed as a medical laboratory professional in a clinical laboratory
- Currently working in chemistry
- 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:
  - 90% are MLS certified
  - 4% are SC certified
- Education:
  - 4% have an associate degree or lower
  - 78% have a baccalaureate degree or post-baccalaureate program certificate
  - 18% have a master's degree or higher
- Experience:
  - 17% have less than 10 years
  - 21% have 11 – 20 years
  - 62% have 20 or more years
- Geographic Distribution: there are respondents from across the U.S., including Guam, Washington D.C., and Puerto Rico, and states with the highest response rate include:
  - 7% from Texas
  - 6% from California
  - 4% each from Minnesota, New York, Ohio, Wisconsin, and Florida
  - 3% each from Indiana, Illinois, and Pennsylvania
- Facility:
  - 72% work in hospitals
  - 11% work in physician offices/clinics
  - 9% work in independent labs
  - 8% work in other types of facilities
- Age:
  - 5% are younger than 30 years of age
  - 79% are 30 – 59 years of age
  - 16% are over 60 years of age
- Gender:
  - 81% are female
  - 17% are male
  - 2% chose not to answer this question

## SPECIALIST IN CHEMISTRY (SC)

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

<b>LABORATORY OPERATIONS</b>
<b>SPECIMEN COLLECTION, PREPARATION, AND PROCESSING</b>
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
<b>REPORTING AND INTERPRETING RESULTS</b>
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)
<b>INSTRUMENTATION</b>
15. Balances
16. Centrifuges (e.g., microhematocrit, cytocentrifuge)
17. Microscopes
<b>LABORATORY OPERATIONS</b>
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. Training of point-of-care operators   |
| 37. Appropriate notification of reportable diseases                                     |
| 38. Maintenance of patient records and laboratory database                              |
| 39. Departmental policy/procedure writing, review, and revision                         |

### POINT OF CARE (WAIVED AND NON-WAIVED)

- |   |
|---|
| 40. Glucose   |
| 41. Electrolytes (e.g., I-Stat, NOVA)                       |
| 42. Pregnancy test  |
| 43. Blood gases   |
| 44. Cardiac markers (e.g., troponin, myoglobin, CK-MB, BNP) |
| 45. Lipids (e.g., total cholesterol)                        |
| 46. Urine dipsticks   |
| 47. Lactate   |

### CHEMISTRY

#### KNOWLEDGE QUESTIONS

- |  |
|--|
| 48. Normal and abnormal physiology including metabolic pathways and disease states |
| 49. The physical and chemical properties of analytes                               |

#### ANALYTICAL TECHNIQUES

- |   |
|---|
| 50. Spectrophotometry and photometry (e.g., photometry - UV or infrared, fluorescence, nephelometry/turbidimetry, reflectance, chemiluminescence) |
| 51. Mass spectrometry (e.g., GCMS, HPLC, tandem MS/MS, MALDI-TOF)   |
| 52. Osmometry   |
| 53. Electrophoresis (e.g., traditional, capillary, isoelectric focusing)  |
| 54. Immunofixation  |
| 55. Chromatography (e.g., thin layer, cation exchange)  |
| 56. Electrochemistry (e.g., potentiometry, pH, pCO <sub>2</sub> , pO <sub>2</sub> , ion-selective electrodes)                                     |

### CARBOHYDRATES

- 57. Galactose and other reducing substances
- 58. Glucose including fasting, post-prandial, tolerance testing, insulin tolerance and gestational challenge
- 59. Tolerance testing to assess other carbohydrates (e.g., xylose, lactose)
- 60. Lactate
- 61. Ketones (e.g., beta-hydroxybutyrate)
- 62. Glycated hemoglobin/Hemoglobin A1c
- 63. Insulin and/or C-peptide
- 64. Fructosamine

### LIPIDS

- 65. Cholesterol including total, HDL, LDL (calculated and/or direct)
- 66. Triglycerides
- 67. Apolipoproteins (A & B)
- 68. Chylomicron
- 69. Lipoprotein electrophoresis
- 70. Lp(a)
- 71. Lipid particle size analysis (e.g., VAP)

### HEME DERIVATIVES

- 72. Hemoglobins (e.g., electrophoresis)
- 73. Myoglobin
- 74. Bilirubin
- 75. Porphyrin, precursors and derivatives (e.g., porphobilinogen, 5-aminolevulinic acid)
- 76. Iron/TIBC (move to electrolytes)
- 77. Ferritin

### PROTEINS AND OTHER NITROGEN-CONTAINING COMPOUNDS

- 78. Total Protein (including albumin)
- 79. Urine albumin (high sensitivity, microalbumin)
- 80. Protein electrophoresis
- 81. Immunofixation electrophoresis
- 82. Newborn screening (e.g., amino acids, inborn errors of metabolism)
- 83. Free light chains
- 84. Beta-2 microglobulin
- 85. Alpha-1 antitrypsin
- 86. C3, C4
- 87. BNP
- 88. Ceruloplasmin
- 89. C-reactive protein/hsCRP
- 90. Haptoglobin
- 91. Immunoglobulins (IgG, IgA, IgM)
- 92. IgE

93. Transferrin
94. Urea
95. Uric acid
96. Creatinine/eGFR
97. Creatinine clearance
98. Ammonia
99. Routine tumor markers, (e.g., CEA, PSA, CA125)
100. Special tumor markers (e.g., AFP, thyroglobulin, CA15-3, CA19-9)
101. Fetal fibronectin
102. Troponin
103. Procalcitonin
104. Nutritional markers (e.g., prealbumin)
<b>ENZYMES</b>
105. Creatine kinase (CK-MB, CK-MM)
106. Lactate dehydrogenase (LD)
107. Alanine aminotransferase (ALT)
108. Aspartate aminotransferase (AST)
109. Alkaline phosphatase (ALP)
110. Gamma-glutamyl transferase (GGT)
111. Serum cholinesterase
112. Lipase/Amylase
113. Glucose 6-phosphate dehydrogenase (G-6-PD)
<b>BLOOD GASES</b>
114. $pO_2$ , $pCO_2$ , pH
115. Calculated blood gas parameters (e.g., $p50$ , % saturation, base excess)
116. Carbon monoxide
<b>ELECTROLYTES</b>
117. Potassium, sodium, chloride, $CO_2$ , bicarbonate
118. Sweat test
119. Calcium
120. Magnesium
121. Phosphorus
122. Osmolality (measured and calculated)
123. Calculated electrolyte parameters (e.g., anion gap/osmolal gap)
<b>HORMONES</b>
124. TSH
125. Total T3
126. Free T3
127. Total and free T4

128. TSH stimulation
129. Cortisol
130. HCG (quantitative)
131. Luteinizing hormone (LH)/Follicle stimulating hormone (FSH)
132. Parathyroid hormone (PTH)
133. Estrogens
134. Progesterone
135. Testosterone
136. Prolactin
137. ACTH stimulation/dexamethasone suppression
138. Renin/aldosterone
139. 17-OH progesterone
140. Growth hormone/IGF-1
141. ADH (AVP)
<b>VITAMINS</b>
142. Vitamin D
143. Vitamin B12/Folate
144. Homocysteine
145. Miscellaneous vitamins (e.g., A, B6, C)
<b>TOXICOLOGY</b>
146. Ethanol
147. Volatiles (e.g. ethylene glycol, methanol, isopropanol)
148. Lead
149. Heavy metals (e.g., arsenic, mercury, bismuth)
150. Analgesics (e.g., acetaminophen, salicylates)
151. Drugs of abuse – class analyses/screening
152. Drugs of abuse – identification/confirmation/quantitation
153. Trace elements (e.g., copper, selenium) (move to electrolytes)
<b>THERAPEUTIC DRUG MONITORING</b>
154. Aminoglycosides (e.g., gentamicin)
155. Cardioactive (e.g., digoxin)
156. Anti-convulsants (e.g., phenobarbital, diazepam, topiramate, levetiracetam)
157. Anti-depressants
158. Immunosuppressants (e.g., tacrolimus, sirolimus)

## IMMUNOLOGY

### KNOWLEDGE QUESTIONS

- 159. Immune response (i.e., cellular and humoral / primary and secondary)
- 160. Principles of antigen-antibody interaction (e.g., immunoglobulin class and antigen structure)
- 161. Complement (i.e., mechanisms, biologic properties)
- 162. Diseases related to the immune system (e.g., hypersensitivities, immunodeficiencies, infections)

### SEROLOGICAL TECHNIQUES

- 163. Specimen collection and/or handling protocols for serology
- 164. Agglutination techniques (e.g., latex, particle)
- 165. Enzyme immunoassay
- 166. Chemiluminescence immunoassay
- 167. Immunofluorescence

### AUTOIMMUNITY

- 168. ANA/ENA/Anti-DNA
- 169. Thyroid antibodies (e.g., TSH receptor TG and/or TPO antibodies)
- 170. RF/anti-CCP
- 171. Celiac Antibodies
- 172. Parietal cell / intrinsic factor antibodies
- 173. Cryoglobulins

### VIRAL/MICROBIAL TESTING

- 174. Nontreponemal syphilis testing (e.g., RPR)
- 175. Treponemal syphilis testing (e.g., MHATP, particle agglutination)
- 176. ASO
- 177. Immunity screening (e.g., rubella, measles, varicella zoster)
- 178. Hepatitis
- 179. HIV (e.g., p24 antigen, HIV antibody, CD4 counts)
- 180. CMV/EBV

## BODY FLUID TESTING

- 181. CSF analysis
- 182. Serous body fluid (e.g., pericardial, peritoneal, pleural) analysis
- 183. Sweat test

## MANAGEMENT/SUPERVISORY ACTIVITIES

184. Supervision/direction of department staff in daily operations
185. Personnel management activities (e.g., hiring, discipline, job descriptions, evaluations, scheduling)
186. Infection control activities (e.g., hospital policies)
187. Reportable diseases activities (e.g., public health)
188. Inventory maintenance and ordering
189. Budgeting and purchasing decisions
190. Direct Laboratory Information System (LIS) development, implementation, and maintenance
191. Quality Assurance Program oversight (e.g., peer group QC evaluation, cross-functional teams, outcome measures, IQCP)
192. Evaluation of quality assessment/improvement activities (e.g., pre-analytical, analytical, and post-analytical)
193. Regulatory compliance and lab accreditation maintenance
194. Development and implementation of disaster or emergency procedures/preparedness
195. Development and implementation of training and educational programs (e.g., in-laboratory trainer, program faculty )
196. Development, implementation, and evaluation of a Competency Testing Program
197. Instrumentation/methodology evaluation, correlation, and application
198. Supervise/direct safety or training activities
199. Point-of-care testing oversight
200. Proficiency testing documentation and follow-up