AMERICAN BOARD OF CRIMINALISTICS

"Professional Competency Certification in Criminalistics"

FORENSIC DNA EXAMINATION

Candidate Study Guide

American Board of Criminalistics

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Introduction

Congratulations on your decision to pursue certification!

This examination was created through the Developing a Curriculum (DACUM) process. Using a panel of Subject Matter Experts (SME), comprised of practitioners from a variety of types of laboratories (e.g., city/county, state, federal, etc.) across the country, a job analysis was completed to define the profession of Forensic Biology. As a result of this job analysis, two separate job classifications were generated – Biological Evidence Screener and Forensic DNA Analyst. The Forensic DNA Analyst Job Description (08-1001S) was created and lists the duties and associated tasks for that position. The tasks and duties in the job description may include ones that are not performed specifically by your Forensic Science Service Provider but are part of the larger role of a Forensic DNA Analyst.

The tasks listed in the job description were aligned to Knowledge-Skill (K-S) categories, and these categories were grouped into larger Domains (e.g., Science and Math, Quality Assurance/Quality Control, etc.) to create the Forensic DNA Examination Blueprint. This blueprint was subsequently used to determine the number of questions in each of the larger domains.

The examination is structured around the knowledge and skills needed to perform tasks and duties of the job. The study guide was developed using the job description and the examination blueprint. All K-S categories are represented in the examination. Refer to the Forensic DNA Examination Blueprint for a detailed breakdown of the Knowledge/Skills and Tasks used to create this examination.

References listed in this Study Guide were used to write examination questions; however, not all questions were written using these references.

For more information on the development of this examination, please refer to additional examination development documents on the ABC website.

Examination Outline

Domain	Knowledge-Skill	% of Exam
Science and Math		**42%**
	Biology (e.g., molecular, cellular)	
	Chemistry	
	Genetics	
	Population Genetics	
	Statistics	
	Math	
Process (DNA)		**19%**
	Organizational (e.g., time management, multi-tasking)	
	Critical thinking (e.g., analytical, decision making, problem solving)	
	Scientific method	
Computer		**12%**
	Computer	
	LIMS	
	CODIS	
Quality Assurance/Quality Control		**9%**
	ISO 17025 / ANAB	
	QAS	
	SWGDAM	
Laboratory		**8%**
	Good laboratory practice (e.g., safety, PPE)	
	Laboratory skills (e.g., pipetting, robotics)	
Communication		**5%**
	Communication (e.g., oral, written, presentation, listening, interpersonal)	
Legal		**3%**
	Legal system	
Forensic Disciplines		**2%**
	Other forensic disciplines	

Science and Math

The Science and Math domain makes up 42% of the examination. The knowledge and skills needed to succeed in this domain are:

- Scientific concepts in the field of biology
  - Biochemistry
  - Cell structure
  - DNA (e.g., nuclear, mitochondrial, Y-chromosome)
  - Genetics
  - Molecular biology
    - Cell and DNA morphology, process, and structure
- Scientific concepts in the field of chemistry
  - Scientific units
  - Scientific nomenclature
  - Basic definitions of scientific concepts (e.g., chemicals, molecules, solutions, etc.)
- Scientific concepts in the field of genetics
  - Inheritance
  - Gene mutation
  - Kinship analysis
- Scientific concepts in the field of population genetics
  - Hardy-Weinberg equilibrium
  - Allele, genotype, and haplotype frequency
  - Mutation, natural selection, genetic drift, migration/gene flow
- Mathematical concepts and their application to the fields of biology and chemistry
  - Dilutions
  - Basic calculations and SI unit conversions
- Statistical definitions and concepts
  - Mean, median, mode, etc.
  - Confidence interval, standard deviation, and variability
  - Bayesian theory
  - Random match probability, CPI/CPE, likelihood ratio, and probabilistic genotyping
  - Binary, semi-continuous, and fully continuous methods
  - Kinship analysis

Process (DNA)

The Process (DNA) domain makes up 19% of the examination. The knowledge and skills needed to succeed in this domain are:

- Organizational
  - Testing plans
  - Technical and administrative reviews
  - Recommendations, guidelines, and best practices from national and international organizations (e.g., ANAB, ASB, ASTM, FBI, NIJ, NIST, OSAC, SWGDAM, etc.)
- Critical thinking
  - Sample collection for forensic DNA analysis
  - DNA analysis procedures (e. g., extraction, quantitation, amplification, typing, and interpretation)
  - Mixture deconvolution
  - CODIS searching
- Scientific method
  - Types of evidence and methods of transfer
  - Handling and storage of evidence
  - Analysis of evidence, including order of analysis for evidence with multiple disciplines requested
  - Sample collection from evidence, especially for downstream processing
  - Adequate note taking
  - Interpretation of results
  - Report writing

Computer

The Computer domain makes up 12% of the examination. The knowledge and skills needed to succeed in this domain are:

- Use of computer software in forensic science
  - Documentation and analysis of evidence
  - Proficiency testing
  - Draft and final reports
  - Court testimony
- Use of LIMS in forensic DNA analysis
  - Maintaining chain of custody
  - Inventory, documentation, and analysis of evidence, samples, etc.
  - Security
- CODIS
  - Data eligibility and suitability requirements
  - Searching and NDIS operational procedures

Quality Assurance/Quality Control

The Quality Assurance/Quality Control domain makes up 9% of the examination. The knowledge and skills needed to succeed in this domain are:

- Quality assurance and quality control in the crime laboratory
  - Validation and verification
  - Different types of controls, performance checks
  - Training programs
  - Note taking
  - Report writing
  - Technical and administrative reviews
  - Proficiency testing
  - Expert testimony
- ISO Accreditation
  - ISO/IEC 17025 and AR 3125 standards and accreditation requirements
  - Accreditation process
  - Guiding Principles of Professional Responsibility
- Quality Assurance Standards (QAS)
  - FBI Quality Assurance Standards for DNA Databasing Laboratories
  - FBI Quality Assurance Standards for DNA Testing Laboratories
  - The Guidance Document for the FBI Quality Assurance Standards for Forensic DNA Testing and DNA Databasing Laboratories
- Scientific Working Group on DNA Analysis Methods (SWGDAM)
  - Recommendations, guidelines, and best practices

Laboratory

The Laboratory domain makes up 8% of the examination. The knowledge and skills needed to succeed in this domain are:

- Basic concepts in good laboratory practice
  - Communication of laboratory safety procedures
  - Proper Personal Protective Equipment (PPE) in the laboratory
- Basic laboratory skills
  - Proper use of laboratory glassware, pipettes, and other measuring devices
  - Contamination prevention procedures
  - Purpose and basic theory of equipment commonly used for forensic DNA analysis
  - Sample collection from evidence through DNA sample processing

Communication

The Communication domain makes up 5% of the examination. The knowledge and skills needed to succeed in this domain are:

- Ways to effectively communicate in forensic science
  - Technical and administrative documentation
  - Adequate note taking
  - Writing and reviewing reports
  - Courtroom testimony
  - Communication between the laboratory and the customer

Legal

The Legal domain makes up 3% of the examination. The knowledge and skills needed to succeed in this domain are:

- Case file documentation for legal proceedings (e.g., administrative, technical, supporting, etc.)
- Knowledge of proper expert testimony
- Basic understanding of the Federal Rules of Evidence
- Understanding the difference between Daubert and Frye
- Basic understanding of different types of warrants, subpoenas, etc.
- Court cases important to the field of forensic evidence

Forensic Disciplines

The Forensic Disciplines domain makes up 2% of the examination. The knowledge and skills needed to succeed in this domain are:

- Basic knowledge of different types of forensic evidence
- Basic knowledge of common forensic analyses performed on different types of evidence
- Collection of samples from evidence
- Preservation of evidence for testing in other disciplines
- Coordination of testing with other disciplines

References

General College Textbooks (or similar)	Edition	Author
• Molecular Biology of the Cell	6th	Alberts, Bruce, et al.
• Campbell Biology	11th	Campbell, Neil A.
• Genetics from Genes to Genomes	5th	Hartwell, Leland H., et al.
• Lehninger Principles of Biochemistry	7th	Nelson, David L. and Cox, Michael M.
• General Chemistry Principles and Modern Applications	7th	Petrucci, Ralph H. and Harwood, William S.

Forensic DNA Typing - Butler Series	Edition	Author
• Forensic DNA Typing	2nd	Butler, John M.
• Fundamentals of Forensic DNA Typing	3rd	Butler, John M.
• Advanced Topics in Forensic DNA Typing: Methodology	3rd	Butler, John M.
• Advanced Topics in Forensic DNA Typing: Interpretation	3rd	Butler, John M.

Other Forensic Science Books	Edition	Author
• Forensic Chemistry	2nd	Bell, Suzanne
• Forensic DNA Evidence Interpretation	2nd	Buckleton, J., Bright, J., and Taylor. D.
• Forensic Practitioner's Guide to the Interpretation of Complex DNA Profiles	1st	Gill, Peter, et al.
• Fundamentals of Forensic Science	2nd or later	Houck, M. and Siegel, J.
• Criminalistics: An Introduction to Forensic Science	7th or later	Saferstein, R.
• Forensic Science Handbook, Volume I	2nd	Saferstein, R.
• Forensic Science Handbook, Volume II	2nd	Saferstein, R.

Guidance/Standards Documents	Edition	Author
• Rules of Professional Conduct		ABC
• ISO/IEC 17025: General Requirements for the Competence of Testing and Calibration Laboratories	2017	ISO/IEC

• AR 3125 ISO/IEC 17025: Forensic Science Testing and Calibration Laboratories Accreditation Requirements	2019	ANSI National Accreditation Board
• Quality Assurance Standards for Forensic DNA Testing Laboratories	2011 and later	Federal Bureau of Investigation
• Quality Assurance Standards for DNA Databasing Laboratories	2011 and later	Federal Bureau of Investigation
• National Best Practices for Sexual Assault Kits: A Multidisciplinary Approach		National Institute of Justice
• The Biological Evidence Preservation Handbook: Best Practices for Evidence Handlers	NISTIR 7928	Ballou et. al.

SWGDAM Publications (or similar, more recent)

- Contamination Prevention and Detection Guidelines for Forensic DNA Laboratories (2017)
- Guidelines for the Collection and Serological Examination of Biological Evidence (2015)
- Guidelines for Missing Persons Casework (2014)
- Guidelines for STR Enhanced Detection Methods (2014)
- Guidelines for the Validation of Probabilistic Genotyping Systems (2015)
- Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories (2017) and Addendum (2019)
- Y-chromosome Short Tandem Repeat (Y-STR) Interpretation Guidelines (2009)
- Interpretation Guidelines for Y-Chromosome STR Testing (2014)
- Mitochondrial DNA Analysis Interpretation Guidelines (2019)
- Mitochondrial DNA Nomenclature Examples (2014)
- Recommendations for the Efficient DNA Processing of Sexual Assault Evidence Kits (2016)
- The Guidance Document for the FBI Quality Assurance Standards for Forensic DNA Testing and DNA Databasing Laboratories (2020)
- Training Guidelines (2020)
- Validation Guidelines for Forensic DNA Analysis Methods (2016)

Example Questions

Below are 10 questions that represent the structure of questions on the examination. The primary Knowledge-Skill (K-S) Category and Associated Job Task(s) are also included. Refer to the Introduction for additional information regarding K-S and Job Tasks.

Knowledge-Skill: 1.4 – Population Genetics
Job Task: D8 – Calculate sample statistics (e.g., RMP, LR, counting method)

1. When a population's alleles at the same locus are inherited independently of one another, the population is said to be in what type of equilibrium?

    A. Homeostatic
    B. Relative Inheritance
    C. Linkage
    D. Hardy-Weinberg

Knowledge-Skill: 1.1 – Biology
Job Task: D2 – Assess quality of DNA typing samples

2. Which of the following **BEST** describes a centiMorgan (cM)?

    A. A distance of 50 centiMorgans equals a recombination factor of 0.5.
    B. A centiMorgan is a unit of measure used to relate distance between two loci.
    C. A distance of 25 centiMorgans is sufficient to assure independence.
    D. A centiMorgan is a unit of measure used to relate distance between two alleles within the same locus.

Knowledge-Skill: 1.6 – Math
Job Task: D8 – Calculate sample statistics (e.g., RMP, LR, counting method)

3. Events that occur with no effect on the probability of each other occurring are considered:

    A. mutually exclusive.
    B. mutually exhaustive.
    C. Independent.
    D. Conditional.

Knowledge-Skill: 5.2 Critical Thinking (e.g., analytical, decision making, problem solving)
Job Tasks: D2 – Assess quality of DNA typing samples
D4 – Eliminate DNA process artifacts
D6 – Deduce contributors
D7 – Compare DNA contributors (e.g., knowns, evidentiary samples)
D8 – Calculate sample statistics (e.g., RMP, LR, counting method)

4. Please order the following steps for the **MOST** reasonable approach to draw conclusions from a 2-person DNA mixture:

    1) Compare genotype profiles with reference samples
    2) Determine approximate ratio of the components in the mixture
    3) Identify artifacts versus alleles
    4) Perform statistical analysis
    5) Identify the number of contributors to the mixture

    A. 1, 2, 3, 5, 4
    B. 5, 2, 3, 1, 4
    C. 1, 5, 3, 4, 2
    D. 3, 5, 2, 1, 4

Knowledge-Skill: 5.2 – Critical Thinking
Job Task: D4 – Eliminate DNA process artifacts

5. Which of the following is a PCR-induced artifact?

    A. stutter
    B. pull-up
    C. spike
    D. elevated baseline

Knowledge-Skill: 5.2 – Critical Thinking (e.g., Analytical, Decision Making, Problem-solving)
Job Task: D1 – Assess quality of DNA typing

6. A sample whose concentration meets the threshold for PCR was amplified and typed. Upon evaluating STR results from the CE, acceptable allelic ladders were observed but no peaks were detected in the evidence samples or the positive amplification/PCR control. What is the most likely explanation?

    A. A PCR inhibitor was present in the amplification master mix.
    B. No DNA was present in the evidence sample.
    C. A PCR reaction component was not added to the master mix during preparation (e.g., primers).
    D. Sample degradation prohibited efficient PCR primer binding.

Knowledge-Skill: 5.2 – Critical Thinking (e.g., Analytical, Decision Making, Problem-solving)
Job Task: C4 – Interpret quantitation results

7. Based on validation studies, a laboratory's expected *y*-intercept for their real-time PCR standard curve is 25. An analyst runs a DNA quantitation plate that results in a y-intercept of 24. How might this affect their actual DNA concentration results?

    A. It will overestimate 2-fold (e.g., reports 1.0ng when it is actually 0.5ng)
    B. It will overestimate 4-fold (e.g., reports 1.0ng when it is actually 0.25ng)
    C. It will underestimate 2-fold (e.g., reports 0.5ng when it is actually 1.0ng)
    D. It will underestimate 4-fold (e.g., reports 0.25ng when it is actually 1.0ng)

Knowledge-Skill: 3.1 – Computer
Job Task: D4 – Eliminate DNA process artifacts

8. Stutter product formation:

    A. decreases when low levels of template DNA are amplified.
    B. decreases with longer repeat units.
    C. has greater impact from the shortest uninterrupted stretch of repeats.
    D. is less for larger alleles within a locus.

Knowledge-Skill: 6.2 – Laboratory Skills (e.g., pipetting, robotics)
Job Task: B10 – Prepare samples for DNA processing

9. Use of laboratory automation (i.e., robotics) aids in all of the following **EXCEPT**:

    A. meeting accreditation requirements.
    B. enhancing quality assurance efforts.
    C. increasing laboratory efficiency.
    D. enabling higher throughput.

Knowledge-Skill: 4.1 – Communication (e.g., oral, written, presentation, listening, interpersonal)
Job Task: E1 – Write draft report (e.g., serology and/or DNA)

10. According to SWGDAM, a contamination event that occurred at or after the start of a controlled forensic process should be documented in the appropriate report if the contamination event:

    A. led to a corrective action process and a new or modified laboratory policy.
    B. was researched and the source could not be determined.
    C. affected multiple cases over an extended period of time.
    D. directly impacted the interpretation of a genetic profile.

Example Questions Key

1. D
2. B
3. C
4. D
5. A
6. C
7. C
8. B
9. A
10. D