

KNOWLEDGE, SKILLS AND ABILITIES ABC TECHNICAL SPECIALIST EXAMINATION – MOLECULAR BIOLOGY

The regional peer groups and the ABC Examination Committee have formulated a list of general knowledge, skills and abilities which they thought were necessary for a typical forensic scientist specializing in Molecular Biology to effectively do casework. Applicants for certification should use this list to help determine their strengths and weaknesses prior to taking the examination.

The successful applicant should have the knowledge of, or skills and abilities to:

I. Evidence Collection and Preservation

- A. Select and use appropriate tools for recording and recovering evidence without loss, contamination or changes that would result in the loss of information.
- B. Recognize the evidence potential of various items and safeguard that potential by proper sampling and collection of controls.
- C. Properly mark, package and store evidence.
- D. Preserve evidence using appropriate prior legal decisions.
- E. Apply the means to retard or prevent changes to evidence caused by time, temperature or biological agents.

II. Evidence Examination and Data Interpretation

- A. General
 - 1. Measurements, procedures and tests commonly used in the examination of biological evidence and the nature and significance of the information derived from these.
 - 2. Testing protocols that will provide the most useful information while avoiding procedures that are redundant, unnecessarily consumptive, or will interfere with subsequent tests.
 - 3. Properties of commonly encountered biological evidence materials that allow their characterization.
 - 4. Limitations in personal skills and laboratory resources and the potential contributions of other expertise.
 - 5. Scientific method and general chemical, physical and biological basis for examinations evaluation and interpretations.
 - 6. Understand and interpret technical data including any conditions or circumstances that could effect the conclusions.
 - 7. Think logically, using inductive and deductive reasoning.
 - 8. Recognize discrepancies or inconsistencies in analytical findings and determine their cause and significance.

III. General Knowledge

- A. Genetics
 - 1. Structure and function of genes and chromosomes.
 - 2. Diploid and haploid genomes.
 - 3. Inheritance.
 - a. Mendelian and Mendel's Laws.
 - b. Non-Mendelian.
 - 4. Modes of inheritance.
 - a. Nuclear.
 - b. Mitochondrial.
 - 5. Population Genetics.
 - a. Principles – product rule, allele frequencies and underlying Hardy-Weinberg assumptions.
 - b. Characteristics of loci appropriate for forensic usage.
 - 6. Application of population frequency data to the interpretation of results.
 - a. NRC reports – likelihood ratios, theta values and relatedness.
 - b. Evaluation of databases – sampling, size and statistical evaluation.
- B. Molecular Biology
 - 1. Structure and properties of nucleic acids.
 - a. DNA.
 - b. RNA.
 - 2. Function of DNA and RNA in living cells.
 - a. Transcription.
 - b. Translation.
 - c. Replication.
- C. Chemistry/Biochemistry
 - 1. Amino acids, proteins, nucleic acids and carbohydrates and their functions.
 - 2. Acid/base equilibrium and the principles of buffers.
 - 3. Enzymes and enzyme kinetics.
- D. Immunology
 - 1. Antigens.
 - 2. Antibodies.
- E. Physiology and Anatomy
 - 1. Physical, chemical and functional characteristics of blood.
 - 2. Physical, chemical and functional characteristics of semen.
 - 3. Physical, chemical and functional characteristics of saliva
 - 4. Basic cell structure.
 - 5. Physical, chemical and functional characteristics of other body fluids and tissues suitable for genetic typing.

- F. Characterization and/or identification of physiological fluids.
 - 1. Blood.
 - a. Presumptive tests.
 - b. Confirmatory tests.
 - c. Species determination.
 - 2. Semen.
 - a. Methods for semen stain location (e.g. visual, tactile, mapping, alternate light source).
 - b. Presumptive tests.
 - c. Confirmatory tests.
 - 1a. Microscopic identification of semen.
 - 1b. Immunological identification.
 - 3. Saliva.
 - 4. Other physiological fluids and tissues.
 - a. Chemical tests.
 - b. Microscopic examinations.

IV. Forensic DNA Human Identification Methods.

- A. Restriction Fragment Length Polymorphism (RFLP).
 - 1. Restriction enzymes and factors affecting their functions.
 - 2. Factors affecting migration of the DNA fragments.
 - 3. Principles of Southern blot transfer and DNA fixation to membrane.
 - 4. Principles of probe labeling.
 - 5. Principles of hybridization.
 - 6. Principles of detection.
 - a. Radioactive.
 - b. Chemiluminescent.
- B. Polymerase Chain Reaction (PCR).
 - 1. Principles of primer selection.
 - 2. Principles underlying selection of PCR reaction conditions.
 - 3. Principles of multiplexing.
 - a. Amplitype PM.
 - b. Short tandem repeats (STR's).
 - 4. Methods for detection of PRC products.
 - a. Dot blot and reverse dot blot.
 - b. Ethidium bromide and SYBR green staining.
 - c. Fluorescence detection.
 - d. Silver staining.
 - 5. Characteristics of thermostable DNA polymerase.
 - 6. Types of polymorphism analyzed with the PCR technique.
 - a. Sequence.
 - b. Length.

- C. Short Tandem Repeats
 1. Choosing STR's for forensic casework.
 2. Stutter.
 3. Structure.
 4. Stability.
 5. Nomenclature.
- D. Mitochondrial DNA.
 1. Structure.
 2. Hypervariable regions.
 3. Heteroplasmy.
- E. Contamination prevention and effects.
 1. Control.
 2. Detection.

V. Isolation and Separation Methods.

- A. Isolation and purification of DNA.
 1. Organic extraction.
 2. Non-organic extraction.
 3. Differential extraction.
 4. Other extraction methods (e.g. Chelex).
 5. Specialization extraction methods (paraffin blocks, bone, etc.).
- B. Evaluation of DNA quality and quantity.
 1. Gel methods.
 - a. Degraded DNA.
 - b. Bacterial DNA.
 2. Hybridization methods.
- C. Electrophoresis
 1. Agarose.
 2. Acrylamide.
 3. Capillary.

VI. Interpretation of Analytical Data.

- A. Potential effects of various amounts and types of DNA contamination.
- B. Principles of visual VNTR (RFLP, ampFLP and STR) and XY pattern interpretation.
- C. Principles and limitations of the computer assisted image analysis of the VNTR (RFLP, ampFLP and STR) band patterns.
- D. Principles of dot blot and reversed dot blot pattern analysis of PCR based results.
- E. Evaluation of test results based on the performance of standards and controls.
 1. Allelic ladders.
 2. Sizing standards.
- F. Formulations of conclusions based on results and literature available.

- G. Use of CODIS.

VII. Laboratory Safety.

- A. General Laboratory Safety.
- B. Hazards associated with firearms, explosives, biological materials and chemical substances and the proper methods for safe handling of all evidence types.

VIII. Instrument/Equipment Usage.

- A. Instruments and equipment used at crime scenes and in the laboratory including their application and principles of operation.
- B. Instrument use based on the size and condition of the sample to be examined.
- C. Various isolation and separation techniques as require for sample preparation.

IX. Quality Assurance and Quality Control

- A. Principles of QA/QC.
- B. Guidelines for forensic DNA testing.
 - 1. TWGDAM.
 - 2. National DNA Advisory Board.
 - 3. National Research Council reports.
- C. Accreditation and certification.
- D. Laboratory audits.
- E. Method validation.

X. Communication – Report Writing.

- A. Write clear, grammatically correct and concise reports on analyses, results and conclusions.
- B. Properly maintain and record examination information.

XI. Communication – Legal Aspects and Court Testimony.

- A. Court decisions, procedures and associated legal terms applying to expert witnesses.
- B. Understand and respond appropriately to questions from council and/or the court.

XII. Rules of Professional Conduct.

The Rules of Professional Conduct as drafted by the American Board of Criminalistics, their interpretation and their application to occupational situations.

XIII. Forensic Science and Other Applicable Literature.

- A. Current criminalistics information (journals, books and newsletters).
- B. Critically evaluate written and oral information.
- C. Foundational basis of criminalistics.