



**Department of Forensic Science**

**FORENSIC BIOLOGY SECTION  
TRAINING MANUAL**

**DNA DATA BANK SAMPLE  
ACCESSIONING,  
POWERPLEX® FUSION ANALYSIS  
AND Y-STR ANALYSIS**

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## 1 OVERVIEW OF TRAINING PROGRAM

### 1.1 Purpose

To provide a uniform training program for the analysis of DNA Data Bank samples using PCR-based STR fluorescence analysis, and in so doing, to adhere to the current version of the “FBI Quality Assurance Standards for DNA Databasing Laboratories”

### 1.2 Scope

This training program applies to DNA Data Bank analysts in the Forensic Biology Section at the Virginia Department of Forensic Science (DFS).

- 1.2.1 Laboratory support personnel in the DNA Data Bank must complete only the training specified in Sections 2 and 3 of this document.

### 1.3 Goals

- 1.3.1 To develop a theoretical knowledge of the principles of PCR-based technology.
- 1.3.2 To develop a thorough understanding of the principles and practices of STR technology as they relate to the forensic analysis of DNA Data Bank samples.
- 1.3.3 To develop a thorough understanding of the theory and application of instrumentation and specialized techniques used to analyze DNA Data Bank samples.
- 1.3.4 To develop the ability to perform independent, accurate analysis of DNA Data Bank samples and to accurately document the results of all analyses in accordance with Department and Section policies and procedures.

### 1.4 Coordination of the Program

#### 1.4.1 Responsibilities of DNA Data Bank Analyst Trainee

- 1.4.1.1 The trainee will keep a notebook containing all work completed. The notebook will include copies of all original electropherogram data, landscape printout(s), plate files, comments on problems that arose and how the problems were corrected, etc. A copy of the training coordinator’s monthly report will also be included in the notebook.
- 1.4.1.2 To provide for exposure to the pertinent literature available in the field, required readings will be assigned by the training coordinator. A list of readings associated with the training (with documented approval by the Biology Program Manager) is to be included in the trainee’s notebook.
- 1.4.1.3 The trainee will assist with DNA Data Bank sample analysis throughout the training period, only under the direct supervision of a qualified DNA Data Bank analyst.
- 1.4.1.4 Prior to beginning independent analysis, DNA Data Bank analyst trainees will satisfactorily complete both an oral and practical competency test.

#### 1.4.2 Responsibilities of Training Coordinator

- 1.4.2.1 The training coordinator will be a DNA Data Bank analyst experienced in the use of DNA PCR-based STR analysis. The coordinator may delegate certain duties and blocks of instruction to other qualified analysts, but will be responsible for the overall training.

- 1.4.2.2 The training coordinator will instruct and monitor the trainee, assign required readings (e.g., scientific literature and technical manuals), and ensure the trainee has an understanding of required concepts and procedures.
  - 1.4.2.2.1 The list of required readings will be approved by the Biology Program Manager for each trainee.
- 1.4.2.3 The training coordinator will verify through the course of training that the trainee understands and follows Department and Section policies and protocols. This will be done through frequent communication and monitoring, as well as a monthly check of the trainee's notebook.
- 1.4.2.4 The training coordinator will provide all samples to the trainee for analysis. Once the sample set is complete, the training coordinator will verify the results and document the completion of each required task for each aspect of training.
- 1.4.2.5 The training coordinator will closely monitor the trainee's progress and evaluate the trainee's performance during the course of the program. The training coordinator must submit monthly written evaluations of the trainee's progress to the Biology Program Manager in accordance with policy set forth in the Quality Manual, Section 19 Personnel and Training. A Qualtrax workflow exists for this purpose. The monthly training report is due within five business days of the beginning of the month.
- 1.4.2.6 The training coordinator must maintain continual, open communication with the DNA Data Bank Supervisor and/or Section Supervisor regarding the trainee's progress.

### 1.4.3 Training Period

It is estimated that this training program can be completed in six to eight months, which includes successful completion of the final oral and practical competency examinations. Some individuals may require more or less time than others to complete the training, depending on prior experience and education. The training program may be altered with the documented approval of the Biology Program Manager.

## 1.5 Analyst Qualification

- 1.5.1 The sequence in which the tasks are presented in the outline should not necessarily be considered as a mandatory order of instruction. Oral and practical examinations may be staged periodically.
- 1.5.2 The final qualification of a trainee as a Data Bank analyst will be based upon the following:
  - 1.5.2.1 Successful completion of the required training samples.
  - 1.5.2.2 Satisfactory completion of technical review training for Data Bank samples.
  - 1.5.2.3 Satisfactory completion of an oral competency exam to include technical questions pertaining to all aspects of examination of DNA Data Bank samples.
  - 1.5.2.4 Satisfactory completion of a practical competency examination which will consist of blood and/or buccal samples.

## 1.6 Guidelines for Final Oral Competency Examination

- 1.6.1 A formal oral examination will serve as an assessment of technical knowledge and of oral communication skills of the trainee and will be conducted by the DNA Data Bank Supervisor, Biology Program Manager, and the Technical Services Director or designee. This will be limited to two (2) hours. Questions will be confined to technical aspects of the training as well as accreditation questions. The

performance of the trainee will be used to ascertain whether the goals of the training program have been achieved.

1.6.2 The outcome of the oral examination evaluation will be:

1.6.2.1 Satisfactory

1.6.2.2 Not satisfactory

1.6.3 Satisfactory performance on both the practical and the oral examination must be achieved before the individual is qualified to independently perform the duties of a DNA Data Bank analyst.

1.6.4 When the trainee has satisfactorily completed all the requirements of the program, a letter will be issued by the Biology Program Manager to the Department Director stating that the person is qualified to perform the duties of a DNA Data Bank analyst. If the trainee cannot meet the criteria expected of him/her during the period allowed for training, appropriate steps will be taken.

## 1.7 References

1.7.1 Quality Manual

1.7.2 Safety Manual

1.7.3 DNA Data Bank Operating Policies and Procedures Manual

1.7.4 Data Bank PowerPlex® Fusion Procedures Manual

1.7.5 DNA Data Bank Procedures Manual, AmpFℓSTR® Yfiler™ System

1.7.6 Forensic Biology Procedures Manual CODIS Operating Policies and Procedures

1.7.7 Forensic Biology Section PM QA Program

## 2 SAFETY

### 2.1 Hazards

Each individual working in the DNA Data Bank must be acutely aware of the potential hazards inherent in his/her work. Refer to the Safety Manual for descriptions of potential hazards in the laboratory.

### 2.2 Safety Procedures

Reference: Safety Manual. All trainees are required to read, understand and follow all policies and procedures set forth in the Safety Manual.

### 3 SAMPLE ACCESSIONING AND HIT VERIFICATION

#### 3.1 Goals

- 3.1.1 To understand the workflow of the sample accessioning and processing areas.
- 3.1.2 To understand Department and Section policies regarding contamination control.
- 3.1.3 To understand the need for confidentiality and security of genetic profiles/personal identifying data and the relevant Code of Virginia sections governing the release of DNA Data Bank information.
- 3.1.4 To understand and correctly perform the procedures described in the DNA Data Bank Operating and Procedures Manual including accessioning, handling, processing and retention of DNA samples.
- 3.1.5 To understand all laws in the Code of Virginia (COV) governing the DNA Data Bank.
- 3.1.6 To understand hit verification requests and compile the appropriate information.
- 3.1.7 To understand the processing of the weekly cleared report for arrestee samples.

#### 3.2 Tasks

- 3.2.1 Read, understand and follow the DNA Data Bank Operating Policies and Procedures Manual.
- 3.2.2 Receive an overview/tour of sample accessioning and processing workflow.
- 3.2.3 To articulate, to the satisfaction of the DNA Data Bank Supervisor, DFS policy and relevant COV sections governing the release of genetic/personal identifying data.
- 3.2.4 Retrieve and accession arrestee samples. The trainee must use proper contamination control techniques and personal protective equipment. The trainee must correctly identify and rectify any issues associated with the samples.
- 3.2.5 Retrieve and accession convicted offender samples. The trainee must use proper contamination control techniques and personal protective equipment. The trainee must correctly identify and rectify any issues associated with the samples.
- 3.2.6 Enter personal identifying data into the DB LIMS database.
- 3.2.7 Gain access to and use multiple databases/agencies to research samples with information issues or to verify lawful inclusion of the sample in the DNA Data Bank. Such databases include, but are not limited to, Virginia Criminal Information Network (VCIN), court websites, Virginia sex offender registry, Department of Juvenile Justice (DJJ) records, and/or Department of Corrections (DOC) records.
- 3.2.8 Gain access to and use the DNA Data Bank Sample Tracking System (DBSATS). The trainee must understand this system to correctly assist user agencies in gaining access, troubleshooting issues, and providing usage assistance and guidance.
- 3.2.9 Read, understand and follow all laws in the COV governing the DNA Data Bank.
- 3.2.10 Process hit verification requests by collecting and distributing the correct information to DNA Data Bank analysts/CODIS administrator and Casework examiner staff.
- 3.2.11 Understand the laws governing the weekly cleared report for arrestee samples and process the report.



### **3.3 Training Evaluation (Knowledge and Skills)**

- 3.3.1 The trainee should perform DNA accessioning, problem sample follow-up, and hit verification requests on a sufficient variety and number of samples to develop and exhibit an unquestionably sound technique. This will be monitored by administrative review of the work product and continual observations by the DNA Data Bank Supervisor and/or other qualified DNA Data Bank staff member.
- 3.3.2 Upon successful completion of sample accessioning training, including a final question and answer session used to evaluate the trainee's competency, a Memorandum for Record (MFR) detailing the recommendation to qualify the trainee in sample accessioning will be submitted to the Biology Program Manager. Once the MFR is accepted and signed by the Biology Program Manager, an authorization to work will be provided, and the trainee will be deemed qualified to perform the duties associated with sample accessioning independently.

## 4 DNA ISOLATION

### 4.1 Goals

- 4.1.1 To develop a basic understanding of the theory and procedure of DNA isolation from blood and buccal samples using the manual QIAamp® extraction procedure.
- 4.1.2 To become acquainted with the operation of the semi-automated BSD puncher instrument.
- 4.1.3 To become acquainted with the sensitivity of the isolation procedure.
- 4.1.4 To become familiar with the limitations of the isolation procedure.
- 4.1.5 To become familiar with the use of controls incorporated at this stage of the procedure.
- 4.1.6 To become familiar with the function of each reagent used for DNA isolation.
- 4.1.7 To become familiar with proper documentation for DNA isolation.

### 4.2 Tasks

- 4.2.1 Prepare reagents necessary for DNA isolation, if applicable during training period.
- 4.2.2 Perform DNA isolation on a minimum of 10 dried blood stains using the manual QIAamp® extraction procedure. These 10 samples will be divided into two sets of 5 samples. Complete the entire DNA analysis process for these 10 samples before proceeding to the next set of samples.
- 4.2.3 Perform DNA isolation on a minimum of 20 buccal samples using the manual QIAamp® extraction procedure. These 20 samples will be divided into two sets of 10 samples. Complete the entire DNA analysis process for these 20 samples before proceeding to the next set of samples.
- 4.2.4 Under the direct supervision of a qualified Data Bank Analyst, the trainee will set up and operate the BSD semi-automated puncher for a minimum of 5 plates of buccal samples (approximately 90 samples per plate). At least one plate must be completed using the non-PS Kit protocol for direct amplification.
- 4.2.5 Read applicable literature and technical manuals.

### 4.3 Training Evaluation

- 4.3.1 Knowledge
  - 4.3.1.1 Review of notes and worksheets in training notebook by training coordinator.
  - 4.3.1.2 Oral and practical examinations.

- 4.3.2 Skills

The trainee should perform DNA isolation on a sufficient variety and number of samples to develop and exhibit an unquestionably sound technique for successfully isolating DNA using the manual QIAamp® extraction procedure. This will be monitored by review of the documentation in the training notes and continual observation by the training coordinator and/or other qualified analysts.

## 5 AMPLIFICATION

### 5.1 Goals

- 5.1.1 To develop an understanding and working knowledge of the amplification process and the purpose of each reagent involved.
- 5.1.2 To become familiar with problems associated with amplification.
- 5.1.3 To understand the importance of an amplification environment that produces no contamination.
- 5.1.4 To understand the importance of quality controls associated with the amplification process.

### 5.2 Tasks

- 5.2.1 Work in an environment free of contamination and follow proper procedure to prevent contamination.
- 5.2.2 Program a thermal cycler
- 5.2.3 Perform the quality control test on a thermal cycler.
- 5.2.4 Perform amplification using the PowerPlex® Fusion System.
  - 5.2.4.1 Amplification using extracted DNA
    - All QIAGEN extracted training samples
  - 5.2.4.2 Direct amplification
    - Perform direct amplification on a minimum of 160 buccal samples provided by the training coordinator using the PowerPlex® Fusion System. These samples will be divided into four sets of 40 samples (2 sets of Bode collectors and 2 sets of FTA collectors). Each set will be carried through the entire DNA analysis process before processing the next set of samples.
- 5.2.5 Read applicable literature and technical manuals.

### 5.3 Training Evaluation

- 5.3.1 Knowledge
  - 5.3.1.1 Review of notes and worksheets in training notebook by training coordinator.
  - 5.3.1.2 Oral and practical examinations.

- 5.3.2 Skills

The trainee should demonstrate an unquestionably sound technique for DNA amplification by consistently achieving uncontaminated results on the electropherograms. This will be monitored by review of the documentation in the training notebook and continual observation by the training coordinator.

## 6 CAPILLARY ELECTROPHORESIS - POWERPLEX® FUSION

### 6.1 Goals

- 6.1.1 To become familiar with the theories of electrophoresis as they apply to capillary electrophoresis (CE) used in STR analysis.
- 6.1.2 To learn the parameters used for CE of the PowerPlex® Fusion System.
- 6.1.3 To develop an understanding and working knowledge of the use of the CE instrument, including the limitations and proper documentation.
- 6.1.4 To become familiar with the controls associated with CE.
- 6.1.5 To become familiar with the quality control tasks done to ensure the CE instrument stays in proper working order.

### 6.2 Tasks

- 6.2.1 Prepare the instrument with necessary reagents to perform CE of the DNA samples.
- 6.2.2 Run the PowerPlex® Fusion System samples on the CE instrument.
- 6.2.3 Under the direct supervision of a qualified Data Bank analyst, perform the monthly QC tasks on the CE instrument.
- 6.2.4 Under the direct supervision of a qualified Data Bank analyst, perform a capillary array change, spectral and spatial on the CE instrument.
- 6.2.5 Read applicable literature and technical manuals.

### 6.3 Training Evaluation

#### 6.3.1 Knowledge

- 6.3.1.1 Review of notes and worksheets in training notebook by training coordinator.
- 6.3.1.2 Oral and practical examinations.

#### 6.3.2 Skills

The trainee should demonstrate an unquestionably sound technique for running consistently interpretable PowerPlex® Fusion electropherogram profiles on the CE instrument using proper documentation. This will be monitored by review of the documentation in the training notebook and continual observation by the training coordinator.

## **7 CAPILLARY ELECTROPHORESIS DATA ANALYSIS AND INTERPRETATION – POWERPLEX® FUSION**

### **7.1 Goals**

- 7.1.1 To develop a working knowledge of the software used for the analysis of the CE data.
- 7.1.2 To become familiar with the visual interpretation of the electropherograms.
- 7.1.3 To become familiar with the PowerPlex® Fusion System loci.
- 7.1.4 To understand the use of controls and the internal lane standard.
- 7.1.5 To understand the problems that may be encountered with regard to interpretation.

### **7.2 Tasks**

- 7.2.1 Analyze the CE data using the GeneMapper™ ID-X software.
- 7.2.2 Interpret all results successfully and properly document the results.
- 7.2.3 Read applicable literature and technical manuals.

### **7.3 Training Evaluation**

#### **7.3.1 Knowledge**

- 7.3.1.1 Review of notes, copies of all electropherograms (including the landscape printout) in training notebook by training coordinator.
- 7.3.1.2 Oral and practical examinations.

#### **7.3.2 Skills**

The trainee should demonstrate a thorough understanding of all aspects of CE data interpretation by accurately interpreting PowerPlex® Fusion results on all training samples and properly recording results. This will be monitored by review of the documentation in the training notebook and continual observation by the training coordinator.

## **8 COMBINED DNA INDEX SYSTEM (CODIS)**

### **8.1 Goals**

Become familiar with the Combined DNA Index System applications/policies and procedures, and documentation required.

### **8.2 Tasks**

- 8.2.1 Read and understand the CODIS Operating Policies and Procedures Manual.
- 8.2.2 Perform CODIS searches under the direct supervision of a qualified DNA Data Bank analyst and generate the proper documentation associated with the CODIS search.
- 8.2.3 Import DNA profiles into CODIS under the direct supervision of a qualified DNA Data Bank analyst and generate the proper documentation associated with the data import.
- 8.2.4 Perform post-CODIS QC numbers check on at least 3 plates. This involves comparing the sample numbers on the Specimen Inventory Report to the sample numbers on the landscape to ensure the numbers are the same. Additionally, the post-CODIS paperwork is checked to make sure that each page contains the plate number and the analyst's initials. The burned disc is also checked to make sure all required files burned to the disc correctly and they can be opened and viewed.

### **8.3 Training Evaluation**

#### **8.3.1 Knowledge**

- 8.3.1.1 Review of notes prepared by the trainee in training notebook by training coordinator.
- 8.3.1.2 Oral and practical examinations.
- 8.3.1.3 Upon successful completion of post-CODIS QC numbers check on at least 3 plates, including a demonstration of general understanding of what is checked and why, an MFR will be written and authorized by the Biology Program Manager. This MFR will allow the trainee to perform this action independently and a copy of the MFR will be stored with the trainee's training binder.

#### **8.3.2 Skills**

The trainee should demonstrate the ability to use CODIS.

## 9 TECHNICAL REVIEW OF DNA DATA BANK SAMPLES

### 9.1 Goals

- 9.1.1 To become familiar with all paperwork associated with the analysis of DNA Data Bank samples generated by the DNA Data Bank.
- 9.1.2 To become familiar with the technical review form used to evaluate data generated by the DNA Data Bank.
- 9.1.3 To develop the ability to recognize a problem with the analytical data.

### 9.2 Tasks

- 9.2.1 Review all the paperwork and electropherograms associated with the analysis of a minimum of 12 plates of DNA Data Bank samples generated by DNA Data Bank analysts.
  - 9.2.1.1 A qualified DNA Data Bank analyst will also review these plates for comparison against the trainee's review.
- 9.2.2 Complete the technical review forms used for evaluating data generated by the DNA Data Bank.
- 9.2.3 Successfully identify problem samples or problems with the controls associated with the samples reviewed in paragraphs 9.2.1 and 9.2.2, when appropriate.

### 9.3 Training Evaluation

- 9.3.1 Knowledge

Review the information reported on the technical review forms with the training coordinator.
- 9.3.2 Skills

The trainee should demonstrate the ability to identify problem samples and/or controls and determine when data is not acceptable and should be rejected.

**10 DNA DATA BANK ANALYST QUALIFICATION****10.1 Goals**

- 10.1.1 To demonstrate technical knowledge by successfully completing an oral competency examination.
- 10.1.2 To demonstrate skills and abilities by successfully completing all practical exercises, including a final practical competency examination.

**10.2 Tasks**

- 10.2.1 Undergo final oral and practical competency examinations.
- 10.2.2 Conduct analysis on blood and/or buccal samples as set forth in this training document.
- 10.2.3 Become familiar with DNA testing guidelines/standards set forth by the following groups:
  - Scientific Working Group on DNA Analysis Methods (SWGDM)
  - ANSI National Accreditation Board (ANAB)
  - FBI Quality Assurance Standards for DNA Databasing Laboratories
- 10.2.4 Read and understand the Department Quality Manual.

**10.3 Training Evaluation**

## 10.3.1 Knowledge

Question and answer sessions.

## 10.3.2 Skills

The trainee should demonstrate the ability to accurately complete the analysis on DNA Data Bank samples and document results in accordance with Department and Section policies and procedures.



## 11 Y-STR ANALYSIS

### 11.1 Introduction

This is a guide designed to lead the qualified and practicing Forensic Biology DNA Data Bank Analyst through the procedures necessary to qualify as a Y-STR analyst in the DNA Data Bank. The guide is not inclusive of all the techniques and procedures that will be encountered during and after training. In addition, the order in which minimum sample sets are listed is arbitrary. Any or all of the samples may be processed in any order and concurrently if desired.

During the training period, the trainee will prepare and maintain an organized notebook.

The training program will be monitored by a training coordinator who will provide monthly training reports to the Biology Program Manager.

Because the Y-STR analyst trainee is a previously qualified and practicing DNA Data Bank analyst, areas such as General Lab Practice, Safety, Administration, etc., can be referenced elsewhere in this manual and are not specifically covered under this training program.

### 11.2 Analyst Qualification

11.2.1 The final qualification of a trainee as a Y-STR analyst will be based upon the following:

11.2.1.1 Successful completion of the required training samples.

11.2.1.2 Satisfactory completion of an oral technical competency examination to include technical questions pertaining to all aspects of DNA Data Bank analysis that relate specifically to Y-STR analysis.

11.2.1.3 Satisfactory completion of a practical competency examination which will consist of blood and/or buccal samples. This test will evaluate the trainee's skill in accuracy in performance of Y-STR PCR-based DNA typing procedures.

11.2.2 The satisfactory completion of the oral technical competency and practical competency examinations will be documented in a memo to be maintained in the training file of the trainee.

### 11.3 Required Knowledge and Skills

11.3.1 The trainee will possess a basic understanding of the principles of molecular biology and genetics that underlie and support both autosomal and Y-STR typing of DNA in the context of a forensic laboratory. Moreover, skills must be acquired in the operation of certain instruments and the evaluation of data derived during the analysis of Y-STRs. It is understood that the trainee already possesses the skills in operation of instruments and evaluation of data needed for autosomal STR analysis.

11.3.2 Required readings (with documented approval by the Biology Program Manager) will be assigned by the training coordinator and a list of the readings/approval will be kept in the training notebook.

11.3.3 Knowledge areas specific to Y-STR analysis

11.3.3.1 Nature of the polymorphic regions examined by DFS on the Y chromosome.

11.3.3.2 Biochemistry of the Polymerase Chain Reaction (PCR).

11.3.3.3 Principles of detection of fragment-length polymorphisms – specifically capillary electrophoresis.

11.3.3.4 Y-STR loci examined by DFS.

11.3.3.5 Quality control/quality assurance measures.

11.3.4 Instrument Operation

11.3.4.1 Thermal cycler.

11.3.4.2 Capillary electrophoresis instrumentation.

11.3.5 DNA Typing Procedures

Steps and procedures are defined in the DNA Data Bank Procedures Manual AmpFℓSTR® Yfiler™ System.

**11.4 Training Samples**

11.4.1 The trainee will demonstrate the skills required of a Y-STR analyst by completing, at a minimum, the following sample sets from amplification through the typing/data analysis process:

11.4.1.1 At least forty (40) male DNA samples.

11.4.1.2 At least five (5) female DNA samples.

11.4.2 It may be necessary that the trainee carry some or all samples from extraction on; however, if extracts are available, the trainee may choose to use them in lieu of extracting them him/herself.

11.4.3 During the completion of these sample requirements, a total of at least five (5) separate amplifications and five (5) separate capillary electrophoretic runs should be conducted so as to demonstrate the skills necessary in conducting each of these portions of the analysis.

**11.5 Technical Review**

The knowledge and skills acquired in Section 9 of this training manual will carry over to Y-STR technical review. Y-STR plates may not be available for practice technical review during an analyst's training; however, if a Y-STR plate is available for technical review, the trainee may technically review the plate. Any plates reviewed by the trainee will be technically reviewed by a qualified Y-STR Data Bank analyst.