

Forensic Analytical Molecular Biology
50:115:430/56:115:530
Rutgers University
Department of Chemistry

INSTRUCTOR: Rui Fen Kubiak, MSFS, ABC-DNA
Semester: Fall 2023

Contact Information:

Rui Fen Kubiak
Email: rk1203@camden.rutgers.edu
Class hours: Wednesday 6-9pm
Office hours: Online Thursday 5-6 (close out if no one shows up first half hr)

Handouts for each lecture will be provided by the instructor on **Canvas**.

Information for reference can be obtained on the following web site: www.cstl.nist.gov/div831/strbase/

REQUIRED TEXT: ADVANCED TOPICS IN FORENSIC DNA TYPING: METHODOLOGY, John M. Butler. Academic Press. Found at University District Bookstore on <https://universitydistrict.bncollege.com/shop/university-district/page/find-textbooks>

I. Course Objectives:

1. To provide an overview of molecular biology and DNA structure as they relate to DNA testing of biological evidence.
2. To provide a comprehensive description of the DNA analysis techniques used in a forensic lab.
3. To provide the theory and application of the most commonly used techniques for DNA extraction.
4. To provide the theory and application of the techniques for general and human specific DNA quantification and calculation related to these methods.
5. To discuss the use and optimization of PCR for amplification of short tandem repeats (STR) and other relevant types of genetic markers.
6. To discuss the effects of inhibition, DNA degradation, and other complications which occur when conducting DNA analysis of evidence.
7. To discuss interpretation and reporting of quantitative STR data.
8. To introduce relevant quality control measures commonly employed in forensic DNA analysis as well as relevant guidelines and standards.
9. To introduce basic statistics and apply them to analytical problems.

II. Competencies: At the completion of this course students will understand the molecular biology theory and techniques on which the current procedures used for analysis of short tandem repeat (STR) loci for forensic identification are based. They will be familiar with current methodology and options for analysis. Students will acquire an appreciation of the quantitative nature of forensic DNA signal and will be exposed to the complexities which occur in the analysis and interpretation of forensic DNA samples.

III. Testing Policy:

Quizzes x7 10%, each (cumulatively 70%)

Mock Trial (graduate section) 10%

Final Exam 20% (graduate); 30% undergraduate

Examination questions will cover all topics.

Bonus Assignment Evidence Interpretation potential additional 5 points to final grade

The case report will be based on results from samples processed by another scientist. Students will be expected to compile their case folders and report as per approved Standard Operating Procedures (SOPs) which are located on CANVAS.

All assignments are due to the instructor in paper-form at before the final exam. No electronic or late bonus assignments will be accepted under any circumstances.

IV. Grading Policy:

A	90+	C+	75-79
B+	85-89	C	70-74
B	80-84	D	60-69
		F	<60

V. Pre-requisites:

- It is assumed that students have a basic background in chemistry and biology.
- It is assumed that students have a basic understanding of descriptive statistics.
- Biochemistry I, Elementary Biochemistry, Introduction to Biochemistry or permission of the instructor.

VI. Proposed Schedule:

Sept 6, 2023

Introduction, Genome Structure, DNA Structure, Synthesis (Read Inside the Cell & Chapter 2 of Assessing the Probative Weight of DNA Evidence)

Review information regarding the size of the human genome including the nuclear and mitochondrial DNA. Review the features of chromosome structure and packaging. Discuss the location and arrangement of repeated sequences in the genome with focus on types of tandemly repeated sequences. Review standard nomenclature for genetic loci, and types of human DNA polymorphisms and their application to forensic testing. Review pedigree analysis, and Mendelian inheritance of autosomal loci.

Sept 13, 2023

DNA Extraction and Purification (Read Chapter 1 & 2)

Phenol Chloroform, Chelex, Silica-based purification

Review of methods for DNA purification, and concentration. Review differential extraction procedures used to separate sperm and non-sperm cells prior to DNA extraction.

Last Day to DROP a class without a "W" grade
--

Thursday, September 14

Sept 20, 2023

The Polymerase Chain Reaction (PCR).

DNA/DNA hybridization, PCR chemistry including primer binding, mechanism of Taq polymerase and rate of amplicon production, DNA synthesis.

[Quiz #1 \(Topic: DNA Extraction\)](#)

Sept 27, 2023

Quantitative PCR (qPCR) for absolute quantification of nucleic acids (Read Chapter 3)

TaqMan and SYBR Green real-time PCR chemistry/probes

QNEG control, Internal PCR Control (IPC)

Demonstration: PCR curves for real-time quantification

[Quiz #2 \(Topic: Extraction and PCR\)](#)

Oct 4, 2023

Polymerase Chain Reaction (PCR) of STRs (short tandem repeats) (Read Chapter 4)

Factors affecting DNA profiles such as stutter and non-template "A" addition during the PCR, contamination, and stochastic effects.

POS control, NEG control

[Quiz #3 \(Topic PCR and qPCR\)](#)

Oct 11, 2023

PCR multiplexing (Read Chapter 5)

Oct 18, 2023

Capillary Electrophoresis (Read Chapter 6)

The electropherogram, and how to recognize artifacts.

Ladders and Internal Lane standards (ILS)

[Quiz #4 \(Topic PCR and STRs and multiplexing\)](#)

Oct 25, 2023

Electropherogram Analysis

Demonstration: Filtering Artifacts, classifications of noise, stutter and allele

[Quiz #5 \(Topic Multiplexing\)](#)

Nov 1, 2023

Electropherogram Interpretation

Demonstration: NOC assumption, distinguishable & indistinguishable mixtures, genotype inference.

Nov 8, 2023

Statistical Analysis

Random Match Probability, Combined Probability of Inclusion and Likelihood Ratios

Demonstration: Calculating stats for single source and mixtures

[Quiz #6 \(Topic Capillary Electrophoresis\)](#)

Nov 15, 2023

Y-STR & DNA database (Read Chapter 13)

Demonstration: Case scenarios & database eligibility

[Hand out sample questions for mock trial.](#)

Last day to WITHDRAW from a class with a W grade. Deadline 5:00 p.m

Monday, Nov 13

Nov 22, 2023

Quality Assurance and Validation (Read Chapter 7)

Summary of DNA controls

Validation of a new DNA technology. Train and then test. The ‘testing’ is what forensics term validation.

[Quiz #7 \(EPG & Interpretation\)](#)

Nov 29, 2023

Mock Trial (for those registered in the graduate section).

Dec 6, 2023

Direct PCR & Rapid DNA

[Hand out bonus assignment.](#)

Dec 13, 2023

Review session

Dec 20, 2023

Final Exam. Wednesday at 6:00-9:00pm as per

<https://registrar.camden.rutgers.edu/sites/registrar/files/Fall2023FinalExams.pdf>

Hand in Bonus Case Report (paper, in-person), if desired before the Final Exam. The student is responsible for reading the instructions independently and generating a final case report as per the written instructions provided and information given during class. Late reports or electronic reports will **not** be accepted, regardless of circumstance. This is a closed book exam. Only basic calculators are permitted.

Policy on Academic Honesty: Rutgers University is committed to the principles of intellectual honesty and integrity. All members of the community are expected to maintain complete honesty in all academic work, presenting only that which is their own work in tests and assignments. For complete details, please refer to the Rutgers University Code of Student Responsibilities. If you have any questions regarding proper attribution of the work of others or additional academic honesty concerns, contact the instructor prior to submitting the work for evaluation.