
FORENSIC SCIENCE
AND THE
FORENSIC BIOCHEMIST
GRACE KORKOR ABABIO

FORENSIC SCIENCE AND THE FORENSIC BIOCHEMIST

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Title: Forensic Science and The Forensic Biochemist
First Edition

Forensic science has received more attention lately and this has led burgeoning of University courses being embedded with it. This book has new case studies with probable exams - oriented questions as well as uncovering the various activities of the forensic biochemist and the need for standardization of protocols. Target group for this book include undergraduates, postgraduates, researchers, and forensic practitioners.

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To all Biochemists and Forensic Scientists Whose Contributions Are The Source of Information Presented Here

Table of Contents

List of Tables

List of Figures

Preface and Acknowledgments

During the past few decades, forensic science has gained enormous attention in developed countries, while little data exists in developing countries like Ghana. With an increase in crime rates, rape cases, accident victims and other adverse instances that the task force and the police services face, there is a need to maximize efforts in teaching forensic science in tertiary institutions. Even though, there is no stand-alone upper-level offering of forensic science in UG, departments (like archaeology, biology, chemistry, biochemistry, biostatistics, criminal justice or law) that offer portions of it in varying subject areas could be empowered as well as their teaching materials standardized, till the set time for an accredited forensic science program at University of Ghana, Legon falls in place.

In addition, a standardized teaching resource could offer students the opportunity to view unique practices for evidence collection, laboratory work and legal issues. In this book, the emphasis is on sample collection best practices, serology, DNA quantification and storage, non-human DNA testing, hair microscopy, paternity testing, short tandem repeat markers, degraded DNA issues, new frontiers - automation and software. By dwelling heavily on these expert areas, this book is hopeful in uncovering the challenging but rewarding Forensic Science as a career. The professional in this field should have an eye for detail as he/she applies science to answer legal questions. Being involved in a career-related internship is also, a sure way to develop one's skill and experience. A student who has very good curriculum vitae, a major or an advanced degree in this field, is set to be employed as either a forensic researcher, a forensic criminalist, a forensic DNA analyst, a forensic anthropologist or a forensic biochemist.

This piece was the product of the labours of many people and the support of a caring family and friends. I am most grateful to my husband for his ongoing encouragement and tolerance of my early risings and times of distractions as I wrestled with the topic. For critics, my gratitude goes to your thoughtful reviews and helpful comments at various stages in the development of this book.

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Foreword

Forensic Science as a programme and profession is gradually gaining grounds in Ghana and the book, Forensic Science and the Forensic Biochemist by Dr. Grace Korkor Ababio with contributions from seasoned Biochemist and Toxicologist and some early practitioners of the field is timely and makes interesting reading. It walks the reader through the field of Forensic Science, introducing the reader to what happens in the Universities in Ghana and the relevant programmes or courses in the various Departments geared towards forensics and then takes up the important issue of sampling using best practices, and taps on case studies to illustrate the dangers of poor sampling. Chapter 3 deals with instrumentation.

The learning objective is to understand the principles behind important equipment used in the laboratory. It provides up to date information and good case studies to reinforce learning. Qualitative and quantitative approaches in scientific investigations using the various samples and methods are dealt with.

A dedicated chapter speaks to skills and competences that must be developed, career orientation and the importance of professionalism and the work of a forensic biochemist supported by case studies. This book adds on the integration of science and law, the scientific expert in court, which brings together all the science, skills and professionalism, again supported by the famous case studies. The book ends with Chapter 8, minimizing observer effects, and extensive references for further reading. It is an important good read for anybody venturing into forensics or interested in the many films, documentaries and investigative pieces on forensics.

The hope of full undergraduate and postgraduate programmes in forensics in Ghana will be a fulfilment of the ideals of the author.

Prof. Agyeman Badu Akosa

Ghana Standards Authority

Background

Forensic Science, first coined as a science in 1936, is a developing field that owes its progression to advancements made in the laboratories (Jermyn, 2013; Jobling and Gill, 2004; O'Handley and Green, 1972). It has gained attention lately, partly due to the fight against crime (Ribaux, Walsh, Margot, 2006; Saks, Risinger, Rosenthal, Thompson, 2003; Tilley, 1996). Below are records of crime obtained from archives in Ghana (Table 1) from the periods 2013, 2014 and 2015 (Records from the Police Service, Ghana).

Table 1: Records from the Ghana Police Service

From records	2013	2014	2015
Murder	551	543	525
Robbery	1,235	1,116	1,411
Rape	484	514	451
General Crime	4,845	4,738	4,715

The discovery of forensics revolutionized the area of molecular biology and became a gateway for many key developments in the formation of databases such as DNA sub data. Elsewhere in developed countries, large databases (Gill, Fereday, Morling, Schneider, 2006; Gill, Werrett, Budowle, Guerrieri, 2004; Martin, Schmitter, Schneider, 2001) exist unlike Ghana.

In Ghana, forensic services have been provided to the Police Service by the Criminal Investigation Department (CID), Ghana Standards Authority (GSA) and the public hospitals. Ghana Forensic Science Department evolved from the Government Chemical Laboratory in 1973 where forensic examination of samples submitted by the law enforcement agencies, pathologists and police personnel formed part of the outfit since colonial times.

In 1973, the Government Chemical Laboratory was absorbed by the Ghana Standards Board. Though forensic science services were not primarily standardizing activities, the activities of the department were retained by the new outfit to continue offering the services it had been doing since the colonial times. To date, the Forensic Science Department continues to provide support services to the Police and a host of government agencies.

Current Activities Include:

- Drug analysis in seized material submitted by NACOB, BNI, GPS, CEPS
- Drug analysis in body fluids of suspects presented by GPS, The Armed Forces, the Prisons Services and other agencies.
- Post mortem toxicological analysis to assist forensic pathologists involved in coroners' inquests

- testing samples collected from victims or accused in scene of crime

In general, the GSA can be described as a laboratory that comprises of scientists analysing evidence in the following disciplines: toxicology, trace evidence, biology (excluding DNA), and controlled substances. Queried documents, firearms, tool marks, latent prints or crime scene examination are not included in the protocol of activities. More recently, a number of individuals have requested the laboratory to include specialized areas such as DNA analyses and Digital evidence. The quality and capacity of the contemporary forensic system have caught the glimpse of Government, the media and the courts. The clamour for the use of forensics have intensified due to the vast increment of acquittals and exonerations resulting from the absence of DNA analysis in a majority of cases.
On a broader note, the GSA Laboratory offers Services to Clients on:

- Controlled Drugs
- Drug Quality
- Forensic Toxicology
- Scene of Crime Samples

However, the refurbished crime laboratory at Kawo Kudi (Exhibit 1 - *see appendix;* Personnel at Kawo Kudi.), Accra, seemed to be the only forensic laboratory serving all the 651 police stations across the regions in Ghana. Other key challenges are the lack of short tandem repeats (STR) and fingerprint database as well as quality control. There is therefore the need to intensify training and or education in that regard.

Even though University of Ghana has no stand-alone upper-level offering forensic science as compared to Kwame Nkrumah University of Science and Technology (postgraduate forensic degree) and University of Cape Coast (BSc Forensic degree); departments offering portions of forensic science in varying subject areas, could be empowered. Standardization of teaching resources could go a long way by helping students view unique practices for medico - legal issues. In this book, emphasis will be on sample collection best practices, serology, DNA quantification and storage, non-human DNA testing, degraded DNA issues and short tandem repeat (STR) markers.

DNA degradation is one of the major problems encountered as it cannot be analysed by restriction fragment length polymorphism (RFLP) (Reynolds, Sensabaugh, Blake, 1991) techniques due to exposure to humidity, heat and or other contaminants. As a result, longer regions of DNA are interrupted and band shift is seen as DNA fragments moves across the electrophoresis gel at different speeds. This, thereby makes it difficult to defend two pieces of DNA as a match if the patterns were slightly different. Hence, single tandem repeat (STR) assays remains the best bet in instances like this. One

unique alternative to STR is single nucleotide polymorphism (SNP). However, SNP requires a large amount of DNA template and polymerase chain reaction (PCR) product. SNPs have much smaller amplicons (Butler, Coble, Vallone, 2007; Dixon, Dobbins, Pulker, Butler, Vallone, et al., 2006; Romanini, Catelli, Borosky, Pereira, Romero, et al., 2012), yet, the bi - allelic nature of SNP makes it arduous to interpret results from a mixed sample, thus, a balanced assay is required. Standardization of protocols is needed to analyse the diversity of DNA samples for consistent results.

By dwelling heavily on these expert areas, this book envisages to uncover the challenging but rewarding Forensic Science as a career for the student and or the professional biochemist as well. Forensic biochemist in this field would therefore have an eye for detail as he/she brings his/her expertise to bear.

Chapter 1:
At School

Learning Objective

To Receive Intense Training on Forensics at Tertiary Level

At School

The available science option at the University is enough to set one's pace in a useful career as a lecturer, a scientist, a pharmacist, a chemist, a physicist, a biologist, a researcher etc., even if a student never gets medicine or dentistry as expected, due to his/her grades. In this way, the stress of a particular course or the fear of inadequacy of support are handled in a quite unique manner. Departments like biology, chemistry, biochemistry at the University of Ghana for example, do offer multidisciplinary subject fields, for example portions of forensic science in varying subject areas. It is about time that methodologies are standardized for effectiveness and consistencies. In this chapter, a student's major, his/her time with the demonstrator would be dealt with extensively.

Taking 'SINGLE MAJOR' Courses at the University of Ghana

Getting acclimatized to one's major or any advanced degree at the University could be daunting. Setting the alarm, eating a decent breakfast, double checking one's schedule, creating one's own study timetable or organizing the study routine around one's classes, charging the necessary devices, printing out official documents and packing the essentials (ID card, textbooks campus map etc.) normally prepares students ahead of time. Courses for a basic science student geared towards forensics at the University of Ghana are shown in table 2.

Table 2: Level 400 Semester 1 and 2 Chemistry Core and Electives.
(University of Ghana single major, chemistry.)

Level 400 1st Semester (Core)	**Electives**
Project	**A**
Kinetics	X-ray Crystallography
Thermodynamics II	Organometallic
Kinetics	Nuclear Chemistry
Natural Products	
Group Theory, Symmetry, Applications	**B**
	Mineral Processing
	Polymer Chemistry and Technology
	Pulp and Paper Chemistry and Technology
	Petroleum Chemistry and Technology
Level 400 Semester 2 (Core)	**Electives**
Project	Photochemistry
Surface Chemistry and Colloids	Textile Chemistry and Technology
Quantum Chemistry	Molecular Spectroscopy
Instrumental Methods of Chemical Analysis	Industrial Chemistry
Transition Metal Chemistry	Elements of Forensic Chemistry
	Medicinal Chemistry
	Solid state Chemistry
	Environmental Chemistry

Table 3: Level 200 Physics
(University of Ghana single major, physics.)

Level 200 1st Semester	**2nd Semester**
Calculus II	Practical Physics IV
Atomic Physics and Quantum Phenomena	Mathematical Methods I
Practical Physics III	Oscillations and Waves
Electro - magnetism I	Computational Methods in Physics I
Select one course	Nuclear Physics I
Algebra	Introduction to Physics of Materials
Statistical Methods	

Table 4: Level 300 Physics semester 1 and 2

Level 300 Semester 1 (Core)	**2nd Semester**
Optics	Practical Physics VI
Physics of Solids I	Mathematical Methods II
Large Systems I	Mechanics and Fields
Practical Physics V	Special Relativity
Electro – magnetism II	Quantum Mechanics I
Electives	**Electives**
Electronics I	Computational Methods in Physics II
Physics of the Atmosphere	Principles and Applications of Neutron Activation Analysis
Physics of the Ocean	Principles of Applied Geophysics
	Design of Experiments

Table 5: Level 400 Physics semester 1 and 2

Level 400 Semester 1	**2nd Semester**
Project	Project
Physics of Solids III	Particle Physics
Seminar I	Seminar II
Physics of Large Systems II	Nuclear Physics II
	Contemporary Physics
Electives	Quantum Mechanics II
Electronics II	
Principles of Radioactive Dating	**Electives**
Energy Systems	Basic Meteorology
Principles of Telecommunications	Introduction to Cosmology and Astrophysics
	Physics of the Nanoscale

Table 6: Level 200 Animal Biology
(University of Ghana Animal Biology Courses)

Level 200 Semester 1	**2nd Semester**
Writing II (Academic)	Introductory Animal Ecology
Principles of Evolution	Introductory Cell Biology and Genetics
Zoological Techniques	Introduction to African Studies
	Introductory Biometry
Vertebrate Anatomy	

Table 7: Level 300 Animal Biology semester 1 and 2

Level 300 Semester 1	**2nd Semester**
Comparative Chordate Biology	General Entomology Practical
Principles of Genetics	Zoological Field Studies
Animal Ecology	Principles of Conservation Science
Venomous Animals	Zoogeography
Behavioural Ecology	Aquatic Biology
Systematics	Public Health Zoology
Comparative Animal Physiology Practical	Public Health Zoology Practical
Microbiology and Immunology	General Entomology
Comparative Chordate Biology Practical	
Comparative Animal Physiology	**Electives**: Westland Ecology
	Terrestrial Invertebrates

Table 8: Level 400 Animal Biology
(University of Ghana single major, biochemistry.)

Level 400 Semester 1	**2nd Semester**
Freshwater Biology Applied Statistics for Biologists Environmental Physiology Research and Project Management Marine Biology Conservation Biology Animal Behaviour **Electives**: Limnology Population Ecology Evolutionary Principles (Application)	Projects Field Trips and Reports **Electives**: Innovations and Business Plan for Biologists Epidemiology of Tropical Diseases Applied Entomology Vertebrate Biology Fishery Biology and Marine Ranching Petroleum Ecology Molecular Genetics and Biotechnology Wildlife Management Radiation Biology and its Applications Wetland Ecology and Management

Table 9: Level 200 Biochemistry

Level 200 Semester 1	**2nd Semester**
Physical Chemistry I	Enzymology
Organic Chemistry I	Practical Biochemistry I
	Introduction to African Studies
Principles of Biochemical Techniques	Cell Biology I
Structure and Function of Biomolecules	Inorganic Chemistry I (S-Block Elements)
	Spectroscopic and radio isotopic Techniques
Analytical Chemistry I	Organic Chemistry II
Academic Writing II	

Electives

Candidates could choose from other departments electives to assure the limited work load per semester.

Table 10: Level 300 Biochemistry

Level 300 Semester 1	**2nd Semester**
Principles of Lab. Organization & Management	Cell & Molecular Biology Practical I
Biochemistry of Hormones	Integration and Control of Metabolism
Molecular Biology I	Molecular Biology II
Intermediary Metabolism	Cell Biology II
Data Handling & Interpretation	Bioenergetics
Chemistry of Aromatic Compounds	Molecular Rearrangement Reactions
Practical Biochemistry II	Membrane Biochemistry
Electives	Reactions of Carbanions
Industrial Microbiology	
Biochemistry of Viruses	

Candidates could choose electives from other departments to assure the limited work load per semester.

Table 11: Level 400 Biochemistry

Level 400 Semester 1	**2nd Semester**
Seminar Presentation and Scientific Writing	Entrepreneurship for Innovations in Biosciences
Cell Signalling	Immunology and Immunochemistry
Molecular Biotechnology & Applications	Protein Chemistry II
Protein Chemistry I	Research Project
Cell & Molecular Biology Practical II	Molecular Genetics
Electives	
Biochemistry of Parasites	**Electives**
Xenobiotic Metabolism	Insect Biochemistry & Chemical Ecology
Clinical Biochemistry	Bioremediation
	Plant Biochemistry

Universities offering Forensic degrees in different countries

Forensics in the Western world have sophisticated equipment that they utilize to teach and train students. These countries (e.g., sixty – nine United Kingdom institutions, a hundred and five USA institutions and the like) have well-structured and accredited forensic courses that run from bachelors, masters (MSc.), postgraduate (Diploma) level and even PhD (University of Copenhagen, Denmark).

In Africa, there had been a gradual progress in forensics, with great progress seen in South Africa's institutions. When the DNA Project was enacted in South Africa (SA), no clear course outline existed for DNA analysts at various institutions. The intertwined DNA Project - Justice System Review Task Team led academicians to develop a qualification scheme aimed at forensic DNA analysis.

Now, University of the Free State, SA, offers four (4) year structured and accredited forensic course.

However, in sister countries like Nigeria and Benin, barely few institutions run undergraduate and postgraduate forensic course.

A well-structured forensic course with tutored-laboratory sessions, will enable students meet increasing academic competence and research.

In The Laboratory with The Demonstrator

Undergraduates and Postgraduates normally have laboratory encounters with the laboratory demonstrator and or their thesis supervisor. From the field or the ward or a scene to the laboratory could be real fun, encouraging and interesting, especially when one is getting the desired results.

The demonstrator and the supervisor as well, are keen on training students how to sample, how to label each specimen, how to package specimen and transport specimen to the laboratory taking precautionary measures. A wide range of specimens could be collected for investigative purposes. Depending on the nature of substance or compound one is interested in e.g., protein or DNA of a suspect; sites of sampling, selection of specimens, and the sampling procedures are important. Nowadays, forensic experts (Exhibit 2 - *see appendix*; Personnel at a crime scene) are noted securing scenes, separating witnesses, scanning scenes, viewing or seeing the scene, sketching the scene, searching for evidence, packaging evidence and analyzing the evidence. Notwithstanding the added input, whether the evidence needed is trace or direct or circumstantial, the exchange it bears is normally a silent witness to prove or disprove hypothetical suspect.'

Summary

In multidisciplinary system, the tension and or the fear of inadequacy of support are handled in unique manner. Courses embedded in these systems at tertiary institutions are enough in setting one's pace in life. All that you need to do is to be acclimatized to your subject area, learn hard and follow all protocols. In this chapter, student's major geared towards forensics and time with the demonstrator were dealt with. It is worth noting that a well-structured and tutored-laboratory sessions in forensics, facilitate the increasing demands in academia with regards to competence and research. In the next chapter we will explore forensic sampling practices.

Chapter Review

Question

1. In institutions not having a dedicated forensic department, what major or combine major could help a student who so desires to be a forensic analyst?

Chapter 2: Sampling: Best Practices

Learning Objective

To Access Best Sampling Protocols

Sampling: Best Practices

For any laboratory investigation, information and material sampling is crucial warranting standard methods and best practices. In forensic investigation, safeguarding the scene and minimizing contamination are the surest way to maintain samples integrity. The two main sources of information for forensic studies are the documentary records (statement from witness or knowledgeable individuals) and measurements from the field (Petrisor, 2005). A reliable sample and information for forensic investigation largely depend on divergent skills and knowledge, combining multiple sampling techniques from several fields of study including biology, chemistry, geology, biochemistry and physics as well as legal consideration. The varying environmental contamination especially in developing countries poses challenges to best practices in forensic sampling and gathering of information.

Without reliable sample or field information there is no forensic case and one cannot prove the existence or non-existence of crime (Hana, Freitas, Oliveira, and Flávio -Bortolozzi, 2008). Availability of sample from a scene contributes a greater percentage to initial preparation to commence forensic analysis. The question is what happens if the sample is not reliable or non-representative or contaminated due to inappropriate sampling techniques? This is a clear indication that availability of sample is not a guarantee of accurate forensic report. Best practices are followed in acquisition of samples from crime scene or the environment forensic study.

Upon arrival at the crime scene, the first responding investigator is required to get medical assistance for injured victims, detain potential suspect, secure the scene (boundary) and restrict movement of people in and out from the scene, (Technical Working Group on Crime Scene Investigation, 2000) call for additional personnel, keep a detailed log, sketch or search the scene for evidence collection, photograph or videotape the scene and survey the scene. Outdoor crime scene samples are more susceptible to contamination than samples from indoor crime scene, but appropriate measures and best sampling methods ensure reliable samples.

Evidence For Forensic Investigations (Vince and Sherlock, 2005)

Types of Evidence:

- Prima facie (Testimonial)
- Physical: hair, imprints, indentations, soil, glass, tool marks, blood, fingerprints, documents
- Physical evidence from rape victims
- Blood sample
- Urine specimen
- Pubic combings
- Vaginal swabs and smear
- Pubic hair standard/reference sample
- Head hairs
- Oral swabs & smear
- External genital dry-skin areas
- Cervix swab
- Fingernail scrapings
- Rectal swabs and smear
- All clothing
- Transient evidence: Odour (perfume), urine, explosives, smoke, gasoline, putrefaction, coffee, water, cadaver, car hood
- Biological: sweat, saliva, feces, insects, blood, semen, tears, urine, hair, bone, animal material, bacteria, botanical, fungal
- Chemical: Glass, soil, drugs, paints, plastics, cosmetics, lubricants, metal, mineral, fiber, fertilizer
- Miscellaneous: voice analysis, vehicle identification, stress evaluation, laundry marks.

Techniques For Sampling in Forensic Investigations

Standard laboratory procedures apply here. See table 12.

Table 12: Sampling techniques (Sampling techniques.)

Site	Material	Equipment	Sampling instructions
Blood	DNA	Appropriate tube	Collect 5 - 10mL venous blood
	Drugs	Appropriate tube	Collect 5 -10mL venous blood
Clothing	Blood, semen, fibres, hair	Paper bags	Bag wet items separately, place clothing in paper bags
Asshole	Semen	Microscopic slides, cotton swabs	Use swabs and slides to gather and plate specimen, moisturize instrument with water
	Emollient (Lubricant)	Cotton swabs	Dry swabs after collection
Groin	Semen	Microscopic slides, cotton swabs	Use swabs and slides to gather and plate specimen, moisturize instrument with water
Hair	Comparison of hair found at scene	Germ - free container	Cut 20 hair strands and place in germ - free container
Mouth	Semen	Cotton swabs, germ - free container	Clean several sites with one or more swabs for oral cleaning, wash mouth with 10mL H_2O and collect in germ - free container
	DNA (victim)	Cotton swabs	
Urine	Drugs	Germ - free container	Collect 100mL urine
Skin	Semen	Cotton swabs	Clean areas where semen might be present
	Blood, saliva	Cotton swabs	Dry swab after collection
	Foreign material	Cotton swabs and tweezers	Place material in germ - free container
Nails	Blood, Skin, fibres	Germ - free toothpick or nail scissors or nail clippers	Use toothpick to assemble specimen from under the nails or the nails could be trimmed and the clippings collected in a germ - free container
Hygienic pads or tampons	Blood, hair, semen	Germ - free container	Collect if used during or after oral or vaginal penetration

Avoiding Crime Scene Contamination: Safety Procedures

Disposable forceps, gloves and sanitized equipment reduce contamination. Unbreakable containers with pressure lids are good points for glass, fibers, hairs, and or other types of trace evidence. Also, screw-cap glass vials, cardboard pillboxes or manila envelopes are good trace evidence containers obtained at crime sites.

Routine mailing envelopes have powders and or fine particles that might leak out when used in airtight containers as evidence containers, cumulation of moisture might stimulate the growth of mold, which could spoil the evidential value when biological materials are stored in them. The introduction of

foreign DNA through coughing, sneezing or incorrectly placing items beside each other during packaging introduces contamination especially in DNA analysis. To prevent DNA contamination, the evidence collector must use disposable gloves, wear a laboratory coat, work with disposable forceps and put on a face mask, when gathering evidence that may contain DNA.

Maintaining Samples Integrity in Forensic Studies

Adhering to standard methodologies with regards to the location of evidence, proper labelling of evidence and adequately completing submission forms of evidence for laboratory analysis is critical to the chain of custody.

A crime scene police personnel collects information, labels it, places it in an evidence bag, and signs off to an investigator who also signs it over to the lab technician who performs the necessary tests. After performing the necessary test, the technician signs it over to the custodian of evidence. From there it will be signed over to the prosecuting attorney for presentation in court.

Transportation of Samples from Crime Scene

The current policy being followed for transporting samples states that certain samples need to be dispatched in the frozen state and that no specimen should ever be sent by post. Stool, cerebrospinal fluid and sputum also need to be transported at room temperature. Urine, skin samples, swabs, water and food samples should be transported quickly at room temperature, but if it is impossible, these samples should be preserved in refrigerator.

Table 13: Specimen conditions for transportation (Specimen conditions for transportation.)

Specimen	Container	Refrigeration	Transport
Faeces	Stool specimen container (blue topped)	Yes, but it depends on the organisms one is interested in; normally refrigerate immediately within 1 - 2 hrs after taking sample	As soon as possible within 24 hrs
Blood	Specific container depending on the test	No	As soon as possible
Vaginal swabs	Vaginal swabs	No	As soon as possible within 4hrs
Midstream urine	Universal container	Yes - overnight only	As soon as possible within 24hrs

Table 14: Quantity of Specimen and Transportation conditions (Quantity of specimen and transportation conditions.)

Specimen	Ideal Amount	Suitable analysis	Transport temperature
Urine	100 mL	Drug, ethanol analyses	2-8°C
Blood	40mL	Drug and Glycated Haemoglobin (HbA1c) analyses (Gray-top tube) Green-top tube blood for carboxyhaemoglobin (HbCO), blood cyanide (CN^-)	2-8°C
Vitreous humour	2 mL	Glucose and ethanol analyses	2-8°C
Spinal Fluid		Drug and ethanol analyses	2-8°C
Gastric contents	100gm	Need-based drug analysis	2-8°C
Spleen	150gm	Drug and ethanol analyses	Frozen
Liver	500gm	Drug and ethanol analyses	Frozen
Muscle	300gm	Drug and ethanol analyses	Frozen
Kidney	100gm	Drug and ethanol analyses	Frozen
Blood	100gm	Drug and ethanol analyses	Frozen
Lungs	100gm	Drug and ethanol analyses	Frozen
Heart	50gm	Drug and ethanol analyses	Frozen

Cataloguing, Evidence Retention and Destruction of Biological Evidence

Inventory taking or cataloguing system is highly important as it augments the available storage space. Retention schedule for unsolved biological evidence is 40years. In convicted cases, retention schedule stays up until the inmate dies, is released on parole or is executed or the defendant is rather convicted of capital felony. Sample letter giving notice of intent of destruction of biological evidence:

RE: INTENT TO DESTROY BIOLOGICAL EVIDENCE
[Date]

To Whom it May Concern

Pursuant to Act ..... Code of ..... I hereby notify your prestigious office that ..... Intends to destroy the biological evidence listed below:
This evidence would be destroyed within ..... days as this letter gets into your custody unless a written objection is received.
Your candid written objection should have:

Victim's name..... Defendant's name.....
Evidence items..... Convicted date.....
Offenses..... Court.....
Case number.....
Yours faithfully,
Name, contact details

Challenges of Forensic Sampling in Developing World

More often than not, developing countries are faced with culture clashes and nomenclature challenges in forensics. Many laboratories in developing countries are somewhat incapable of coping with the complex mixture of low template poor quality touch samples. Only a few scientists have technical knowledge of the statistical approaches used in genotyping.

Summary

Securing the scene to minimize contamination maintains samples wholeness in forensics. Documentation and adhering to benchmark procedures are also critical to the chain of custody. In this chapter, best sampling protocols were accessed. The chapter identified the techniques involved as far as sample's integrity is concerned. In the next chapter important equipment used by the forensic biochemist and the principles behind such equipment were explained.

Chapter Review:

Question 1

1. The first thing a Crime Scene Investigator need to do at a crime scene is.....
   A. Retain suspects
   B. Collect evidence
   C. Preliminary examine the scene
   D. Solicit medical assistance for the injured
   E. None of the Above

From South Africa's archives

a. Disappearances (Disappearances of an adult.)
b. Pistorius case (Oscar Pistorius case.)

Case study

Contaminated DNA (Contaminated DNA evidence strikes three (3) cases.) Somewhere in Applied Biosystems Inc., California, a supplier of plastic test tubes, an unmasked female worker coughed. This set off series of events that led to queries on DNA evidence in three (3) local crime cases in USA. DNA analysts at the Police Department crime lab at Tucson, who worked on the match profile of a suspected man of attacking seven (7) women between May 2004 and February 2005 identified the unknown woman's DNA in three (3) unrelated cases: an assault, a murder and a rape.

Presenting facts in court seemed shaky. Deputy County Attorney Shawn Jensvold said the hearing hanged importantly on the credibility of the DNA evidence, and the dangerous situation is the probability to delude the jury to be convinced of the credibility of DNA results. This same profile turned up in two (2) more crime labs in Florida on homicide issue(s).

This was definitely discovered because of rigorous quality control. For now, Tucson analysts have halted the use of sets of possibly contaminated supplies and have apprised other analysts and/or investigators around the country to sanitize any equipment that could not be certified as DNA-free using ultraviolet light (UV).

Question 2

What happens when an evidentiary sample is contaminated?

Chapter 3: Instrumentation for The Forensic Biochemist

Learning Objective

To Understand the Principles Behind Important Equipment used in the Laboratory

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FORENSIC SCIENCE AND THE FORENSIC BIOCHEMIST

During the past few decades, forensic science has gained enormous attention in developed countries, while little data exists in developing countries like Ghana. With an increase in crime rates, rape cases, accident victims and other adverse instances that the task force and the police services face, there is a need to maximize efforts in teaching forensic science in tertiary institutions. Even though, there is no stand-alone upper-level offering of forensic science in UG, departments (like archaeology, biology, chemistry, biochemistry, biostatistics, criminal justice or law) that offer portions of it in varying subject areas could be empowered as well as their teaching materials standardised, till the set time for an accredited forensic science program at the University of Ghana, Legon falls in place. In addition, a standardised teaching resource could offer students the opportunity to view unique practices for evidence collection, laboratory work and legal issues.

In this book, the emphasis is on sample collection best practices, serology, DNA quantification and storage, non-human DNA testing, hair microscopy, paternity testing, short tandem repeat markers, degraded DNA issues, new frontiers - automation and software. By dwelling heavily on these expert areas, this book is hopeful of uncovering the challenging but rewarding Forensic Science as a career.

Dr. G.K. Ababio is a well-focused, diligent and dynamic young lady who has a keen interest in advancing herself in Academia and in Science. Her interest is in BIOMARKERS AND DISEASES. She lectures at the University of Ghana and has a broad background in medical biochemistry.

As a research fellow at the University and elsewhere e.g. University of Botswana and University of Namibia, she trained young researchers on DNA extraction and polymerase chain reaction (PCR) techniques. As a PI, she laid the groundwork for some of her proposed research. In addition, she has successfully administered projects (e.g. staffing) collaborated with other researchers.

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