13-139
UWUCC: App- 2/11/14
Senate: Info-2/25/14

Undergraduate Distance Education Review Form
(Required for all courses taught by distance education for more than one-third of teaching contact hours.)

Existing and Special Topics Course

Course: BIOL 107 Introduction to Forensic Biology

Instructor(s) of Record: Bharathan Narayanaswamy & Seema Bharathan

Phone: 7-2584 **Email:** Bharathn@iup.edu & Bharaths@iup.edu

Step Two: Departmental/Dean Approval

Recommendation: ☑ Positive (The objectives of this course can be met via distance education)

☐ Negative

Megan Knoch 2/2/14

Signature of Department Designee Date

Endorsed: [signature] 2/7/14

Signature of College Dean Date

Forward form and supporting materials to Liberal Studies Office for consideration by the University-wide Undergraduate Curriculum Committee. Dual-level courses also require review by the University-wide Graduate Committee for graduate-level section.

Step Three: University-wide Undergraduate Curriculum Committee Approval

Recommendation: ☑ Positive (The objectives of this course can be met via distance education)

☐ Negative

Gail Stechuist 2/11/14

Signature of Committee Co-Chair Date

Forward form and supporting materials to the Provost within 30 calendar days after received by committee.

RECEIVED
FEB 18 2014
ASSOCIATE PROVOST OFFICE

FEB 10 2014

Step Four: Provost Approval

☑ Approved as distance education course ☐ Rejected as distance education course

Timothy S. Mescher (ar) 3/3/14

Signature of Provost Date

Forward form and supporting materials to Associate Provost.

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Narrative Rationale Items A1-A5

1. How is/are the instructor(s) qualified in the distance education delivery method as well as the discipline?

Narayanaswamy Bharathan has sought professional development in online course design and pedagogy. Since Spring 2013, he has participated in biweekly consultations with IUP's instructional design staff to discuss the design of the online course, potential teaching strategies, and technologies available for course delivery, resulting in the development of the online version of BIOL 117, which was taught in Winter 2013.The instructor also completed the Desire2Learn Boot Camp offered by the IUP IT Support Center. Bharathan Narayanswamy also received a National Science Foundation Instrumentation and Laboratory Improvement grant for a server to use online resources in his Principles of Biology I course. Bharathan Narayanswamy has over twenty years of experience in the field of biology. He has been teaching at IUP since 1997 and holds a PhD degree from the University of Maine.

Dr. Seema Bharathan has participated in the development of technology-enhanced learning opportunities. In 2006-07, the instructor worked closely with instructional designers and production staff from Concurrent Technologies Corporation (CTC) on a Department of Defense grant project Developing Basic Biology Operations (SDR 111) class online. Currently, the instructor uses several online resources for this course and other courses. The instructor is working with the Technology Support Center (Desire2Learn (D2L) Instructor Self-Directed Training program and is planning to attend the Boot Camp for D2L workshop and training in spring 2014. Dr. Seema Bharathan has over twenty years of experience in the field of biology. She has been teaching at IUP since 1997 and holds a PhD degree from the University of Maine.

2. How will <u>each objective</u> in the course be met using distance education technologies?

General overview: Course modules will require students to watch narrated lectures (10 minutes or less) and read chapters in the textbook and essays. As part of the modules, students will complete self-tests to help them and the instructor gauge their understanding and progress. Also, students will also participate in both small- and large-group discussions on the LMS forums, enabling the instructor to assess their higher-level learning and to provide feedback to students. Throughout the course, the instructor will interact with the students through the LMS, as well as via Skype, e-mail, and telephone as the need dictates. Students will be assessed through the completion of the final exam, case studies, and critiques.

<u>Objective 1:</u>

Describe an understanding of the general methodology of modern biology in forensic science.

Students must gain an understanding of general methodology in forensic biology and, more specifically, recent advances in DNA fingerprinting. This understanding provides a basis for the rest of the course as students explore scientific and forensic indicators

including development and maintenance of DNA databases. This course material involves human remains decay, knowledge of DNA, tissues, and bodily fluids and is best delivered through short narrated lectures and animations on the LMS. Given the importance of this material and its relationship to the remaining course content, students must pass the self-test related to this material. There will be opportunities for all students to interact synchronously with the professor through chat, Skype, or the telephone. Students will also complete case study questions as part of this objective. Students will submit their responses via the LMS assignment drop box.

Objective 2:

Compare how general forensic evidence has been perceived over the years by identifying the issues related to forensic science and modern methods and strategies in forensic biology.

Textbook resources and short lectures delivered via the LMS will enable students to follow the development of our understanding and perception of DNA fingerprinting analysis over the last 50 years. Specifically, students will study the use of DNA and RNA for the identification of individuals along with discussion of ethical issues associated with the maintenance of DNA databases. Students will complete self-assessments and participate in small-group forum discussions to receive feedback on their understanding of the concepts. Students will demonstrate attainment of this objective through completion of the final exam, case studies, and the critique.

Objective 3:

Describe how Forensic Biology and DNA finger printing technology is perceived and dealt with in today's society.

Students will take a DNA fingerprinting technology assessment survey on the first day of class which has them describe their level of understanding of the role of DNA fingerprinting analysis and criminal justice. The same survey will then be given during the last module with small-group and full-group discussions to follow. Readings, course materials, and assignments will require students to assess their own views and concerns about the impact of DNA technology on threats to liberty and privacy and how DNA typing technology has the potential for uncovering and revealing a great deal of information that most people consider to be intensely private. Other assignments will have the students analyze the impact of DNA finger printing technology in the public realm (e.g., legal system, prosecution of crimes, and in civil litigation) and to use this analysis to determine how their personal lives are and will be affected. Students will demonstrate attainment of this objective through critiques of both student case studies and the non-textbook reading.

Objective 4:

Assess historical figures last 25 years that have made contributions to our understanding of DNA finger printing in the court room.

Assignments will require students to gain an understanding of how quality DNA analysis and methods are fundamental to forensic DNA technology and its use in tracing the origins of criminal evidence. They will then apply these analyses to the evaluation of their own view for high-quality final results which are comparable to the results of other laboratories and to ensure the making of correct and impartial decisions in DNA testing.

Students will read a series of articles and chapters in the textbook about historical figures who have made significant contributions to our understanding of forensic science and criminal justice in the US. This material is covered, and students will have opportunity for feedback throughout the course through the class discussions. Students will be assessed on this objective through the Final Exam and the completion of the Case Studies.

3. How will instructor-student and student-student, if applicable, interaction take place?

Chat—the instructor will have set times during which he will be available to students for synchronous interaction. He will also be available at other times by appointment. Times will be posted in the LMS and the course syllabus. Different dates and times will be used to ensure all students can participate.

Forum—the instructor will use the forum for asynchronous interactions with the students. Students will be required as part of the course modules to participate in asynchronous discussions about the course topics. Students will take turns leading and facilitating these discussions among their fellow group members on assigned readings and resources. The instructor will facilitate the process, provide guidance to the group leaders in facilitating the discussions, and to provide commentary and feedback to the discussion groups as needed.

Office Hours—the instructor will also offer virtual and on-campus office hours to assist students as needed. During these times, the instructor will be available via chat, phone, and Skype. The instructor will communicate through e-mail as well. These office hours will also be posted in the course syllabus and on the course page.

4. How will student achievement be evaluated?

1. Final Exam (15%)—Students will be required to take a final comprehensive exam on the course content. The exam will consist of multiple choice questions. The exam will take place on the last day of class, and students may only have one attempt.

2. Self-Tests (30%; 5% for each self-test)—Students will be given six multiple-choice self-tests that relate to the material from their readings and the online resources. Self-tests are designed to assess student understanding of the material and to provide them feedback on their understanding. Students will be evaluated on their ability to correctly respond to the questions.

3. Case Studies (20%; 10% for each case study)—Students will be given two case studies. These case studies will cover the role of invertebrates as forensic indicators in cases of murder or suspicious death, Post-conviction DNA Testing and Wrongful

Convictions; and Advancing Criminal Justice through DNA Technology. Students must prepare a response to each case study based on the questions provided by the instructor. Students will be evaluated on the case studies based on their ability to summarize the case, respond to questions, and provide support using the textbook and online resources.

4. Forum Discussions (25%; 5% for each discussion)— Students will participate in five small-group, student-led forum discussions throughout the semester. These discussions will cover course resources and materials regarding topics, such as bloodstain pattern analysis, DNA profiling, stigmatization, legal issues, and models of Research on Actual Innocence and DNA Exoneration. For each discussion, the student leader will facilitate the discussion, in consultation with the instructor, regarding the assigned readings and materials. Students will be evaluated on their posting frequency, posting quality, and grammar and spelling as outlined in the Group Discussion Rubric.

5. Critique of Non-Textbook Reading (10%)—Students may select one of the supplemental texts for the course to read and write a critique. Critique papers should be a minimum of five pages and demonstrate a connection to the course content, quality of the response, use of technical and descriptive terms associated with Forensic Biology, and grammar and spelling.

5. How will academic honesty for tests and assignments be addressed?

The following methods will be used to maintain the academic integrity in the course:

Academic Integrity Statement—At the onset of the course, students will be provided with an academic integrity statement in both the course syllabus and the course material. Additionally, all written work will include an academic integrity clause.

Varied Assessments—The course makes use of a variety of assessments and levels of assessment to assure that students have multiple opportunities for feedback and to demonstrate their performance. This also provides the faculty member with ample opportunities to assess student performance.

Written Work—Students will be required to submit their material through Turnitin or similar product to assess the authenticity of the work.

Exams and Quizzes—Academic integrity measures for tests and quizzes include the use of large item pools, timed testing, and test security features.

Part II. New Syllabus of Record

I. Catalog Description

BIOL 107 Introduction to Forensic Biology

3 class hours
3 credits
(3c-0l-3cr)

Prerequisites: Non-Biology department majors and minors only

This course offers a broad overview on the firm understanding of basic principles underlying modern applications of biology in forensic science. The course explores the science of forensic biology, traditionally known as *serology*, and the broad scope of laboratory tests used to investigate crimes involving DNA, blood and other body fluids. The course will focus on the issues related to DNA fingerprinting as they apply to public or legal proceedings in the law enforcement arena. (Does not count toward Biology electives, Controlled electives, or Ancillary Sciences for Biology department majors and minors.)

II. Course Outcomes

Objective 1:

Describe an understanding of the general methodology of modern biology in forensic science

Expected Student Learning Outcomes 1 and 2:

Informed and Empowered Learners

Rationale:

Assignments will require students to have a level of knowledge DNA finger printing and serology that will enable them to understand how these techniques work. Assignments will also require students to evaluate ways to collect evidence, preserve samples of biological evidence, and critically analyze DNA data and to use this examination to explain how DNA finger printing tests are interpreted

Objective 2:

Compare how general forensic evidence has been perceived over the years by identifying the issues related to forensic science and modern methods and strategies in forensic biology

Expected Student Learning Outcome 2:

Empowered Learners

Rationale:

Assignments will require students to evaluate common forensic evidence collected by crime scene labs from the crime scene (photography, weapon, narcotics, ballistics tissues, and blood). In addition, these assignments will engage students in assessing a knowledge base in science and how that knowledge influenced the perception and management of DNA finger printing data with crime scene investigation

Objective 3:

Describe how Forensic Biology and DNA finger printing technology is perceived and dealt with in today's society

Expected Student Learning Outcomes 3:

Responsible Learners

Rationale:

Assignments will require students to assess their own views and concerns about the impact of DNA technology on threats to liberty and privacy and how DNA typing technology has the potential for uncovering and revealing a great deal of information that most people consider to be intensely private. Other assignments will have the students analyze the impact of DNA finger printing technology in the public realm (e.g. legal system; prosecution of crimes; and in civil litigation) and to use this analysis to determine how their personal lives are and will be affected.

Objective 4:

Assess historical figures last 25 years that have made contributions to our understanding of DNA finger printing in the court room

Expected Student Learning Outcome 1 and 2:

Informed and Empowered Learners

Rationale:

Assignments will require students to gain an understanding of how quality DNA analysis and methods are fundamental to forensic DNA technology and its use in tracing the origins of criminal evidence. They will then apply these analyses to the evaluation of their own view for high-quality final results which are comparable to the results of other laboratories and to ensure the making of correct and impartial decisions in DNA testing.

III. Course Outline

A. Introduction- What is Forensics? (3 hours)

1. Forensic Sciences: Type of Evidence
2. Forensic Anthropology, Forensic Dentistry and Toxicology
3. Definition and scope of Forensic DNA
4. Functions of the Forensic Scientist

B. Forensic Biology terminology and definitions (7 hours)

1. Blood
2. Serum
3. Proteins
4. Saliva
5. Semen
6. X and Y chromosomes; Loci
7. DNA- source and types
8. Nucleotide Repeats

Exam 1 (1 hour)

C. DNA finger printing – Evidence Based Science (6 hours)

1. DNA structure
2. DNA Evidence: Basics of Identifying, Gathering and Transporting
3. Types of Samples Suitable for DNA Testing: Questioned or Unknown Samples
4. Samples From Unidentified Bodies: Samples collected from unidentified bodies can include: blood, buccal swabs, hairs, bone, teeth, fingernails, tissues from internal organs (including brain), muscle, and skin.
5. Significance of Reference Samples From Known Individuals
6. Use of Samples from Relatives for Testing: Because a child inherits half of its DNA from each parent, it is possible to use reference samples collected from close relatives
7. Determination of Paternity or Maternity of a Child or Fetus Aborted fetal tissue significance for determining paternity, for example, in sexual assault and/or incest cases where conception occurred

D. Safety as it relates to Evidence Collection, Sample Preservation, and Examples of contamination (4 hours)

1. Crime Scene Integrity: Protection of the crime scene is essential to the protection of evidence

2. Contamination: The risk of contamination of any crime scene can be reduced by limiting incidental activity
3. Chain of Custody: If DNA evidence was contaminated, it may be necessary to identify persons who have handled that evidence
4. Transportation and Storage: Any probative biological sample that has been stored dry or frozen, regardless of age, may be considered for DNA analysis
5. DNA finger printing and criminal justice system

Exam 2 (1 hour)

E. DNA Evidence: Basics of Analyzing (3 hours)

1. Overview of Steps in Analyzing DNA Evidence
2. Steps in DNA Sample Processing: Samples obtained from crime scenes or paternity investigations are subjected to defined processes involving biology, technology, and genetics
3. Types DNA Evidence Analysis Polymerase Chain Reaction (PCR); Short Tandem Repeats (STR); Y-Chromosome; and Mitochondrial DNA

F. Evolution of DNA testing: Restriction Fragment Length Polymorphism (RFLP) and PCR (7 hours)

1. DNA Typing — Short Tandem Repeat (STR) Analysis of Short tandem repeat (STR) technology is a forensic analysis that evaluates specific regions (loci) that are found on nuclear DNA.
2. Significance of 13 specific STR loci and The Federal Bureau of Investigation (FBI)
3. DNA Typing — Y-Chromosome Analysis: Several genetic markers have been identified on the Y chromosome that can be used in forensic applications. Y-chromosome markers target only the male fraction of a biological sample.
4. DNA Typing — Mitochondrial Analysis Mitochondrial DNA (mtDNA) analysis: significance of mtDNA testing to the investigation of an unsolved case.

Exam 3 (1 hour)

G. DNA Initiative: Advancing Criminal Justice through DNA Technology (4 hours)

1. DNA Initiative Goals: Significance of DNA technology to ensure accuracy and fairness in the criminal justice system. DNA can be used to identify criminals with incredible accuracy when biological evidence exists, and DNA can be used to clear suspects and exonerate persons mistakenly accused or convicted of crimes.
2. The Initiative calls for increased funding, training, and assistance Federal, State, and local forensic labs; to police; to medical professionals; to victim service providers; and to prosecutors, defense lawyers, and judges.
3. DNA Legislative Milestones: Significance of "Justice for All Act of 2004," enforceable rights for victims of crimes; enhances DNA collection and analysis efforts; provides for post-conviction DNA testing; DNA Backlog Elimination Act (2000)-- To make grants to States for carrying out DNA analyses for use in the Combined DNA Index System of the Federal Bureau of Investigation; Crime Information Technology Act (1996),-- CITA allowed for grants for programs relating to the identification and analysis of DNA.
4. DNA Initiative Partners: Office on Violence against Women, U.S. Department of Justice; Federal Bureau of Investigation, U.S. Department of Justice

H. Post-conviction Testing and Wrongful Convictions (5 hours)

1. Overview of Wrongful Convictions: The strength of our criminal justice system depends on its accuracy — its ability to convict the guilty and to clear the innocent.
2. Post-conviction DNA Testing Post conviction DNA testing is a major factor contributing to the increased discovery of wrongful convictions.
3. Research on Actual Innocence and DNA Exoneration: The increase in exonerations over the last 20 years has accentuated the need for research on how, why and how often wrongful convictions occur.

Final exam (four) during final exam week (2 hours)

IV. Evaluation Methods

1. 60% Four examinations (15% for each exam) – three during the semester and a fourth during exam week. Exams will be short answer essays.

2. 20% Four case studies (5% for each exam) - Students will be given four case studies one for each of the following sections of lectures: 1-11; 12-20; 22-31; and 33-42. These case studies will have questions that must be answered and turned in by the student. Each case study will be worth 5% of the final grade.

3. 15% Students will develop one case study for the class. The case study will be based on articles and ideas gathered from sources such as newspapers, newsmagazines, and popular science and medical magazines (e.g. Discover Magazine, Science and Medicine or Journal of Forensic Research). It will follow the format of the case studies given by the professor and will be worth 15% of their final grade. This will be a class assignment (no presentations in class).

4. 5% Critique of the non-textbook reading. Students will submit a critique with a maximum of five printed pages.

V. Grading Scale

Grading scale: A 90-100; B 80-89; C 70-79; D 60-69; F 59 and below

VI. Undergraduate Course Attendance Policy

The IUP attendance policy will be followed.

VII. Required Textbook

Alan Gunn Essential Forensic Biology 2009 2nd Edition ISBN 978-0-470-75803-8 Wiley-Blackwell

Supplemental Non-text book readings

Bowen, T.R., 2009 Ethics and the Practice of Forensic Science 2009 CRC press

Richard Li 2008. Forensic Biology: Identification and DNA Analysis of Biological Evidence ISBN-13: 978-1420043433. CRC Press, Boca Raton

Koff, C. 2005. Bone Woman: A Forensic Anthropologist's Search for Truth in the Mass Graves of Rwanda, Bosnia, Croatia, and Kosovo - 04 edition ISBN13: 978-0812968859 Publisher: Random House, Inc

Ramsland, K. The Human Predator: A Historical Chronicle of Serial Murder and Forensic Investigation. 2007. ISBN13: 9780425213780 Published by Berkley Trade

Roberts, G.W., 2012 Forensic Crime Scenes Health and Safety CRC Press

Savino,O.J., Turvey,B.E., Baeza, J.J. *2005 Rape Investigation Handbook* ISBN-13: 978-0120728329 Academic Press

Suggested Readings

Alessandrini, F., M. Cecati, M. Pesaresi, C. Turchi, F. Carle, and A. Tagliabracci, 2003. "Fingerprints as evidence for a genetic profile morphological study on fingerprints and analysis of exogenous and individual factors affecting DNA typing," *J. Forensic Science* 48(3): 1–7

Bertino A.B., and Bertino, P.N. 2012. Forensic Science: Fundamentals and Investigations ISBN 13: 978-0-538-73155-3 South-Western Publishers

Butler, J.M., 2005. Forensic DNA Typing, Second Edition: Biology, Technology, and Genetics of STR Markers ISBN-13: 978-0121479527

Houck, M.A., Siegel,J.A., 2010 Fundamentals of Forensic Science 978012374989-5 Academic Press

Levy, R.J., 2011. The Michael Jackson Autopsy: Insights Provided by a Forensic Anesthesiologist. J Forensic Res 2:138. doi:10.4172/2157-7145.1000138

President's DNA Initiative, *Lessons Learned From 9/11, 2006. DNA Identification in Mass Fatality Incidents*, NCJ 214781 (Washington, D.C.: U.S. Department of Justice, National Institute of Justice, Available at http://massfatality.dna.gov/.

Roman, J., K. Walsh, P. Lachman, and J.Yahner, "Post-Conviction DNA Testing and Wrongful Conviction" 2012, Final report to the National Institute of Justice, contract number 2008F-08165, NCJ 238816.

Verma, K., Joshi, B., 2012. Different Animal Species Hairs as Biological Tool for the Forensic Assessment of Individual Identification Characteristics from Animals of Zoological Park, Pragti Maidan, New Delhi, India. J. Forensic Res 3:160. doi:10.4172/2157-7145.1000160

VIII. Bibliography

Barnett, P.D., 2001. *Ethics in Forensic Science: Professional Standards for the Practice of Criminalistics*, CRC Press.

Carracedo, A., 2005. *Forensic DNA Typing Protocols (Methods in Molecular Biology, V. 297.)* Humana Press

Casarett, T., & Doull's K., 2003 Essentials of Toxicology edited by Curtis D., and Watkins, J.B. McGraw-Hill

Colin,E., 2002. Question of Evidence: The Casebook of Great Forensic Controversies, from Napoleon to O. J. John Wiley & Sons Inc.

Coyle, H.M. 2004 Forensic Botany: Principles and Applications to Criminal Casework CRC Press

DiMaio, V.J.M. 2001. *Forensic Pathology, Second Edition*, CRC Press.

Inman, K. 2000. *Principles and Practice of Criminalistics: The Profession of Forensic Science*, CRC Press.

James, S.H. and Nordby, J.J.2003. Forensic Science: An Introduction to Scientific and Investigative Techniques, CRC Press, Boca Raton.

Kubic, T. 2005 *Forensic Science Laboratory Manual and Workbook, Revised Edition*, CRC Press.

LeBeau, M.A. 2004. *Quality assurance guidelines for laboratories performing forensic analysis of chemical terrorism: Scientific Working Group on Forensic Analysis of Chemical Terrorism*, Thomson Gale.

Lincoln, P.J., Thomson, J.A.1998. DNA Profiling Protocols: Methods in Molecular Biology ed., by Humana Press, New Jersey, USA

Mozayani, A, Noziglia, C., 2005. *The Forensic Laboratory Handbook: Procedures and Practice (Forensic Science and Medicine)*, Humana Press.

Ngaire E.G. 2008. The Forensic Casebook: The Science of Crime Scene Investigation Prentice hall

Ogle, R.R., and Fox, M.J. 1998. Atlas of Human Hair: Microscopic Characteristics CRC Press
Rudin, N. 2001. *An Introduction to Forensic DNA Analysis*, Second Edition, CRC Press

Saferstein, R.E., 1982, 1988, & 1994. Forensic Science Handbook Vols. I, II & III, Prentice-Hall, Englewood, NJ

Stuart, J. 2005. Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd ed., Humana Press, New Jersey, USA

Stuart, J.2005 Principles of Bloodstain Pattern Analysis: Theory and Practice2nd ed., Humana Press, New Jersey, USA

Answers to Liberal Studies Questions

1) Not applicable only one instructor will teach this course

2) Major aspect including women will be a section about specific investigative and forensic processes related to sex crimes from the work of John Savino, Brent Turvey, and J Baeza and the recent work by a researcher in the United States that has led to a new, more efficient approach to processing DNA from rape evidence. The majority of contributions by women in the field of Forensic science have come in the past decade. In the last portion of the class we will discuss the contributions of two of the major contributors in the field of forensic research - Katherine Ramsfield and Clea Koff. Three of the four non-textbook readings available are related to sex crimes case studies that will incorporate women and minorities as part of the study.

3) Students will be required to read one of the following books a supplementary book in addition to the required text for the course. In addition to the textbook ", a number of non-textbook readings like *The Human Predator: A Historical Chronicle of Serial Murder and Forensic Investigation"; Chemistry and Crime : From Sherlock Holmes to Today's Courtroom* by Samuel M. Gerber will be incorporated into the course. In addition, students will read summaries of case-studies in forensic science including but not limited to

4) The students will be required to read one of the following books: *" Forensic Crime Scenes Health and Safety"* by Gareth W. Roberts; or *"Ethics and the Practice of Forensic Science" by* Robin T. Bowen. These books will provide a different approach for students than the lectures by describing practical considerations and the underpinning laws of the United States, the United Kingdom, and Europe; and how range; of ethical issues facing those who work in the field and highlights the complicated nature of ethical decision-making in this complex arena. The book also reviews international legislation.

Answers to Course Analysis Questionnaire

Section A: Details of the Course

A1 How does this course fit into the programs of the department? For what students is the course designed? (majors, students in other majors, liberal studies). Explain why this content cannot be incorporated into an existing course.

This course is intended to satisfy the Liberal Studies Natural Science non-Lab Science requirement and the Liberal Studies Elective scientific literacy requirement. This course will give the student as up-to-date introduction of a particular field of forensic biology that is intended to be relevant to their everyday lives. The content of this course reflects growing recognition of the importance of biological evidence in forensic science. This course will include several topics previously not taught in any of the courses offered by the biology department.

A2 Does this course require changes in the content of existing courses or requirements for a program? If catalog descriptions of other courses or department programs must be changed as a result of the adoption of this course, please submit as separate proposals all other changes in courses and/or program requirements. This will not change the content of any other existing course in the program.

A3 Has this course ever been offered at IUP on a trial basis (e.g. as a special topic) If so, explain the details of the offering (semester/year and number of students). This is a newly designed course that is being created to fulfill the new requirements of the Liberal Studies component at IUP.

A4 Is this course to be a dual-level course? If so, please note that the graduate approval occurs after the undergraduate.

No.

A5 If this course may be taken for variable credit, what criteria will be used to relate the credits to the learning experience of each student? Who will make this determination and by what procedures?

N/A

A6 Do other higher education institutions currently offer this course? If so, please list examples (institution, course title).

University of Central Florida: Forensic Biochemistry

University of Portsmouth: Forensic Biology and Biochemistry

Suffolk University: Forensic Biochemistry

University of Kent: Forensic Biology

Southern Illinois University: Forensic Biochemistry

New Mexico State University: Forensic Biochemistry

A7 Is the content, or are the skills, of the proposed course recommended or required by a professional society, accrediting authority, law or other external agency? If so, please provide documentation.

No.

Section B: Interdisciplinary Implications

B1 Will this course be taught by instructors from more than one department or team taught within the department? If so, explain the teaching plan, its rationale, and how the team will adhere to the syllabus of record.

Not applicable

B2 What is the relationship between the content of this course and the content of courses offered by other departments? Summarize your discussions (with other departments) concerning the proposed changes and indicate how any conflicts have been resolved. Please attach relevant memoranda from these departments that clarify their attitudes toward the proposed change(s).

There are no conflicts with other departments at IUP.

B3 Will this course be cross-listed with other departments? If so, please summarize the department representatives' discussions concerning the course and indicate how consistency will be maintained across departments.

No.

Section C: Implementation

C1 Are faculty resources adequate? If you are not requesting or have not been authorized to hire additional faculty, demonstrate how this course will fit into the schedule(s) of current faculty. What will be taught less frequently or in fewer sections to make this possible? Please specify how preparation and equated workload will be assigned for this course.

The current faculty resources are sufficient.

C2 What other resources will be needed to teach this course and how adequate are the current resources? If not adequate, what plans exist for achieving adequacy? Reply in terms of the following:

*Space- the current rooms used for lectures that can accommodate 132 students are adequate.

*Equipment- Not applicable

*Laboratory Supplies and other Consumable Goods- Not applicable

*Library Materials- there will be no necessity of using library materials in this course other than existing electronic databases.

*Travel Funds- there will be no travel funds required for this course.

C3 Are any of the resources for this course funded by a grant? If so, what provisions have been made to continue support for this course once the grant has expired? (Attach letters of support from Dean, Provost, etc.)

None.

C4 How frequently do you expect this course to be offered? Is this course particularly designed for or restricted to certain seasonal semesters?

This course will be offered every other semester. Because of the nature of the topics covered in this course, there are no seasonal requirements.

C5 How many sections of this course do you anticipate offering in any single semester?

While it is difficult to determine ahead of time, it is expected to have one lecture section.

C6 How many students do you plan to accommodate in a section of this course? What is the justification for this planned number of students?

In the lecture, we plan to accommodate up to 132 students. This course is a non-lab course and therefore is not limited by laboratory classrooms- capacity.

C7 Does any professional society recommend enrollment limits or parameters for a course of this nature? If they do, please quote from the appropriate documents.

No.

C8 If this course is a distance education course, see the Implementation of Distance Education Agreement and the Undergraduate Distance Education Review Form in Appendix D and respond to the questions listed.

It is not a distance education course.

Part III. Letters of Support or Acknowledgment

Department of Criminology

Department of Chemistry

Assignment 4 (4% of grade)

1. Read the following article.
2. Answer the following three questions:

1. What is Forensic entomology? What information can a forensic entomologist provide at the death scene?
2. What are the major challenges of identification of the maggots to the species?
3. What were the major methods of Human DNA analysis that the authors employed to non-human organisms?
4. Based on this article how would you relate the application of Entomological evidence to help determine the circumstances of abuse and rape?

Grading Rubric:

1% - You gave no (or very little) observations, background material or what you gave was inappropriate to support your answer.

2% - You gave some observations and background material, but it is either too little, incorrect, or didn't provide a context for your answers.

3-4% You provided observations and background material that provide a context for your answers.

Identification of a Death-scene Maggot using Standardized Molecular Methods: *Sarcophagabullata* Parker 1916 (Sarcophagidae) Out-numbers Blowflies (Calliphoridae) on an Urban Cadaver in Southeastern Texas

Rekha Raghavendra[1], Christopher P. Randle[2] and Sibyl Rae Bucheli[2]*

[1]*School of Medicine Case Western Reserve University, Cleveland OH, USA*
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Abstract

In forensic entomology,fly data including maggot age are frequently used to help estimate the time since death.Accurate identification of the maggot to species is critical for time since death estimations. However, within a family, maggots are notoriously difficult to identify to species.In this study, we employ phylogenetic datafrom the mtDNAgenes COI and COII to identify an unknown maggot to species (member of the family Sarcophagidae) harvested from a cadaver in June 2009 in Harrison County, Texas. The most closely related species to our unknown maggot was SarcophagabullataParker 1916, a somewhat common carrion-feeding species in southeastern United States that is now gaininggreater recognition as a forensically significant species.

Keywords: Forensic entomology; case study; Sarcophagidae; Sarcophagabullata Parker 1916

Introduction

Decomposition of a large mammalian carcass is greatly accelerated through the action of insects belonging to the order Diptera (flies) [1]. In southeastern Texas, initial colonizers include members ofthe families Calliphoridae (blow flies), Sarcophagidae (flesh flies), and Muscidae (house flies), with blow flies and flesh flies often arriving and laying eggs or giving birth tomaggots (rather than laying eggs) within minutes of death (unpublishedrecords from cadavers at the Southeastern Texas Applied Forensic Science Facility at the Center for Biological Field Studies at Sam Houston State University). Maggots acquirebiomass as a function of physiological time rather than calendar time and therefore develop at a predictable rate. Since flies arrive and lay eggs or maggots immediately, they are considered useful tools for estimation of the time that has elapsed since death, or the postmortem interval (PMI), by estimating the time since maggot colonization [1-7]. By recreating the conditions of the death scene in the laboratory and working backwards through time to determine the age of the oldest maggot, the forensic entomologist can correlate the age of the maggot to the PMI [1-7].

Identification of maggots to species remains a challenging aspect to forensic science even though maggots are frequently collected evidence during a death scene investigation. Identification keys are not currently available for all life stages are not currently available andmaggots are difficult to identify particularly at early life stages because morphological features among maggots are similar, rendering them virtually undistinguishable beyond the family level [8-12]. Molecular data can aid in the identification of larvae where morphology is limited in utility [8-12]. In this study, we employ an established phylogenetic protocol by Wells et al. [10] using the mitochondrial DNA genes of COI and COIIto identify an unknown maggot of the family Sarcophagidae harvested from a cadaver in Harrison County, Texas.

Materials and Methods

Specimens: The unknown maggot was recovered from a body discovered in June 2009 in Harris County, TX, and was the largest observed maggot and most abundant larval type; in fact, no other species were collected despite law enforcement agents reporting the remains to be in a state of fresh/bloated decomposition.The unknown maggots were identified as members of the family Sarcophagidae using standard morphological features of the spiracular complex but could not be further identified (Peterson 1960). Common species of Sarcophagidae which frequent cadavers in this area include *Sarcophaga (Neobellieria)bullata* Parker, 1916 and *Sarcophaga (Bercaea) africa* (Wiedemann 1824: 49) (=*cruentata* Meigen 1826;=*haemorrhoidalis* auct.) [14-16]. Proper species identification is critical to generate proper growth curves for age estimation; Wells et al. [10] demonstrate that these two species grow at rates disparate enough to create as much as a 24 hour discrepancy.

DNA extraction: Genomic DNA was extracted from the unknown maggotstarting with tissue homogenization using a Disruptor Genie TM and followed by a standardChelex DNA extraction method [17].

Amplificationand Sequencing: PCR protocols were modified from Wells et al. [10] using their published primers for COI and COII in various combinations (Table 1) and carried out in 50 µl volumes including 1X PCR buffer (Promega, Madison WI), 0.4 µM forward and reverse primers, 0.2mMdNTPs, 2.5UGoTaq polymerase (Promega, Madison WI), with 3 µl of template DNA. PCR reaction conditions were as follows: 94°C for 2 min(initial denaturation), continued with 35 cycles of 94°C for 1 min (denaturation), 50°C for 1 min (primer annealing), 72°C for 2 min (extension), and 72°C for 10 min (final extension). PCR products were visualized on 1% agaroseand purified

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using a QIAquick PCR Purification Kit (QIAGEN INC., Valencia, CA). The COI and COII regions were sequenced on a Bechman-Coulter 8000 CEQ Genetic Analyzer using the GenomeLab DTCS Quick Start Kit method.Contig assembly was performed using Geneious [18].

Selection of Sequences for comparison: NCBI nucleotide MEGABLAST was used to identify 100 closest Genbanksequence matches to the unidentified maggot sequence.These were downloaded, and aligned with the unknown sequence using the MUSCLE [19] algorithm in Geneious [18]. Of these, 81 sequences were chosen that had sufficient overlap with each other and the unknown sequence to allow unambiguous alignment. Multiple accessions for species were retained when available, including two sequences each from *Sarcophaga africa* and *S. bullata*. Additionally, a sequence obtained from *Eucalliphora latifrons* (Calliphoridae) was selected as an outgroup. The reduced matrix was realigned using the MUSCLE [19] algorithmfor phylogenetic analysis.

Phylogenetic Analysis: Maximum parsimony searches were conducted using WinClada [20] as a shell program. The parsimony ratchet [21] was implemented with 200 iterations (10% of the matrix sampled; one tree held per iteration). The tree generated via the ratchet search was the starting tree for a more thorough analysis conducted in NONA ver. 2.0 [22] using the commands "rs 0; hold 1000; mult* 50." Parsimony jackknife percentages (23) were calculated in NONA ver. 2.0 [22] with 1000 replications (200 search steps; one starting tree per replication; rs 0). For maximum likelihood (ML) analysis, the most appropriate stationary model of evolution was inferred using the Akaike Information Criterion [24] in jMODELTEST [25,26]. ML searches were performed using GARLI 1.0 (27) using the default configuration. One thousand non-parametric bootstrap replicates were analyzed with two search replicates each to obtain clade support. Phyutility [28] was used to generate the majority rule consensus of 1,000 bootstrap trees.

Results

NCBI nucleotide MEGABLAST returned a COI sequence from *Sarcophaga bullataas* the best sequence match with 97% sequence identity, while *S. africa* obtained 92% identity and the outgroup, *Eucalliphora latifrons* obtained an identity of 86%. Sequence alignment resulted in a matrix of 2,305 characters. Parsimony searches resulted in a single most parsimonious trees (L=3921;CI=0.30; RI=0.65). AIC identified GTR+Γ as the best fitting model of evolution. The maximum likelihood tree obtained anln likelihood score = -21,146.499. MP and ML trees were largely congruent, differing only in the resolution of clades that were poorly supported and inconsequential in the identification of the known sequence. While overall clade support was low, the two most probable species matches, *Sarcophaga africa* and *S. bullata* were separated by several strongly supported nodes (jackknife and bootstrap >80%; Figure 1 (included as supplementary data)). Both parsimony and likelihood identified the unknown sequence as sister to the two sequences of *Sarcophaga bullata* (jackknife =100%; bootstrap = 67%). *Sarcophaga polistensis* (jackknife =85%; bootstrap = 89%) is sister to this clade, and *S. cooleyi* is sister to the clade including *S. polistensis-S. bullata* (jackknife =95%; bootstrap = 97%). *Sarcophaga polistensis* occurs in Texas, but is not known to feed on carrion [14]. *Sarcophaga cooleyi* is not known to occur in Texas. Therefore, evidence best supports the hypothesis that the unknown maggot is *S. bullata*.

Discussion

Many modern forensic techniques that employ DNA profiling to make associations between individuals and individuals, individuals and locations, and/or individuals and events (such RFLP analysis, PCR analysis, STR analysis, AmpFLP, DNA family relationship analysis, Y-chromosome analysis, mitochondrial analysis) [29] are sound due to the process of evolution acting on marker loci. Marker similarityis interpreted as evidence for shared ancestry [30]. Overall, the process leads to situations where more closely related organisms share in common more regions of their DNA. In most situations, DNA profiling analyses are based in principles of phylogenetics (the study of evolutionary relatedness among groups of organisms) and population genetics (the study of the effects of evolutionary processes on allele frequenciesin populations) [30,31]. In a growing number of situations, it has been useful to extend methods commonly employed in human DNA analyses to non-human organisms (for a discussion see 29). For species identification of unknown organisms, modern methods of

Location on the mtDNA			
Primer Sequence	Paired combination of primers used in this study		
1	TY-J-1460	TACAATTTATCGCCTAAACTTCAGCC	2, 4
2	C1-N-1687	CAATTTCCAAATCCTCCAATTAT	1
3	C1-J-1751	GGATCACCTGATATAGCATTCCC	6, 8
4	C1-N-1840	AGGAGGATAAACAGTTCAC/TCC	1
5	C1-J-2183	CAACATTTATTTTGATTTTTTGG	11
6	C1-N-2191	CCCGGTAAAATTAAAATATAAACTTC	3
7	C1-J-2319	TAGCTATTGGAC/TTATTAGG	10, 13
8	C1-N-2293	AGTAAACCAATTGCTAGTATAGC	3
9	C1-J-2495	CAGCTACTTTATGAGCTTTAGG	13, 14
10	C1-N-2514	AACTCCAGTTAATCCTCCTAC	7
11	C1-N-2659	GCTAATCCAGTGAATAATGG	5
12	C1-J-2792	ATACCTCGACGTTATTCAGA	16
13	C1-N-2800	CATTTCAAGT/CTGTGTAAGCATC	7, 9
14	TL2-N-3014	TCCAATGCACTAATCTGCCATATTA	9
15	C2-J-3138	AGAGCCTCTCCTTTAATAGAACA	18
16	C2-N-3389	TCATAAGTTCA[R]TATCATTG	12
17	C2-J-3408	CAATGATAT/CTGAAGT/ATATGA	18
18	TK-N-3775	GAGACCATTACTTGCTTTCAGTCATCT	15, 17

Table 1: PCR primers* used in this study.* Primers were taken from Wells et al. [10]. N-forward primer; J-reverse primer.

phylogenic analyses are the preferred method. In a now famous paper, Scadutoet al. [32] demonstrate the source of transmission of HIV strains by standard and rigorous phylogentic analysis (using maximum likelihood and Bayesian estimators). Such methods are frequently employed in insect identification (for a forensic focus on Calliphoridae and Sarcophagidae only see: [8-12,33-36]).

The intent of this study was identification to species of the largest larval flies harvested from a cadaver by using established phylogenetic protocols. These protocols have only been worked out for controlled situations and have not been used "in the field." Larvae were identified initially by standard morphological methods as members of the family Sarcophagidae. Both parsimony and likelihood trees generated from COI and COII mtDNA data matrices of GenBank data-based sequences and the largest unknown specimen strongly allied the unknown sequence as sister to *Sarcophaga bullata*. (Figure 1 (included as supplementary data)) shows all species included in the analysis and their GenBank accession numbers. In the analysis, Sarcophagidae forms a monophyletic group. Analysis of reference sequences downloaded from GenBank database shows little variation between species with different accession numbers. This suggests that the protocol developed by Wells et al. [10] for the use of reference sequences available in the GenBank database is a sensible tool to reveal identity ofan unknown specimen. Phylogenetic analysis using these reference sequences was able to determine the species of the flesh fly collected from a cadaver and hence and may be used to provide supporting information to aid in the estimation of the time sinceinsect colonization.

The occurrence of *Sarcophaga bullata* as the largest and most abundant species of larval fly recovered from the corpse is note-worthy. Despite the remains being reported by law enforcement as fresh/bloated, this species outnumbered members of the family Calliphoridae (no larvaeof Calliphoridae were recovered). While many published accounts of necrophagous species biodiversity of a corpse note the presence of *S. bullata*, no published accounts rely primarily on data provided by this species as the largest and most abundant member of the community for applied aspects of the science. Anecdotal accounts of the utility of this species in forensic applications exist; an entry made on the open-access on-line Encyclopedia Wikipedia discusses their forensic importance. Their abundance in this situation may be explained by the location of the corpse and time of death in terms of season. In June, southeastern Texas (Houston and surrounding cities) experiences average daytime high temperatures above 90˚F/32˚C, nighttime lows around 70˚F/21˚C, and relative humidity levels that fluctuate widely between 50% at noon and 90% at midnight (average minimum and maximum when not raining) [37]. This generally results in dehydration of tissues of the corpse at an accelerated rate (personal observations made of human decomposition at STAFS at CBFS at SHSU, Bucheli and Lindgren) when compared to published descriptions of cadavers at other forensic anthropology stations through out the United States (2; 3; 5; 6; 38; 39). Furthermore, extensive areas of Montgomery County are urbanized. Unpublished photos of crime scenes from variousHouston, TX, urban and rural locations reveal corpses with fewto no observed species of Calliphoridae and much greater numbers of Sarcophagidae (personal observations, Bucheli). Reasons for the absence of Calliphoridae may include the lack of a constant supply of large, fresh mammalian corpses due to urbanization in certain areas to sustain populations of significant size. The authors recognize this discussion as largely speculative but do so to draw attention to the fact that very little is known regarding the utility of *Sarcophaga bullata* in forensic situations.

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Online Syllabus

BIOL 107 Introduction to Forensic Biology

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Online Office Hours: *[Hours to be added when course is taught]**

On-Campus Office Hours: *[Hours to be added when course is taught]**
During online office hours, I am available by telephone and e-mail and other means of communication by special arrangement. If you are unable to make online office hours, other times can be arranged by appointment. For on-campus office hours, you can stop by or contact me via telephone. Other on-campus times are also available by appointment.

*All times presented in the course syllabus and schedules are expressed in Eastern Time (ET).

Course Catalog Description

BIOL 107 Introduction to Forensic Biology 3c-0l-3cr

Prerequisites: Non-Biology department majors and minors only

This course offers a broad overview on the firm understanding of basic principles underlying modern applications of biology in forensic science. The course explores the science of forensic biology, traditionally known as *serology*, and the broad scope of laboratory tests used to investigate crimes involving DNA, blood and other body fluids. The course will focus on the issues related to DNA fingerprinting as they apply to public or legal proceedings in the law enforcement arena. (Does not count toward Biology electives, Controlled electives, or Ancillary Sciences for Biology department majors and minors.)

Course Objectives

Course Outcomes and Assessment (Expected Undergraduate Student Learning Outcomes – EUSLO)

II. Course Outcomes

Objective 1:

Describe an understanding of the general methodology of modern biology in forensic science

Expected Student Learning Outcomes 1 and 2:

Informed and Empowered Learners

Rationale:

Assignments will require students to have a level of knowledge DNA fingerprinting and serology that will enable them to understand how these techniques work. Assignments will also require students to evaluate ways to collect evidence, preserve samples of biological evidence, and critically analyze DNA data and to use this examination to explain how DNA fingerprinting tests are interpreted.

Objective 2:

Compare how general forensic evidence has been perceived over the years by identifying the issues related to forensic science and modern methods and strategies in forensic biology

Expected Student Learning Outcome 2:

Empowered Learners

Rationale:

Assignments will require students to evaluate common forensic evidence collected by crime scene labs from the crime scene (photography, weapon, narcotics, ballistics tissues, and blood). In addition, these assignments will engage students in assessing a knowledge base in science and how that knowledge influenced the perception and management of DNA fingerprinting data with crime scene investigation.

Objective 3:

Describe how Forensic Biology and DNA finger printing technology is perceived and dealt with in today's society

Expected Student Learning Outcomes 3:

Responsible Learners

Rationale:

Assignments will require students to assess their own views and concerns about the impact of DNA technology on threats to liberty and privacy and how DNA typing technology has the potential for uncovering and revealing a great deal of information that most people consider to be intensely private. Other assignments will have the students analyze the impact of DNA fingerprinting technology in the public realm (e.g. legal system; prosecution of crimes; and in civil litigation) and to use this analysis to determine how their personal lives are and will be affected.

Objective 4:

Assess historical figures last 25 years that have made contributions to our understanding of DNA finger printing in the court room

Expected Student Learning Outcome 1 and 2:

Informed and Empowered Learners

Rationale:

Assignments will require students to gain an understanding of how quality DNA analysis and methods are fundamental to forensic DNA technology and its use in tracing the origins of criminal evidence. They will then apply these analyses to the evaluation of their own view for high-quality final results which are comparable to the results of other laboratories and to ensure the making of correct and impartial decisions in DNA testing.

Required Textbook

Alan, Gunn. Essential Forensic Biology 2009 2nd Edition ISBN 978-0-470-75803-8 Wiley-Blackwell

Supplemental Non-text book readings

Bowen, T.R., 2009. Ethics and the Practice of Forensic Science 2009 CRC press

Richard, Li., 2008. Forensic Biology: Identification and DNA Analysis of Biological Evidence ISBN-13: 978-1420043433. CRC Press, Boca Raton

Koff, C., 2005. Bone Woman: A Forensic Anthropologist's Search for Truth in the Mass Graves of Rwanda, Bosnia, Croatia, and Kosovo - 04 edition ISBN13: 978-0812968859 Publisher: Random House, Inc

Ramsland, K., 2007. The Human Predator: A Historical Chronicle of Serial Murder and Forensic Investigation. ISBN13: 9780425213780 Published by Berkley Trade

Roberts, G.W., 2012. Forensic Crime Scenes Health and Safety CRC Press

Savino,O.J., Turvey,B.E., Baeza, J.J., 2005. *Rape Investigation Handbook* ISBN-13: 978-0120728329 Academic Press

Suggested Readings

Alessandrini, F., M. Cecati, M. Pesaresi, C. Turchi, F. Carle, and A. Tagliabracci, 2003. "Fingerprints as evidence for a genetic profile morphological study on fingerprints and analysis of exogenous and individual factors affecting DNA typing," *J. Forensic Science* 48(3): 1–7

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Ngaire E.G. 2008. The Forensic Casebook: The Science of Crime Scene Investigation Prentice hall

Ogle, R.R., and Fox, M.J. 1998. Atlas of Human Hair: Microscopic Characteristics CRC Press

Rudin, N., 2001. *An Introduction to Forensic DNA Analysis*, Second Edition, CRC Press

Saferstein, R.E., 1982, 1988, & 1994. Forensic Science Handbook Vols. I, II & III, Prentice-Hall, Englewood, NJ

Stuart, J., 2005. Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd ed., Humana Press, New Jersey, USA

Stuart, J., 2005. Principles of Bloodstain Pattern Analysis: Theory and Practice2nd ed., Humana Press, New Jersey, USA

Required Technology Skills and Software Technology Skills

Students enrolled in this course should possess the following technology skills:

- The ability to access information via the Web
- The ability to use the learning management system and associated tools, including discussion/chat, quizzing, and assignment submission features
- The ability to use word processing software and to save in the appropriate format
- The ability to use Internet communication tools, specifically the IUP e-mail system (i-Mail)
- The ability to attach files on email message
- The ability to demonstrate netiquette (appropriate online conduct)

Software

The following software is required in order to view course content and to participate in

planned course activities. If you do not have this software currently loaded on your computer or are unsure, you can download the software for free by clicking on the following links:

- Adobe Reader (http://get.adobe.com/reader/)
- Flash Player (http://get.adobe.com/flashplayer/)

You will need an office productivity suite, such as Microsoft Office or Open Office (available free at http:www.openoffice.org). You will be required to turn in word processed assignments and to work with electronic software at various points in the semester.

Technical Support

To obtain technical support for computer issues related to this course, please contact Indiana University of Pennsylvania's IT Support Center Monday-Friday between 7:30am-4:30pm Eastern Time (ET) by logging a ticket at http://ihelp.iup.edu. If you have trouble accessing this site, please call 724-357-4000. You should be prepared to give specific details regarding your technical issue(s), including what you were doing before the error occurred and the exact text of any error messages received.

After hours and weekend support for Desire2Learn can be obtained at 1-877-325-7778 or by completing D2L's Web form.

Course Participation Requirements

Course modules will be assigned on a weekly basis according to the Course Schedule and include objectives, lesson guide, and expectations for completing homework assignments. You are expected to actively participate in all aspects of the course. This includes completion of assigned readings, homework assignments, self-tests and exams and participation in online discussions. By design, you will be expected to participate in the course daily. Course modules have definitive timeframes, and grades for discussion posts and assessments are assigned after every module. All work assigned in course modules(s) must be turned in by the end of the course week unless otherwise noted. **Late work will not be accepted.** It is suggested that you read through all course content in the week's assigned module(s) to get a feel for what is expected during the course week and to help you plan your time wisely.

For any forum discussions in the course, you must have a minimum of one original post and two responses to other student's posts. You should also read all of the posts before responding so as to not duplicate information. For small-group discussions, the instructor will be assigning a student to serve as the group discussion leader. This means prior to the small-group discussion, you will want to prepare your discussion

items so that you are ready and can post to the discussion board as close to the beginning of the module as possible.

E-mail
IUP e-mail (i-Mail) is the official means of communication of the University. You should be sure to check your e-mail daily. Important class announcements will be sent to your IUP e-mail account.

Questions Regarding the Course or Course Content
It is understood that questions about the course and the course content will come up from time to time. If you have a question for the instructor, please do the following:

- Post a message to the Course Questions discussion forum—This forum is located in the course's introductory module. If you have a question about the course, other students may also have the same question as you. Posting your question here enables the instructor to respond to your question, as well as to assist other students in the course who may have the same question.
- Contact the Instructor directly—The Course Questions discussion forum may not be the appropriate place to ask certain questions, such as questions regarding personal matters and individual course grades. You may also contact the instructor via e-mail or telephone with your questions.

Online Discussions (Forums)
Throughout the course, you will participate in a series of small-group discussions. The instructor will be assigning students to serve as the weekly discussion leaders in each group. Prior to your assigned discussion you will want to prepare your discussion items so that you are ready and can post to the discussion boards as close to the beginning date of the discussion a possible.

As discussion leaders and/or participants in the discussions, you must make at least one original post and a minimum of two responses to other students' posts for each discussion. You are also expected to read all postings as part of the discussion.

Discussion forums will be graded following the discussion deadline noted in the Course Schedule. Your participation in the discussion forums will be evaluated according to the Group Discussion Rubric. Posts made after the due date will not be graded, resulting in a loss of points toward your final grade. It is imperative that you follow the discussion forums, as many questions and issues regarding the course content will be answered through these forums.

Online Etiquette
Discussion, chat, and e-mail spaces within this course are for class purposes only,

unless otherwise stated. Please remember to conduct yourself collegially and professionally. Unlike in the classroom setting, what you say in the online environment is documented and not easily erased of forgotten. The following guidelines:

- Avoid using ALL CAPS, sarcasm, and language that could come across as strong or offensive.
- Read all postings before posting your responses to discussion topics so as to not repeat information.
- Keep chat comments brief and to the point. Use /// to indicate that you are finished sharing your input.
- Focus on one topic at a time when chatting or posting to discussions.
- Remember that, unlike in face-to-face learning environment, what you say in discussions and chats is documented and available to be revisited. Choose your words and discussion topics carefully.
- Course e-mail should only be used for messages pertaining to the course. Please refrain from sending forwards, jokes, etc. within e-mail.
- When posting, make sure to check grammar and spelling before submitting your post.

Students with Disabilities

If you are a student who has a documented disability and need special accommodations, the instructor will work with you to provide reasonable accommodation to ensure you a fair opportunity to perform in the class. Please advise the instructor in the first week of the semester regarding the disability and the desired accommodations. Assistance for individuals with disabilities is available through IUP Disability Support Services at http://www.iup.edu/disabilitysupport or at 724-357-4067.

Academic Integrity Policy

Indiana University of Pennsylvania expects a full commitment to academic integrity from each student. This syllabus represents a contract between you and the instructor of this course and that you agree to follow the rules and expectations set up therein. Academic integrity means

- Providing or receiving unauthorized assistance in coursework, including papers, quizzes, and examinations.
- Using unauthorized materials and resources during quizzes and tests.
- Possessing course examination materials without the prior knowledge of the instructor.
- Plagiarizing, using papers, dissertations, essays, reports, speeches, and oral presentations, take-home examinations, computer projects, and other academic exercises or passing off of ideas or facts beyond common knowledge, without attribution to their originators.

- Engaging in behaviors that are disruptive or threatening to others.
- Using computer technology in any way other than for the purposes intended for the course.

Please note that the IUP faculty uses a variety of technologies to check the authenticity of student work. Violations of academic integrity will be handled per IUP's Academic Integrity Policy and Procedures. Failure to comply with the policies and procedures may result in a decrease in grade, involuntary withdrawal from an academic program, suspension, expulsion, or rescission of a conferred degree. IUP's full policy on academic integrity is available in the Undergraduate Catalog under Academic Policies at http://www.iup.edu/registrar/catalog.

Evaluation Methods

1. Final Exam (15%)—Students will be required to take a final comprehensive exam on the course content. The exam will consist of multiple choice questions. The exam will take place on the last day of class, and students may only have one attempt.

2. Self-Tests (30%; 5% for each self-test)—Students will be given six multiple-choice self-tests that relate to the material from their readings and the online resources. Self-tests are designed to assess student understanding of the material and to provide them feedback on their understanding. Students will be evaluated on their ability to correctly respond to the questions.

3. Case Studies (20%; 10% for each case study)—Students will be given two case studies. These case studies will cover the role of invertebrates as forensic indicators in cases of murder or suspicious death, Post-conviction DNA Testing and Wrongful Convictions; and Advancing Criminal Justice through DNA Technology. Students must prepare a response to each case study based on the questions provided by the instructor. Students will be evaluated on the case studies based on their ability to summarize the case, respond to questions, and provide support using the textbook and online resources.

4. Forum Discussions (25%; 5% for each discussion)— Students will participate in five small-group, student-led forum discussions throughout the semester. These discussions will cover course resources and materials regarding topics, such as bloodstain pattern analysis, DNA profiling, stigmatization, legal issues, and models of research on actual innocence and DNA exoneration. For each discussion, the student leader will facilitate the discussion, in consultation with the instructor, regarding the assigned readings and materials. Students will be evaluated on their posting frequency, posting quality, and grammar and spelling as outlined in the Group Discussion Rubric.

5. Critique of Non-Textbook Reading (10%)—Students may select one of the supplemental texts for the course to read and write a critique. Critique papers should be a minimum of five pages and demonstrate a connection to the course content, quality of the response, use of technical and descriptive terms associated with Forensic Biology,

and grammar and spelling.

Grading

The following grading scale will be used: A: 90-100%; B: 80-89%; C: 70-79%; D: 60-69%; F: below 60%

Grading Policies
Incomplete grades
Incomplete grades will only be granted in the event of major life crisis. The instructor reserves the right of judgment as to what qualifies as a major life crisis.

Withdrawal Grades
According to IUP Policy, if you wish to receive a withdrawal (W) grades for the course, you must do so by university deadline for processing withdrawals, which can be found on the IUP academic calendar. A student who fails to withdraw by the deadline must file for a deadline waiver through the dean of his or her college and provide documentation of catastrophic circumstances preventing the student from completing the course/semester. In the event withdrawal would be required, failure to process a withdrawal will result in a failing grade for the course.

Course Schedule
Each module will cover several types of assessments. Weekly activities may include review of chapters, self-tests, case studies, and forum discussions based on assigned readings, slide presentations, supplemental readings.

Module 1 (Week 1)
Introduction to BIOL 107
1. Review the Course Overview.
2. Review of the Syllabus and Course Policies.
3. Post an introduction to the class.

Module 2 (Week 2)
Introduction/Overview-History

1. Connect to the book's website: http://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=4629&itemId=0470758031&resourceId=16107
2. Read textbook Chapter 1
3. PowerPoint Presentation
3. D2L content Introduction to Forensic Biology:

   a. Introduction- What is Forensics?
   b. Forensic Sciences: Application of Science Matters of Law
   c. Physical Science, physics, geology on drugs, glass, explosives and soil
   d. Forensic Anthropology (Are these bones human?)

e. Chemistry Toxicology (Is this white powder cocaine?)
f. Medicine (How did the child die?)
g. Definition and scope of Forensic DNA
h. Functions of the Forensic Scientist: Serology, DNA testing of Biological Materials
i. Firearms units—Examination of firearms, discharged bullets, cartridge cases, shotgun shells, ammo, and clothing for residues are performed
j. Document Examination Unit- handwriting and typewriting studies to ascertain authenticity or source
k. Photography Unit- Digital imaging, IR, UV X ray
l. Toxicology, Latent Fingerprints, Polygraph, Voiceprint, and Evidence collection units

4. Due: Forum Discussion 1: Teeth and their Secrets – Forensic Dentistry: Singh K, Anandani C, Bhullar RK, Agrawal A, Chaudhary H, et al. (2012) Teeth and their Secrets – Forensic Dentistry. J Forensic Res 3:141. doi:10.4172/2157-7145.1000141

5. Due: Self-Test #1

Module 3 (Week 3)

Characteristics of Human Remains, Decay, Tissues, and Fluids

1. Connect to the book's website: http://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=4629&itemId=0470758031&resourceId=16107
2. Read textbook Chapter 1, 2, & 3.
3. D2L content
   a. Compare the chemical and physical characteristics of the different stages of decomposition
   b. Factors affecting the speed of decay
   c. The sequence in which insects arrive and colonize a corpse during the decomposition process
   d. Summary of the stages of decomposition and their characteristic features
4. Answer review questions for the Chapters 1 & 2 to assist you in preparing for the self-test.

5. Due: Case Study # 1: Read and respond to the questions for what factors contributed to conclude that Michael Jackson's death was a homicide?
Levy RJ (2011) The Michael Jackson Autopsy: Insights Provided by a Forensic Anesthesiologist. J Forensic Res 2:138. doi:10.4172/2157-7145.1000138

Module 4 (Week 4)

Body Fluids (Blood) and Waste Products

1. Read textbook Chapter 2.
2. D2L Content
   a. Blood cells and Blood Typing
   b. Methods for Detecting Blood
   c. Bloodstain Pattern Analysis
   d. Interpreting Blood Stains

Read: Blood Spatter Interpretation at Crime Scenes For First Responders, Homicide Detectives, Crime Scene Technicians. http://www.akininc.com/PDFs/BSI%20FBI-LE%20version.pdf by Louis L. Akin 3/01/04

Read: http://www.independent.co.uk/news/science/the-blood-detectives-scientific-breakthrough-in-reading-stains-may-help-solve-crimes-8906451.html

Due: Forum Discussion 2: How does an investigator use blood spatter interpretation to determine

- What events occurred.
- When and in what sequence they occurred.
- Who was, or was not, there.
- What did *not* occur.

5. Due: Self-Test #2

Module 5 (Week 5)
Body Fluids (Saliva and Semen) and Waste Products (Feces and Urine)

1. Read textbook Chapter 2.
2. D2L Content
   a. Characteristics of saliva and semen
   b. Demonstrating the presence of saliva and semen
   c. Saliva and semen as forensic indicators
   d. Post mortem toxicology: feces and urine
   e. High turnover of K ions in vitreous humor

3. Read "Cocaine in surface waters: a new evidence-based tool to monitor community drug abuse http://www.ehjournal.net/content/pdf/1476-069X-4-14.pdf

Module 6 (Week 6)
Introduction to DNA and Basic Human Genetics

1. Read textbook Chapter 3.
2. D2L Content
   a. Why DNA? Law enforcement; Evolutionary/Biological applications
   b. Diversity, Bioinformatics, and specificity of DNA
   c. The structure of DNA
   d. DNA sampling
   e. DNA profiling
3. Watch: **DNA: An introduction to DNA (khanacademy.org)**
4. **Due: Self-Test # 3** (Modules 5 & 6)

Module 7 (Week 7)
The Scientific Basis for DNA Typing and Quantification

1. Read textbook Chapter 3.

2. D2L Content
   a. Polymerase Chain Reaction (PCR)
   b. Short Tandem Repeat markers
   c. Single Nucleotide Polymorphism Markers
   d. DNA databases
   e. FBI and DNA Typing
3. **Watch:** What are genes? https://www.23andme.com/gen101/genes/
4. **Read:** What are SNP's? https://www.23andme.com/gen101/snps/
5. **Read:** Variations: Are Warren and Jimmy Buffett Related?
   https://www.23andme.com/gen101/variation/buffett/
6. **Due: Self-Test # 4**

Module 8 (Week 8)
DNA finger printing – Evidence Based Science

1. Read textbook Chapter 3.
2. D2L Content
   a. DNA Evidence: Basics of Identifying, Gathering and Transporting
   b. Types of Samples Suitable for DNA Testing: Questioned or Unknown Samples
   c. Samples from Unidentified Bodies: Samples collected from unidentified bodies can include: blood, buccal swabs, hairs, bone, teeth, and finger nails, tissues from internal organs (including brain), muscle, and skin.
   d. Significance of Reference Samples from Known Individuals
   e. Use of Samples from Relatives for Testing: Because a child inherits half of its DNA from each parent, it is possible to use reference samples collected from close relatives
   f. Determination of Paternity or Maternity of a Child or Fetus Aborted fetal tissue significance for determining paternity, for example, in sexual assault and/or incest cases where conception occurred

3. Read: http://nij.gov/topics/forensics/evidence/dna/basics/Pages/welcome.aspx

4. Read Issues on Methods of Identification in Court Ordered Paternity Testing –The Case of Portugal
Machado H, Silva S (2012) Issues on Methods of Identification in Court Ordered Paternity Testing –The Case of Portugal. J Forensic Res S2:007. doi:10.4172/2157-7145.S2-007

5. Due: Forum Discussion # 3 DNA **and Paternity Testing**

Module 9 (Week 9)
Safety as it relates to Evidence Collection, Sample Preservation, and Examples of contamination

1. Read textbook Chapter 1, 2, 3, 5, and 6
2. D2L Content

a. Crime Scene Integrity: Protection of the crime scene is essential to the protection of evidence

b. Contamination: The risk of contamination of any crime scene can be reduced by limiting incidental activity

c. Chain of Custody: If DNA evidence was contaminated, it may be necessary to identify persons who have handled that evidence

d. Transportation and Storage: Any probative biological sample that has been stored dry or frozen, regardless of age, may be considered for DNA analysis

3. Read: https://wilenet.org/html/crime-lab/physevbook/Ch1_EvidenceIntegrity.pdf

4. Due: Case Study # 2: Read and respond to the questions for Crime scene preservation, integrity of the evidence and the criminal justice department. Forensic Evidence and Crime Scene Investigation.
http://www.avensonline.org/wp-content/uploads/2013/10/JFI-2330-0396-01-0004.pdf

Module 10 (Week 10)

Fight Crime with a Universal DNA Database?

1. Read textbook Chapter 3.
2. D2L Content
   a. Bioinformation and National DNA Data Base (NDNAD)
   b. Is the potential for bias within the Database acceptable?
   c. How should bioinformation be transferred between different agencies and countries?
   d. Would the collection of DNA from everyone at birth be more equitable?
3. **Read: A New Era of DNA Collections: At What Cost to Civil Liberties?**
http://www.acslaw.org/sites/default/files/Simoncelli__Krimsky_-_DNA_Collection__Civil_Liberties.pdf
4. **Read: Liberty, Privacy, and DNA Databases**
http://www.thenewatlantis.com/docLib/TNA01-Rosen.pdf
5. **Due: Forum Discussion #4: National DNA Database and Civil Liberties**

Module 11 (Week 11)
Standards on DNA Evidence and American Bar Association
1. Read textbook Chapter 3, 5, and 6
2. D2L Content
   a. Overview of Scope of the DNA Standards and General Principles
   b. Collecting, preserving, DNA containing samples for **Use of DNA Evidence**
   c. Judicial order to collect DNA samples from a person/by non-**law enforcement entities**
   d. Testing of DNA evidence
   e. Admissibility of DNA evidence

f. Charging by DNA profile
g. DNA Databases? Authorized and proscribed DNA databases
h. Expungement

3. Read about **ABA Criminal Justice Standards on DNA Evidence**
http://www.americanbar.org/publications/criminal_justice_section_archive/crimjust_standards_dnaevidence.html

4. Due: Forum Discussion # 5: American Bar Association (ABA) Justice Standards and DNA Evidence

5. Due: Self-Test #5

Module 12 (week 12)
DNA Initiative: Advancing Criminal Justice through DNA Technology

1. Read textbook Chapter 3 and 10.
2. D2L Content

a. DNA Initiative Goals: Significance of DNA technology to ensure accuracy and fairness in the criminal justice system. DNA can be used to identify criminals with incredible accuracy when biological evidence exists, and DNA can be used to clear suspects and exonerate persons mistakenly accused or convicted of crimes.
b. The Initiative calls for increased funding, training, and assistance Federal, State, and local forensic labs; to police; to medical professionals; to victim service providers; and to prosecutors, defense lawyers, and judges.
c. DNA Legislative Milestones: Significance of "Justice for All Act of 2004," enforceable rights for victims of crimes; enhances DNA collection and analysis efforts; provides for post-conviction DNA testing; DNA Backlog Elimination Act (2000)
d. DNA Initiative Partners: Office on Violence against Women, U.S. Department of Justice; Federal Bureau of Investigation, U.S. Department of Justice

3. Read http://nij.gov/topics/forensics/evidence/dna/dna-initiative/Pages/welcome.aspx
   a. DNA Initiative Goals
   b. DNA Initiative Milestones
   c. DNA Initiative Partners
   d. DNA Initiative Legislation

Module 13 (Week 13)
Post-conviction DNA Testing and Wrongful Convictions

1. Read: Chapters 3.
2. D2L Content

a. Overview of Wrongful Convictions: The strength of our criminal justice system depends on its accuracy — its ability to convict the guilty and to clear the innocent.
b. Post-conviction DNA Testing Post-conviction DNA testing is a major factor contributing to the increased discovery of wrongful convictions.

c. Research on Actual Innocence and DNA Exoneration: The increase in exonerations over the last 20 years has accentuated the need for research on how, why and how often wrongful convictions occur.

3. **Read:** a) Overview of Post-conviction DNA Testing
b) Research on DNA's Role in Uncovering Wrongful Convictions
http://nij.gov/topics/justice-system/wrongfulconvictions/Pages/exonerations.aspx
4. **Due: Self-Test #6** (Modules 12 and 13)

Module14 (Week 14)
Microbial Forensics in Biodefense

1. Read Chapters 10.
2. D2L Content
   a. Role of law enforcement response and microbial forensics in investigation of bioterrorism
   b. Role of scientist in investigative microbial forensics
   c. Biological analytes in the characterization of evidentiary material
   d. Transmission of HIV can, in certain circumstances, be considered a criminal act
   e. Criminal use of microorganisms and techniques used to detect their presence

Critique of Non-textbook Reading

1. Critiquing non-textbook reading and instructions.
2. **Due:** Non-textbook reading. Students will submit a critique with a maximum of five printed pages (15%)

Final Exam Module (Week 15)

3. **Due: Final Exam (15%)** Final Exam [Specific date for the exam to be added when the course is taught].

Article Critique/Peer Review Rubric

Criteria	Excellent 3 Points	Good 2 Points	Acceptable 1 Point	Unacceptable 0 Points
Summary of Article	Summary written in proper paragraph format. Complete sentences, correct spelling, punctuation, & grammar, were used.	Most of Summary written in proper paragraph format. 3 to 5 errors: sentences structure, spelling, punctuation, & grammar.	Summary is incomplete missing major point and not written in an appropriate format, 6 to 10 errors: sentences structure, spelling, punctuation, & grammar.	No Summary provided or Summary is short and includes none of the major points, more than 10 errors: sentences structure, spelling, punctuation, & grammar.
Answer to Questions	All questions are answered and include explanation, rationale, and uses sources outside of book and PowerPoint.	All questions are answered and include a weak explanation, rationale, and uses sources outside of book and PowerPoint.	1 to 2 questions are not answered and include a very weak explanation, rationale, and uses no sources outside of book and PowerPoint.	Answers to questions are not provided or no explanation given for answers, and uses only book and PowerPoint resources.
Timeliness of responses	Responds to questions on time.	Occasionally responses are late.	Half the time responses are late.	Responses are often past the due date.
Comprehension of Articles	Responses summarize important points and reference specific points; responses reveal understanding, interpretation, and perspective.	Responses generally summarizes article but do not make interference to different perspectives.	Limited evidence that article was understood; superficial explanation or description of reading.	No evidence that article was even read.
Response to other students' statements	Often responds to other students statements by embellishing or disagreeing with specific explanations.	Often responds to other students statements, always agreeing.	Occasionally responds to other students.	Doesn't respond to other students.
Connections	Good connection between readings and either classroom or personal experiences.	Some connection between readings and own experiences.	Little connection between readings and experiences.	No connection between readings or experiences.

Forum Discussion Rubric

Category	1 Points	2 Points	3 Points
Posting Frequency	Student made one post to the discussion board to either a topic question or a peer.	Student made two posts to the discussion board to a topic question of a peer.	Student made at least one post to the topic question and responded to at least two peers.
Content Represent significant contribution to discussion	Student makes a minimal contribution to the discussion and/or does not support the post with evidence from the course topics, materials, and resources.	Student makes postings that significantly contribute to the discussion, but does not support the post with evidence from the course topics, materials, and resources.	Student makes postings that significantly contribute to the discussion and connects post content to course topics, readings, and resources
Grammar and Spelling	Student posts contained more than 3 spelling or grammar errors.	Student posts contained 1 or 2 spelling or grammar errors.	Student posts did not contain spelling or grammar errors.

Sample Module Materials

Module 4 (Week 4)
Body Fluids (Blood) and Waste Products

1. Connect to the book's website: http://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=4629&itemId=0470758031&resourceId=16107

2. Read textbook Chapter 2.

3. D2L Content

Slide Presentation
a. What are different types of Blood Cells?
b. What is Blood Typing?
b. What are the different methods for detecting human blood?
c. Bloodstain Pattern Analysis
d. Interpreting Blood Stains

4. Read: Blood Spatter Interpretation at Crime Scenes For First Responders, Homicide Detectives, Crime Scene Technicians. http://www.akininc.com/PDFs/BSI%20FBI-LE%20version.pdf by Louis L. Akin 3/01/04

5. Read: http://www.independent.co.uk/news/science/the-blood-detectives-scientific-breakthrough-in-reading-stains-may-help-solve-crimes-8906451.html

Due: Forum Discussion 2: How does an investigator use blood spatter interpretation to determine?

- What events occurred?
- When and in what sequence they occurred?
- Who was, or was not, there?
- What did *not* occur?

5. Due: Self-Test #2

Small-Group Forum Discussion# 2: Blood Spatter Interpretation at Crime Scenes For First Responders, Homicide Detectives, Crime Scene Technicians.

Read: http://www.akininc.com/PDFs/BSI%20FBI-LE%20version.pdf by Louis L. Akin 3/01/04

The article and the other resources presented in this module will assist you developing your response to the discussion questions that follow.

What events occurred? When and in what sequence they occurred?

Who was, or was not, there?What did *not* occur?

Blood Spatter Interpretation at Crime Scenes

for First Responders, Homicide Detectives, Crime Scene Technicians.

Excerpted from: *Blood Spatter Interpretation at Crime and Accident Scenes: A Step by Step Guide for Medicolegal Investigators.*©

By Louis L. Akin, LPI

Through a variety of schools, classes, and seminars homicide detectives and crime scene technicians are garnering a level of expertise that has not previously existed in law enforcement. New technologies, sciences, and applied sciences are available for detectives and criminalists to use in solving crimes and apprehending offenders. Criminalists need to be more knowledgeable in the scientific aspects of technology and techniques; however, law enforcement personnel do not have to become scientist to take advantage of the technology or to apply the scientific methods that are available. Blood spatter analysis is a clear example of an applied science that a homicide detective or first responder can learn without having to become an expert in the field.

Blood spatter interpretation may be compared to tracking. It may take considerable training to reach the level of a tracker who can say that a footprint was made two days before by a running, pigeon towed, 180 male, who has bunions on both feet. It does not require that level of training or expertise to be able to look at a footprint and determine which way the person was going. Just pick out the heel and toe. Although, an expert may be able to see things in the blood that the crime scene detective doesn't, a detective can learn to determine where a victim was positioned by looking at the blood spatter at a scene the same way he could tell which way a footprint is going. The first responder can learn to see patterns at a scene that indicate that the incident may not have happened as witnesses have described it.

A basic understanding of blood spatter analysis will also allow the first responder and investigator to assist in correctly collecting and preserving blood stain data at the scene. Fortunately, the principles and procedures to learn are not complicated and, while it is easier to use software to make the calculations, the basic principles can be learned from a source as brief as this article and applied using a hand held calculator. Some critical determinations, such as establishing the point of convergence that shows where the victim was standing can be done without use of a calculator at all. This basic understanding is important, because the interpretation of blood spatter patterns and other evidence at crime scenes may reveal critically important information such as:

- The positions of the victim, assailant, and objects at the scene.
- The type of weapon that was used to cause the spatter.
- The number of blows, shots, stabs, etc. that occurred.
- The movement and direction of victim and assailant, after bloodshed began.
- It may support or contradict statements given by witnesses[i].

The investigator may use blood spatter interpretation to determine:

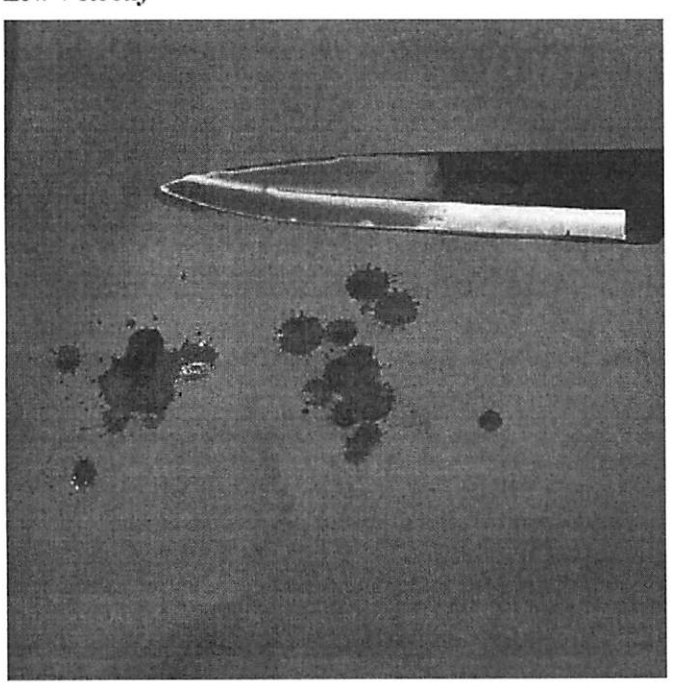
- What events occurred.
- When and in what sequence they occurred.
- Who was, or was not, there.
- What did *not* occur.

The lists of precisely what information can be learned by the interpretation of blood stain patterns are similar for Bevel and Gardner[ii], James and Eckert[iii], Hueske[iv], Akin[v], and Sutton[vi].

VELOCITIES OF BLOOD SPATTER

The velocity of the blood spatter when it strikes a surface is, within certain limitations, a strong and reasonably reliable indicator of the speed of the force that set the blood in motion in the first place. The velocity is that of the force causing the blood to move rather than of the speed of the blood itself and it is measured in feet per second (fps); high velocity blood, for instance, *may* be caused by a bullet moving at 900 fps, medium velocity blood spatter may be caused by a spurting artery or by a blunt instrument striking the already bloody head or limb of a victim.

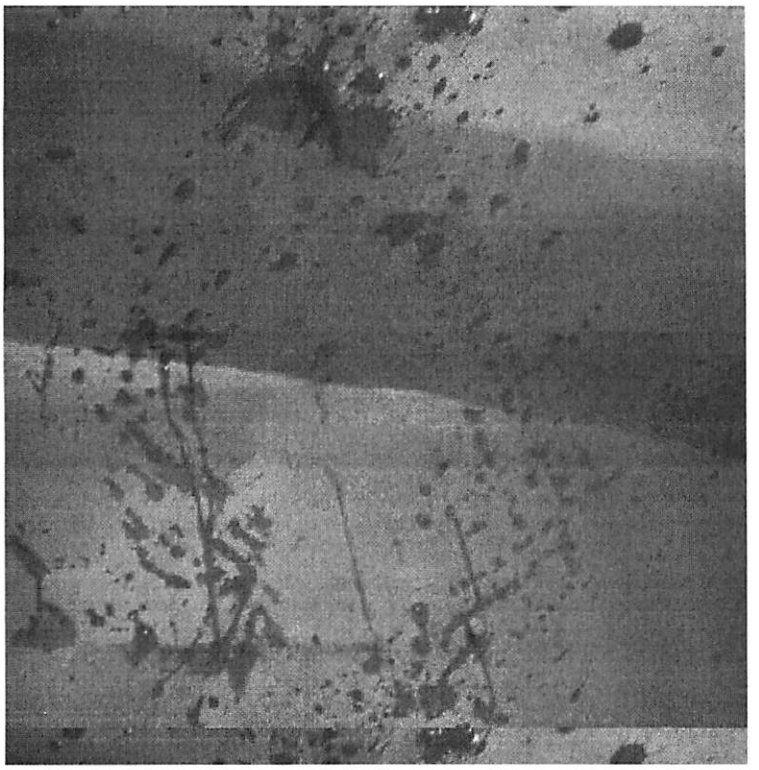
Low Velocity



Low velocity stains are produced by an external force less than 5 fps (normal gravity) and the stains are generally 3mm and larger. It is usually the result of blood dripping from a person who is still, walking, or running, or from a bloody weapon. Dripping blood often falls at a 90° angle and forms a 360° circumference stain when it hits a flat surface, depending, of course, on the texture of the surface. Low velocity blood may also be found

in the trail of a person who is bleeding and larger pools of blood may indicate where the person paused. See Figure 1 as an example of low velocity spatter.

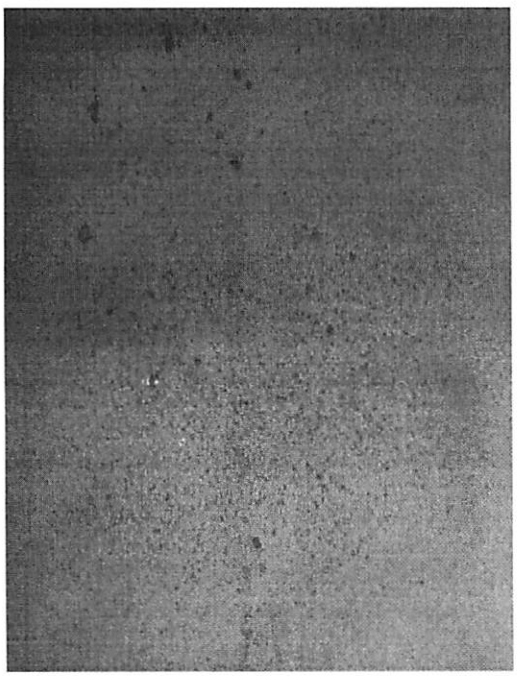
Medium Velocity



Medium blood spatter is produced by an external force of greater than 5 fps and less than 25 fps. The stains generally measure 1-3mm in size. They are often caused by blunt or sharp force trauma that is, knives, hatchets, clubs, fists, and arterial spurts.

Most medium velocity blood found at crime and accident scenes will be in the form of patterns created by blood flying from a body to a surface as a result of blunt or sharp trauma or the body colliding with blunt or sharp surfaces. It may be the result of a punch, stabbing, or a series of blows or in the case of an accident, the body striking surfaces inside or outside a vehicle. A void space may be created by anything that blocks the blood from falling on the surface where it would have landed. The object creating the void may be either the victim or the attacker's body or a piece of furniture that was moved in order to stage the scene See Figure 2 for an example of medium velocity spatter.

High Velocity



High velocity blood spatter is produced by an external force greater than100 fps and the stains tend to be less than 1mm. The pattern is sometimes referred to as a mist. High velocity patterns are usually created by gunshots or explosives, but may also be caused by industrial machinery or even expired air, coughing, or sneezing. In any case, the spatter tends to be tiny drops propelled into the air by an explosive force. High velocity droplets travel the least far because of the resistance of the air against their small mass. See Figure 3 as an example of high velocity spatter.

Theory: The Teardrop vs. The Blood Drop in Flight

Experiments with blood have shown that a drop of blood tends to form into a sphere rather than a teardrop shape when in flight. The formation of the sphere is a result of surface tension that binds the molecules together.

Fresh blood is slightly more viscous than water, and like water it tends to hold the spherical shape in flight rather than a tear drop shape as seen in cartoons.

This spherical shape of blood in flight is important for the calculation of the angle of impact of blood spatter when it hits a surface. That angle will be used to determine the point from which the blood originated which is called the Point of Origin or as this author prefers, the Point of Origin (POHm)

Generally, a single spatter of blood is not enough to determine the Point of Origin at a crime scene. The determination of the Angle of Impact and placement of the POHm should be based on the consideration of a number of spatters and preferably spatters that will provide an arc of reference points in order to create a triangulation effect.

The process for determining the Angle of Impact is not complicated. When a drop of blood strikes a flat surface the diameter of the drop in flight will be the same as the width of the spatter on the surface as seen in Figure 4 below. The length of the spatter will be longer, depending on the angle at which the drop hit. The following diagram will help the reader to understand this concept.

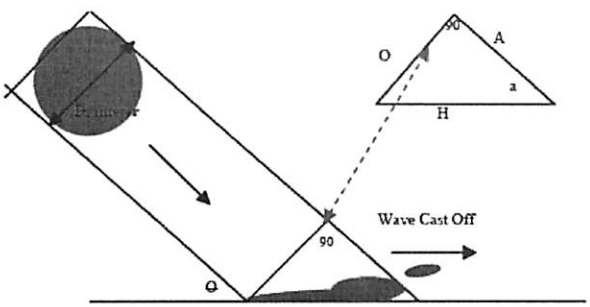


Figure 1 Side View of blood drop in air, and then striking a flat surface

Point of Convergence (POC)

For purposes of instruction, we will consider a case in which a fan shape blood pattern is found on a floor as the result of a gun shot wound to the head. When blood disperses in various directions from a wound the blood drops will tend to fan out. As the drops strike the floor, they will elongate into oval shapes. An imaginary line drawn through the middle of the oval shape lengthwise will run back to the area where the blood came from. If lines are drawn through several of the blood spatters as in Figure 2, the lines will cross at the point where the person was standing. That point is called the Point of Convergence and will be flat on the floor (if that is where the spatter is located). Somewhere above that point is where the blood originated. If the victim was shot in the head, it may be 4-6 feet (roughly the height of an average person) above that point. Where the blood left the person's body is called the Point of Origin as previously mentioned. To find the Point of Origin (POHm), first determine the two dimensional Point of Convergence (POC) on the floor as seen in Figure 2 below.

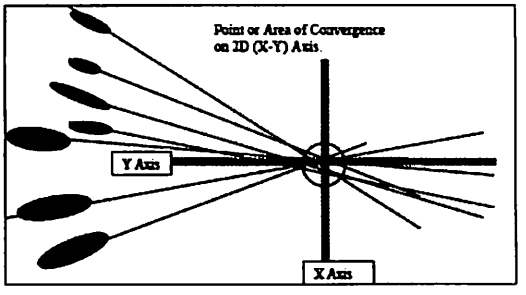


Figure 2 Lines through the central axes of the spatter cross at the Point of Convergence.

Determining the Angle of Impact (AOI)

The next step in the process is to determine the Angle of Impact (AOI) for representative bloodstains. Specialized software that performs all the calculations automatically is available from vendors, but all the calculations can be done on an ordinary hand held scientific or graphing calculator or even by the use of printed copies of arc sine and tangent tables.

The Angle of Impact is the angle at which the blood drop hit the floor. It can be determined by taking the inverse arc sin of the width divided by the length ratio of an individual blood spatter.

Step One: If using software just enter the width and length into a laptop computer and the calculation will be done automatically. If using a hand held calculator, just divide the length of the drop into its width, then take the arc sin which is the second function on a hand held calculator (or just look on an arc sin table) to get the degrees of the AOI.

Example:

If a drop measures 0.5 mm wide and 1.0 mm long, dividing 1. into .5 would give a ratio of .5. The arc sin of .5 is 30 degrees. Find that by using the inverse sine function on the calculator, or by looking at an arc sine table. This calculation determines that the blood drop hit the ground at 30 degrees and it is already known that it came from the Point of Convergence.

Step Two: Measure the distance from the individual drop to the Point of Convergence and multiply that number by the TAN of the Angle of Impact. This calculation will tell how high up the spatter originated from. The following section explains this more thoroughly.

The Perpendicular Axis

The Z axis is perpendicular to the floor where the Point of Convergence is located. It is an imaginary line that sticks straight up from the point of convergence on the floor. The perpendicular axis would align with the backbone of a person who is standing up.

Once the point of convergence and the angles of impact have been established, the next step is to locate the point of convergence *three dimensionally* on the perpendicular axis.

This point will be called the Point of Origin since it will be the location on the body where the blood was disgorged, or hemorrhaged, from the body when it was standing upright.

The *Point of Origin* (POHm) is located above the Point of Convergence (POC) on the perpendicular axis 90 degrees perpendicular to the floor. It is the point from where the blood hemorrhaged or was disgorged from the body. The formula to determine the Point of Origin on the perpendicular Axis is similar to the one used to establish the Angle of Impact except that the TAN function is used. First, measure the distance from each blood stain along its central axis to the POC. Second take the TAN of the degrees AOI. Third, multiply the TAN of the AOI by the distance along the Y axis.

Sine, Cosine, and Tan tables can be found at various sites on the web and downloaded by those who don't like to us calculators. The author's site posts simplified tables of the arc sine and the tangents of degrees from 0 to 90 that can be viewed or copied at any time.

Conclusion

Blood spatter analysis experts can develop vast amounts of information from the patterns of blood at a crime scene. First responders and homicide detectives will be more aware of the value of blood spatter evidence if they understand the basics of pattern analysis. Additionally, first responders and detectives can glean a great deal of information themselves at the scene without becoming experts and assist the experts later with the data that was gathered at the scene. If the blood spatter evidence is properly photographed and if accurate measurements are taken of the length and width of the individual spatters and the distance from each spatter to the Point of Convergence, the expert analyst can make the necessary calculations based on that data and draw his conclusions from them. If the measurements and photographs are not taken, critical information may be lost forever.

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[i] James, Stuart H, Eckert, William G. Interpretation of Bloodstain Evidence at Crime Scenes, 2nd Edition, CRC Press 1999 p10-11
[ii] Bevel, Tom; Gardner, Ross M. Bloodstain Pattern Analysis, 2nd Ed. CRC Press 2002
[iii] James, Stuart H, Eckert, William G. Interpretation of Bloodstain Evidence at Crime Scenes, 2nd Edition, CRC Press 1999.
[iv] Hueske, Edward E., Shooting Incident Investigation/Reconstruction Training Manual, 2002
[v] Akin, Louis L., ***Blood Spatter Interpretation at Crime and Accident Scenes: A Step by Step Guide for Medicolegal Investigators***, On Scene Forensics, 2004 www.akininc.com
[vi] Sutton, Paulette T., Bloodstain Pattern Interpretation, Short Course Manual, University of Tennessee, Memphis TN 1998

1. After reading the various resources from the module, how would you define a blood stain pattern?

2. After reading the article, briefly describe what can an investigator learn from the analysis of a blood spatter?

3. How is blood evidence detected at a crime scene?

4. What arguments would you present for role of VELOCITIES OF BLOOD SPATTER in determining the kind of instrument used in striking the head or limb of the victim?

Prepare your individual responses by Day 6 and – small-group response due by end of day 8.

Self-Test 2: Body Fluids (Blood) and Waste Products

____1. Which of the following statements is correct? The Duffy antigen (phenotype a-b-) is a good indication of:

a) African descent b) European descent c) Asian descent d) American descent
e) Welsh descent

____2. Which of the following statements is correct? The Kastle-Meyer test is used to detect the presence of:

a) Seamen b) DNA c) Blood d) Serum e) Feces

_____3. Which of the following tests is <u>not</u> used as a presumptive test blood?
a) Luminol b) Titanium dioxide c) Infra-red radiation d) Phenolphthalein
e) Hydrogen perchlorate

_____4. Which one of the following tests would be used to determine that a bloodstain was of human origin?

a) Anthrone Test b) Acid Phosphatase Test c) Precipitin Test d) Amylase Test
e) Iron test

_____5. Which of the following compromise the effectiveness of serological typing as a forensic tool?

a) The rapidity with which serological markers degrade
b) The lack of standardized protocols
c) The requirement for expensive and complex laboratory equipment
d) It cannot be applied to semen samples

e) Interference from enzymes released by viruses

_____6. How much loss of blood volume would usually be fatal for an adult human?

a) 20% b) 30% c) 40% d) 50% e) 60%

_____7. How much blood does a typical adult human contain?

a) 5 liters b) 10 liters c) 15 liters d) 20 liters e) 25 liters

_____8. What is the shape of a blood droplet in free flight?

a) Tear drop b) Spherical c) oval d) Amorphous e) Pear-shaped

_____9. If a line of small teardrop-shaped bloodstains is found upon a wall which of the following interpretations could be correct?

a) The direction of the tails indicates the direction of the force that generated them
b) This pattern is characteristic of arterial bleeding
c) This pattern can only come from blood cast off from a knife or similar weapon
d) The direction of the tails is at 45 degrees to the force that generated the bloodstains
e) None of the above

_____10. A dead woman is found stabbed to death in the kitchen of a house. Which of the following statements could explain the appearance of a smooth edged circular bloodstain 2cm in diameter found on the lino flooring?

a) The blood was cast off from the knife used in the stabbing incident.
b) The blood fell passively onto the floor.
c) The blood fell from a height of over 1 meter
d) The blood fell horizontally
e) It is a transfer bloodstain

_____11. Which of the following could be classed as 'transfer bloodstains'?

a) Blood that has dripped from an axe onto the floor
b) Blood expelled from the nose onto a wall
c) Blood smears on a tap that has been grasped by someone with bloody hands
d) A series of splashes on a wall that were caused by blood gushing from a severed artery
e) Blood thrown onto the ceiling from a knife during a frenzied and sustained attack

_____12. Which of the following equations is used to determine a bloodstain's angle of impact?

a) Sine of angle = width of stain divided by length of stain
b) Sine of angle = width of stain multiplied by length of stain
c) Sine of angle = (width of stain divided by length of stain) ^{2}
d) Tangent of angle = width of stain divided by length of stain
e) Tangent of angle = width of stain multiplied by length of stain

_____13. When blood droplets are cast off, what shape does their flight path take?

a) Parabolic b) Straight line c) Sinusoidal d) Vertically down
e) Hyperbolic

Identify True or False Statements

____ 14. The area of convergence and the area of hemorrhage are two names for the same thing

____ 15. Bloodstains exhibiting low impact angles provide the most accurate measurements from which to estimate the area of hemorrhage

____16. Aerosolized blood droplets can remain airborne for long periods

____17. Large blood droplets travel further than small droplets

____18. Large blood droplets develop a higher terminal velocity than small blood droplets

____19. Semen always contains spermatozoa

____20. The serological profile of blood and semen are always the same