Forensic Science: Direction of Our Future

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Overview

The natural curiosity that originates in grade school children, although still existing as they advance into their adolescent years, tends to narrow and shift towards more focal areas of interest. Today's generation, that is matriculating through secondary education, is constantly exposed to storylines and jolts of reality based on "Who done it?" and "How was it done?" crimes and mysteries that are currently plaguing our communities, both factual and fictional. The media constantly revolves around real life stories involving crimes that are always incorporating a forensic team who come in and solve these crimes through various scientific approaches and test analysis, like the "Hero who saves the day." And everybody wants to be the HERO. Entertainment and televised programming and publications also have shifted their focus towards forensic science in shows such as CSI (Criminal Scientific Investigations), Criminal Minds (serial killer profilers), Without a Trace (missing persons' investigations) and SVU (special victims' unit). The talk show forums have also become a part of the Forensic movement by incorporating this science into their teaching publications and creating platforms, in which, real people personally affected by crimes are able to tell their stories in testimonials and are able to find answers and gain closure through the support of Forensic science and the experts who plague the field.

Many of my high school students do spend a large amount of time watching television or on the computer and have definitely been exposed to some form of Forensics. This has led to their growing interest in this area of science. These students do respect this area of study and are very interested in learning more about it. I am a teacher at a Title I high school. I have been a Chemistry instructor here for over 7 years and the demographics of our students range from middle socioeconomic class to very low socioeconomic class, with the majority being the latter. There are multiple living conditions that our students have to endure that create very hard challenges for them to survive. The realities for some are very harsh but many are still able to obtain successful futures against the many obstacles. Being submerged in this harsh reality, many of our very own students have been victims of crime, witnessed crime or been touched by crime in some way. This has left many scars in their young lives. Many have had great losses due to crime and grief daily because they have no answers to the why, how, and who could have committed these acts that led to them losing their loved ones. Others find comfort in the pursuit of answers and seek knowledge that will bring them peace.

This is why and where the common interest of many of my students peak because in the area of Forensic Science, investigations and scientific analysis of gathered evidence brings victims and those left behind closer to learning the truth. I first witnessed their evolving interest in solving crimes and mysteries when I introduced to my Human Anatomy and Physiology class demonstrations involving blood typing and analysis labs, blood splatter exercises and charting techniques, genetic identity puzzles, and "Who Done It" mini crime scenarios with follow-up questions and collaborative discussions. The excitement and engagement my students had in the activities left me amazed and speechless. I knew at that moment this must be a part of my curriculum because what excites a student to learn excites and motivates me to want to offer more learning experiences and opportunities for them. There is an incredible amount of media attention directed towards crime investigations that I can use as an opening catalyst to introduce a Forensic Science unit. This unit can be used as a vehicle to teach current scientific approaches and skills of this very interesting and useful trade. This will also be an opportunity to introduce them to educational opportunities, in which, they can advance in this area of study and acquire many career options. In this field of study, students obtain careers in the judicial system, government agencies (Federal Bureau of Investigations-FBI, Criminal Investigation Agency), Medicine and Research field and Military Special Forces.

Self Portrait

I am an educator with a license in Comprehensive Science. My interest in Science and Math led me to pursue a career in Medicine. My inquisitive mind was always nurtured and challenged because of the great teachers I had been taught and mentored by, while on my educational journey. They offered many venues of teaching that mainly focused on grasping the student's interest by keeping the content enlightening and current. They engaged the learner with creative platforms, in which, our young minds did not only obtain the base knowledge their coursework, but allowed us to become independent thinkers and analyst in our own right.

I learned how to transfer and integrate concepts in different areas of study and expound on ideas and apply them to different scenarios to gain resolution. I was motivated to establish goals for my future because my instructors exposed us to career options and taught us how to prepare for opportunities to come. We were encouraged to take advantage of more challenging coursework and internships that centered on our career goals. I was advantageous in becoming involved with the demands of my community and its progression by committing to service projects because my teachers incorporated our community into our educational plight by having them come in as volunteer mentors and guest speakers.

My teachers kept me invested in my academic progression by supporting my eagerness to learn from multiple sources and to service and help others. This is what an educator is and does for their students. As an Educator, aspiring to follow in my teachers' footsteps, I too want to pass on the art of teaching my students, while keeping them interested and invested in learning. This Unit will help in reaching even a few more students to get excited about learning Science.

Preface

This Forensic science unit will be an excellent opportunity to allow students to be able to incorporate all science base knowledge acquired at this level of their educational journey. They will be able to integrate and cross reference the scientific areas of Earth Science, Biology, Physical Science and Chemistry and gain experience in applying these sciences to various problematic situations and reach solutions or answers to many questions rendered in the world of science. It will require the student to evolve from a textbook learner to becoming an independent, analytical and integrative thinker. This thinking ability and application of knowledge, as well as, their innate curiosity to find answers to their many burning questions is all the motivation needed to lead the future generation's scientists into a new era of discoveries. "Isn't science wonderful?"……and getting better.

Introduction

If crime could talk or if witnesses could tell exactly what occurred scene by scene or if the victim of a brutal and fatal crime could come back to life and explain in their last raspy breath of life what had happened, why it happened and who had done it then Forensic Science would be obsolete. But this rarely or never happens and we have to depend on Forensic Investigations and analysis of various clues of evidence to get questions answered. The crime investigation usually starts after somebody sees or hears something and reports it to the proper authorities or there is a discovery of a body or its remains and someone reports it or a report of a missing person has been called in. These channels of reporting a crime or foul play will usually lead to the crime scene and the gathering of evidence begins.

The crime scene investigation will involve a Forensic Specialist's team that will be responsible for gathering samples or evidential clues such as hair, blood, fingerprints, footprints, soil and debris, drug traces, bullet fragments, bodily secretions and even a body that they will have to get to a crime lab safely using preventative contamination methods of transport. Multiple lab tests will be administered to obtain the best data results and based on these results the team may be able to target, identify or eliminate the weapon(s), victim(s), witness(s) and suspect(s).

Forensic science is a multidisciplinary area of science that is designed around the conceptual study of Biology and Chemistry. It focuses on gathering important evidence at crime scenes, securing the evidence and making sure it is not contaminated by using proper collective methods and bagging procedures. The collected evidence is then transported to the crime lab and analyzed by using multiple tests to acquire non bias evidential support of what actually happened and identify the suspect(s) and/or victim(s). These tests are usually based on the concepts studied in Chemistry and Biology.

The Departments in forensic labs are composed of various specialty labs. The Trace lab investigates samples such as hair, fabric, dust, skeletal or skin debris. The Chemistry lab focuses on blood and urine analysis, drugs screening, drug identification, alcohol, poison, toxins, synthetic drugs (medicine), dyes, and stain identification. They also assist with fingerprinting identification by using gas chromatography. The Serology lab targets blood stains and other bodily fluids as well as DNA sequencing by using mitochondrial DNA or polymerase chain reaction (PCR). The Material department is used to identify paint, ceramics, metals, soil and wood. The Biological department assists the Material department when plant life, seeds and animal excrement or remains are recovered from a crime scene. The Photography, Arson and Firearm departments complete the remaining forensic specialty labs.

Strategies

I want this unit to focus on the Chemistry specialty lab's responsibilities and create a Forensic introductory unit around their duties in Forensic investigations. The unit will involve doing short informative lectures based on prepared background notes on Blood basics, ABO blood typing, Fingerprinting pattern analysis and identification, Chemical reactions (oxidation-reduction) and applications of various reagents to help with identification of unknown substances with further inquiry based challenges for further reading and studying opportunities. There will be lab procedures based on ABO-blood typing, blood detection, making latent (invisible) fingerprints visible to the naked eye, fingerprint lifting techniques to help remove and transport them from a crime scene, and a chemical reaction lab identifying an Unknown White Substance based on their physical and chemical properties.

These lab procedures and techniques will help the student to become skilled in the application of basic lab techniques (rules, policy, and procedures), observation and data collection, recording data, compare and contrast data analysis, and creating an elimination flow chart approach to narrow down and eventually identify an unknown substance. By selecting these main focal points, blood detection based on an oxidation chemical reaction process, blood typing analysis based on the antigen-antibody clumping or not clumping Red Blood Cell surface type A, B, AB or non A or B Antigens,

identification of an Unknown based on the use of multiple testing methods using acidic/basic properties, pH scale, universal indicators, boiling and melting point, flame test, chemical signs (gas release, color change, precipitate), solubility and doing a fingerprinting method to help visualize the print for identification of pattern specificity using a form of the chromatography method, the student will be able to use this knowledge and apply it to the final challenge of the unit, which is to design their own crime scene and an investigative approach by using methods in Chemistry.

Opening Discussion

Prior to the start of the unit, students will select 1 real crime that has happened, whether they have witnessed it or heard about it through media exposure or read about it in a journal publication, newspaper or an internet source. They are then to organize their selected crime under the heading of arson, murder, manslaughter, robbery/battery assault, accidental or suicide. They must list one piece of evidence that led them to believe the crime would have been listed under their selected heading. An actual question guideline will be given to help them with their summary write-up.

This assignment should be completed, written and brought to class for discussion in three days, start date of the unit. Upon completion of the discussion they will write a quick statement explaining why they believe Forensic Science is important. This curriculum will take 8 days of instruction and an additional week or two for the students' inquiry based final assessment challenge. The unit will also involve a range of activities that will entail fun, thinking outside the box puzzles and games to doing laboratory techniques and procedures and evolve into students creating their own crime scene investigation based on the content learned in this unit and further research. I also will have the students view short documentaries of crime scene investigations through website links and view crime scene photos to help them visualize a day in the life of a forensic investigator. At the end of this unit, I want the students to have gained more of an appreciation for how Chemistry and other integrated sciences play a major role in helping solve crimes.

Class Selection

I am teaching Human Anatomy and Physiology this semester and the majority of these students are seniors who have taken and mastered their Chemistry, Biology and other supported sciences which will be very beneficial when introducing the Forensic Science Unit.

They have successfully passed their EOC gateway coursework and are very independent and motivated thinkers. They have good writing and comprehensive skills that allow them to communicate well in verbal and written form. When these high

achievers succeed in completion of their required coursework, they choose science electives and Human Anatomy and Physiology is what they want. This motivates me as a science instructor to create more units devoted to new areas of science electives because the demand and need is increasing.

Forensic Science is basically an integration of Chemistry, Biology and Ecology just to name a few, which is the usual pre-requisite course work needed to become enrolled in Human Anatomy and Physiology. These students are taking this course as an elective because they are interested in this area of science and want to learn and gain more exposure in the areas of nursing, medicine and research. These students have already learned how to integrate various subjects, analyze and problem solve. This is why I chose to introduce this unit curriculum to them and see what works and does not for student engagement.

The class size is smaller (25 students) and the students are more mature and secure enough to participate in group collaborations and discussions. They have more experience and base-knowledge in labs focused on biological and chemical background study. They also will be able to give critical feedback on the unit and even suggest future ideas that can help make the unit more engaging and beneficial to help with their future career goals.

Rationale

My purpose for creating this unit is to add support to a growing field of science that is very interesting and versatile for science lovers and problem solvers and it sets the foundation for career options and job security.

Forensic science consists of many departments that integrate Biology, Chemistry, Physics, Entomology, Geology, Ecology, Psychology and Social Science. Science can catapult students into career opportunities that offer different areas of study but fits their area of interest under one main umbrella, Forensics. This unit will be an opportunity to show students how different sciences integrate to help resolve problematic cases. All science coursework involves identifying the problem, gathering data (evidence), doing multiple experimental trials and testing on collected data, analyzing, illustrating and explaining data based non- bias support and without human error. The Scientific method is the baseline for every general science course of laboratory investigation. This unit will reinforce the steps of scientific investigation in a more real and engaging scenario.

It allows students a broader venue in which to create and incorporate their ideas with others to find resolution in a mystery cases, puzzles, activities and crime scenarios. Students will become creative but contained in certain boundaries of concrete, evidential truth. The scientist must only draw conclusions based on the evidence. This teaches

them how to use observation (observing the crime scene) to make an hypothesis of what could have occurred, using gathered data to test in repeated laboratory trials to develop a rational theory that supports or disproves the hypothesis.

I want the students to understand how separate test of evidence such as blood typing, fingerprinting, and substance identification is part of a whole investigation that could lead to resolving a crime and identifying the suspect. This lets them see how different parts of science collaborate to play a major role in one investigation. I want this unit to enlighten students on the fact that science (Chemistry) is everywhere and it consumes us. To teach them to become more knowledgeable in science allows us to become more knowledgeable about ourselves and our universe. I believe I can teach this and motivate them to embrace how science has solved mysteries, helped bring missing people home, and determined why and how a victim became a victim, as well as, be able to identify the suspect and resolved the crime.

This unit will definitely give students a better understanding of Chemistry and how laboratory processes are used to solve "real life" problems experienced in the World of Forensics. This unit will offer inquiry-based methodology and a collaborative working environment to create critical thinking abilities that help in solving problematic scenarios.

Unit Preparatory Assignment (students)

Pre-assignment: Three options to use as their source of information for their selected crime-Option (1)-*The student will view a true forensic file investigation on media publications and/or a televised showcase.* Option (2)-*The student will read a crime report or investigation (newspaper, journal, internet about a forensic file investigation.* Option (3)-*The student can share a true crime testimonial of a crime associated with a forensic file investigation.*

After choosing their option, they will write a summary on as many facts as they can learn to answer the following questions: *1) Label the type of crime committed from the headings of Arson, Murder, Manslaughter, Robbery, Sexual Assault, Battery/Assault, Accidental or Suicide? 2) What evidence led to solving the crime? And what was the most important single piece of evidence? 3) What had occurred? 4) Where was the crime location? 5) How many victims and were their survivors or fatalities involved? 6) Were there any witnesses? 7) How was the crime discovered? 8) Was a weapon discovered and what was it? 9) How long was the investigation? 10) Was there any evidence that was contaminated or was the crime scene compromised due to contamination? And what was the contamination, if any? 11) Did they have a suspect or suspects? 12) Why were they a suspect? 13) What was the Motive? 14) Did any biases or prejudices come up during the investigation and what supported that? 15) What lab test were done or techniques used to acquire and analyze collected data? 16) Was the case resolved?*

Objectives of the Unit

Objective 1: *Students will learn what Forensic Science is and its purpose*. Skills needed to be a good analyst and investigator for this area of science. Learn what is classified as credible evidence and how to obtain this evidence. Become familiar with the Departments within the Forensic Science Headquarters. Objective 2: *The students will learn the steps of a real forensic files investigation.* Objective 3: *Students will learn some techniques and methods used to detect, collect and test evidence like blood and fingerprints.*

Objective 4: *Identify various white powders* based on the observations and comparative analysis of collected data based on chemical and physical reactions.

Objective 5*: Students will create their own crime scene investigation,* incorporating the unit content. Objective 6*: Students will become familiar with scientific inquiry* involving the following steps and incorporate it into their final inquiry based challenge. The steps are to:

●Formulate a hypothesis as to what happened to create the problem.

●Create or design a (non- bias) investigation of data collection and experimental testing of data.

●Present data using graphs, charts or diagrams, helps organize to see patterns and trends to aid in answering questions of interest.

●Analyze and interpret data to report the results of the investigation, offer explanations based on scientific concepts and tested data and help review for errors, credible supportive results and answer/explain if the hypothesis is supported or is not.

Unit Plan: Day 1- Day 8

Day 1- Introduction to the Unit/Overall Synopsis of Forensic Science:

Students will bring a pre-requisite assignment: A (summary) answering specified questions about an actual forensic file investigation based on the resources of three given options.

They will share their summaries (open- based forum). A statement explaining why they feel Forensic Science is important will follow the forum. Students will participate in diverse thinking activities presented in handouts and power point illustrations involving mini criminal scene investigations and storylines, pictorials and puzzles/riddles to test their observational skills and abilities, memory/recall, sequential organization, and perception of specificities in relation to compare/contrast analysis. These activities will help show them the very important skills used by a Forensic Investigator. Students will refer to following websites-activity resources:

http://sciencespot.net/Pages/classforsci.html.
www.trutv.com/shows/**forensic**_files/**games**/fingerprint/index.html, and
http://investigation.discovery.com/interactives/interactives.html to learn what Forensic Science is and the departments and the specialists involved in this field.

Conclusion: Day 1- Question and Answer session of the day's activities, and compose a class list of things we will determine as credible evidence at a typical crime scene (bodily secretions-saliva, semen, blood, hair, clothing, prints, cigarette butts, debris, soil samples, excrement, tire treads, pet prints or bugs). This will give them creative sources, in which, to pull from when they are designing their own Crime Scene.***Homework: Start thinking of a crime scenario idea.**

Day 2- Learning the chronological order of events, methods of gathering credible evidence at a crime scene and who are the chief players in crime resolution. *Students will view a photo of an actual crime scene and speculate what had occurred and what crime had been committed, if any during an open collaborative group discussion*. View the video clips of the real crime scene photos previously viewed and the forensic investigations that followed to determine if their hypothesis were correct. (Crime photos and video clips suggested websites):

http://www.trutv.com/video/forensic-files/picking-up-the-trail.html
http://www.trutv.com/video/forensic-files/purebread-murder.html
http://www.trutv.com/video/forensic-files/family-ties.html
http://www.trutv.com/video/forensic-files/insignificant-others.html
http://www.trutv.com/video/forensic-files/insulated-evidence.html

Upon completion of the viewing, they are to re-access the crime and try to answer questions based on the question outline they receive for their homework summary. We will then have a discussion on the sequential events that led up to the crime, who and what played a crucial role in gathering and testing evidence. More pictorial representations of different crime scenes from the assortment of available content provided from the websites above will be viewed and they will collaborate with their peers and try to determine what had occurred based on the following descriptions: Suicide, Homicide, Accidental Death, Robbery, Manslaughter, Domestic altercation or Sexual Assault. They are to determine the weapon, suspect, and motive. Some answers will be creative and speculative and others will have actual evidential support. This exercise shows how individual's interpret observations in different ways creating room for human prejudices and biases within a case, which cannot be a part of a credible and efficient forensic investigation. Forensic science is based on non bias observations, minimal human error, and documented evidence based on objective testing and fair clinical trials. They will be asked, "Did they have any preconceived ideas based on other things other than the evidence?"

Examples- The room was filthy, with pornographic magazines, numerous alcohol bottles and drugs, meaning the victim had to have been murdered instead of them just having an accidental slip and fall. The room was cheap and dingy, meaning the white powdered substance on the bed had to be drugs and a drug deal had gone down instead of it just being baby powder that the victim had transferred from his body to the bed while laying down. The house had expensive décor and was in a wealthy neighborhood so a robbery had to have been committed and the victim was an unfortunate casualty or did the victim commit suicide because of loneliness? These are pre judged forms of individual human biases.

Conclusion: Day 2-Involves reiterating to the students how damaging a bias driven investigation can be and can lead to an investigation being taken off course, stalled and never resolved.***Homework-The students will be given a handout of the standard laboratory safety rules, policies and procedures from Flinn Scientific Incorporated. (Refer fig. 1 in the appendix). They are to read and study this document in preparation to be tested on it the following day.**

Day 3(Pt. I)- Review the Flinn Lab Safety Rules, followed by Lab Safety Assessment: *Students must pass with an 80% or retest to obtain this percentage before they can enter the lab and do the chemical reaction's lab on day 4*. (Refer to Fig. 2 in the appendix).

Day 3(Pt. II) - Blood Basics and ABO-blood Typing. *Lecture with student prepared notes containing information on blood basics/ABO-typing and Laboratory Background Notes*.

Introductory Blood Notes

Blood analysis is very important when it comes to DNA serology for the Forensic Science Department of Criminal Investigation. The basic components of blood are Erythrocytes (red blood cells), Leukocytes (white blood cells), Thrombocytes (platelets), and plasma. The erythrocytes are the most abundant and carry a protein called hemoglobin which carries oxygen to the living tissues of the body. These cells originate from bone marrow. The leukocytes are representative of our defense team and destroy infectious antigens called pathogens. Platelets are carried within the plasma and help in the clotting of blood through a process called coagulation. This helps in sealing cuts, tears and wounds and aids in the prevention of blood loss. The final component of blood is plasma which is a pale to yellowish liquid that contains electrolytes, nutrients, hormones, vitamins, clotting factors, and protein antibodies that fight infection. There is a big emphasis on genotyping in DNA serology and this helps in crime investigations when it involves identifying suspects or victims at a crime scene. The blood type that an individual has is established before birth from their gene pool inherited from their mother and father. The genes are responsible for determining what proteins (agglutinogens) will exist on an individual's red blood cells and this will be identified as the red blood cell

markers and determines the individual's blood type. There are three genes that contribute to blood typing surface markers. These genes are A, B, and O. Each individual has two genes inherited which allow six gene combinations. These combinations are AA or AO (Type A), BB or BO (Type B), AB (Type AB) and OO (Type O). Another factor that makes blood types even more specific is the absence or presence of a protein (Rhesus factor) or Rh gene factor. This protein was found to exist in the blood of the Rhesus monkeys and later found to exist in some human blood. The people who carry the Rhesus factor are positive (+) and those without this factor are negative (-). These symbols are inserted behind the blood genotypes. Examples are AB^+, OO^-, or AA^-.
Teacher side note reference (optional) Blood types can narrow down and eliminate a certain percentage of the population based on percentages of represented blood types in the total population. (See Fig. 3, Appendix B). ***The rarer the blood type makes it easier to identify persons because the suspect or victim population is smaller.***

Pre-Lab-ABO-Blood Typing Lab Notes

1) Surface proteins on red blood cells determine an individual's blood type.
2) Surface proteins = antigens.
3) ABO system is how we classify human blood types.
4) Antigens determine the blood type.
*A surface antigens → Type A blood
*B surface antigens → Type B blood
*A and B surface antigens → Type AB blood (universal acceptor)
*No antigens → Type O blood (universal donor)
5) Blood plasma has circulating proteins called → Antibodies.
*A surface antigens →produce → B antibodies
*B surface antigens → produce→A antibodies
*AB surface antigens →produce→No antibodies
*No surface antigens → produce→ A and B antibodies (AB antibodies)
Teacher side note reference (optional) Visual Representation of the Red blood cells surface protein markers: **Sciencespot.net/Media/FrnsScience/bloodbasics.ppt (5th pictorial)**
Students will do a blood typing procedural lab (See Fig. 4, Appendix C). They will have follow-up questions to reinforce lab content: 1-Antigen surface markers, 2-Antigen-Antibody complex,
3- ABO-typing.

Conclusion: Day 3-Min -assessment on blood basics. (See questions below)

Assessment- Blood Basics-Mini Assessment Question Bank: 1) What are the four main components of blood? 2) Which blood component is responsible for supplying living cells with oxygen? 3) Which blood component is most abundant and produced in the bone marrow? 4) What is the protein that carries oxygen within the blood? 5) What are

the names for red blood cells, white blood cells, and platelets? 6) What is the main function of white blood cells? 7) What blood component prevents blood loss through clotting factors? 8) Name 4 things that plasma contains. *Answers: 1-red blood cells/erythrocytes, white blood cells/leukocytes, platelets/thrombocytes, plasma, 2-red blood cells/erythrocytes, 3-red blood cells/erythrocytes, 4-hemoglobin, 5-erythrocytes, leukocytes, thrombocytes, 6-destroy infectious pathogens, 7-platelets/thrombocytes, 8-Any (4) of the following answer choices: electrolytes, vitamins, hormones, nutrients, protein, antibodies.*

***Homework: They will have to look up information on the Rhesus factor and determine which of the following situations below will be the safest scenario for a mother to not have to be treated for the Rh factor (Rhesus protein),which eliminates the threat of spontaneous abortion of the fetus and explain why this scenario would not need the mother to be treated: Mother is Rh negative, child is Rh positive/Mother is Rh negative, child is Rh negative/Mother is Rh negative, father of the child is Rh positive/Mother is Rh negative, father of the child is Rh negative/ Mother is Rh positive, child is Rh negative/Mother is Rh positive, child is Rh positive**

*******This will be an extended knowledge inquiry challenge****

Day 4- This will be the introduction to Fingerprinting and how it is used to narrow the suspect pool or assist in identifying a victim or witness. Lecture pertaining to the following information.

Fingerprinting is a key piece of evidence in a crime scene and plays a major role as supportive evidence used in the conviction of a suspect or the identity of a victim. When an individual touches an object, their skin comes into contact with the surface and leaves what forensic investigators call "contact traces. Each fingerprint or contact trace is unique between individuals, a blueprint identifier. There are no individuals that share the same fingerprint, including twins. The fingerprint of an individual does not change from the day of their birth to their death. Fingerprints are created based on the indentations of papillary ridges found on the bottom surface of fingers and toes. Fingerprint identification is based on the whorls, arches, and loops left within the patterns of the actual contact print. There must be twelve points of ridge identification that match the points of another fingerprint to be declared an exact identification match and make the evidence absolute and conclusive.(See Fig.5, Appendix B)

Identifying a victim, or suspect through fingerprinting is based on developing a visible print at an actual crime scene so that it can be lifted and transported to a lab for comparative analysis. This involves using chemical procedures, methods and applications. There are many techniques that help to visualize latent (invisible) prints, and as a class we will learn about a variety of techniques and complete one fingerprinting laboratory procedure. A fingerprint enables an investigator to put a suspect or witness at

a crime scene. The three types of fingerprint patterns arch, whorl and loop. The human population has one of these print patterns. (See Fig. 6, 8, Appendix B)

Fingerprints are composed of a mosaic of multiple swirling lines, and the arrangement of the lines and patterns can create seven different line types within fingerprints. Line prints can begin, divide, or end at diverse points in the fingerprint and create numerous patterns with different angles, lengths and thickness. In the human population the loop is the most common pattern. Fingerprinting is based on visual comparative analysis. Professionals will view the print patterns and point markings to compare and then match with other prints found at the crime scene to those in the data base. This helps the investigation lead to the identity of suspects, victims or even witnesses at a crime scene. The techniques used by the forensics team can vary because of the multiple techniques, chemicals and resources available, cost and drawbacks in some methods.

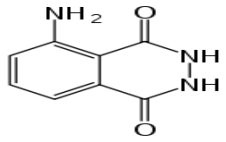
The most economical approach is using powder composed of carbon or aluminum and dusting it over the latent (invisible) print; however, the print must be on a dry surface. The print residue will cling to the powder and result in the print becoming visible. Adhesive tape is then put over the visible print and the print is lifted. Another way to make prints visible is the use of the Magna brush and using its magnetic property of attracting iron filings to cover prints. Florescent colors are used in this procedure because they can reflect the outline of the print when Ultraviolet light or laser rays are used. This is based on the electromagnetic spectrum of using alternative light sources as oppose to visible light. Other methods used to detect latent fingerprints can involve the direct application of chemicals. Ninhydrin is a chemical indicator that interacts with the amino acids in the fingerprints and results in the production of a purple to pink colored residue outlining the print. The reaction of this chemical with amino acids produces a color change because it is a protein indicator specific for amino acids found in the print. The method I will introduce to my students is called the Cyanoacrylate fuming method or also called the Superglue Fuming Method. The superglues used in this method are composed of
ethylcyanocrylate or methylcyanoacrylate. These chemical components react with proteins, amino acids, and fatty acid (oils) deposited within latent prints and after air moisture exposure become visible.

Finger print Lab: Cyanoacrylate Superglue Method, (Fingerprint Lab-See Fig.7, Appendix C)

Follow-up activity: Taking the prints from their lab procedure and randomly pooling them with their classmates and seeing if they can determine the fingerprinting patterns (loop, whorl, or arch) by using the fingerprint pattern template. (See Fig. 6, 8, Appendix B)

Conclusion: Day 4-Brief review of fingerprint patterns and suggested websites to practice matching and identifying fingerprint patterns. ***Homework: The students will receive a sheet of random finger prints (See Fig. 9, Appendix A) Template (See Fig. 6, 8, Appendix B).**

Day 5- Blood Detection Laboratory "Luminol -Chemiluminescence Test"



Luminol

At every crime scene, forensic investigators always believe nothing disappears without a trace of some evidence left behind. Traces left behind could be a shoe print, a finger print, a lipstick stain and of course the everlasting, clinging tiny particle of blood invisible to the naked eye. When blood or any bodily secretions containing blood detected to see if a crime or accident has occurred, the forensic specialists will use the Luminol-Chemiluminescence Blood Test. This test is based on a chemical reaction involving an oxidation-reduction reaction pathway. Luminol ($C_8H_7O_3N_3$) is a powdery substance made of Carbon, Hydrogen, Oxygen and Nitrogen elements chemically combined. The Luminol powder is mixed with Hydrogen Peroxide (H_2O_2) and Hydroxide within a water solution. This solution is then applied to a dried blood stain and the reaction is catalyzed. Blood contains the protein hemoglobin that is responsible for transporting oxygen to cellular tissues and this protein is rich in iron.

The iron in blood will work as a catalyst to accelerate the reaction forward. This oxidation reaction causes Luminol to lose Nitrogen and Hydrogen atoms and the gain oxygen atoms producing a compound called 3-aminophthalate. The product 3-aminophthalate is in an excited state because the electrons in the acquired oxygen atoms have climbed to a higher energy level and are in higher orbitals. When the excited oxygen atom electrons fall back to a lower energy level or ground state lowered orbitals, energy is emitted or released in the form of a photon of light. This photon is a bright florescent bluish-green. This process is called Chemiluminescence, which involves the oxidation of chemicals to produce a luminous glow.

Students will do the Luminol-Chemiluminescence Lab: Make a Luminol blood detection solution, sample it on dried blood and view the results in a dark room.(See Fig.11, Appendix C) ***Teacher side note (optional): Luminol oxidation reaction illust. (See Fig. 10, Appendix B)***

Conclusion: Day 5- Discuss the oxidation-reduction reaction of the Luminol pathway and review when electrons jumped to higher energy orbitals in their excited state energy

is absorbed and when the electrons fall back down to ground state they have to expend energy in the form of heat and light. Do some inquiry based questioning based on how to factor in different colors of light emission. ***Homework: Find some other methods to help detect blood at a crime scene that does not destroy evidence or results in false positives.**

Day 6-Identification of an "Unknown White Powder" (Chemical Reactions)

At this time students must have all successfully passed the Flinn Safety Assessment for laboratory participation in this chemical reaction lab. Briefly review lab rules and procedures and answer any questions the students may have.

Student Pre-Lab Notes:

Identity of an Unknown White Substance

Multiple chemical reactions are used to determine the identity substances that cannot be distinguished just by their appearance alone. For example, various samples of a white powdery or granular substance without chemical testing cannot be determined to be safe or harmful or toxic or therapeutic. Crime scene investigations can lead to a variety of motives and traces of illegal narcotics is a major player in many crimes. This is why it is important to determine the identity of an unknown substance and it is crucial to the investigation. Students will learn about the various tests available to determine the identity of an unknown substance through the process of compare/contrast/flow chart elimination till the substance is verified as being cake flour or an illegal white powder. This process has become known as "Identity of the Unknown White Powder." Students will determine the identity of the unknown and use the following reference data sheet to help them with their process. *(Groups of 4) (See Fig. 12, Appendix C- Lab-I)*

Lab Reference Data Sheet: Test available - Identity of an Unknown White Powder

Probe conductor test-(determines if the substance has an electrical current present and if so means when the substance is in solution will it result in free cat-ions and anions forming (with ionic compounds like sodium and potassium chlorides). This can differentiate between ionic compounds (solution) and covalent molecules (like carbohydrates, sugars, starches).
Melting point and Boiling point test-(determines the substances physical property melting/boiling point for data charted referenced melting/boiling points) ***pH test***-(readings 1-6.9 for acidic, 7 for neutral salt, and 7.1-14 for basic)
Litmus paper indicator test-Blue paper turns red for acid (proton donor) and red paper turns blue for a base (proton acceptor). The pH range extends from 4.5-8.3.

Phenolphthalein indicator test- Indicator that when added to the unknown turns it bright pink for detection of a base because of its reaction with the base OH- group and colorless for acid because of the absence of the OH- group.
Universal indicator test (pH indicator test)-determines strong acid (0-3, red), acid (3-6, orange/yellow), neutral salt (7, green), base (8-11, blue) and strong base (11-14, violet).
Solubility test-Soluble –no precipitate formed or insoluble-precipitate formed in solution.
Flame Test- Detection of cat-ions (atoms that have ionized by losing valence electrons/ metals), and form positive ions that emit spectrums of light. Use of a Nichrome wire loop dipped in water and put into a red hot flame for eliminating residue. Dip into unknown substance and put back into flame and observe color. Examples of the flame test results consist of the following ionized metals and polyatomic/ Cat-ions formed: Sodium Na^{+1}(yellow), Potassium K^{+1} (violet), Calcium Ca^{+2}(yellowish red), Ammonium $NH_4{}^{+1}$ (green), Lithium Li^{+1}(carmine red), Aluminum Al^{+3}(colorless).
Iodine Lugol's reagents test- This test is an indicator for the presence of starch from monosaccrharides (simple sugars) and disaccharides (compound sugars) because of its unique coiled helical configuration that reacts with the iodine(Lugol's solution) to produce blue/black color -positive test. Lugol's solution is iodine dissolved in an aqueous solution of potassium iodide (KI). When applied to a starch, a reaction will occur resulting in the formation of
polyiodide chains. The amylose portion or straight chain of the starch forms long helices where the iodine molecules can assemble and will produce a dark purple/black colored result (positive for starch). The amylopectin branched portion of starch helices are much smaller and shorter and the iodine molecules cannot assemble resulting in an orange/yellow color (positive for starch). A yellowish/brown color indicates there is no starch present. This test must not be done under low pH or increased temperature application due to the starch being susceptible to hydrolysis (breakdown of the compound) resulting in no color change.
Benedict's Solution-Detection of monosaccharides (galactose) and disaccharides (glucose, maltose) because of their free terminal aldehyde groups (carbon-oxygen double bond) and free interior ketone group (carbon-oxygen double bond). This test detects reducing sugars which includes all monosaccharides and most dissacharides with the exception of sucrose. When the sugar is mixed with the Benedict's solution and heat is applied, an oxidation-reduction reaction occurs. The sugar will oxidize gaining an oxygen atom and the Benedict's solution will reduce from Copper II sulfate to Copper I sulfate by losing an oxygen atom resulting in a Brick red/orange colored precipitate that is positive for a reducing sugar. Sucrose is the only sugar that has been noted to test negative with the Benedict's test. This is because it is a non-reducing sugar which means it does not contain free aldehyde and ketone groups because these carbon-oxygen double bonds are occupied in a bond between monosaccharide units and the oxygen double bond is are not free to interact with the Benedict's solution to create an oxidation-reduction reaction and a color change. Polysaccharide long chains (starch) also result in a negative Benedict's test because of their numerous monosaccharide chains that only have free

aldehyde groups at the end of each chain and decreased bond availability in which the Benedict's solution can react.

Fat emulsion test-Test to determine the presence of lipids. Lipids do not dissolve in water because lipid (oils and triglycerides) is non-polar and water is a polar molecule and like polarities only dissolve in like polarities. Lipids do dissolve in ethanol. Test the sample by shaking it up in ethanol and then decant the liquid into a test tube containing water. The lipid will dissolve in the ethanol and precipitate out in water forming a cloudy white emulsion which is positive for the presence of lipids.

Sudan Lipid test-This reagent is a fat soluble dye that gives a positive color change of abright red to target the presence of any lipid. This is based on solubility properties, as well, of like only ***Biuret Test-***This is a blue solution that contains a copper ions that will react with the nitrogen atoms in the peptide bonds (protein) resulting in a positive test of purple color change. This test is positive for the presence of protein.

Limewater test-This test is an indicator of Carbon dioxide gas being present due to the breakdown of a Carbonate compound (CO_3). The will be a bubbling reaction due to the release of the gas.

Bromthymol blue-This test also detects the presence of dissolved carbon dioxide in solution. The test will result in a deep blue color if there is a high concentration of carbon dioxide because a weak acid is present and it will turn yellow if the concentration of carbon dioxide is low and a strong acid is present. The most common weak acid is acetic acid (vinegar)

****Physical (descriptive) traits: texture, color, odor, particle size, density, brittle, hard, etc.***

Conclusion: Day 6- Review their data charts and Lab clean up.

***Homework: Students are to review their data charts and the Lab reference data sheet, compare/contrast data results and try to find patterns to help prepare for part II of the lab. "Determining an unknown white Powder" (see fig. 12, Appendix C-Lab II)**

Inquiry based extension of "Identity of an Unknown White Powder (optional)

Students will receive the following list of testing reagents and research how these can help further in the identification of specific drugs based on their structure, functional groups and reaction products.

*Bromine water * Ethanoic acid and Sulfuric acid w/ heat application *Fehlings solution *Tollen's solution * Iron III chloride *Potassium dichromate

Day 7-*Part II- Identity of an Unknown White Powde*r, Two students will receive an unknown white powder *(one of the known white substances they tested Pt. I)* and determine its identity by repeating the testing process they used in Pt. I. Use their Data Charts (A, B, C) from Pt. I and compare similar physical and chemical properties. They can eliminate other white powders by creating a flow chart to determine which test would be better identifiers as they narrow down their suspects .*(Lab done in partners)*

Conclusion: Day 7-Each partnership must turn in a data chart with supporting results and the identity of their unknown white powder.

Day 8-INQUIRY BASED CHALLENGE-Final Assessment/ (1 to 2 weeks)

Final assessment:

Students (groups of 5): Each group will have the challenge to create their own crime scene incorporating the data, laboratory procedures and knowledge acquired during this unit. The main topics to be incorporated are Blood Detection, Blood typing analysis, Fingerprinting Identity and Determining the Identity of an Unknown white substance. There must be a storyline: victim (profile: blood type, finger print pattern, background story)
-suspects (variety) (profile: blood type, finger print pattern, background story)
-crime location (creative-will vary)
-evidence (blood sample, blood pool or spatter arrangement, fingerprint, white substance sample, and a weapon)
-motive (robbery, adultery, drug bust, accident, or suicide)
-methods of laboratory procedures to analyze the collected evidence
This must be written and turned in to be assessed by the instructor in 1 week. After a week, one team will be selected to orchestrate their crime scenario and the other groups must determine "WHO DONE IT?"

Conclusion: Students will become creative but contained in certain boundaries of concrete, evidential truth. This unit will show them how to use observations (observing the crime scene) to make an hypothesis of what could have occurred and using gathered data to test repeatedly in laboratory trials and obtain results that support or disprove their hypothesis. Students will learn how to apply Chemical methods of testing and laboratory procedures through instruction, activities and various labs. The focus will be on blood analysis and blood typing, fingerprinting identification and determining the identity of an Unknown substance using chemical and physical properties. They will discover that Chemistry is an important part of Forensic investigations and could lead to resolving a crime and identifying the suspect. This unit will enlighten students on the fact that science (Chemistry) is everywhere and it consumes us. It will help students see how science has solved mysteries, helped bring missing people home and determined why and how a victim became a victim, as well as, be able to identify the suspect and solve the crime. This unit will give students a better understanding of Chemistry and how laboratory processes are used to solve "real life" problems experienced in through the World of Forensics.

Appendix A: Student Handouts (Lab Safety Rules/Assessment/Fingerprint activity)

Fig. 1 Student Safety Contract-PURPOSE- Science is a hands-on laboratory class. You will be doing many laboratory activities which require the use of hazardous chemicals. Safety in the science classroom is the #1 priority for students, teachers, and parents. To ensure a safety learn the following rules: 1. Conduct self in a responsible manner at all times in the laboratory.2. Follow all written and verbal instructions. If you do not understand any direction or procedure, ask the instructor. 3. Never work alone or without an instructor present.4. Do not touch any equipment, chemicals, or materials in the laboratory area until instructed to.5. Do not eat, drink or chew gum. 6. Perform only those experiments authorized by the instructor. Follow all instructions. Unauthorized experiments are prohibited.7. Be prepared to work. 8. Read all procedures thoroughly before entering the lab. No Horseplay, practical jokes, and pranks.9.Keep lab clean. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the class.10. Keep aisles clear.11. Know the locations and operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket. Know where the fire alarm and the exits are.12. Work in a well-ventilated area. Use the fume hood with poisonous vapors. 13. Be alert and cautious at all times. Notify the instructor immediately of any unsafe conditions.14. Dispose of all chemical waste properly. Sinks are to be used only for water and those solutions designated by the instructor. Check the label of all waste containers twice before adding your chemical waste.15. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions or by your instructor.16. Keep hands away from face, eyes, mouth and body while using chemicals or preserved specimens. Wash your hands with soap and water after performing all experiments. Clean all work surfaces and apparatus at the end of the experiment. Return all equipment clean and in working order to the proper storage area.17. Experiments must be monitored at all times. Stay at your designated station.18.No Students allowed in science storage rooms or preparation areas unless with an instructor.19. Know all safety procedures to do with a fire drill- containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off. 20. When using knives and other sharp instruments, always carry with tips and points pointing down and away. Cut away from your body. Never try to catch falling sharp instruments. 21 If you have a medical condition (e.g., allergies, pregnancy, etc.), check with your physician prior to working in lab.22. Students wear laboratory goggles always. 23. Contact lenses should not be worn in lab unless instructor knows.24. Hanging long hair, dangling jewelry, and loose or baggy clothing are all hazards. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot.25. Lab aprons must be worn. 26. Report any accident (spill, breakage, etc.) or injury (cut, burn) immediately. 27. If you or your lab partner are hurt, immediately yell out "Code one, Code one" to get the instructor's attention.28. If a chemical splashes in your eyes or on your skin, immediately flush with running water from the eyewash station or safety shower for at least 20 minutes. Notify the instructor immediately.29. When mercury thermometers are broken, do not touch, Notify the instructor immediately. 30. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemicals unless specifically instructed to do so. The proper technique for smelling chemical fumes will be demonstrated to you.31. Check the label on chemical bottles twice before removing any of the contents. 32. Never return unused chemicals to their original containers.33. Never use mouth suction to fill a pipette. 34. When transferring reagents from one container to another, hold the containers away from your body. 35. Acids must be handled with extreme care. Always add acid to water, swirl or stir the solution and be careful of the heat produced, particularly with sulfuric acid. 36. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.37. Never remove chemicals or other materials from the laboratory 38. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Place broken or waste glassware designated disposal container.39.nserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels or cotton gloves.40. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry 41. Never use chipped, dirty or cracked glassware. 42. Report

damaged electrical equipment immediately, do not use. 43. If you do not understand how to use a piece of equipment, ask the instructor for help. 44. Do not immerse hot glassware in cold water; it may shatter.45. Exercise extreme caution when using a gas burner. Do not put any substance into the flame unless specifically instructed to do so. Never reach over an exposed flame. Light gas (or alcohol) burners only as instructed by the teacher.46. Never leave a lit burner unattended. Always turn the burner or hot plate off when not in use 47. Never point the open end of a test tube being heated at yourself or anyone else.48. Heated metals and glass should be set aside to cool and picked up with caution. Use tongs or heat-protective gloves.49. Never look into a container that is being heated.
50. Hot and cold glassware have the same visual appearance. Treat all glass like it is hot.

Fig. 2 SCIENCE LABORATORY SAFETY TEST:

1. Flammable materials, like alcohol, should never be dispensed or used near
a. an open door. b. an open flame. c. another student. d. a sink.
2. If a laboratory fire erupts, immediately
a. notify your instructor. b. run for the fire extinguisher. c. throw water on the fire. d. open the windows.
3. Approved eye protection devices (such as goggles) are worn in the laboratory
a. to avoid eye strain. b. if you don't have glasses. c. to improve your vision. d. at all times
4. If you do not understand a direction or part of a lab procedure, you should
a. figure it out doing the lab. b. try until something works. c. ask the instructor before proceeding. d. skip it.
5. upon completing an experiment, all chemical wastes should be
a. left at your station. b. disposed of by your instructor's directions. c .dumped in the sink. d. taken home.
6. You are heating a substance in a test tube. Always point the open end of the tube
a. toward yourself. b. toward your lab partner. c. toward another classmate. d. away from all people.
7. You are heating a piece of glass and now want to pick it up. You should
a. use a rag or paper towels. b. pick up the end that looks cooler. c. use tongs. d. pour cold water on it.
8. You have been injured in the laboratory (cut, burn) . First you should
a. visit nurse after class. b. see a doctor after school. c. tell the lab instructor at once. d. treat yourself.
9. When gathering glassware and equipment for an experiment, you should
a. read all directions b. check glass for chips or cracks. c. clean dirty glass d. All of the above
10. Personal eyeglasses provide as much protection as
a. a face shield. b. safety glasses.
c. splash proof chemical goggles. d. none of the above.
11. Long hair in the laboratory must be
a. cut short. b. hold away from the experiment with hand. c. neatly groomed. d. tied back out of the way
12. If an acid is splashed on your skin, wash at once with
a. soap. b. oil. c. weak base. d. plenty of water.
13. When you finish working with chemicals, biological specimens, and other lab substances, always
a. treat hands w/ lotion. b. wash hands w/soap and water. c. wipe hands on a towel. d. wipe hands on pants
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Fig .9 ID the fingerprint patterns



Appendix B: Reference Charts, formulas, and diagrams

Fig. 3 **(Population Blood Type Percentages)**

Blood type	Distribution	Ratio/Percentages
O positive/O+	1 in 3	38.4%
O negative/O-	1 in 15	7.7%
A positive/A+	1 in 3	32.3%
A negative/A-	1 in 16	6.5%
B positive/B+	1 in 12	9.4%
B negative/B-	1 in 67	1.7%
AB positive/AB+	1 in 29	3.2%
AB negative/AB-	1 in 167	.77%

Sciencespot.net/Media/FrnsScience/bloodbasics.ppt (6th pictorial)

Fig. 5

Minutiae-Based Matching

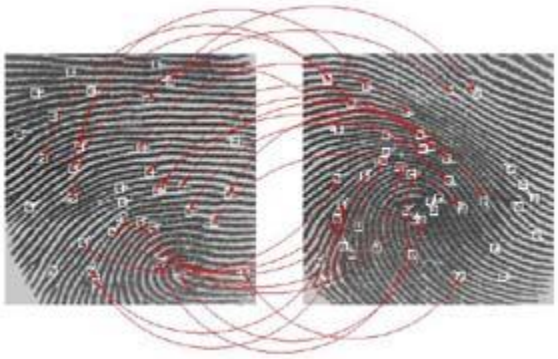
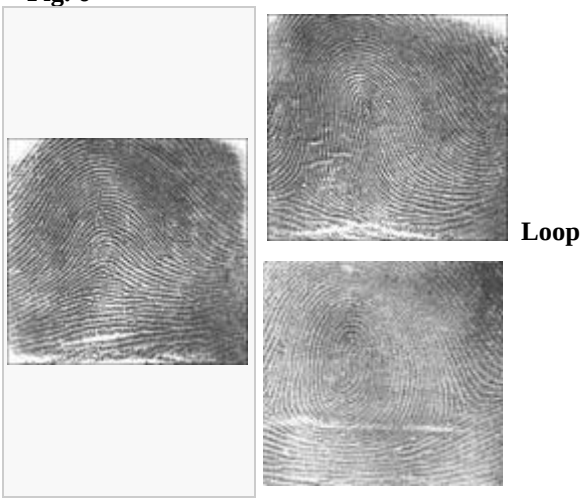


Figure 4: When using a minutiae-based approach, individual properties of the fingerprint are matched, instead of using the correlation of values.

Edited by Scott Harrison on Dec 23,2004@3:37am US/central

Fig. 6



Loop

Arch **Whorl**

LOOP
In a loop pattern, the ridges enter from either side, re-curve and pass out or tend to pass out the same side they entered.

WHORL
In a whorl patte
ridges are us
circular
WHO
In a whorl pa
ridges are
circul

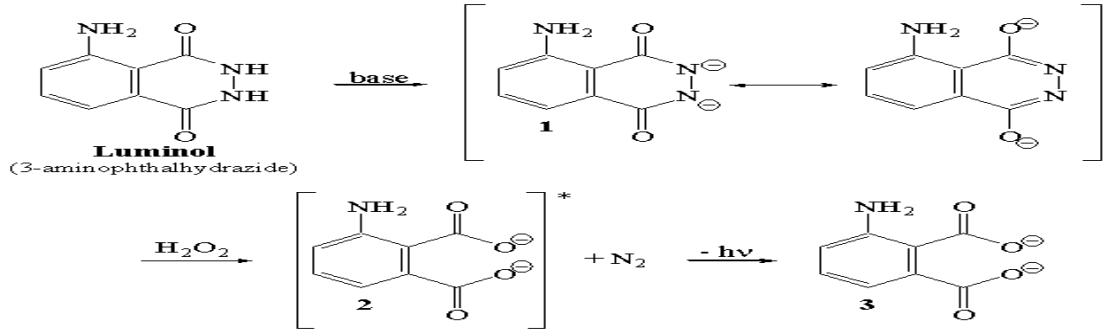
ARCH
In an arch patter
the ridges enter fr
one side, make
rise in the cente
and exit generally
the opposite side

FI

The three fingerprint patterns are illustrated here (FBI website).

The three fingerprint patterns are illustrated here (FBI website).

Fig. 10 **Luminol Oxidation Reaction**



http://chemistry.about.com/od/glowinthedarkprojects/a/luminolblood.htm

Appendix C: Laboratory Procedures (Student handouts)

Fig.4 Blood Typing Laboratory Procedure

Materials/ Per-student:

Anti-A serum, Anti-B serum, 4 blood samples, paper towel, tray w/ 2 indented wells, stirring sticks -2 different colors

Procedure: Determine the ABO blood group and the Percent frequency of each blood group in your class. Place 3-4 drops of patient blood sample in each well. Place 3 drops of Anti-A serum in Well A. Place 3 drops of Anti-B serum in Well B. Use a separate stirring stick to mix the simulated blood and serum in each well for 10 seconds. Determine if the blood in the wells clumps (agglutinates) or not and record results and observations. **clumping indicates blood contains surface antigens for that specific antibody.* .

Type A: A clumps Type B: B clumps

Type O: No clumps Type AB: A and B clumps.

Pool the class results and determine the frequency of your blood type. Then have them compare it on a smaller scale with the population percentage blood type chart that was provided in the introductory notes received by the students. (Fig 3, Appendix B)

http://learningenetics.utah.edu/units/basics/blood/types.cfm

Inquiry based lab questions:

1) If your blood type is B, which antigens are present on your red blood cells? 2) What if your blood type is A, Type AB or Type O? 3) Based upon your results, which ABO blood type can your patient receive safely? 4) How could you determine if a blood sample is compatible (safe) to transfuse from one individual to another in an emergency situation, if blood typing serum is not available? 5) What would happen to a type O patient if they receive type A or B blood?

Fig. 7 CYANOACRYLATE-SUPERGLUE LAB PROCEDURE
Developing Visible Fingerprints

Materials: Microscope slide, aluminum foil, Super glue, Jar, Ink pad, notecard, magnifier

****Make sure the laboratory procedure is done in a well-ventilated area because the vapors from the superglue are toxic. If any superglue comes into contact with the skin, let it dry and then remove it with a small amount of acetone (nail polish remover).***

Procedure:

1) Have student put their fingerprint on a clean microscope slide.
2) Place a small piece of aluminum foil in the bottom of the small jar.
3) Add a few drops of superglue onto the aluminum foil.
4) Place the microscope slide into the jar and close it.
5) Allow this to stand for at least five minutes and up to thirty minutes
6) While this process is being completed, use the same finger you used on microscope slide and put it on the black ink pad and make another print on the notecard.
7) After the print becomes visible on the slide, remove the slide from the jar without touching the print. 8) Compare the print on the slide with the print on the notecard and try to see the similarities between the prints. Then try and determine what fingerprint pattern it is (whorl, arch, or loop). **http://www.chymist.com/fingerprinting.pdf**

Extended Inquiry: *Pool all the students' fingerprinted microscope slides, randomly assort them and do the same with the notecard prints. Then have students do a match the print game and see how perceptive they are with comparative analysis.*

Fig. 11 **Luminol Chemiluminescence Blood Detection Test:**

Materials: Luminol stock solution (2 g Luminol, 15 g potassium hydroxide, 250mL of water), 3% hydrogen peroxide, and potassium ferricyanide (blood assimilation) or blood sample (red meat product) prepared on an alcohol pad to produce a dried or latent blood sample. Blood sample substitutions (copper alloys, horseradish, and bleach)

Procedure: Mix 10mL of Luminol solution and 10mL of hydroxide peroxide in a beaker. Pour the mixture in a spray bottle dispenser. Create a dark room and then spray on a dried blood sample or potassium ferricyanide (blood assimilation). The florescent glow last for only 30 seconds but documented for further investigation by the use of a long exposure photograph. **Do not let the Luminol solution come into contact with skin, eyes, or mouth.* On a crime scene, if Luminol shows blood traces, investigator will record the blood patterns through photos or videotape. However, whether it is human blood or a typical household cleaning source that contains the same copper, iron or metal alloy that will respond like a catalyst to the Luminol solution causing the glow, cannot be determined. This test cannot identify blood specificity or blood origin or even if it is blood but it can still help with the initial start of the investigation. The patterns of blood spatter or blood pooling can help investigators determine the point of attack, type of weapon, the position or height of the victim or assailant, and the direction the suspect could have fled based on blood trail or the path of the victim's blood trail to try to get to safety. It can also lead investigators to find more evidence or even the weapon of the crime by following the blood traces. Although Luminol is very important on the crime scene it is becoming less prevalent because the reaction can destroy or contaminate other evidence in the crime scene.
http://chemistry.about.com/od/glowinthedarkprojects/a/luminolblood.htm

Fig. 12 **"Identity of an Unknown White Powder"**

A forensic specialist, while collecting evidence at a crime scene discovers and bags a mysterious white powdered substance. It is taken back to the lab to determine if it is an illegal substance or not, based on the dynamics of chemical testing. Let us begin our journey to the truth of the identity of what this could be.

Data Charts

Chart A **Color/Texture/Odor/Size/Shape/Solubility/Density/mp./conductivity**

Sodium sulfate
Calcium chloride
Sodium chloride
Potassium chloride

Calcium sulfate
Calcium carbonate
Magnesium carbonate
Potassium sulfate
Sucrose
Lithium carbonate
Magnesium sulfate
Cornstarch
Sodium hydrogen carbonate
Benzoic acid
Glucose

Chart B **Universal indicator/pH # -color/litmus paper /flame test/HCl/NaOH**
Same substance list as chart A

Chart C **Phenolphthalein/Iodine/Benedict/Ethanol/Sudan/Buiret/Limewater/Bromthymol**
Same substance list as chart B

Materials

10ml graduated cylinders	large (500ml) beakers	rubber bands
Measuring weigh boats	test tube rack	stirring rods
Magnifying glass	Bunsen burner	conducting probes
Litmus paper (blue, red)	wire loop	well plates/watch glass
Pipettes/droppers	hot plate	thermometers
16 small (25 mL beakers)	digital scale	capillary tubes
Test tubes	ring stand/ring	wire gauze
Water	plastic containers (16)	labels and dark paper

White solid samples (Known)
Sodium sulfate (Na_2SO_4)
Glucose ($C_6H_{12}O_6$)
Calcium chloride ($CaCl_2$)
Sodium chloride (table salt) (NaCl)
Potassium chloride (KCl)
Calcium sulfate ($CaSO_4$)
Calcium Carbonate/ white chalk ($CaCO_3$)
Magnesium Carbonate ($MgCO_3$)
Magnesium Hydroxide (milk of magnesia) $Mg(OH)_2$
Potassium sulfate (fertilizer) $K_2(SO_4)$
Sucrose /table sugar ($C_{12}H_{22}O_{11}$)
Lithium Carbonate /prescribe anti-manic drug (Li_2CO_3)
Magnesium sulfate heptahydrate /Epsom salt ($MgSO_4$)
Cornstarch
Sodium hydrogen carbonate /baking soda ($NaHCO_3$)
Benzoic Acid /aspirin (C_6H_5COOH) ***(make sure all samples are similar in presentation-powdery or granular form)**

Testing Reagents:
Hydrochloric aci(HCl)
Phenolphthalein indicator
Sodium Hydroxide (NaOH)
Ethanol
Universal indicator
Iodine Lugol's solution
Benedict's solution
Buiret solution
Sudan III solution
Limewater
Bromthymol blue

Pt. I Procedure: Each student needs to place ¼ teaspoon (1ml) of each of the 16 white known samples on black construction paper and label them accordingly. Use the magnifying glass to make observations based on the appearance of the substance and record those observations in Chart I. Record the physical observations based on feel, smell and sight and record under the proper headings. Determine the density by taking the exact same amount in grams of each known sample measured out in weight boats on a scale and record the mass of each substance. Then record the volume of that exact mass representation of each sample by putting the amount weighed out into (10mL) graduated cylinders. Determine the Density by dividing the mass of each sample by its corresponding volume. *(Density = mass/volume)*. Place each substance (1ml) in a well plate and use an eyedropper to add 3-4gtts of water, stir and see if it dissolves in solution (solubilizes) or does not. Repeat this process but use 3-4gtts of ethanol instead of water, stir and determine the solubility. Put a (1ml) of each known sample into different test tubes and label accordingly. Affix with a rubber band the test tube to a thermometer and submerge them into a hot water bath, created by placing a large beaker of water on a hot plate. Determine the melting point by observing at what temperature you observe the sample going to a liquid phase and the time allotment. Some substances will not melt even at 100 degrees Celsius but some will and those that melt early and at lower temperatures have low melting points and could be classified as molecular compounds (sugars, starches, and carbohydrates).
Place the each sample (1ml) into different test tubes and place 5 ml of water into each test tube, stir, and insert a conductive probe into test tube one at a time (being sure to wipe the conductor tips clean after each insertion) and see if the light comes on or not to determine is conductivity (electrical current). Record all results on the data chart. Refer to the Flame test procedure from the lab reference data and complete this process with a small dry sample each known substance. Record results on data chart. Use the reference data table to go through each reagent or testing process and record results on the appropriate data table.

Pt. II Procedure: After the student groups have observed and recorded all data, they are to get a sample of an unknown white solid and determine its identity based comparing/contrasting and eliminating using the data of the known white solids.

Extended Inquiry based challenge: *The student will receive the following list of testing reagents and research how these can help further in identifying specific drugs based on their structure, functional groups and reaction products. Bromine water, Ethanoic acid and Sulfuric acid w/ heat application, Fehlings solution, Tollen's solution, Iron III chloride, Potassium dichromate, Phosphorus pentachloride, and 2, 4 Dinitrophenyl-hydrazine 3 or 2,4 DNP*

Resource: Detective Science: 40 Crime-solving, Case Breaking Crook Catching Activities for Kids by Jim Wiese –White Powder Lab

Appendix- D
Implementing District Standards- Chemistry I-Essential Standards

Essential Standard: 1.1-Analyze the structure of atoms and ions.
Objective 1.1.3- Explain the emission of electromagnetic radiation in spectral form-Bohr model (energy levels and orbital). Unit exemplified this in the laboratory procedure of chemical reactions "Identity of An Unknown White Powder" with the flame test colored spectrum of ionized metals, Luminol Blood Detection Lab with fluorescent light emission as a result of an Oxidation – Reduction Reaction.

Essential Standard: 2.2-Analyze chemical reaction in terms of quantities, product formation and energy. Objective 2.2.2- Analyze the evidence of chemical change.
Unit exemplified this in "Identity of An Unknown White Powder" Lab by doing various chemical reactions to observe signs of chemical change (precipitate formation, color change, heat and light emission, bubble release due to gas formation)

Essential Standard: 3.2- Understand solutions and the solution process
Objective 3.2.2- Acids and Bases, pH scale, Hydrogen ions and Hydroxide ions
Unit exemplified this in "Identity of An Unknown White Powder" Lab by determining if an unknown is acidic, basic or neutral salt based on testing its pH measured value (Litmus paper – red and blue used), Universal Indicator used to indicate and determine the strengths of acid or base, weak or strong)

Essential Standard: 1.2.5- Compare the properties of Ionic, Covalent, Metallic compounds.
Unit exemplified this by doing a lab test that emphasized properties of Ionic compounds in solution's conductivity property- electrical current due to the presence of cat ions and anions in solution. This was exemplified in the "Identity of An Unknown White Powder" Lab which tested this property by using a conductivity rod and seeing if conductivity was present and include or eliminate an Ionic Compound (Metal and Nonmetal) as being the Unknown White Powder.

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Benjamini, Eli, Sidney Leskowitz. Immunology, A Short Course. John Wiley & Sons Inc. New York, NY 1991

P.R.Wheater, H.G. Burkitt, V.G.Daniels. Functional Histology. Longman Group, UK 1990.

Websites that will be helpful for teachers and students:

"Forensics for kids," www.**forensicscience**.org
"All to know about Fingerprinting," http://www.dltk-kids.com/crafts/miscellaneous/fingerprint_characters.htm
"Forensic-science projects www.hometrainingtools.com
"Forensic Activity Demos," www.colorado.edu
http://www.fbi.gov/**kids**/6th12th/investigates/investigates .htm
*"Forensic-science for kids"*www.criminology-degree.com
*"Who done it Forensics, Unknown White Powder,"*www.cyberbee.com
*"Forensic Laboratory/Labs,"*www.hschem.org
"Forensic Chemistry," www.nclark.net/**Forensic**Chem
"A Closer Look at Forensics,"www.nclark.net
FBI investigates a crime: http://www.fbi.gov/**fun**-games/**kids**/**kids**
"Forensic and DNA,"http://learningenetics.utah.edu/units/basics/blood/types.cfm
"Fingerprinting," http://www.chymist.com/fingerprinting