

JS 185 (04)

DNA and Crime



- I. Welcome and Introductions
Steven Lee- Instructor

- II. Overview of the course
Description- Requirements
Small Groups-Your background, interests
First “case” assignment

- III. Introduction to DNA typing
Why DNA?
Learn the main uses of DNA in Forensics
Progression and Comparison of DNA markers
Overview of DNA typing
Brief History of DNA typing

My Background

- **Who am I? Scientist, Teacher and Dad**
 - Professor and Director Forensic Sci (SJSU)
 - Consultant -Biotech (Illumina), Forensic DNA
 - Adjunct Prof Chem FIU, Adjunct Prof Bio SFSU
 - Blessed to have been a mentor to my students
 - Husband and Dad to 4
 - Interests: music, running, fitness
- **How did I get here? Research and Teaching Experience**
 - CA DOJ DNA (94-99), Adj SFSU (96-), Biol UNC (92-94)
 - SUNYB, AECOM, NYU, Columbia, UCB, UGA
 - Courses: Mol Genetics, Genetics of For DNA(UCDavis), Chemistry of DNA typing (FIU- F 2001, Sp 2003)
- **Forensic Experience? All in DNA**
 - CA DOJ DNA Research, Validation and Training
 - Served on TWGDAM 1994-1999
 - AFDIL mtDNA QA, ASCLD-LAB certified, AAFS full member, CAC full member
 - Qualified expert DNA witness



Contact Information

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Overview of the Course

- **Course Description:** This course is designed to introduce students to the **basics of DNA and the application of DNA to solving crime**. Students will be introduced to DNA testing utilized in criminal casework and convicted offender DNA databases. Students will become familiar with the scientific concepts, methods, practices and analytical instrumentation utilized for DNA analysis. Legal issues including national standards for quality assurance, validation, legal admissibility and training will also be covered.

Course Texts:

- *Required Texts:*
- *Fundamentals of Forensic DNA Typing.* John Butler 2010. ISBN 9780123749994. Academic Press
- *Forensic DNA Analysis.* Rudin, N. and K. Inman. 2nd Edition. **2001**. ISBN: 0849302331 Publisher: CRC Press; 2nd edition (December 21, 2001) 312 pp.
- *You may also replace the Butler book from 2010 with the following book-*
- *Forensic DNA Typing: Biology and Technology Behind STR Markers* John Butler PhD. **2005**. ISBN: 0-12-147952-8, 688pp. Academic Press

Required reading and internet materials:

- **Journal articles and other readings will be accessible at the SJSU library, on reserve or will be accessible on line. Citations and URLs for on line materials will be provided in assignments.**
- **President's DNA Initiative:** www.dna.gov Now found at <http://www.nij.gov/training/courses/welcome.htm>
- **NIST :**<http://www.cstl.nist.gov/div831/strbase/index.htm>
- **NCJRS publications will be used extensively**
<http://www.ncjrs.org/forensic/publications.html>
http://www.ojp.usdoj.gov/nij/sciencetech/dna_pub.htm
- **DNA and crime links will also be utilized to supplement the course including:**
<http://www.mass.gov/cpcs/links/>, http://www.forensic.to/links/pages/Forensic_Sciences/Field_of_expertise/DNA/ and *Genetic Witness: Forensic Uses of DNA Testing*, Office of Technology Assessment;
<http://www.wws.princeton.edu/~ota/disk2/1990/9021/9021.PDF>

Course Format:

- The course will include **lectures by the instructor and guest lectures** including scientists from crime laboratories. **Discussions, videos, and small-group hands-on activities**, will also be included throughout the semester. If possible, on-line chats will be scheduled (TBA).

Small group formation

6-8 per team (form 4 teams)- Designate one team leader

Gather emails and phone numbers

Find out the following from each other

- 1) Name, Year (class), Major
- 2) Why are you interested in DNA and Crime?
- 3) Something special/to remember you

Course requirements:

- Exams: Three exams will be given in this course. Exams will be cumulative and will include all material covered up to the date of the exam. Exams may include multiple choice, matching, true/false, short answer, diagrams, drawings and sketches, short essay and/or long essay. Each exam is worth 100 points. The final will be comprehensive and is worth 200 points.
- Exam 1: 09/19
- Exam 2: 10/31
- Final: 12/16

Quizzes and Small Group Activities

- Quizzes on assigned readings, small group activities and other assigned materials will be given during the semester. These will generally be multiple choice, matching, true/false and short answer but may also include essay questions. Quizzes are worth a total of 100 points

Grading

- Quizzes/Activities 100 points
- Exam 1 100 points
- Exam 2 100 points
- **Final exam** **200 points**
- Total required 500 points
- **Extra Credit** A total of 10 points may be granted for additional extra credit small group assignments and other assignments during the semester. Each assignment will be worth 1-2 points each. These extra credit points may be used to augment your final point total.

Grading Policies

- Make-up exams will not generally be permitted. However, under extraordinary circumstances, with proper documentation and approval by the instructor, a 15 page single-spaced term paper of an instructor assigned topic, may substitute for 1 exam.
- A+ 483.5 to 500 C+ 383.5 to 399.9
- A 467 to 483.4 C 367 to 383.4
- A- 450 to 466.9 F <367
- B+ 433.5 to 449.9
- B 417 to 433.4
- B- 400 to 416.9
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Course Schedule

Section 1.

Introduction/Overview- History

Basics of Physical Evidence and Collection and Preservation

DNA Biology- The Scientific Basis for DNA typing

Methods Used in Forensic DNA

Section 2

Short Tandem Repeats

DNA Databases

Interpretation of DNA results

Cold Hits

Section 3

Additional DNA markers

Quality Control, Validation, Training Standards

Admissibility, Court Testimony,

Legal and Ethical Implications of DNA testing

Innocence Project

Future of DNA typing

16 weeks- Last class 12/05

Course Add/Drop Statement

- Instructors are permitted to drop students who fail to attend the first scheduled class meeting and who fail to inform the instructor prior to the second class meeting of the reason for any absence and their intention to continue in the class. Some instructors will drop students who do not meet the stated course prerequisites. However, instructors are not required to drop a student from their course. **It is the student's responsibility to make sure classes are dropped.**
- **You, the student**, are responsible for understanding the policies and procedures about add/drops, academic renewal, withdrawal, etc. found at:
http://sa.sjsu.edu/student_conduct

Course Add/Drop Statement

- Dropping and Adding
- Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. Information on add/drops are available at <http://info.sjsu.edu/web-dbgen/narr/soc-fall/rec-324.html>
- . Information about late drop is available at <http://www.sjsu.edu/sac/advising/latedrops/policy/>
- Students should be aware of the current deadlines and penalties for adding and dropping classes.

Academic Integrity and Plagiarism

- Academic integrity statement (from the Office of Student Conduct and Ethical Development):
- “Your own commitment to learning, as evidenced by your enrollment at San José State University, and the University’s Academic Integrity Policy requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the Office of Student Conduct and Ethical Development. The policy on academic integrity can be found at
- **http://www.sa.sjsu.edu/download/judicial_affairs/Academic_Integrity_Policy_S07-2.pdf**

Plagiarism

- Plagiarism at SJSU includes but is not limited to:
- The act of incorporating the ideas, words, sentences, paragraphs, or parts thereof, or the specific substances of another's work, without giving appropriate credit, and representing the product as one's own work; and representing another's artistic/scholarly works such as musical compositions, computer programs, photographs, painting, drawing, sculptures, or similar works as one's own. All students are required to take the on-line tutorial and quiz on plagiarism:
- Go to: <http://tutorials.sjlibrary.org/plagiarism/index.htm> Take the quiz and print out your results
- You must complete this tutorial and print out your report at the end to hand in to the instructor. All due by class period Wednesday 012709

Full Service Crime Lab Services

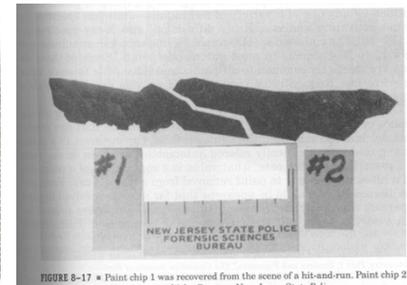
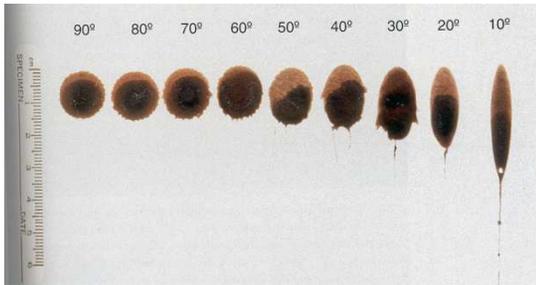


FIGURE 8-17 • Paint chip 1 was recovered from the scene of a hit-and-run. Paint chip 2 was obtained from the suspect vehicle. Courtesy New Jersey State Police.

- Physical Science Unit- chemistry, physics, geology on drugs, glass, paint explosives and soil
- Biology Unit- biologist and biochemists conduct serology and DNA testing of biological material (Fluids)
- Firearms Unit- Examination of firearms, discharged bullets, cartridge cases, shotgun shells, ammo, and clothing for residues are performed
- Document Examination Unit- handwriting and typewriting studies to ascertain authenticity or source
- Photography Unit- Digital imaging, IR, UV X ray
- Toxicology, Latent Fingerprints, Polygraph, Voiceprint, and Evidence collection units

Why DNA?

- **Law Enforcement**
 - **Criminal Investigation- Casework, Databanks**
 - **Reuniting immigrant families- Paternity**
 - **Missing persons**
- **Evolutionary, Agricultural and Zoological applications**
 - **Assessing genetic diversity**
 - **Fingerprinting endangered species and pathogens**
 - **Assessing unrelatedness to breed for increasing genetic diversity**
 - **Assessing relationships for all biological predictions**
 - **Ancient DNA analyses for reconstructing history (how we populated the globe)**
- **Other Human Applications**
 - **Making sense of the Human Genome project results- Bioinformatics**
 - **Developing rapid medical diagnostics such as those associated with triplet repeat diseases (STRs)- (Moxon et al. 1999 Sci Amer. 280:94)**
 - **Understanding the molecular basis of development, disease and aging**
 - **Screening candidates for bone marrow/organ transplants and grafts**

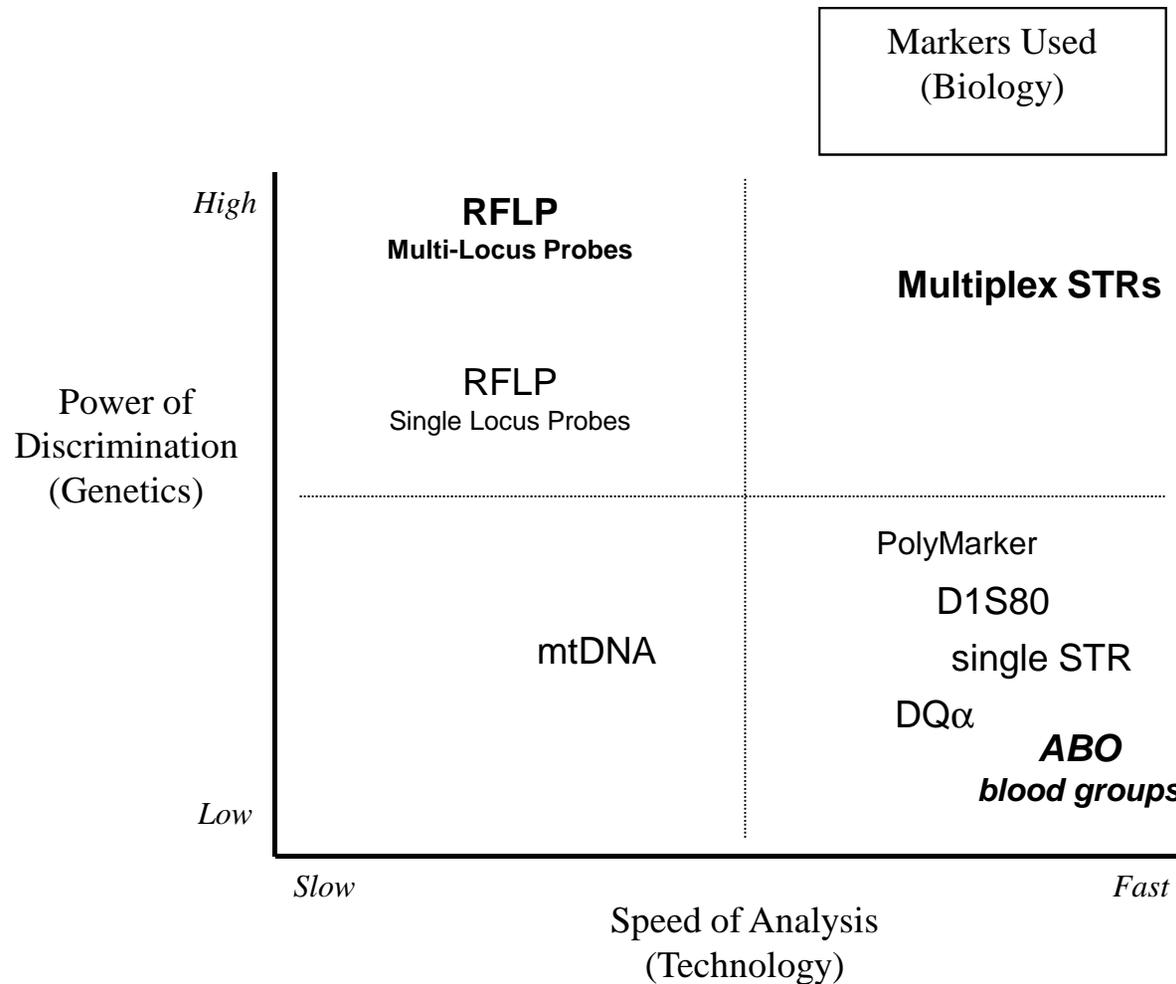
Human Identity Testing

- Forensic cases -- **matching suspect with evidence**
- Exonerate persons wrongly accused of crimes--**freeing the innocent**
- Establish paternity and other family relationships—**identifying dad**
- Historical investigations—**DNA testing of human remains**
- Missing persons investigations
- Mass disasters -- **putting pieces back together**
- Military DNA “dog tag”— **Missing soldier ID**
- Identify endangered and protected species as an aid to wildlife officials (could be used for prosecuting poachers)- **Wildlife forensics**
- Authenticating consumables- **e.g. caviar or wine**
- Detect bacteria and other organisms that may pollute air, water, soil, and food or that may be used in bioterrorism- **Homeland security**
- Convicted felon DNA databases

Progression of DNA Typing Markers

- RFLP
 - multilocus VNTR probes
 - single locus VNTR probes (**^{32}P and chemi**)
- PCR
 - DQ-alpha (**reverse dot blot**)
 - PolyMarker (**6 plex PCR; dots for SNPs**)
 - D1S80 (**AMP-FLPs**)
 - singleplex STRs with silver staining
 - multiplex STRs with fluorescent dyes

Comparison of DNA Typing Technologies



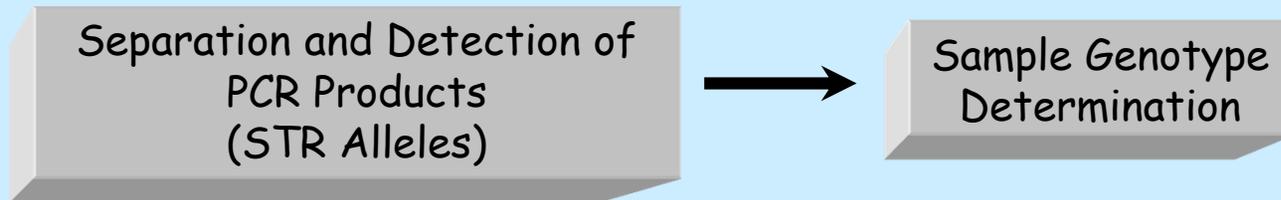
Overview of DNA typing

Sample Obtained from
Crime Scene or Paternity
Investigation

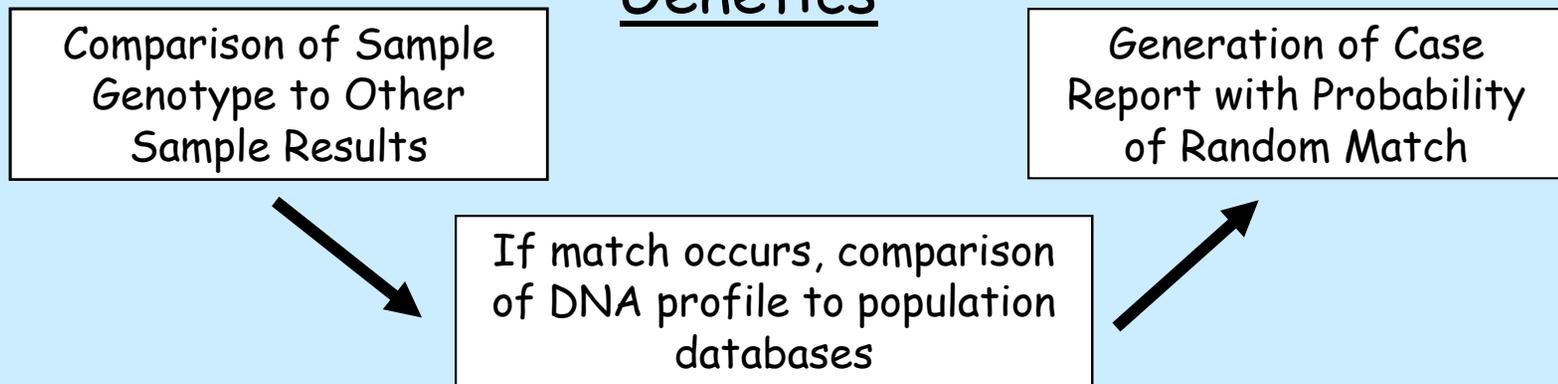
Biology



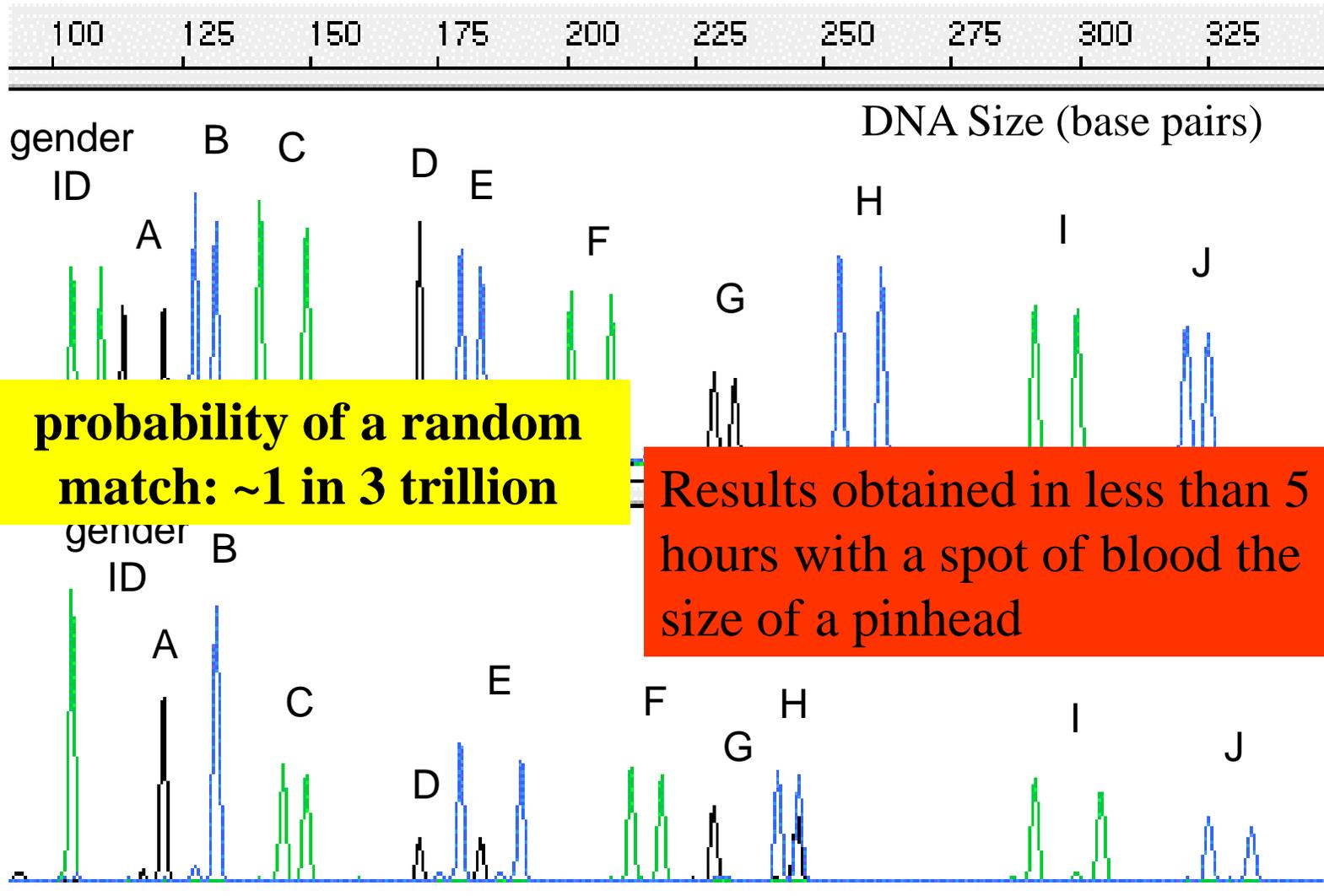
Technology



Genetics



Human Identity Testing Involves Comparing DNA Profiles



Simultaneous Analysis of 10 STRs and Gender ID

Brief History of DNA Typing

- 1980 - Ray White describes first polymorphic RFLP marker
- 1985 - Alec Jeffreys discovers multilocus VNTR probes
- 1985 - first paper on PCR
- 1988 - FBI starts DNA casework
- 1991 - first STR paper
- 1995 - FSS starts UK DNA database
- 1998 - FBI launches CODIS database

Detailed History of Serology and DNA 1

FORENSIC SEROLOGY AND DNA ANALYSIS TIME LINE

384	→ Hume II, used bloodstains to corroborate a crime or supply additional evidence.	Bloodstains	384 AD
1247	Sen-en-Roku, treatise on the mixing of blood of parties in a paternity dispute.	Blood groups	1888
1853	Teichman Test, microscopic crystal test for hemoglobin using hemin crystals.	Secretor status	1937
1862	J. (Izaak) Van Deen (Denmark), test for blood using guaiac, a West Indian shrub.		
1863	Schönbein, blood test, ability of hemoglobin to oxidize hydrogen peroxide making it foam.		
1888	→ Leopold Landsteiner, discovered human blood groups, Nobel Prize 1930.		
1901	Dr. Paul Uhlenhuth discovered method to differentiate between human and animal blood.		
1904	Oskar and Rudolf Adler developed a presumptive test for blood based on benzidine.		
1912	Masaeo Takayama microscopic crystal test for hemoglobin using hemochromogen crystals.		
1915	Leone Lattes antibody test for ABO blood groups.		
1923	Vittorio Siracusa, absorption-elution test for ABO blood typing of stains.		
1924	Bernstein, mathematician, proves that ABO blood types are in fact under genetic control.		
1927	Landsteiner and Levine, M, N, and P blood factors lead to the MNSs and P typing systems.		
1929	K. I. Yoshida finds serological isoantibodies in body fluids other than blood.		
1931	Franz Josef Holzer developed the absorption-inhibition ABO typing technique.		
1937	→ Holzer published the first paper on secretor status for forensic applications. Walter Specht developed the chemiluminescent reagent luminol to test for blood.		
1940	Landsteiner and A.S. Wiener first described Rh blood groups.		
1945	Frank Lundquist developed the acid phosphatase test for semen.		
1946	Mourant first described the Lewis blood group system. R.R. Race first described the Kell blood group system.		
1950	M. Cutbush, and colleagues first described the Duffy blood group system.		
1951	F.H. Allen and colleagues first described the Kidd blood grouping system.		
1958	A. S. Weiner and colleagues used H-lectin to positively determine O blood type.		

Detailed History of Serology and DNA 2

- 1958 A. S. Weiner and colleagues used H-lectin to positively determine O blood type.
- 1960 Maurice Muller used the Ouchterlony antibody-antigen diffusion test to determine species.
- 1964 N. Spencer et al. identified the polymorphic nature of red cell phosphoglucomutase (PGM).
- 1966 Culliford and Wraxall developed the immunoelectrophoretic technique for haptoglobin typing in blood stains.
- 1967 Culliford initiated gel-based methods to test for isoenzymes in dried blood stains. Developed and disseminated tests for proteins and isoenzymes in blood, body fluids and secretions.
- 1968 Spencer et al. identify the polymorphic nature of red cell adenosine deaminase (ADA).
- 1971 Culliford published *The Examination and Typing of Bloodstains in the Crime Laboratory*.
- 1973 Hopkinson and colleagues first identified the polymorphic nature of esterase D (ESD).
- 1978 Wraxall and Storolow developed the "multisystem" method for testing the PGM, ESD, and GLO isoenzyme systems simultaneously. Developed methods for typing blood serum proteins such as haptoglobin and Gc.
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- 1983 → Kerry Mullis, Cetus Corp, develops polymerase chain reaction (PCR). Published in 1986.
- 1984 → DNA profiling, first DNA 'fingerprint', discovered by Dr. Alec Jeffries of the Lister Institute of Leicester University, England. It involved detection of multilocus RFLP pattern. He published his findings in *Nature* in 1985.
- 1986 → Henry Erlich, Cetus, developed PCR technique for clinical and forensic applications. Resulted in first commercial PCR typing kit, HLA DQ-alpha (DQA1), specifically for forensic use. In *People vs. Pestnikas*, PCR-based DNA testing (HLA DQ-alpha) used to confirm different autopsy samples are from the same person. First DNA tests accepted by U.S. civil court.
- 1987 → Jeffreys used DNA profiling to identify Colin Pitchfork as the murderer of two young girls in the English Midlands. In the same case DNA exonerated an innocent suspect. RFLP used in U.S. criminal court to convict Tommy Lee Andrews of sexual assaults. *New York v. Castro*, admissibility of DNA challenged. Leads to quality control guidelines.
- 1990 → K. Kasai et al. suggest the D1S80 locus (pMCT118) for forensic DNA analysis.
- 1992 → Nat. Res. Coun. Com. on Forensic DNA publish *DNA Technology in Forensic Science*. Thomas Caskey et al. publish work on Short Tandem Repeats for forensic DNA analysis.
- 1994 → Roche released 5 additional DNA markers to add to HLA-DQA1 for forensic DNA typing.
- 1996 → Nat. Res. Coun. Com. on Forensic DNA publish *The Evaluation of Forensic DNA Evidence*. *Tennessee vs Ware*, mitochondrial DNA typing admitted in a U.S. court.
- 1998 → FBI DNA database, enabling interstate cooperation in lining crimes, was put into practice.

Small Group Exercise 1

What samples provide DNA?

- DNA can be typed from a number of different types of samples and sources. You have a missing person and there are no known blood samples available as a reference.
- In your small groups, list all types of samples you believe will provide DNA typing results that may provide a reference for the missing person. Start with the ones with the highest probability of typing.
- You have 10 minutes to complete, review and edit your lists
- Be sure that all members of your group sign and print their names and submit the list

DNA Chant

The subject of the course today (me)
Is simply stated DNA (you)
Sugar-Phosphate backbone chains (me)
Hold the base pairs heres their names (you)

Chorus: AT(me)- AT(you)
GC(me)- GC(you)
ATGC, ATGC (together)

RFLP holy grail
Put bad guys away in jail
PCR can lend a hand
Amplifying those weak bands ----->**Chorus**

Blood, saliva, semen too,
Can be used as crucial clues
Fingernails and skin and hair
DNA is everywhere ----->**Chorus**

Office Hours Policies

- Set up 15 minute appointments by email steven.lee@sjsu.edu
- **Benefits (to you and me)**
 - Review the course material.
 - Show me how hard you are working
 - Provide feedback
 - Ask specific questions or Ask for help
 - Extra credit may be provided for coming to discuss questions on the reading, exams, DNA, assignments, forensics, news articles, department, college and campus scholarships...etc