

UCLA
Dr. Bob Goldberg
**HC70A: Genetic Engineering in Medicine, Agriculture
and Law**

*An Introduction to Forensic DNA Analysis &
Crime Scene Investigation*

Presented by
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UCLA, '88 - B.Sc. in Microbiology
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(Molecular Biology)

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My career (so far)

- Criminalist, start date 11/26/1990
 - LAPD Crime Lab
 - Serology Unit, 11/90-5/92 & 1995-present
 - OTJ training in the fundamentals of CSI, lab work
 - FBI Academy April-May 1991
 - Blood Alcohol Unit 1993-1995
 - Fellow, American Board of Criminalistics 1995
 - Forensic Accident Investigation Team 1994-2003
 - Criminalist-III, July 1997
 - DNA Technical Leader 2000-2011
 - Supervising Criminalist, December 2008
 - High-profile cases: “North Hollywood Shoot-out”, Ennis Cosby murder case, Yoo family inv., etc.
 - CSI >>300
 - Expert witness testimony >>100

Criminalist

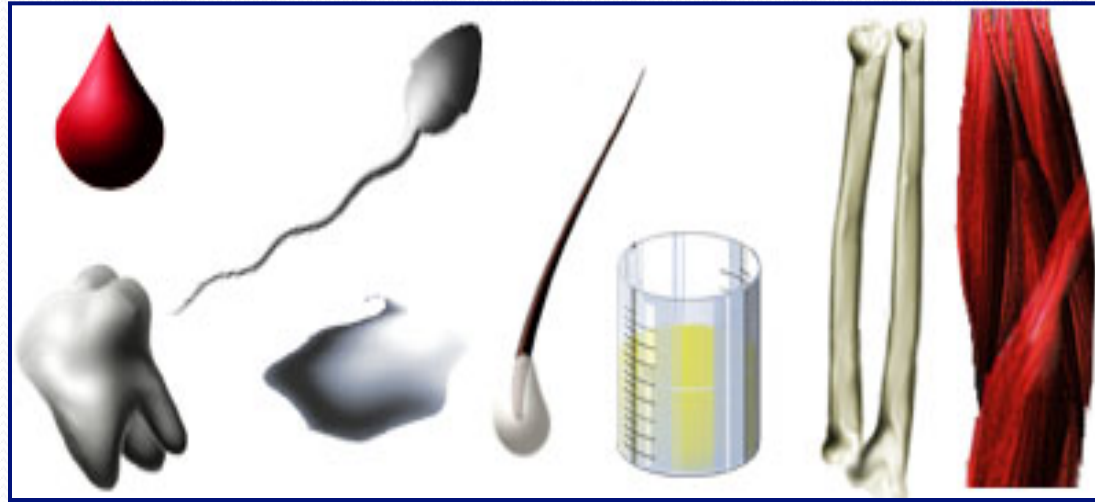
- What does a Criminalist do?
 - Crime scene investigation
 - A Criminalist searches for, collects and preserves physical evidence as part of criminal investigations.
 - Lab work:
 - Toxicology, Blood Alcohol, Narcotics, Trace Analysis, Serology/DNA, Firearms, Questioned Documents.
 - Criminalists analyze physical evidence and prepare written reports regarding their findings.
 - Courtroom testimony

Objectives of forensic DNA analysis

- LAPD DNA Detail:
 - To link an individual to a crime scene or criminal act.
 - To exclude suspects, persons of interest or consensual partners.

Sources of DNA in biological material

- Blood
- Semen
- Saliva
- Hair



- Teeth
- Bone
- Tissue
 - Urine??



Bloodstain

Only a very small
bloodstain is
needed to obtain a
DNA profile.

Locations of potential evidence

- Saliva: Envelopes, stamps, stocking masks, ski masks, bite marks or other sites of oral contact (from licking, sucking, etc.).
- Clothing: Obvious body fluid stains and on places of potential wear and contact (neckline, underarm area, inside of hat brims, gloves, and waist areas).
- Personal items: Jewelry, eyeglasses, and wristwatches.
- Cigarette butts



Touch DNA

- Humans shed tens of thousands of skin cells each day, and these cells are transferred to every surface our skin contacts.
- Touch DNA has been successfully sampled (by swabbing) items such as door knobs, steering wheels, gun grips, and eating utensils.



Other potential evidence

- Latex gloves found near a scene may have been discarded by the perpetrator.
- Open beverage containers, chewed gum, or partially consumed food left at scene.



iClicker question

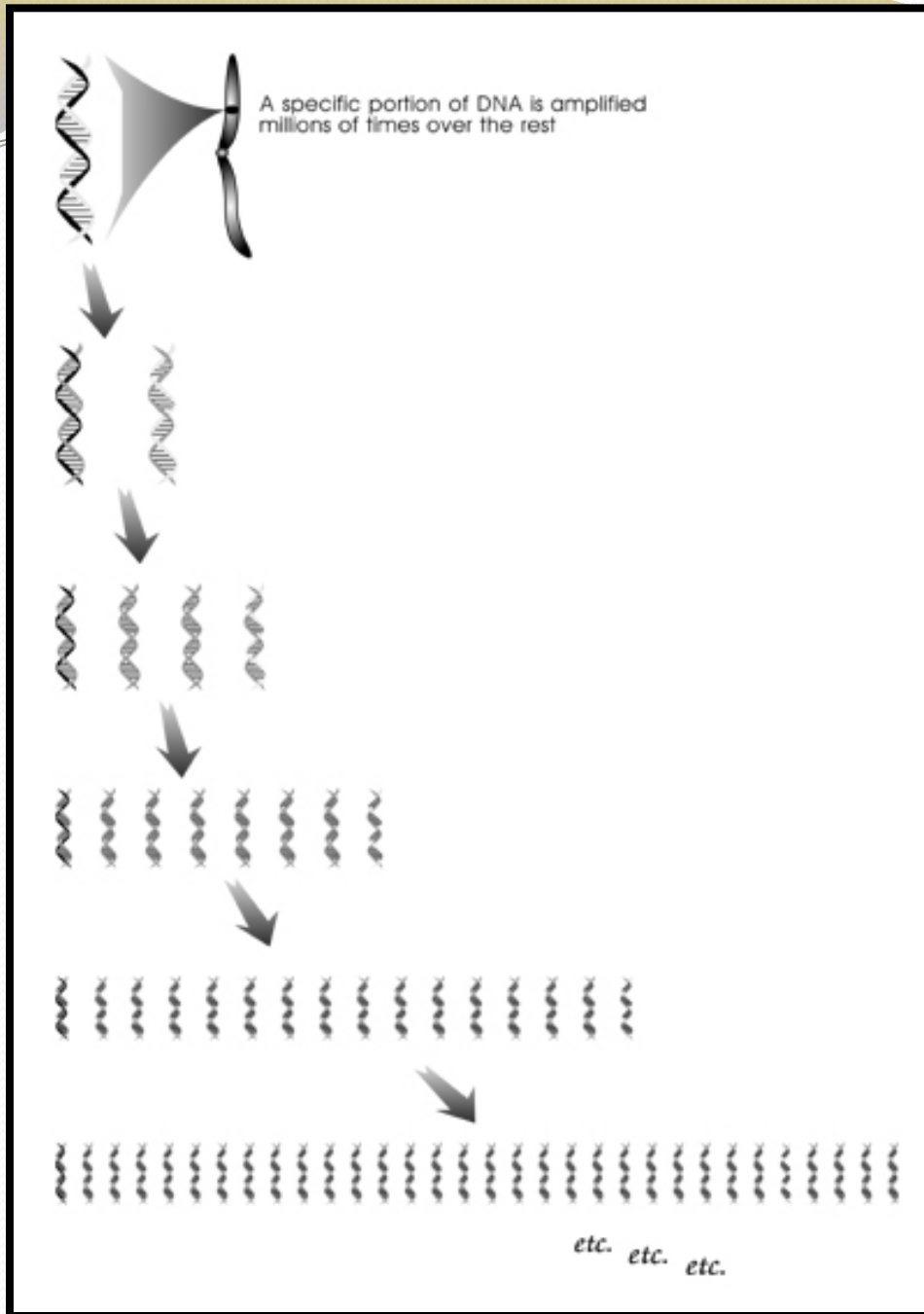
- What is a common type of biological evidence encountered at a burglary crime scene?
 - A. Urine.
 - B. Touch DNA.
 - C. Human bone.
 - D. Neanderthal DNA.

PCR



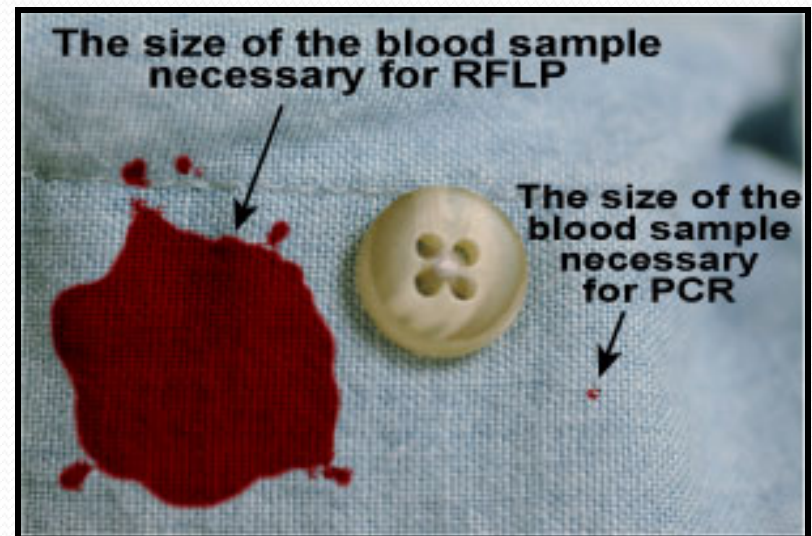
Dr. Kary Mullis
Nobel Laureate

- **Polymerase Chain Reaction**
 - “molecular Xeroxing”
- Three temperature phases, carried out in a thermal cycler instrument, replicate or “amplify” the desired DNA fragments.



PCR

Polymerase Chain Reaction



The current method of choice: autosomal Short Tandem Repeats (STRs)

- Non-coding, tetra-nucleotide sequences
DNA sequences which vary greatly from
person to person (polymorphic).
- Requires 0.5-1.0 nanograms of DNA to
type 15 STR loci (markers).
 - ~75 (diploid) -150 (haploid) cells!
- Random Match Probability ranges from
 10^{14} - 10^{23} (100 trillion to 100 sextillion)
 - World population est. 7×10^9 (7 billion)

Steps in STR DNA typing

“Why does it take so long? On “CSI” TV show they can do it in an hour!”

- The process:

- Select swab/stain (1 hour)
- Extract DNA (6 hrs-O/N)
- Quantify human DNA (RT-PCR) (3 hrs)
- Amplify human DNA (PCR) (4-5 hrs)
- Prep samples for analysis; set-up instrument (1-2 hrs)
- AB 3130 CE “run” (12 hrs)
- Data analysis (2-3 hrs)
- Report writing, tech and admin reviews (1-2 days)

(1) evidence sample plus standards and controls.

Total Time: 5-6 days

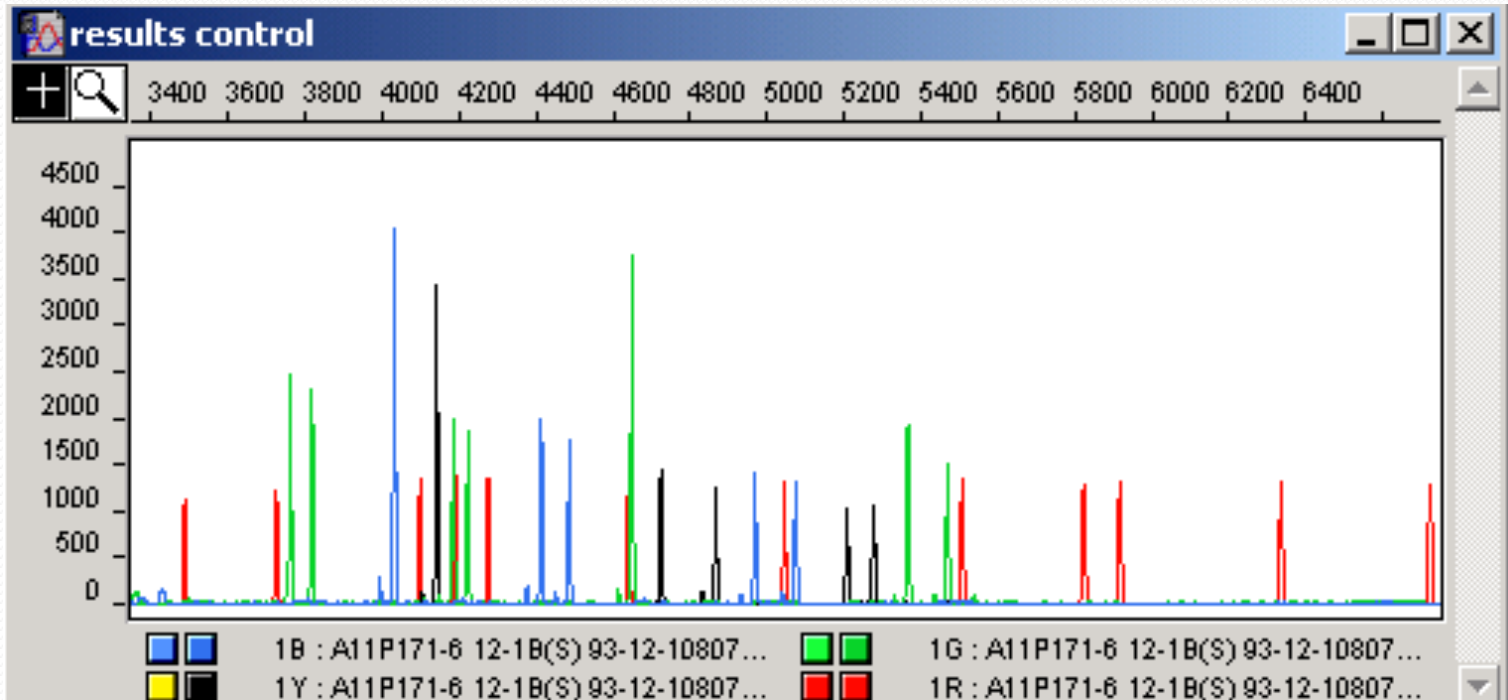
Applied Biosystems 3130 Genetic Analyzer



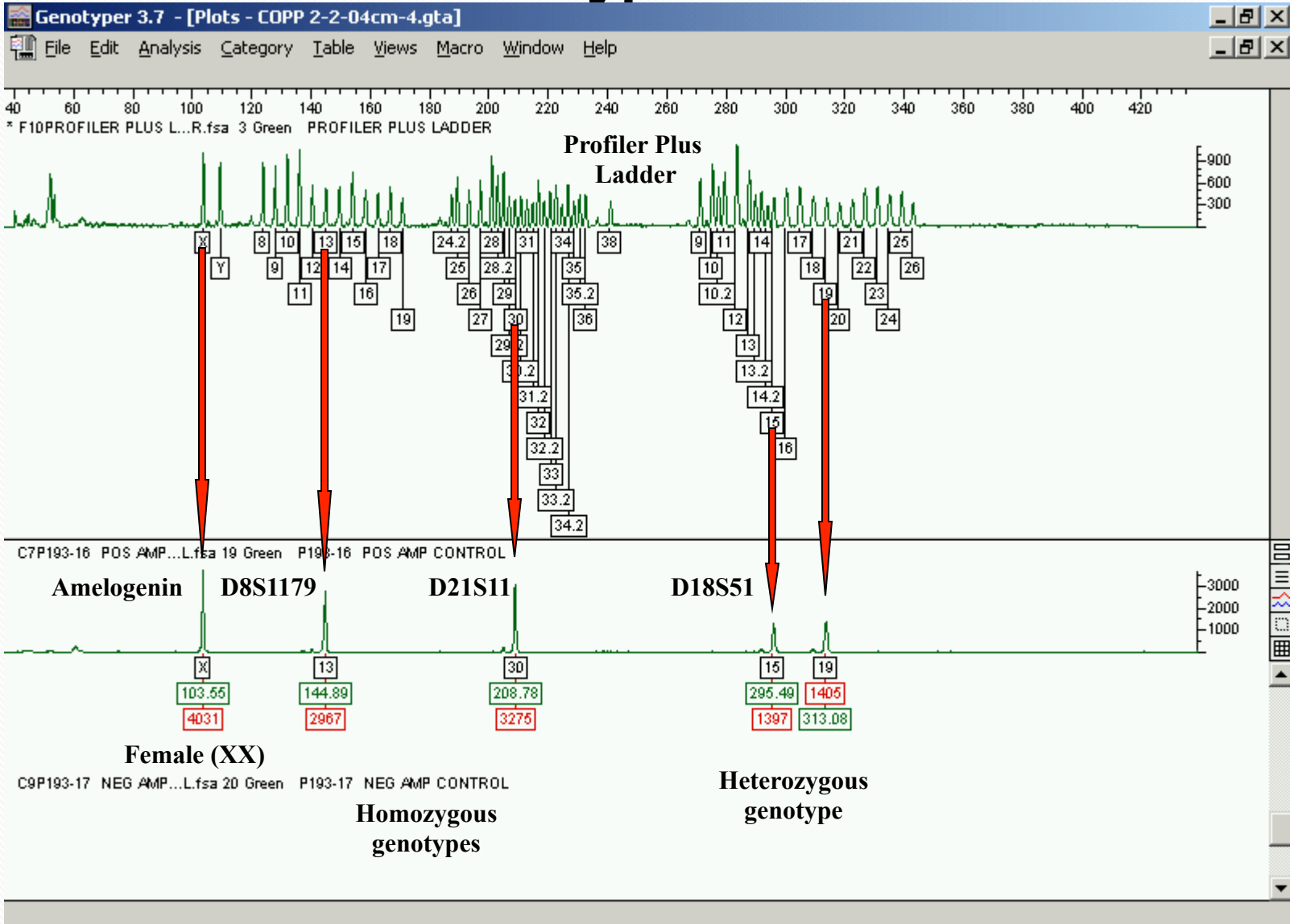
iClicker question

- Which of the following choices is not an advantage of Short Tandem Repeat (STR) DNA typing?
 - A. A 15-locus STR profile is rare.
 - B. Requires a small test sample.
 - C. Polymorphic loci.
 - D. All of the above.

STR raw data



STR typed data



Item #25 – vaginal swab

S – sperm fraction

E – epithelial fraction

STR profiles

STR TYPING SUMMARY SHEET

Date:			DNA Analyst / Serial #:							DR #:			
9/24/1999			MATTHIES V9780							00-00-00001			
Item #	AMEL	D3S1358	vWA	FGA	D8S1179	D21S11	D18S51	D5S818	D13S317	D7S820	D16S539	TH01	TPOX
25(S)	X, Y	17	15, 17	23, 26	14, 15	26	12, 15	10	9, 13	8, 10	9, 10	8, 9	9, 10
	X, Y	17								8, 10			
25(E)	X	15, 17	16, 18	19, 26	15	28, 32.2	14, 16	8, 13	12	11	11, 12	7, 8	11
	X	15, 17								11			
VICTIM	X	15, 17	16, 18	19, 26	15	28, 32.2	14, 16	8, 13	12	11	11, 12	7, 8	11
	X	15, 17								11			
SUSPECT	X, Y	17	15, 17	23, 26	14, 15	26	12, 15	10	9, 13	8, 10	9, 10	8, 9	9, 10
	X, Y	17								8, 10			

“The DNA profile obtained from Item #25 (sperm fraction) matches the DNA profile of the suspect. The combination of genetic marker types exhibited by Item #25 (sperm fraction) and the suspect occurs in approximately one in one hundred quadrillion (10^{17}) unrelated individuals in the general population.”

The Combined DNA Index System (CODIS)

- Convicted Offender and Forensic databases are maintained.
 - Local (LDIS), State (SDIS) and National databases (NDIS)
- Laws concerning who is eligible for the database vary from state to state.
- US National database (as of Dec. 2011):
 - 11,423,117 offender profiles
 - 408,951 forensic profiles
 - >168,500 “hits”
 - <http://www.fbi.gov/about-us/lab/codis/ndis-statistics>

iClicker question

- The profile matching the suspect occurs in approximately 1 in 100 quadrillion (10^{17}) unrelated individuals. Do you think this indicates identity? (The semen came from the suspect and only the suspect.)
 - A. What does Nancy Grace say?
 - B. No.
 - C. I don't know.
 - D. Yes.

California CODIS stats

(Dec. 2011)

- 1,384,862 Offender profiles
- 33,710 Forensic profiles
 - LAPD DNA Detail uploads forensic (crime scene) profiles to SDIS located at the CA DOJ DNA Laboratory in Richmond, CA.
 - CA DOJ Richmond uploads DNA profiles received from 22 CA law enforcement DNA laboratories to NDIS located at the FBI Laboratory in Quantico, VA.

iClicker question

- Prop 69 now permits collection of DNA samples from adults and juveniles arrested for any felony offense. Are you in favor of DNA collection on all arrested individuals?
 - A. Yes.
 - B. No.
 - C. The jury is out.
 - D. It's the law. It must be good.