Introduction to Genetics, Ethics, & Society

BIOS 232

Course overview

1. Connect the historical context of genetics research to its modern-day practice
2. Evaluate the social and ethical implications of genetics research
3. Analyze how societal norms and structures, along with personal identities, biases, and responsibility, impact the conduct of scientific research

Week 1: Principles of Bioethics Science and Society History of Heredity

Week 2: Human Genetic Data Race, Ancestry, Genetics, and Identity

Week 3: Reproductive Genetics **Criminal Justice** Reflections and Actions

Session 6: Genetics and Criminal Justice; Ideation and Action

Learning goals

- Identify the role of genetics in the criminal justice system via forensic applications and genetic databases
- Design potential safeguards of current and future uses of genetics in the criminal justice system
- Evaluate scientists' role and responsibilities regarding applications of genetics in the criminal justice system
- Ideate ways to make existing academic structures more equitable, inclusive, and just, and will create actionable goals to do so

Taught by Emily Greenwald & Daphne Martschenko

Outline

- Mini-lecture on CODIS and DNA databases
  - Way more to criminal justice and genetics that we encourage you to read about after class!
- Read articles about example uses of genetics in forensics and discuss
- Activity: Develop chart of safeguards and scientists' role
- End of course: Ideation and action

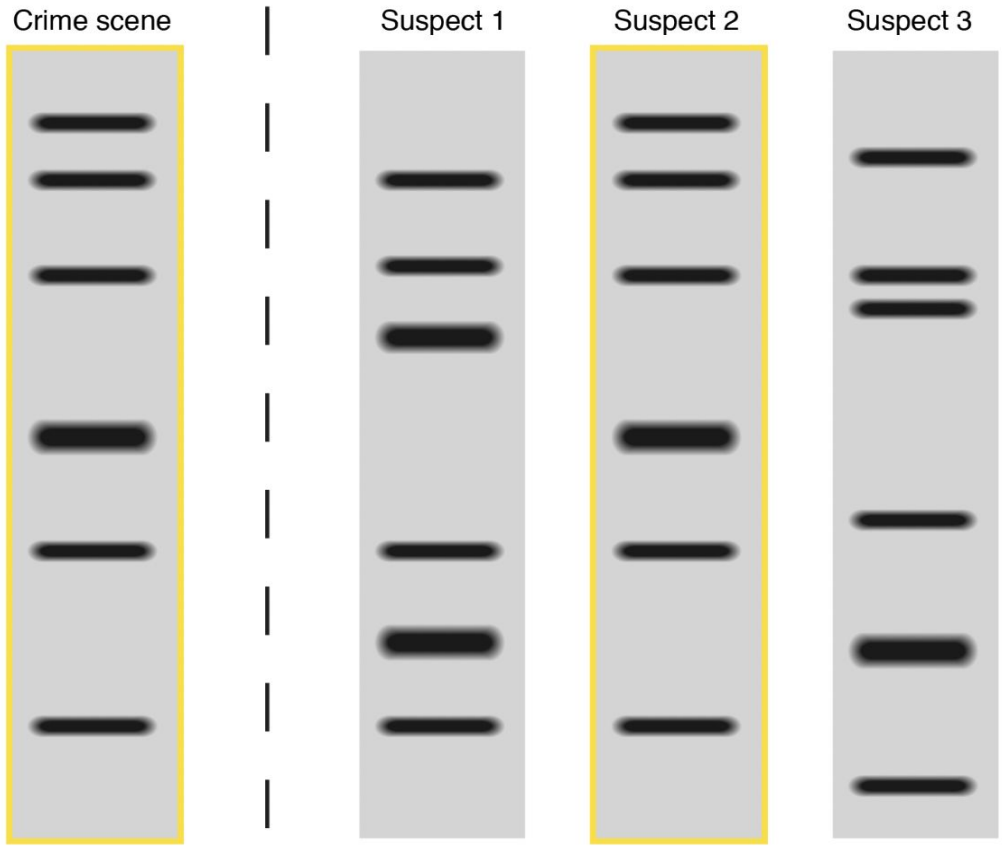
Applications of Genetic Data: Criminal Justice and Forensics

Fingerprints can be used to identify people

(Image: Win *et al.* 2020. *Future Gen Comp Sys.)*

DNA fingerprinting:

- DNA extraction
- PCR amplification
- Gel electrophoresis
- Profile matching



(Image: Green, E. NHGRI. *genome.gov*)

DNA fingerprinting: CODIS loci

- CODIS stands for Combined DNA Index System
- Short tandem repeats
- Noncoding

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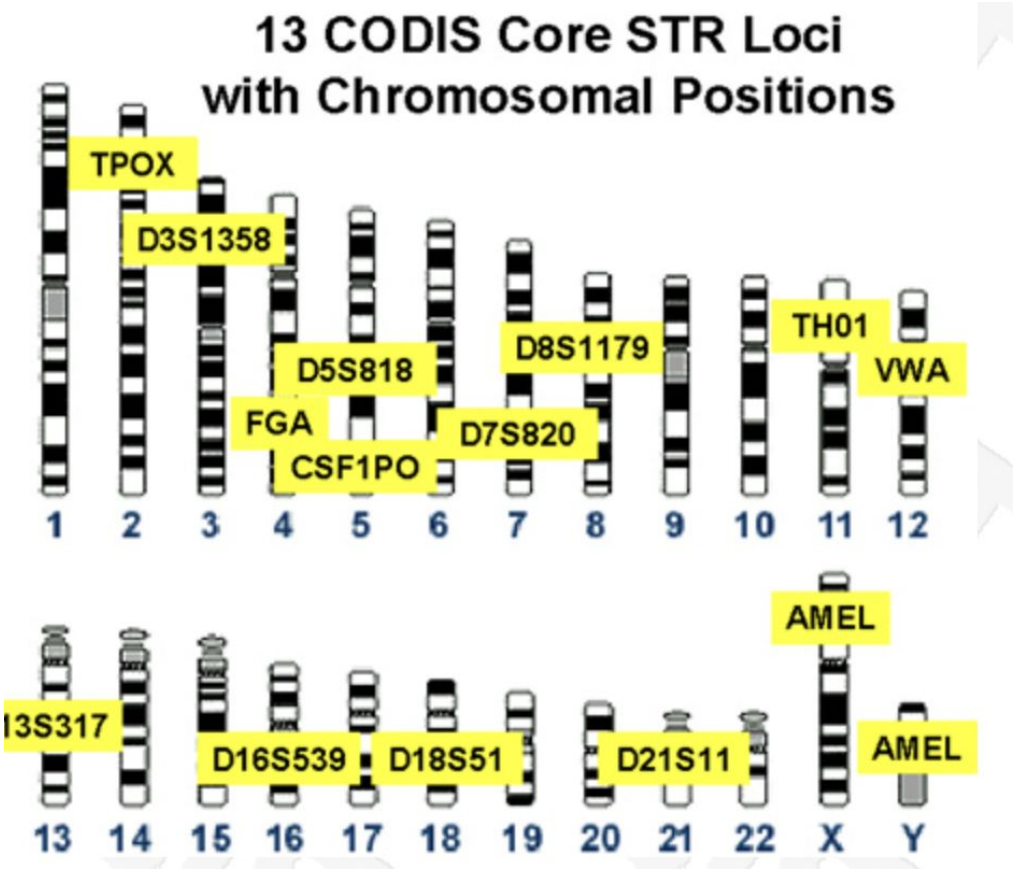
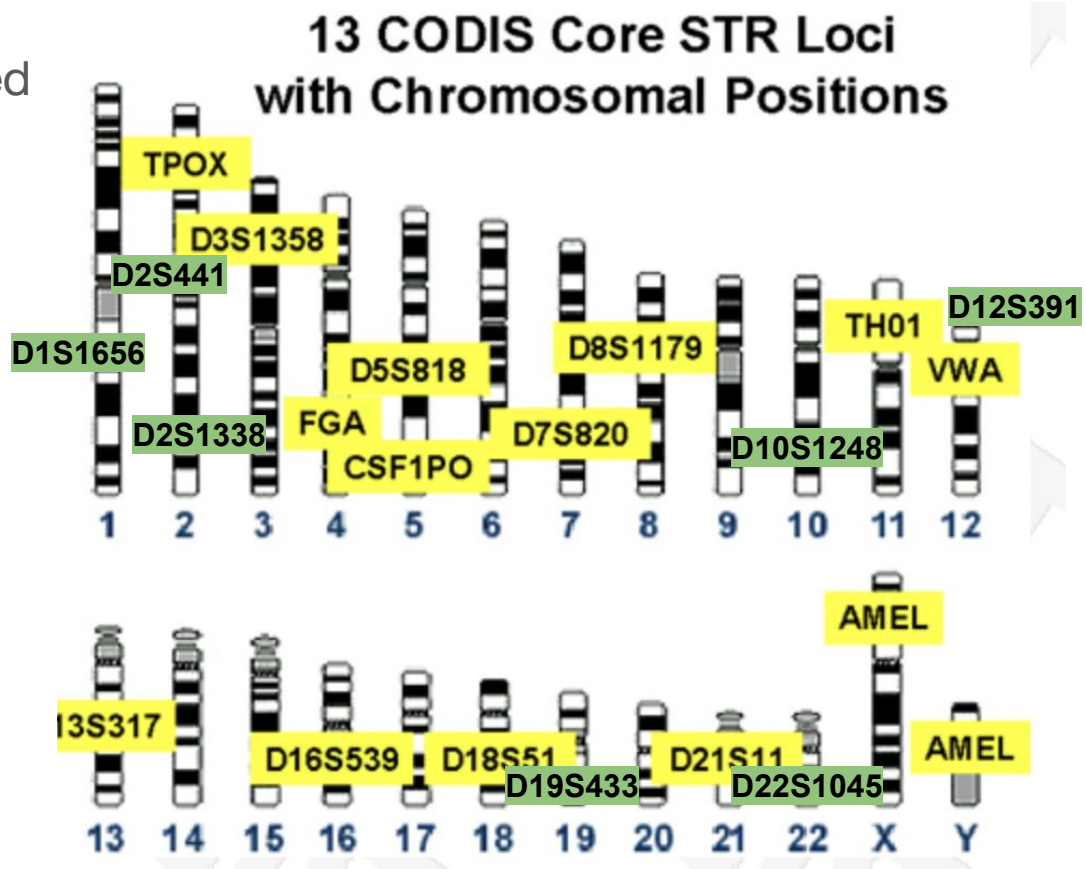


(Image: National Institute of Standards and Technology. 2015. *strbase.nist.gov*)

DNA fingerprinting: CODIS loci

- CODIS stands for Combined DNA Index System
- Short tandem repeats
- Noncoding
- Updated to 20 loci in 2017

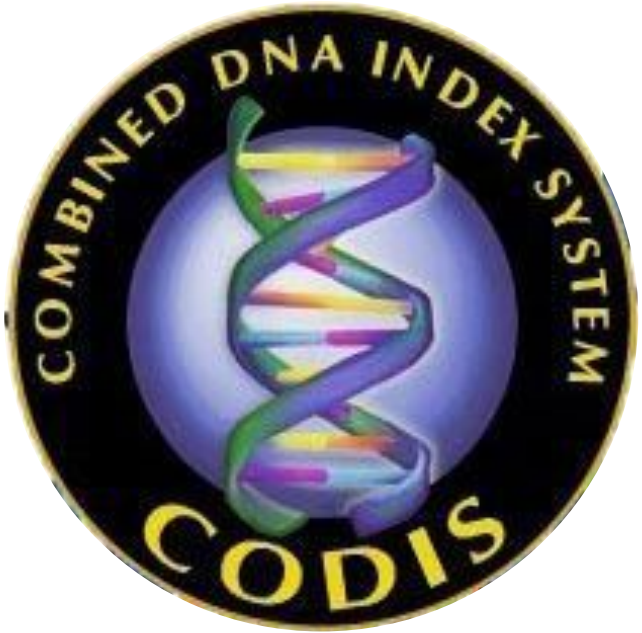


(Image: National Institute of Standards and Technology. 2015. *strbase.nist.gov*)

What is “CODIS”?

- CODIS stands for Combined DNA Index System

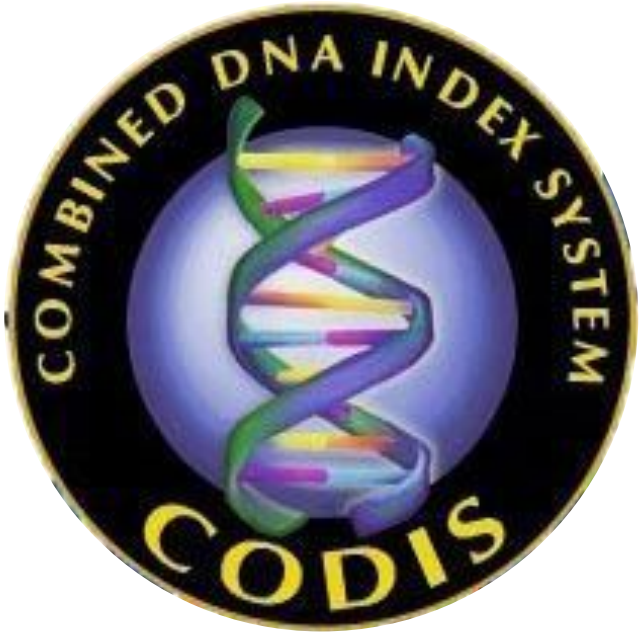
- CODIS refers to the FBI databases, the software used to maintain them and perform analyses, and the genetic loci sequenced for these purposes



(Image: Biometric Analysis: Combined DNA Index System (CODIS). *FBI.gov*)

What is “CODIS”?

- CODIS stands for Combined DNA Index System
- CODIS refers to the FBI databases, the software used to maintain them and perform analyses, and the genetic loci sequenced for these purposes
- DNA Identification Act of 1993 approved the creation of an “index,” or database that can be searched for genetic matches
    - Used for criminal proceedings and identifying human remains



(Image: Biometric Analysis: Combined DNA Index System (CODIS). *FBI.gov*)

Questions on CODIS?

Databases are searched for matches to crime scene DNA

- There are national, state, and local databases (Office of the Inspector General. 2006. *CODIS Audit.*)

- In 12 states as of 2018, partial-matches to crime scene DNA are used for familial searches (Grabell, Shomron. 2021. *Methods Mol Bio*.)

- **Arrestees**, regardless of conviction status, can have DNA collected and added to CODIS databases in 30 states (*FBI.gov)*

Databases are searched for matches to crime scene DNA

- “Celebrated” 20 millionth genetic profile in 2021
  - Almost 15 million offender profiles
  - Over 4.5 million arrestee profiles
  - Over 1.1 million forensic profiles

- CODIS has yielded almost 600,000 genetic matches with crime scene OR human remains DNA, and helped with almost as many investigations

(CODIS and NDIS Statistics. 2021. *FBI.gov)*

California allows arrestees to be added to CODIS database and has the most information in the FBI database

California

	Statistical Information	Total
Convicted ⇨	Offender Profiles	2,152,679
Not convicted ⇨	Arrestee	909,059
	Investigations Aided	102,341

(Images: CODIS and NDIS statistics. 2021. *FBI.gov*.)

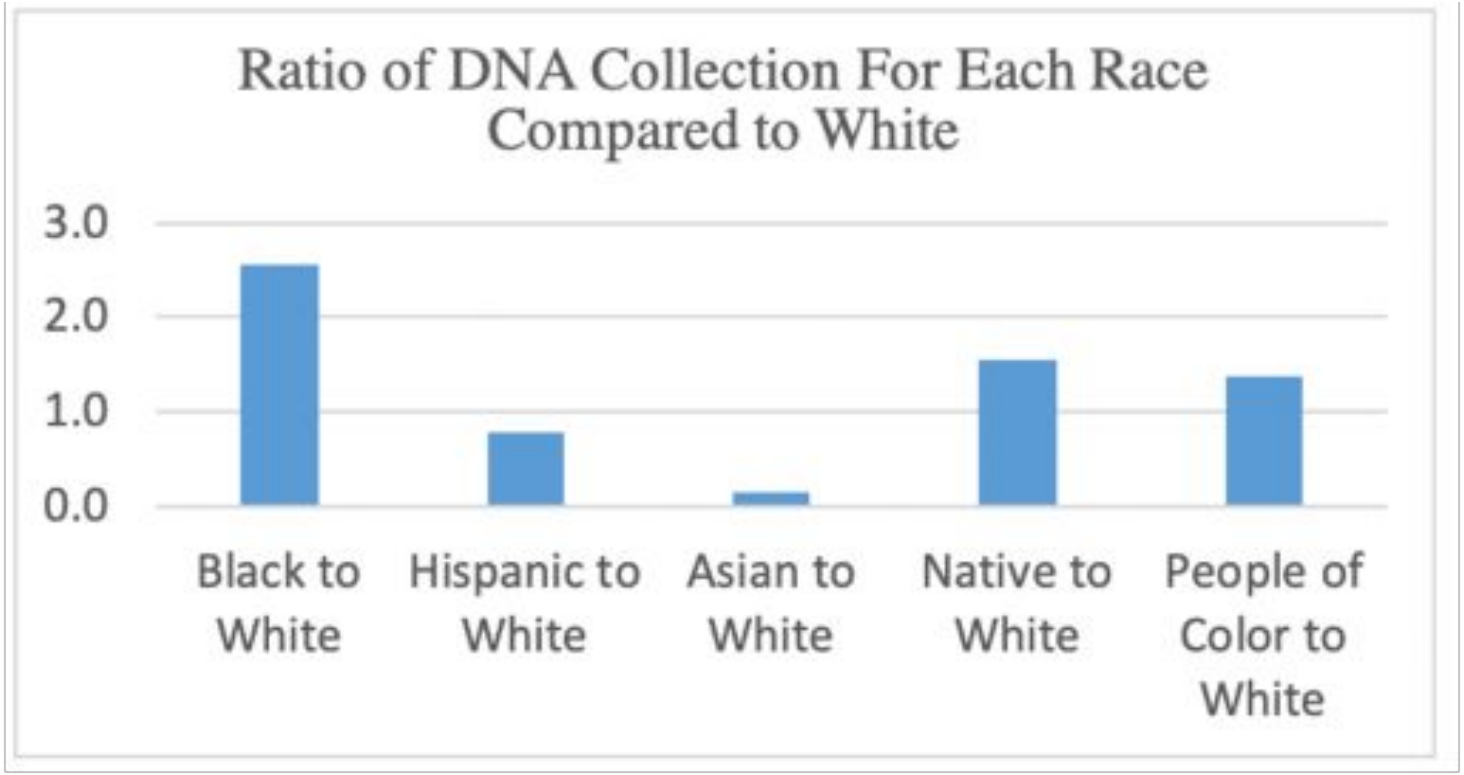
Louisiana has nearly three times the number of arrestee profiles than offenders in the FBI database

Louisiana

	Statistical Information	Total
Convicted ⇨	Offender Profiles	155,821
Not convicted ⇨	Arrestee	457,523
	Investigations Aided	11,293

(Images: CODIS and NDIS statistics. 2021. *FBI.gov*.)

Racial biases of genetic databases



(Images: Murphy, Tong. 2020. *CA Law Review*.)

Questions on databases?

Important applications of forensic genetics beyond criminal proceedings

- Exonerations of wrongfully convicted people
- Identifying human remains
- Reuniting families that have been separated

Questions?

Reading + small-group discussion (15 min)

7 min Read the article assigned to your group

7 min Small group discussion

- How was genetics used in this case?

- What, if any, were the benefits of using genetics in this case?

- What, if any, were the harms of using genetics in this case?

Chart activity (20 min)

Get together with people who read DIFFERENT articles from yours (ideally someone who represents each article).

- What safeguards can we put into place as a society, policymakers, government officials, the public?

- Which of these safeguards and responsibilities should scientists be involved in and how?

Feel free to use the internet, the in-class readings, and lecture in developing your chart.

Chart building activity: Example

Scenario (if helpful)	Safeguards	Should scientists be involved?	What is the ideal role of scientists?

Chart building activity: Example

Safeguards	**Should scientists be involved?**	**What is the ideal role of scientists?**
Ensuring juries and defense attorneys know the potential for false positives		

Chart building activity: Example

Safeguards	**Should scientists be involved?**	**What is the ideal role of scientists?**
Ensuring juries and defense attorneys know the potential for false positives	yes	Educate public and lawyers about false positives with few loci in genome

Chart building activity

- What what safeguards can we put into place as a society, policymakers, government officials, the public?

- Which of these safeguards and responsibilities should scientists be involved in and how?

- How can we advocate for implementing these? What actions can we (as scientists or members of the public) take to get there?

Large group share-out (10 min)

Ideation and Action

We have discussed strengths and shortcomings of equity, justice, and inclusion at the intersection of ethics and science.

Discuss with a partner (5 min)

- What is your “big dream” for science as an ethical institution? What would it look like in an ideal world?
- What is your “big dream” for yourself, as an individual scientist?
- (optional) How has this class changed your answers to these questions?

What actions can we take? (10 min)

With a partner:

- Fill out the spreadsheet while talking through it
- Spend 5 minutes per person total

What actions can we take? (14 min)

With a partner:

- Fill out the spreadsheet while talking through it
- Spend seven minutes per person total
- *Write a goal or two on a post-it note and put in the front*

Group share-out (10 min)

- What goals did you set that can be accomplished in the near term?
- What goals did you set that are more big picture?

Learning goals

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THANK YOU!

Introduction to Genetics, Ethics, & Society

Stanford | Ethics, Society, & Technology Hub

THANK YOU!

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Optional research survey

15 mins

This survey will be available for 24 hours to complete

bit.ly/bios232-exit

Readings: Cases that used forensic genetics

- Golden State Killer
- San Francisco sexual violence survivor's DNA was added to a local genetic database and they were later arrested for a property crime
- Reuniting separated families
- Exonerating wrongfully convicted individuals

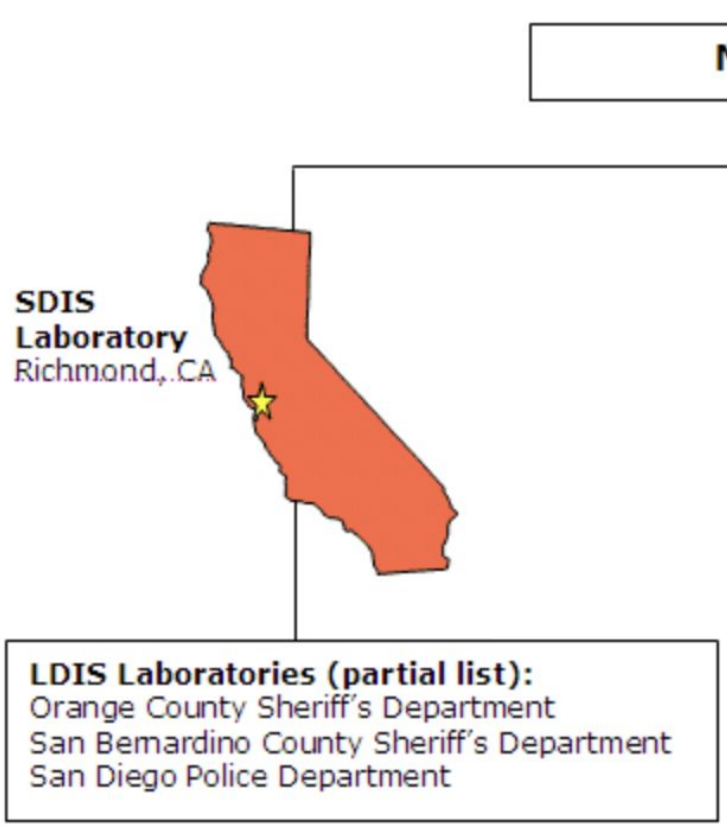
Serial killer cases that used forensic genetics

- Grim Sleeper - 2010, familial search through CODIS database, confirmed from discarded piece of pizza

- Golden State Killer - 2018, familial search through genealogy platform

Blood type can be used to determine whether someone was not at a crime scene

DNA Database Structure



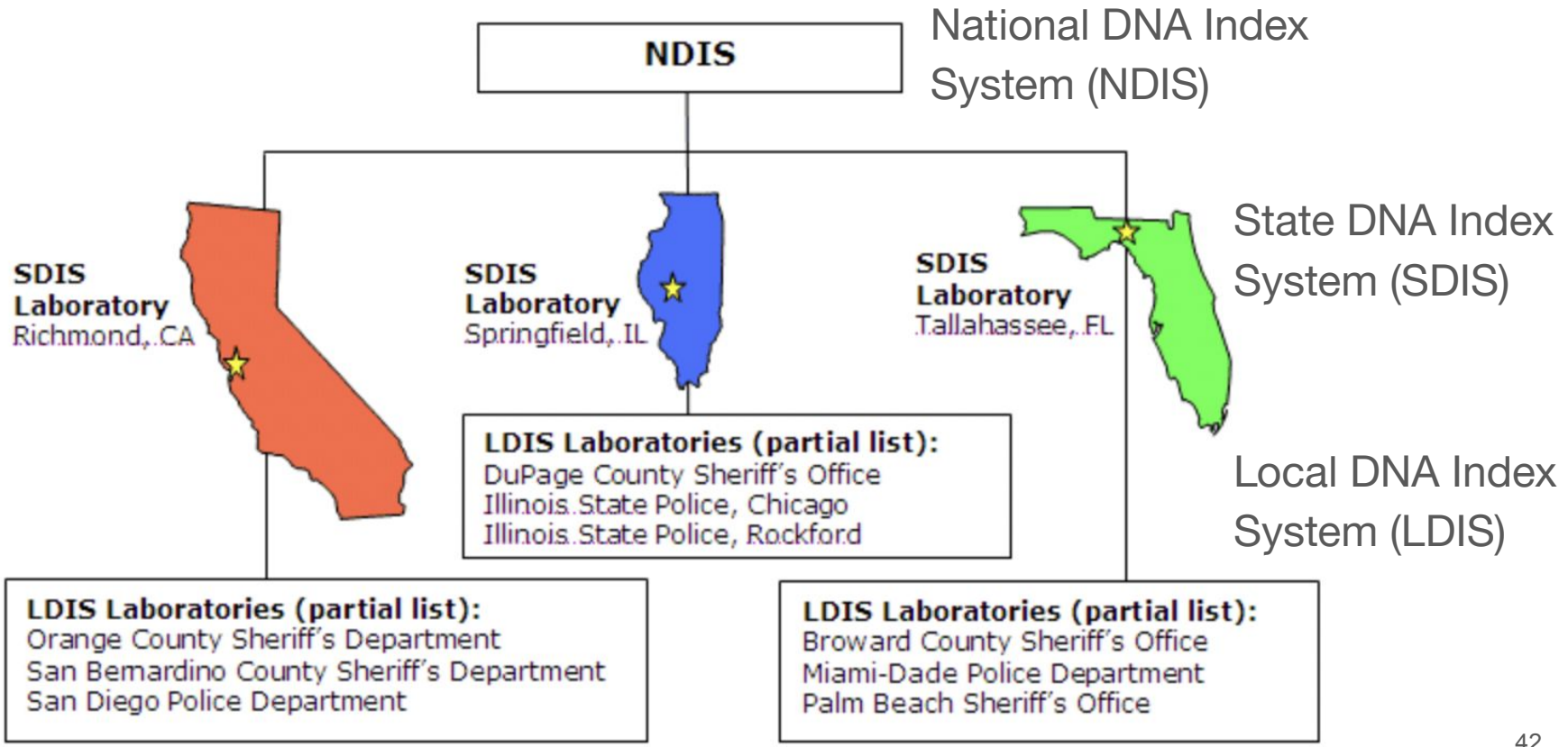
National DNA Index System (NDIS)

State DNA Index System (SDIS)

Local DNA Index System (LDIS)

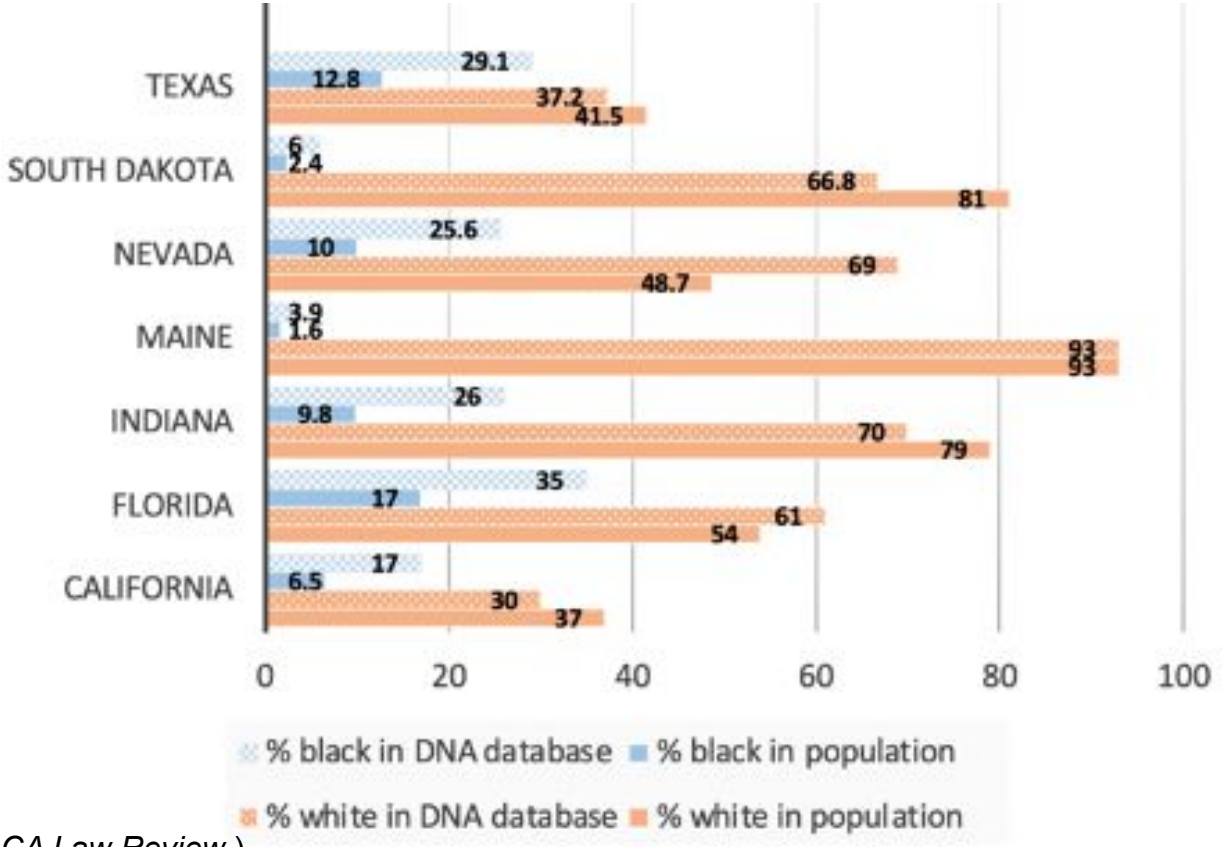
(Image: Office of the Inspector General. 2006. CODIS Audit).

DNA Database Structure



(Image: Office of the Inspector General. 2006. CODIS Audit).

Racial biases of genetic databases



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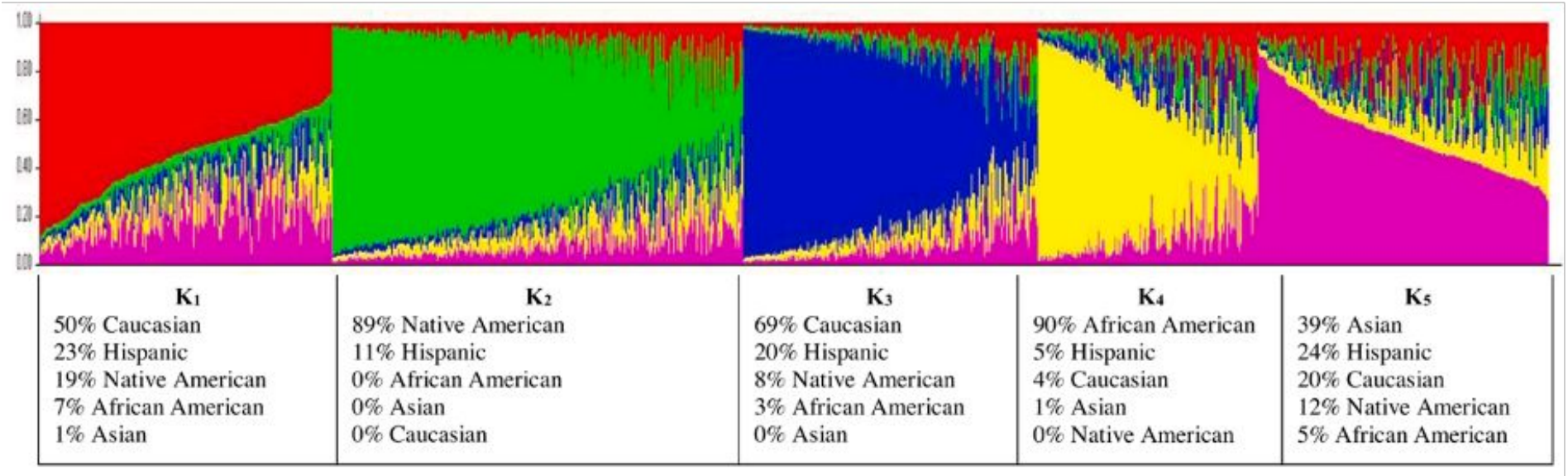
Racialized calculations and CODIS loci in ancestry studies



K_1	K_2	K_3	K_4	K_5
50% Caucasian	89% Native American	69% Caucasian	90% African American	39% Asian
23% Hispanic	11% Hispanic	20% Hispanic	5% Hispanic	24% Hispanic
19% Native American	0% African American	8% Native American	4% Caucasian	20% Caucasian
7% African American	0% Asian	3% African American	1% Asian	12% Native American
1% Asian	0% Caucasian	0% Asian	0% Native American	5% African American

(Image: Oldt, Kanthaswamy. 2020. *Legal Medicine*.)