What is DNA?

“The Blueprint of Life”
DNA Structure and Location

- Four bases: A, T, C, G
- Spiral staircase (Double helix)
- Genes and non-coding regions
- All nucleated cells
Location of DNA in the Cell

- Mitochondria
- Nucleus
- mtDNA
- Nuclear DNA
Useful DNA Facts

- Inherited
- Same only in identical twins
- Stays the same for life
- Same in every cell
- Stable in dry conditions
DNA Analysis

• PCR amplification
  • Copies small amount of DNA
  • Look at 16 different areas of DNA

• STR Typing
  • “1 in 100 million billion”
  • Identity statement
DNA Analysis

• Step 1
  • Extract and purify DNA

• Step 2
  • Quantitate
DNA Analysis

- Step 3
  - Amplify (make copies)

- Step 4
  - Separate and detect
PCR Amplification of DNA
PCR Advantages

- Requires small sample size
- Old/degraded samples may give results
- Can be automated
Future of DNA Testing

- Mitochondrial DNA (mtDNA)
  - Transmitted through maternal line
  - Works on samples without nucleus (hair shafts)
Future of DNA Testing

• Y Chromosome DNA
  • Transmitted through paternal line
  • Useful in resolving DNA mixtures in sexual assaults
Future of DNA Testing

- Automation
  - Relieve backlog
  - Process offender samples

- Miniaturization
  - Portable, typing done at scene
  - Direct access to database from scene
Future of DNA Testing

CODIS (*Combined DNA Index System*)
- Convicted offender profiles
- No suspect cases
- Cold cases
Future of DNA Testing

NDIS (National DNA Index System)

- Re-examination of old cases where conviction was based on non-DNA evidence
Cold Case Testing
What is a “Cold Case”?

“…cases that other investigators, for whatever reason, could not solve.”

- Bureau of Justice Assistance Bulletin
Reasons for Cold Cases

- Rising crime rates
- Staff shortages
- Budget restrictions
Reasons for Cold Cases

• “Do more with less”
• Changing forensic laboratory policies
• Changing forensic laboratory priority/backlogs
Law Enforcement Responsibilities

- Identify cases with remaining biological evidence
- Of these cases, determine if material witnesses or victims are available
- Identify statute of limitation issues

-APRI
• Define categories of cases
• Case review
Cold Cases

• Locate case files
  • Reports
  • Evidence logs
  • Forensic testing reports
  • Previously tested evidence
  • Crime scene evidence containing biological evidence
Remember
Cold hits begin the investigation rather than end the investigation!
Cold Cases

- Evaluate probative DNA evidence & submit appropriate evidence for testing
- Consult with prosecutor & laboratory
- Continue investigative protocol
Cold Cases

- Identify witness issues
- Follow agency procedures for submitting DNA profile to CODIS
- Prepare a John Doe warrant if applicable
If a “Cold Hit” is Obtained

- Identify other unsolved cases believed to have been committed by the same offender

- Confirm the availability of biological evidence in those cases

-APRI
If a “Cold Hit” is Obtained

- Locate the suspect identified by the hit
- Obtain a confirmation sample
- Interview that suspect
- Complete the investigation
Unadjudicated Cold Hits

In the event the crime cannot be adjudicated, it may helpful for:

- Leverage for plea agreements
- Evidence of other crimes/bad acts

-APRI
Unadjudicated Cold Hits

In the event the crime cannot be adjudicated, it may helpful for:

- Enhancement of punishment at sentencing hearings
- Information to withhold parole
Evaluating Cold Cases for DNA

- Previous case activity
  - No viable suspect(s)
  - No evidence to link developed suspect(s)
- Review the case file
  - Investigative reports
  - Photographs
  - Evidence recovered
  - Forensic reports
Evaluating Cold Cases for DNA

Is the original investigator of assistance?
Locating Cold Evidence for DNA

- Locate and document the evidence packages
  - Police storage?
  - Court storage?
  - Laboratory storage?
  - Attics, desks, and vehicles?
  - Destroyed?
- Chain of Custody?
Evidence Evaluation

- Evaluate evidence with respect to the forensic laboratory’s capabilities

- Use a Forensic Scientist to assist this process!
Evidence Consumption

- US Supreme Court found that
  
  “[i]n general, the destruction or failure to preserve potentially useful evidence does not constitute a violation of the due process clause, unless it can be shown that the police, the prosecutor or the laboratory acted in bad faith.”


- Dixon v. State, 275 Ga. 232 (Georgia Supreme Court 2002)
Evidence Consumption

- “Half” Rule observed by some laboratories
  - No more than half of the evidence sample may be consumed
  - Repeat testing? Not possible by the original laboratory
- Check with your forensic laboratory to determine policy
Cold Evidence

• Each item of evidence has a history – can’t go back in time!

• Unintentional historical contamination
  • Police and crime scene personnel
  • Scientists – both DNA and other examiners
  • Jurors, lawyers, and some judges!
Overlooked Cold Evidence

• **TOUCH** evidence
  • Handles of weapons, ligatures, etc.

• **WEARER** evidence
  • Items of clothing, masks, etc.

• **ORAL** evidence
  • Bottles, utensils, etc.
Important DNA Principles To Consider

- DNA continues to degrade over time, although more slowly in cool, dry environment.

- mtDNA may also have been used in these types of cases
Advantages of Applying DNA to Cold Cases

- Advanced DNA capabilities
  - “Do more with less” evidence sample
  - Results are more discriminating
    » Not to be confused with “accurate”

- Use of DNA Data Bank in the absence or elimination of a suspect
  - State
  - National (NDIS)
Law Enforcement Responsibilities

- Identify which cases
  - Were closed before DNA evidence was available to the jurisdiction
  - Still have biological evidence remaining and the location of that evidence
  - Resulted in a conviction of a person who is still alive

-APRI
Post-Conviction Cases

• Share many of the same evidence issues as cold cases

• Must consider possible contamination by
  – Attorneys
  – Judges
  – Juries from original trial
How DNA Helps Solve the Crime

DNA Extraction → Quantitation of DNA

PCR Amplification → Separation & Detection of PCR Products → Genotyping

Comparison of Geontype to Other (Known) Sample Results
- If Genotypes Match, Compare DNA Profile to Population Databases
- Generate Report with Statistical Probabilities
Cold Case Summary

- Computerization of DNA profiles will enable us to:
  - Solve no suspect cases
  - Connect cases that no one knows were perpetrated by the same individual
Cold Case Summary

• It’s never too late to revisit cold cases

• We are able to use all parts of a human to solve crimes, from head to toe!
CODIS

Combined DNA Index System

- Enables state & local crime labs to exchange and compare DNA profiles electronically
CODIS

Contains two database files:

- Convicted offender file
  » Contains DNA profiles of offender convicted of a qualifying offense
- Forensic file
  » Contains DNA profiles developed from crime scene evidence
CODIS

- Convicted offender file match
  - Obtain warrant to confirm match

- Forensic file match
  - Investigators from different jurisdictions can exchange information
• Possible outcomes:
  • Link 2 or more unsolved cases
  • Link a solved case to an unsolved case
  • Link 2 or more solved cases
Using Results

Understanding “Hits” and “Misses”

The “Reality” of DNA evidence in our society.
Reality vs. T.V.

- Public perception is influenced by TV.
  - Crime solved and offender brought to justice within an hour

- DNA collection at crime scenes is increasing
  - Technology improving
  - DNA processing takes time!
Public Perceptions

• Latent fingerprint technology improving
  • People expect police to locate & collect prints at crime scenes

• With increased knowledge of DNA
  • People expect DNA collection at crime scenes
Fingerprint vs. DNA

- “Swabbing” for DNA and “dusting” for fingerprints
  - Overlap conceptually but not practically
  - DNA labs able to perform more tests with less evidence
  - Fingerprint brush can transfer DNA between crimes
Who’s the Bad Guy?

• Police are taught not to leave fingerprints at a crime scene
• It’s nearly impossible NOT to leave your DNA
• Some agencies require fingerprints & DNA profiles of officers entered into databases.
“HIT” = a person’s DNA was left at the scene
  - Friends and family leave DNA behind
  - “hit” might not be that important.

“MISS” = A failure to find evidence.
  - Doesn’t mean someone is not responsible for a crime.
  - The person’s DNA might not be in the database.
DNA History

- DNA collection was *not* possible prior to 1950’s.
- The discovery of DNA structure by Watson and Crick
  - Police able to link people to crimes
  - Failure to link a person to a crime by DNA does not mean “not guilty”
Strategic Uses for DNA Evidence

- Prove guilt
- Exonerate the Innocent
- Paternity Testing
Strategic Uses for DNA Evidence

- Determine identity of human remains
- Evolution of human populations
  - National Geographic
- Study inherited disorders
DNA in the Courtroom

• Circumstantial Evidence
  • Information collected from witnesses
  • Documents pointing an individual as the perpetrator
DNA in the Courtroom

- Physical Evidence
  - Information collected from actual objects
    - Bodies
    - Weapons
    - Body Fluids
    - Stains
    - Fingerprints
    - Hairs, Fibers, etc.
DNA in the Courtroom

- Prosecutor must present evidence to the court
- Must prove an overall “theory” from evidence to jury
- Scientific evidence is precise
DNA in the Courtroom

- Evidence can be:
  - Documents
  - Exhibits
  - Facts agreed on by both sides
  - Testimony of witnesses
Is the scientific evidence trustworthy?

- Must demonstrate
  - accuracy (validity)
  - consistency (reliability)
Scientific Evidence Admissibility Standards

- **Frye Rule**
  - U.S. v. Frye (1923)
  - Standard on accepting scientific evidence.
- **People v. Kelly (1976)**
  - Proponent of the evidence must demonstrate the correct use of scientific procedures