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02 August 10

LATENT FINGERPRINTS 101

Objectives

- What are fingerprints and what are the premises that allow us to use them for identification?
- What can and *can't* fingerprints do?
- How are prints developed on evidence?
- What are AFIS and IAFIS?
- How do examiners reach conclusions?
- Current state of affairs and what the future holds.

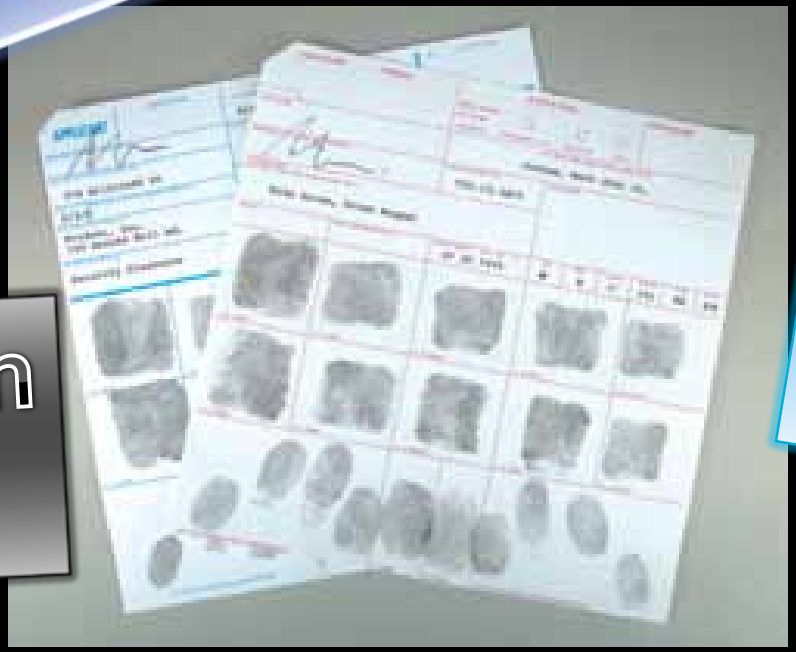
What are “fingerprints”?

- Most often a two-dimensional representation of the skin
- Friction skin impression
- Three levels of detail

What are “fingerprints”?

Tenprints

Known Prints



Elimination Prints

RECORD PRINT

Inked Prints

Exemplars

What are “fingerprints”?

Latent

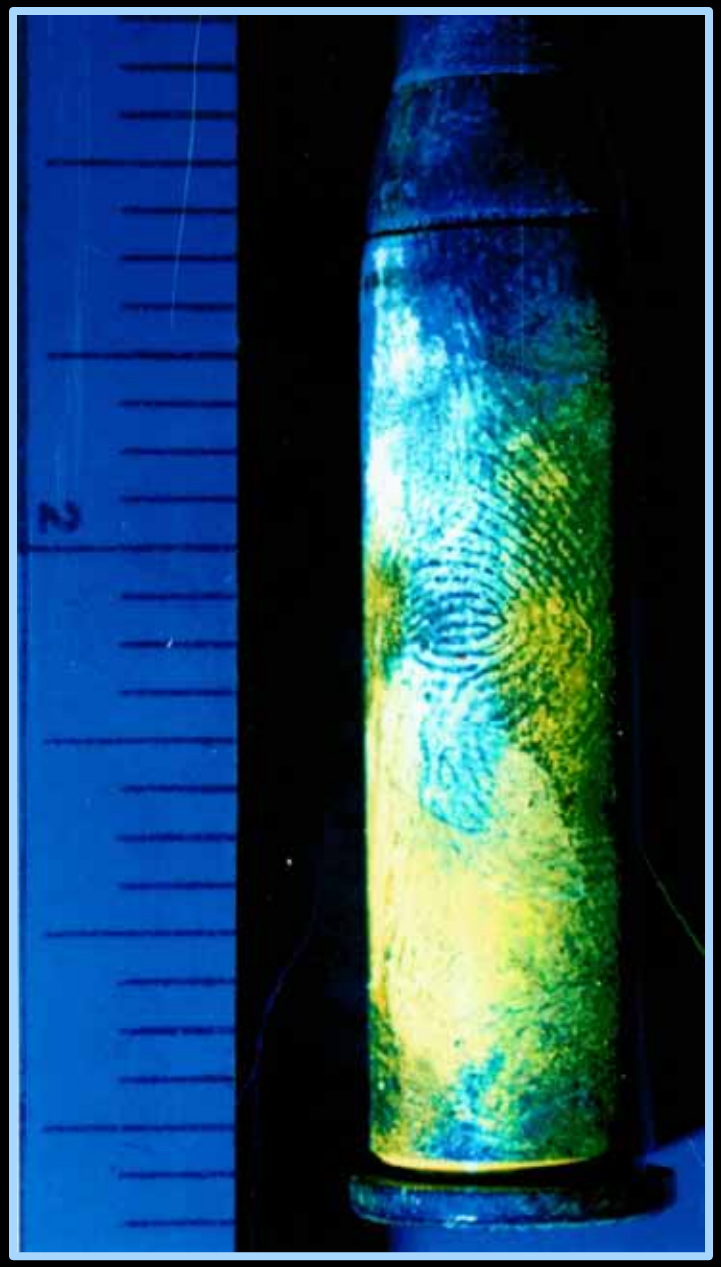
Patent

Etched

Plastic

Latent Print

- Transferred impression of friction ridge detail not readily visible – “hidden”
- A fingerprint that is not apparent to the eye but can be made visible using light energy, chemicals or powders.

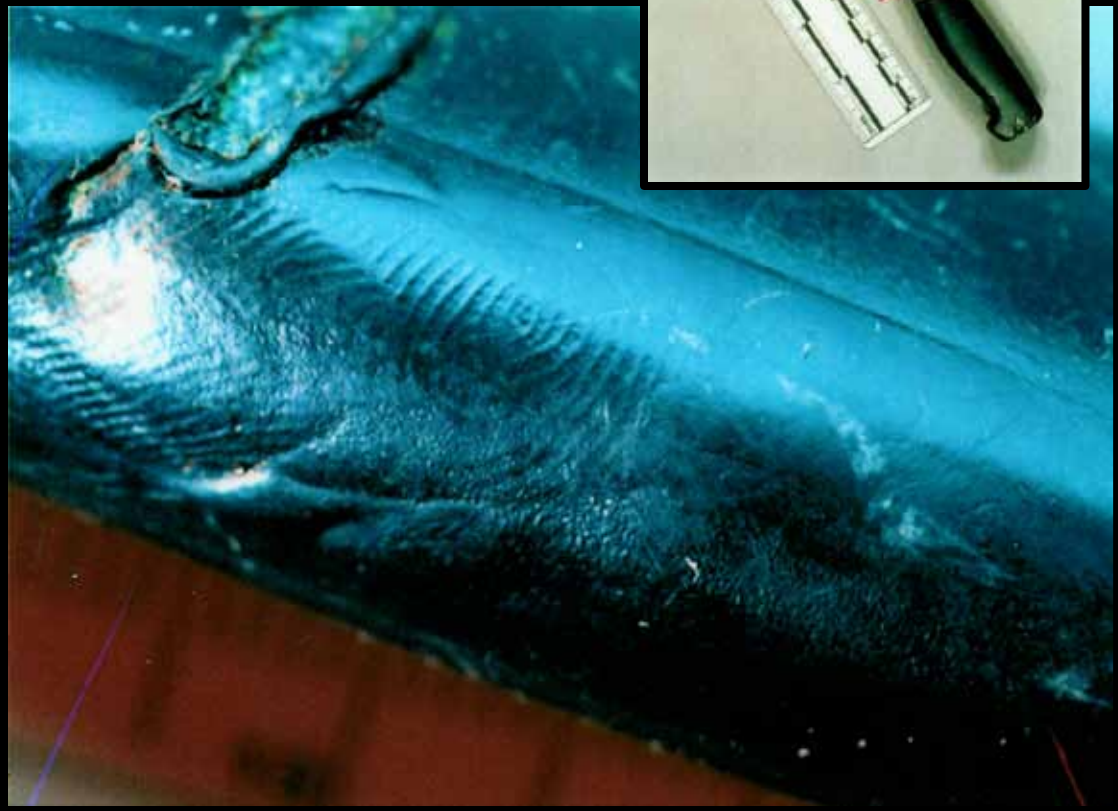


Patent Print

- A print that is visible and may not require further development
- May be deposited on an object in a contaminant such as blood, grease, dirt etc.

Plastic Print

- A visible impression of friction skin left on a soft pliable surface such as wet paint, clay, wax etc...
- 3-D
- Molded or impressed



Etched Print

- A latent print that becomes permanently “etched” onto the substrate due to a reaction between the substrate and the acids in fingerprint residue.

- Most often occurs on metal

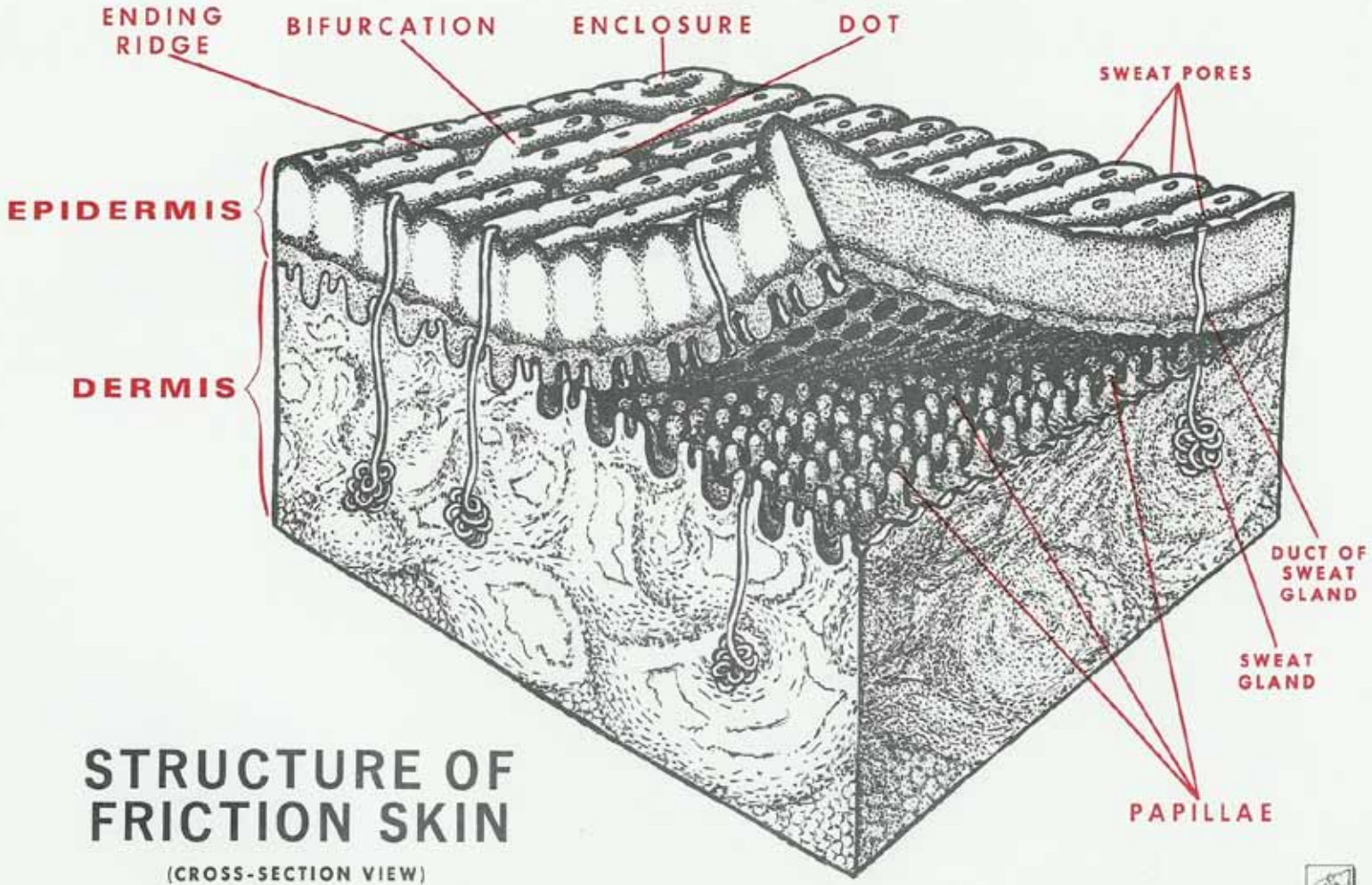
Why can we use fingerprints?

- Main Premises:
  - Unique
  - Permanent
  - Ability to group or classify for searching purposes

Why can we use fingerprints?

- Friction skin and impressions of friction skin serve as a reliable and verifiable means of positive identification
- Easier to obtain and analyze than other human features
- Accepted by the court system

FEDERAL BUREAU OF INVESTIGATION
UNITED STATES DEPARTMENT OF JUSTICE



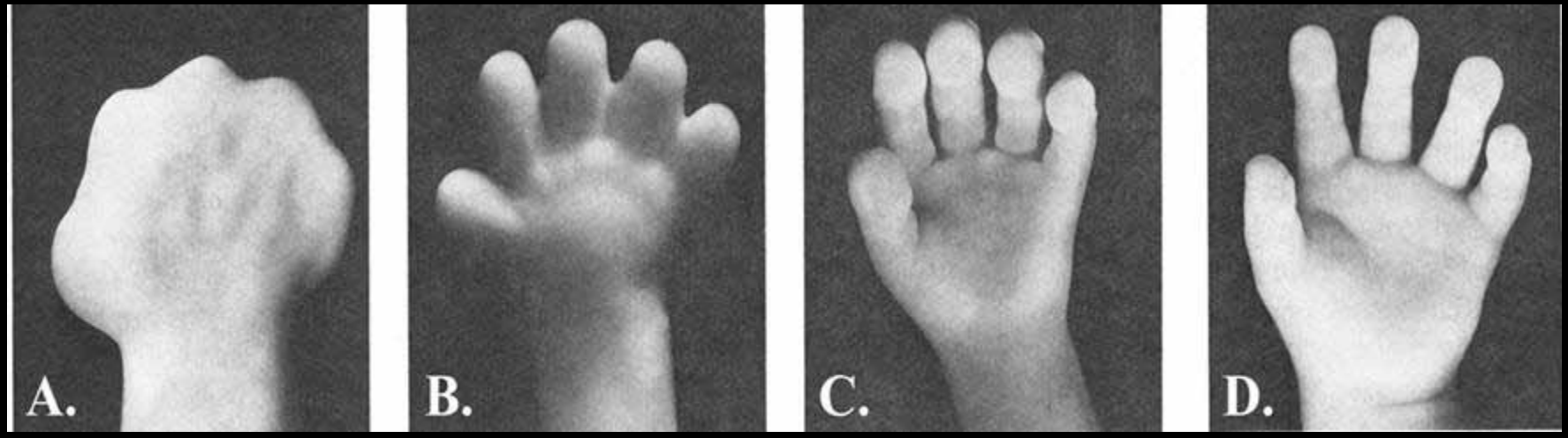
STRUCTURE OF FRICTION SKIN

(CROSS-SECTION VIEW)

Uniqueness

- Differential Growth
  - Random growth aspect of friction skin
  - Different rates of growth in associated tissues or structures
- Epigenetic
  - Combination of environmental and genetic factors

Volar Pads



- Volar
  - Related to the palmar and plantar surfaces
  - To do with areas that are covered with friction skin

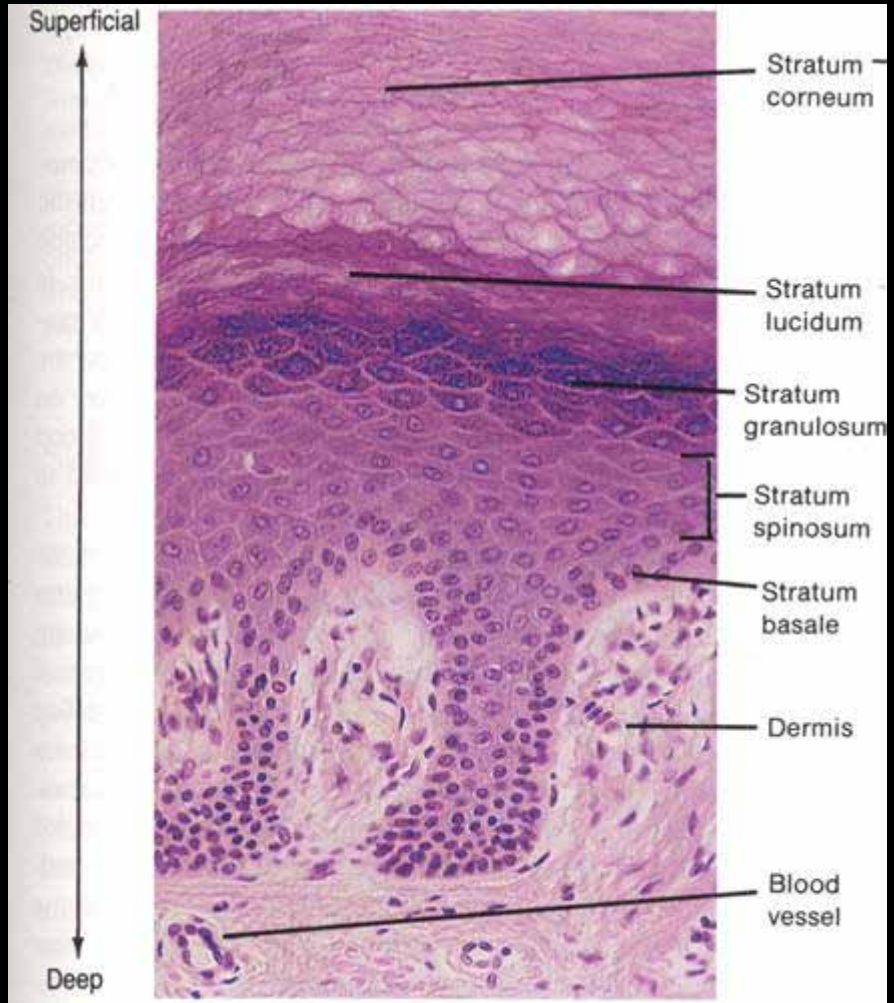
Purpose of Volar Skin

- Create friction between volar surface and surface contacted
- Removes waste
  - Volar surfaces tend to sweat slightly more than other surfaces
  - Triggered more when nervous or in “fight or flight” situations

From Atlas of Human Prenatal Morphogenesis, 1983

Basal Layer

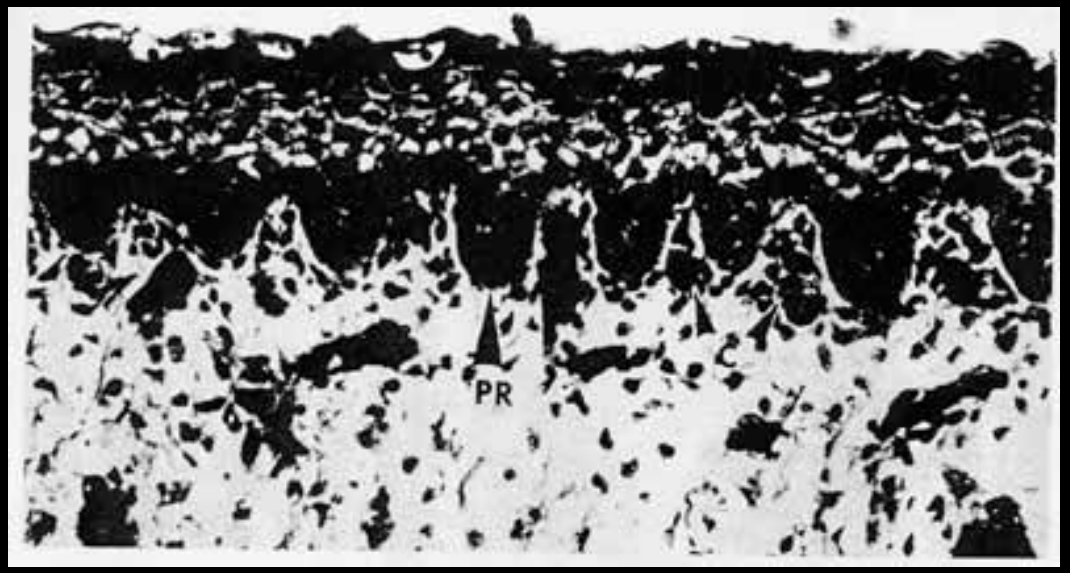
- Also known as the generating layer or Stratum basale
- Sub-layer of the epidermis
- Contains living stem cells
- “template” for permanent ridge detail



(a) Photomicrograph of a portion of the skin at a magnification of 496×

Primary Ridges

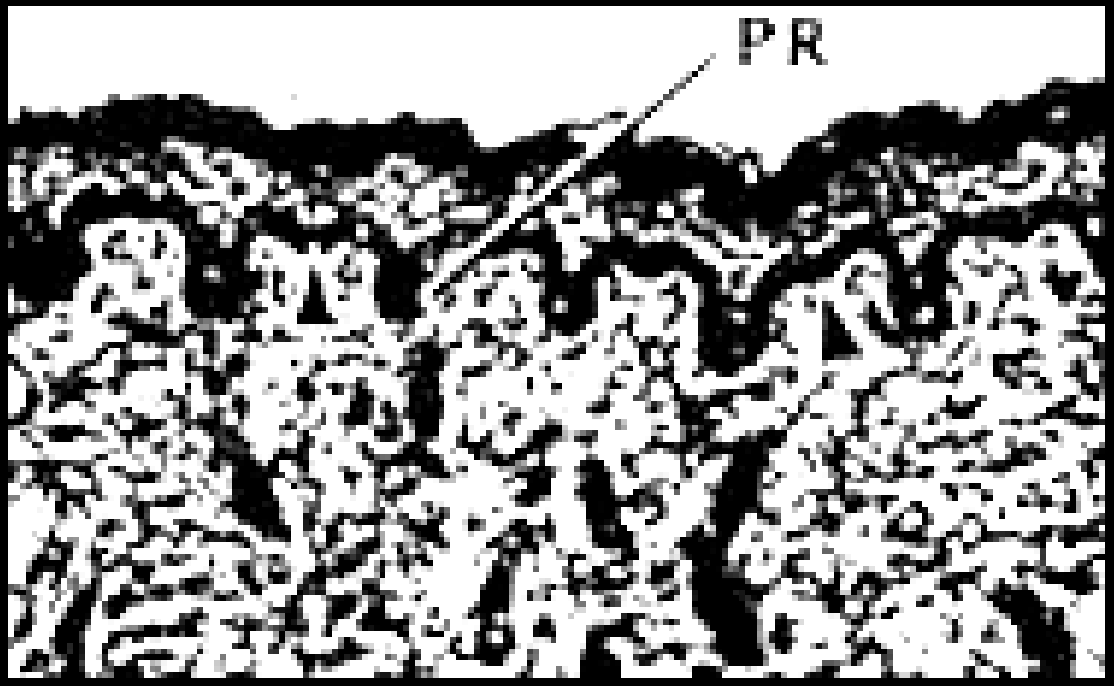
- Friction skin begins forming at ~9-11 weeks EGA beginning with Primary Ridge Formation
- Primary ridges begin forming on the underside of the epidermis
- Ridge units anticipate sweat pore openings then fuse together forming linear ridges



From Hale, 1952

Secondary Ridges

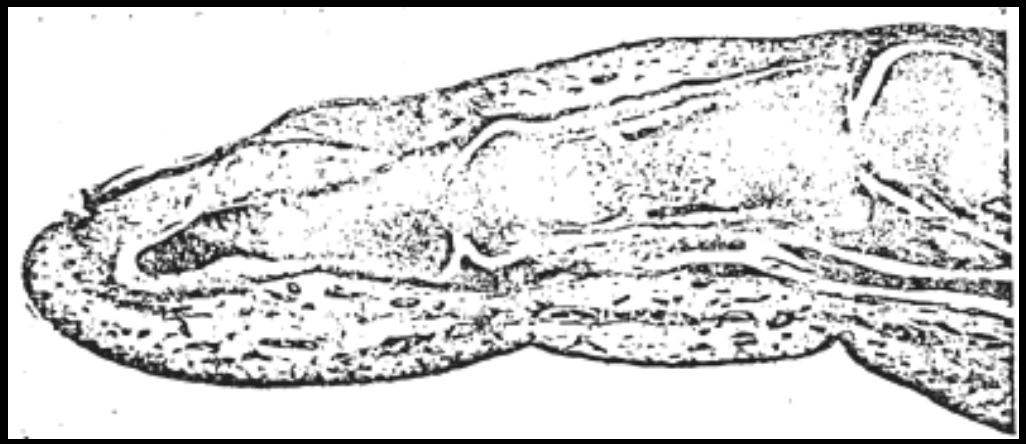
- Form at ~15-17 weeks EGA
- Contain no sweat glands
- Primary ridge formation stops when secondary ridge formation begins



From Hale, 1952

Factors affecting size and shape of volar pads, therefore ridge flow.

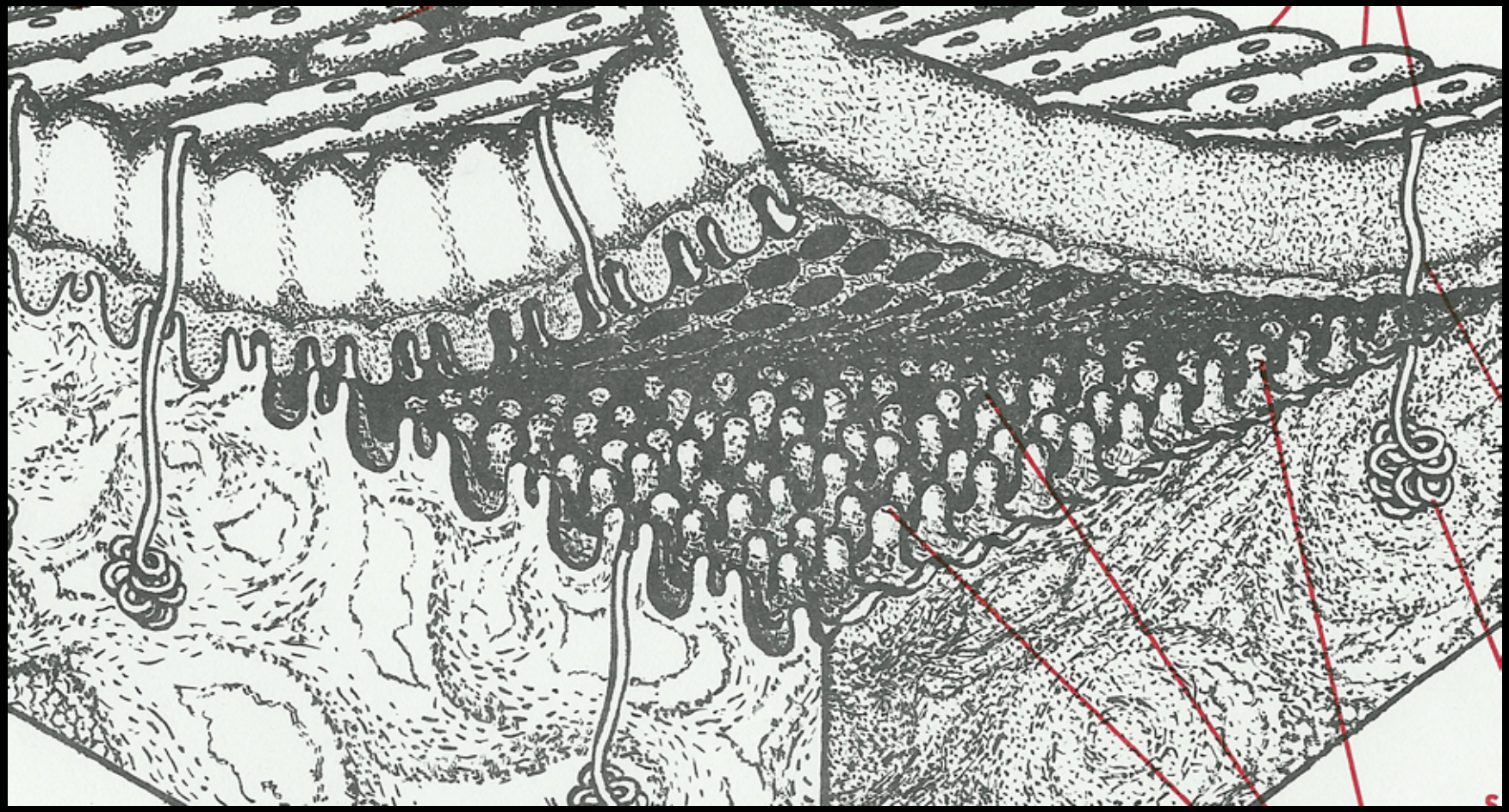
- Genetics
- Bone Growth
  - Size
  - Shape
- Nutrition
  - Diet
  - Chemical
- External Factors
  - En-uterine Environment
  - Possible Physical Stresses



Permanence

- Final ridge configuration is established between ~4th-5th month of fetal development
- Ridge configuration will not change with the exception of permanent scarring or disease

Dermal Papillae fill in between primary and secondary ridges.

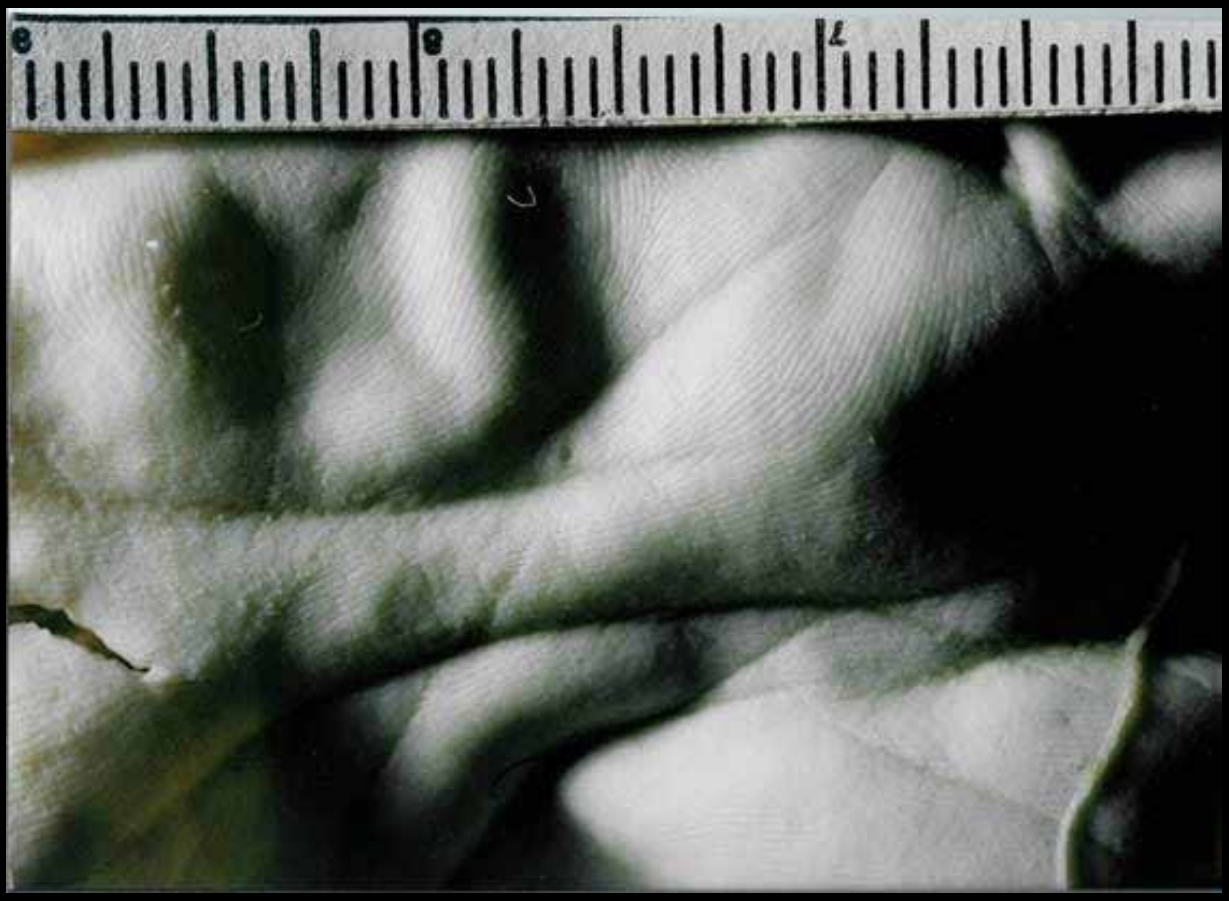


Permanence


463351
11/18/63
TURN CARD DIAGONALLY FINGER TIPS HERE
SIGNATURE OF PERSON BEING PRINTED
SIGNATURE OF OFFICIAL PRINTING
463391
PALM MASTER

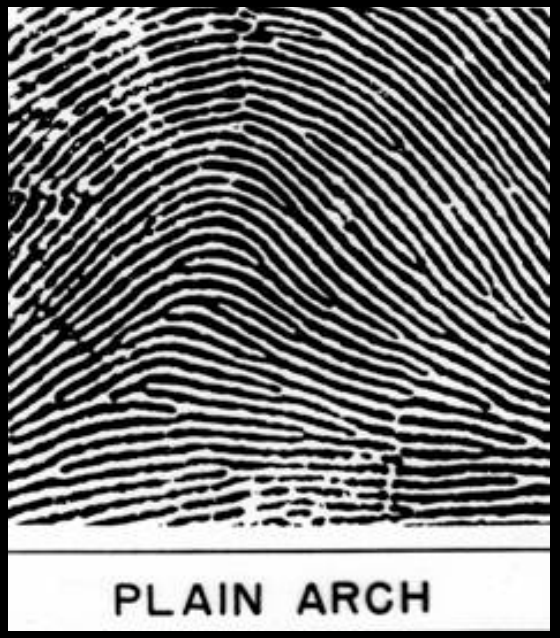

METRIC 1
3
4
5
6
7
8

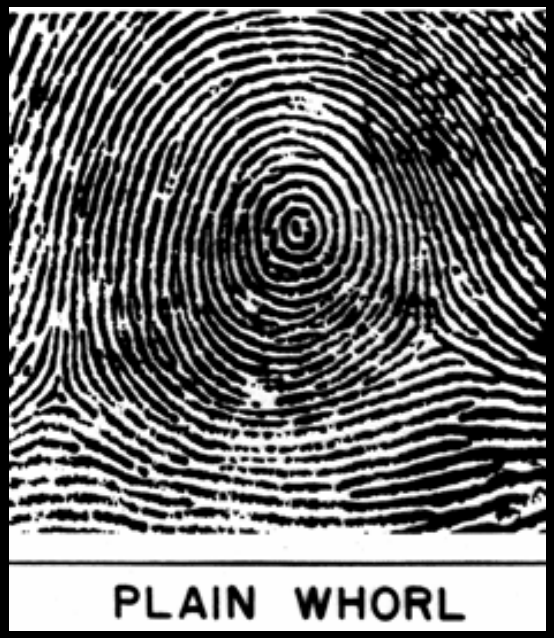

METRIC 1
2
3
4



Patterns in Nature

Basic Fingerprint Patterns



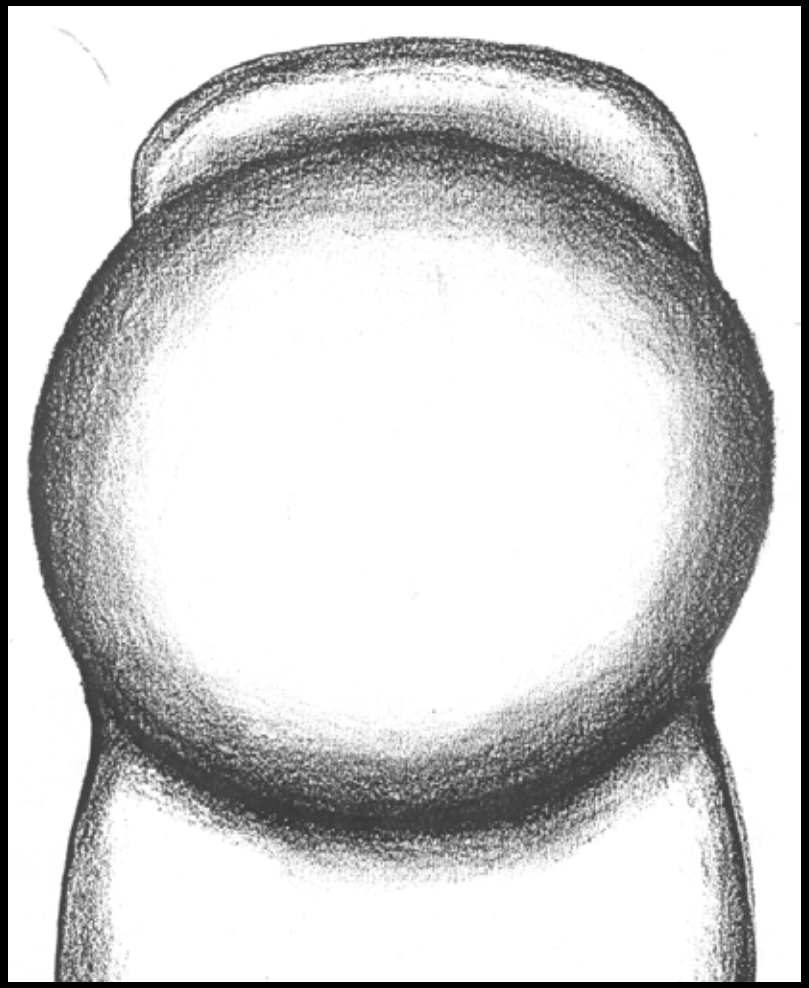


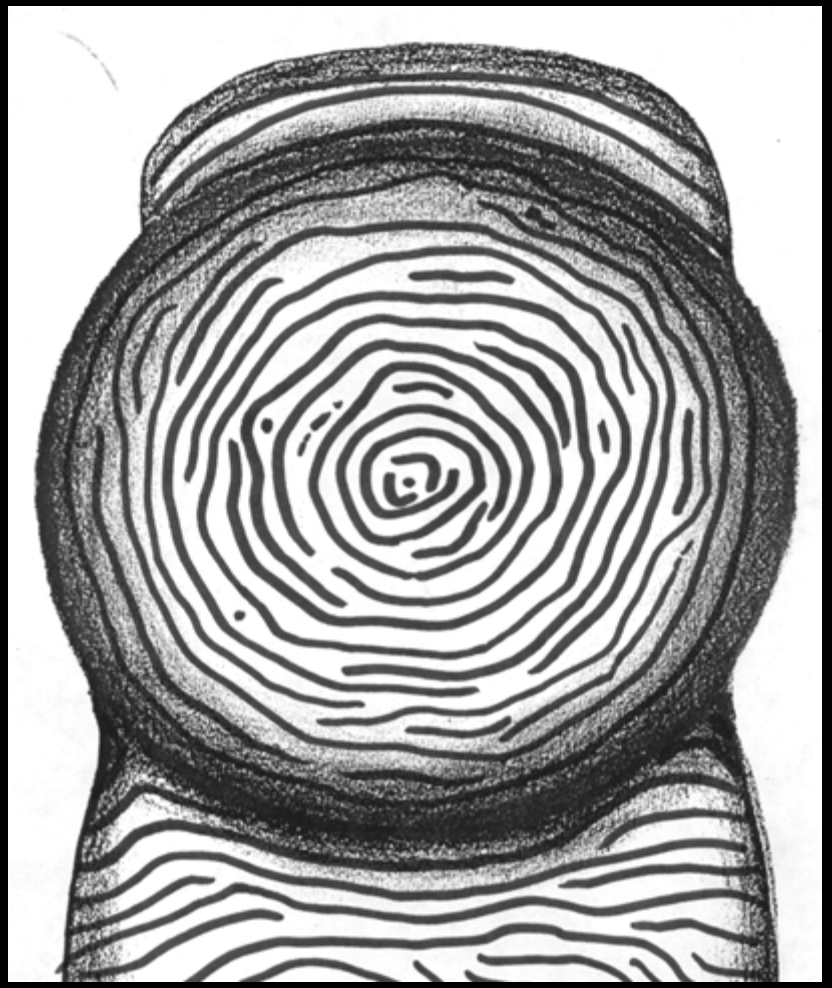
2 Basic Factors Affecting Fingerprint Patterns:

- Shape/symmetry of the volar pad affects pattern type

- Size of the volar pad during primary ridge formation (*TIMING*) affects pattern ridge count

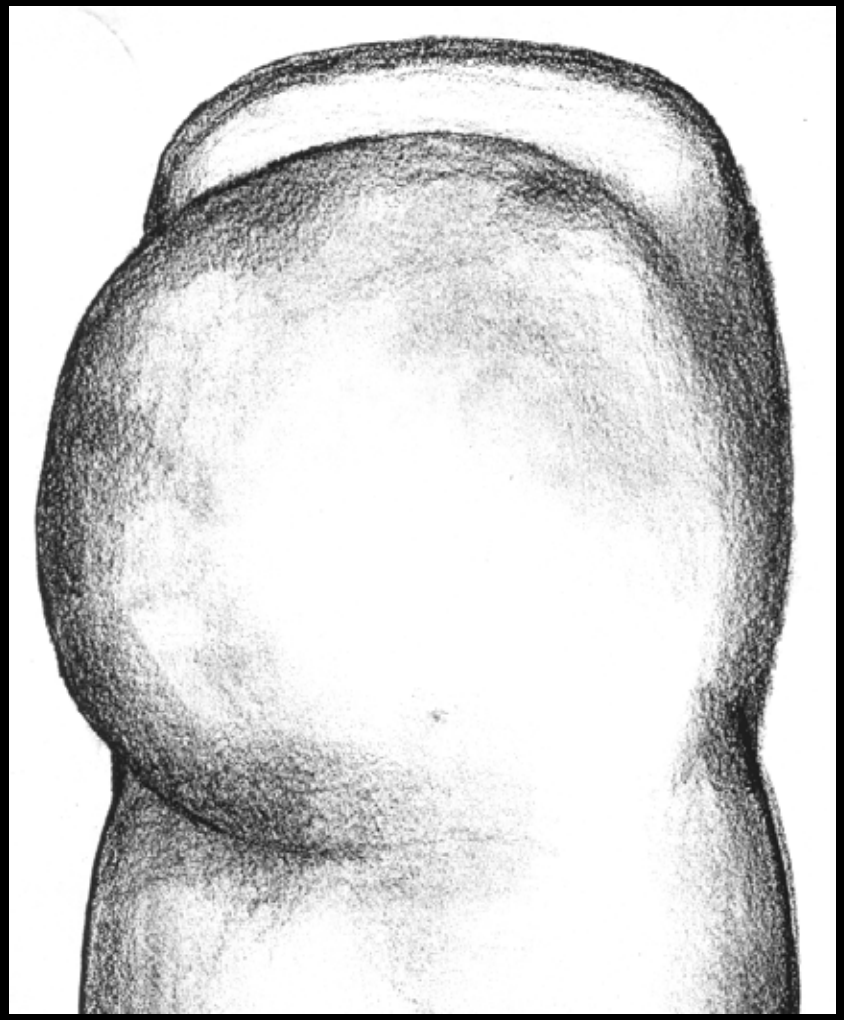
Symmetrical pad

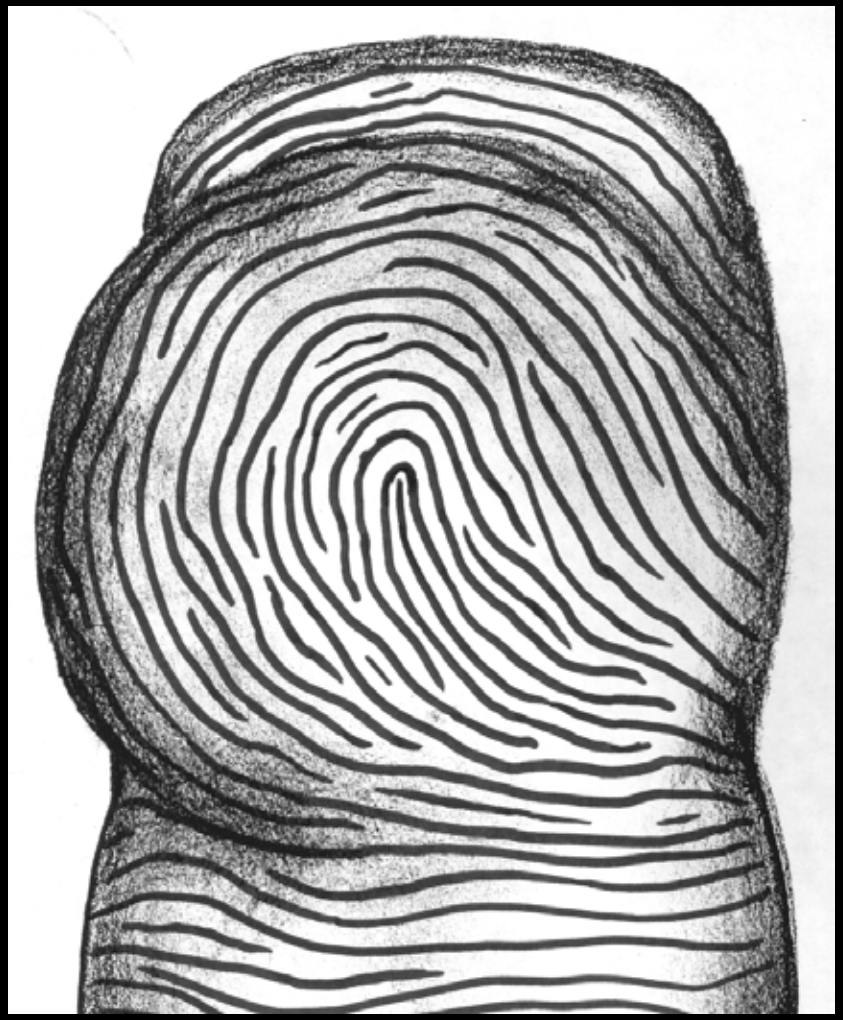




Kasey Wertheim, 2001

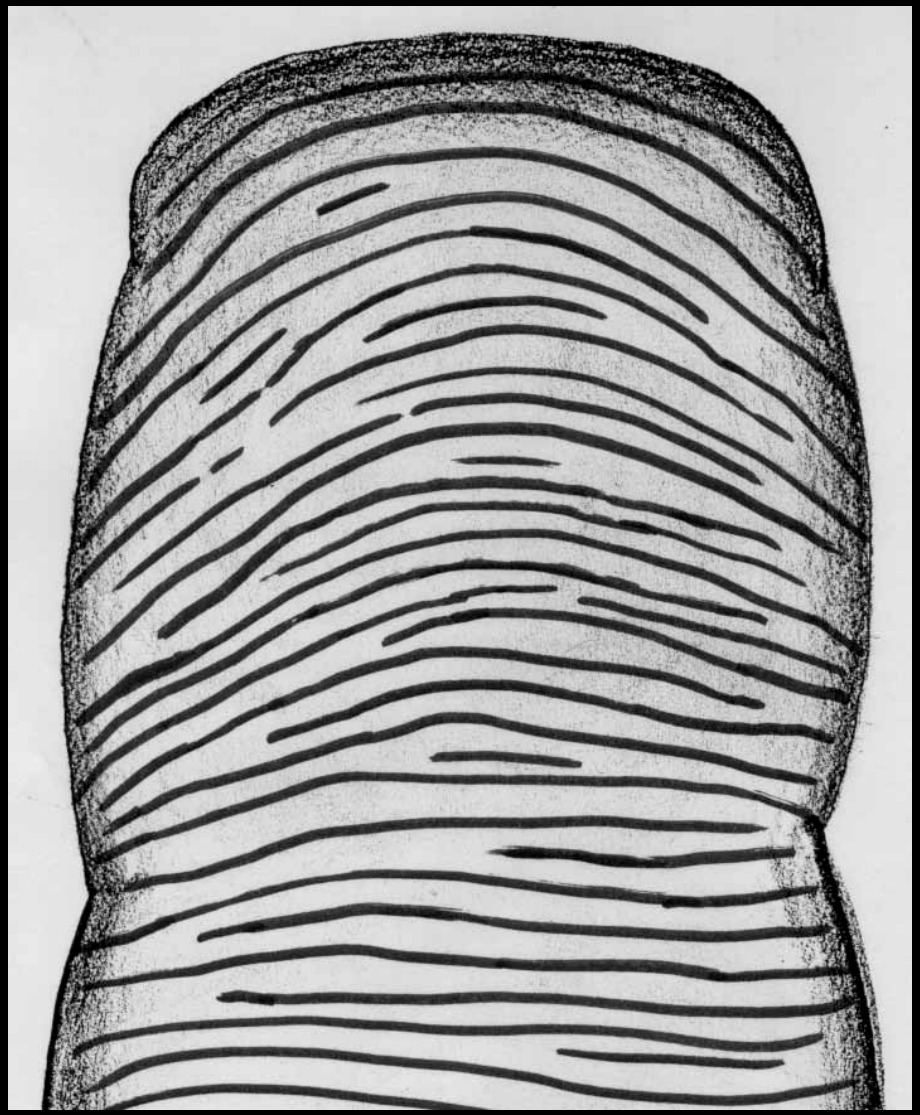
A-symmetrical pad





Kasey Wertheim, 2001

Low or nonexistent pad



Kasey Wertheim, 2001

Summary

- Combination of environmental and genetic factors (“epigenetic”) and *differential growth* cause friction ridge characteristics to be truly **unique** to each individual.

- Physiological skin structure ensures **permanence**, barring scarring and disease.

What can and can't an fingerprints do?

- Determine a person touched an object
- Common source attribution

- Determine age
- Determine race
- Determine gender
- Estimate age of the print
- Determine guilt

How are prints left?

- Transference of contaminants lining the friction ridges when an object is touched
  - Eccrine sweat (98-99.5% water; remainder is acids & salts)
  - Sebum
  - Other contaminants (dirt, grease, make-up, blood etc…)

How are latent prints developed on evidence?

- *Substrate type* primarily determines what development techniques will be chosen:
  - Porous
  - Non-porous
  - Semi-porous
- Presence and type of contaminants will also factor in to processing
- Sequential processing is used to include optical, chemical and physical development techniques.

Porous Substrates

- Absorbent surfaces
- Latent print residue is absorbed into the item
- Latent prints are much less fragile on porous surfaces
- Some examples: paper, cardboard, untreated wood

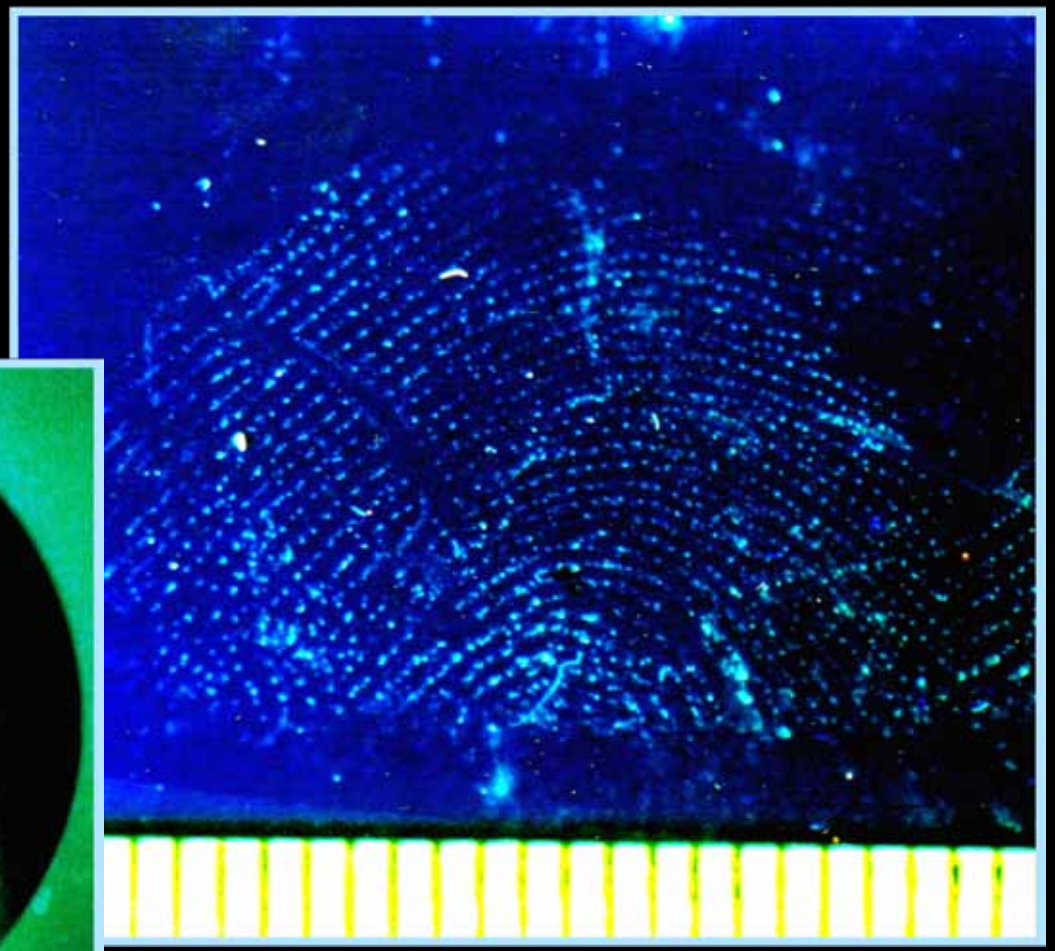
Non-porous Substrates

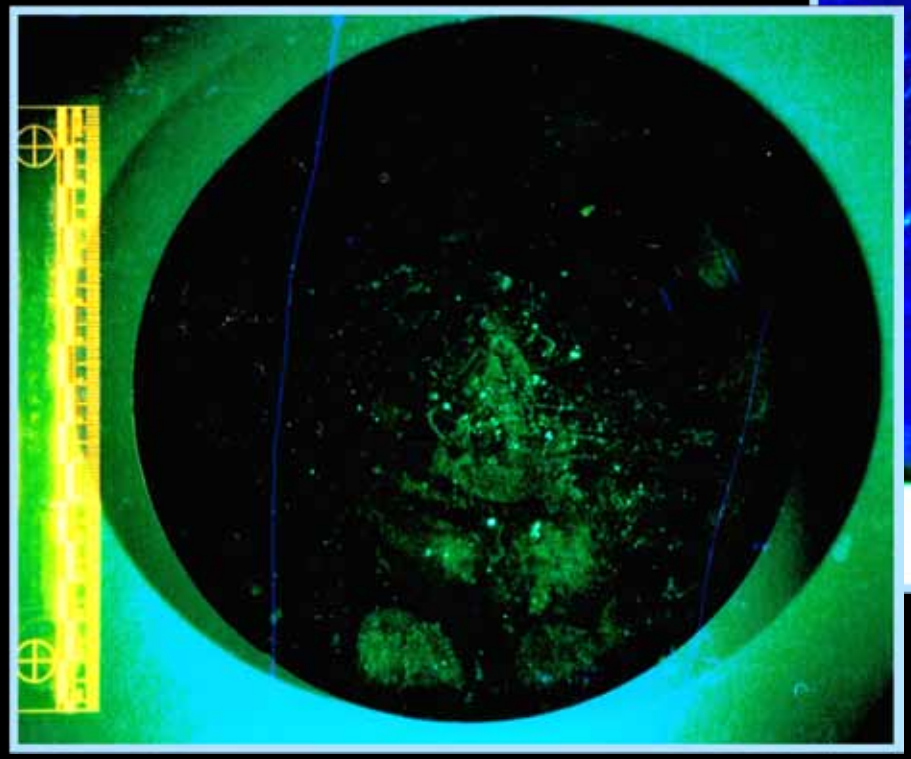
- Non-absorbent surfaces
- Latent print sits on the surface of the object
- Latent prints on non-porous surfaces tend to be very fragile
- Some examples: glass, metal, plastic, painted or sealed wood

Semi-porous Substrates

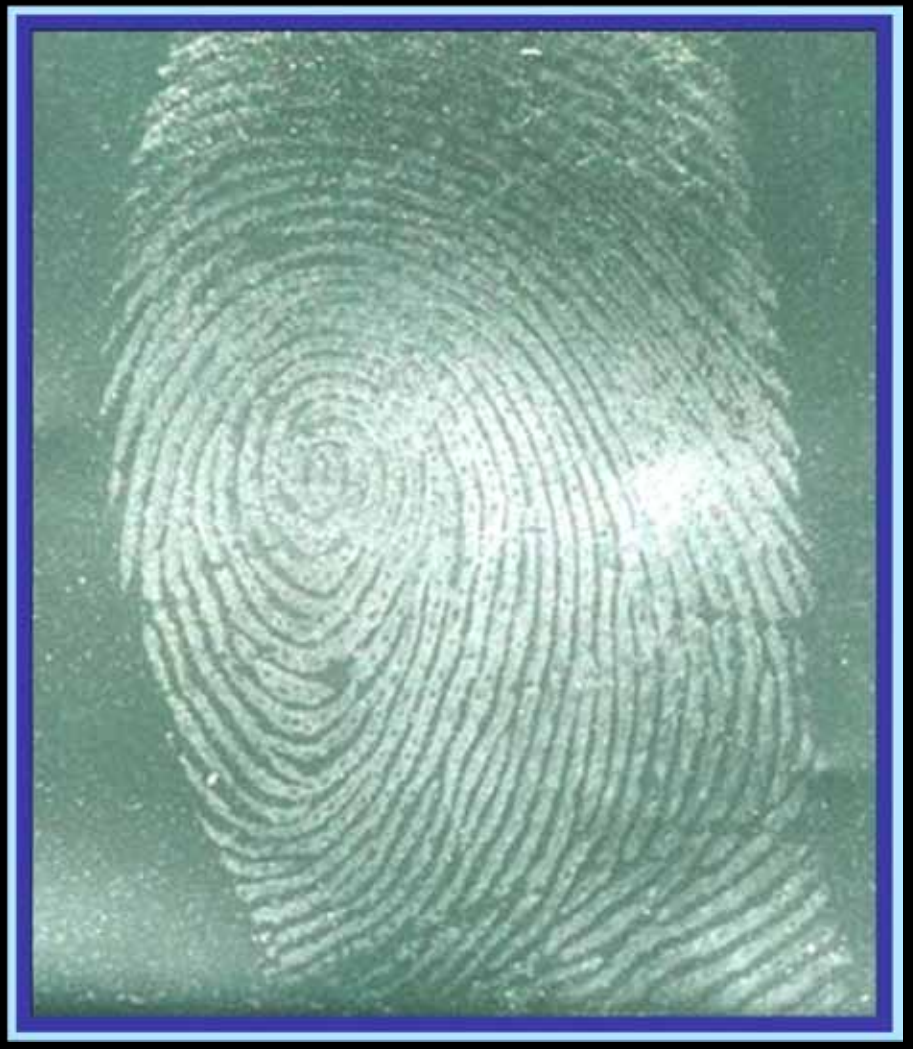
- A substrate that may or may not absorb latent print residue. Usually depends on:
  - The viscosity of the transferring medium
  - How long it has been on the surface.
- Some examples: glossy paper or cardboard, latex gloves, leather

Inherent Fluorescence

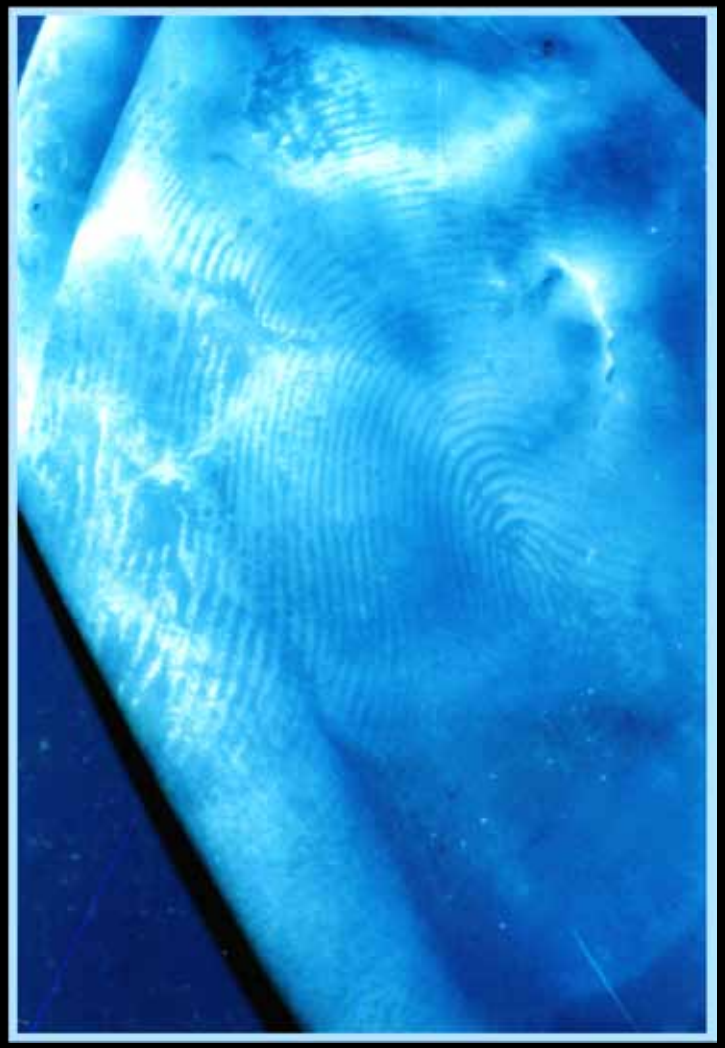


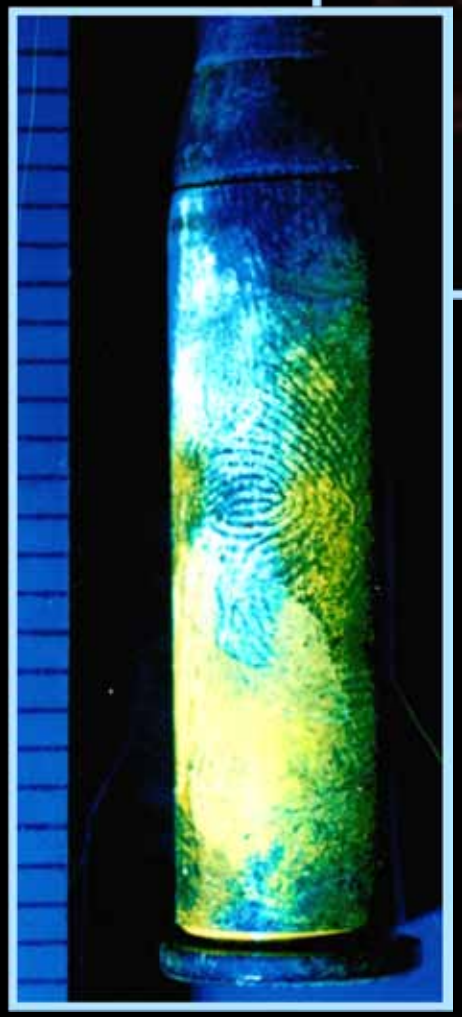


Cyanoacrylate à “Super Glue”



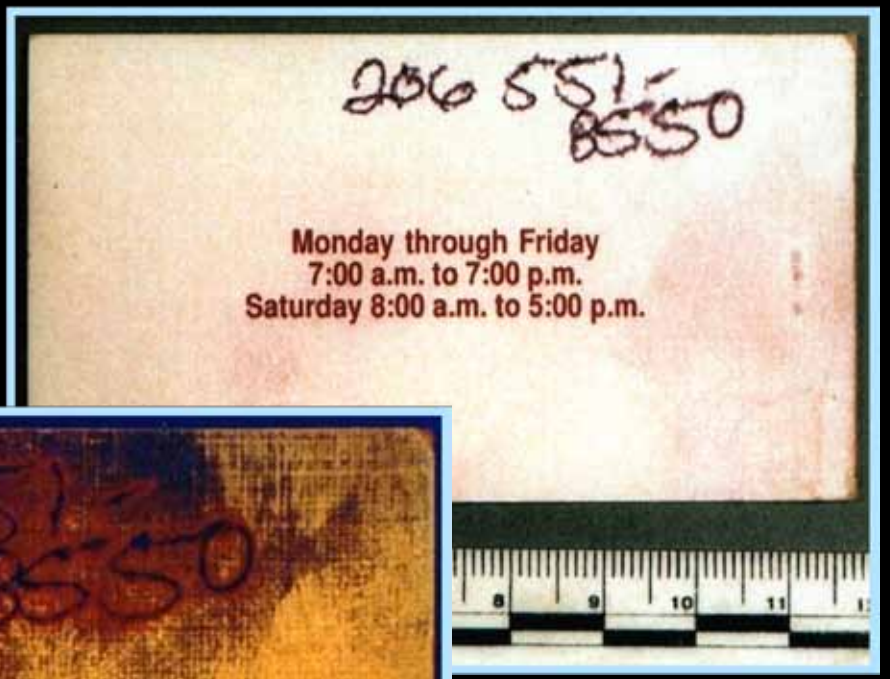
Dye Stains





Powders

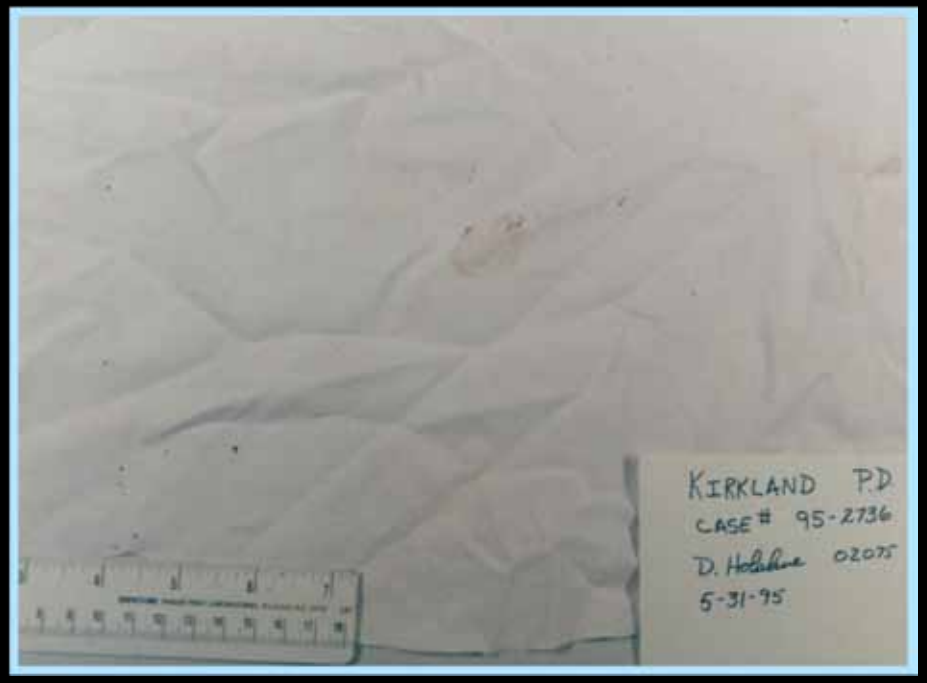
DFO


206 551 8550
Monday through Friday
7:00 a.m. to 7:00 p.m.
Saturday 8:00 a.m. to 5:00 p.m.


206 551 8550
7:00 a.m.
Saturday 8:00
p.m.

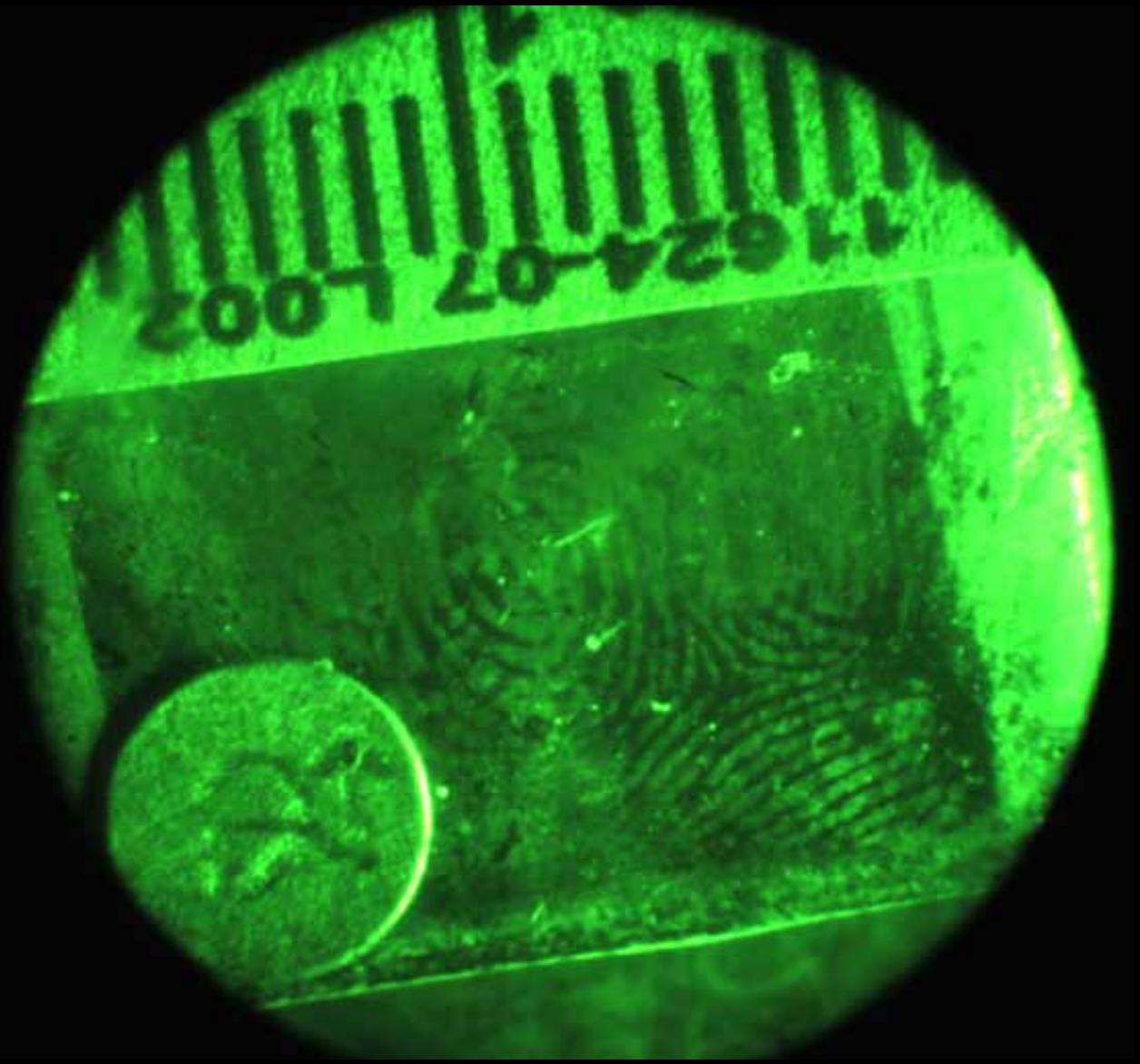
Ninhydrin

Blood Prints



Adhesive Surfaces

RUVIS



“I know they touched it – why didn’t you get prints??”

- Subject Factors
  - Skin condition
  - Type and amount of sweat
- Transposal Factors
  - Substrate type and condition
  - Contaminant type and amount
  - Deposition pressure and handling
- Environmental Factors
  - Temperature and humidity
  - Handling and storage of item after prints are deposited

How do examiners reach conclusions?

- Quantitative-Qualitative Analysis
  - Evaluative friction ridge identification
  - Ridgeology: “The study of the uniqueness of friction ridge structures and their use for personal identification”

Scientific basis (Biology / 3D)	← Clarity → (Details / Distortion)	ID Process (Procedural / 2D)

Three Levels of Detail

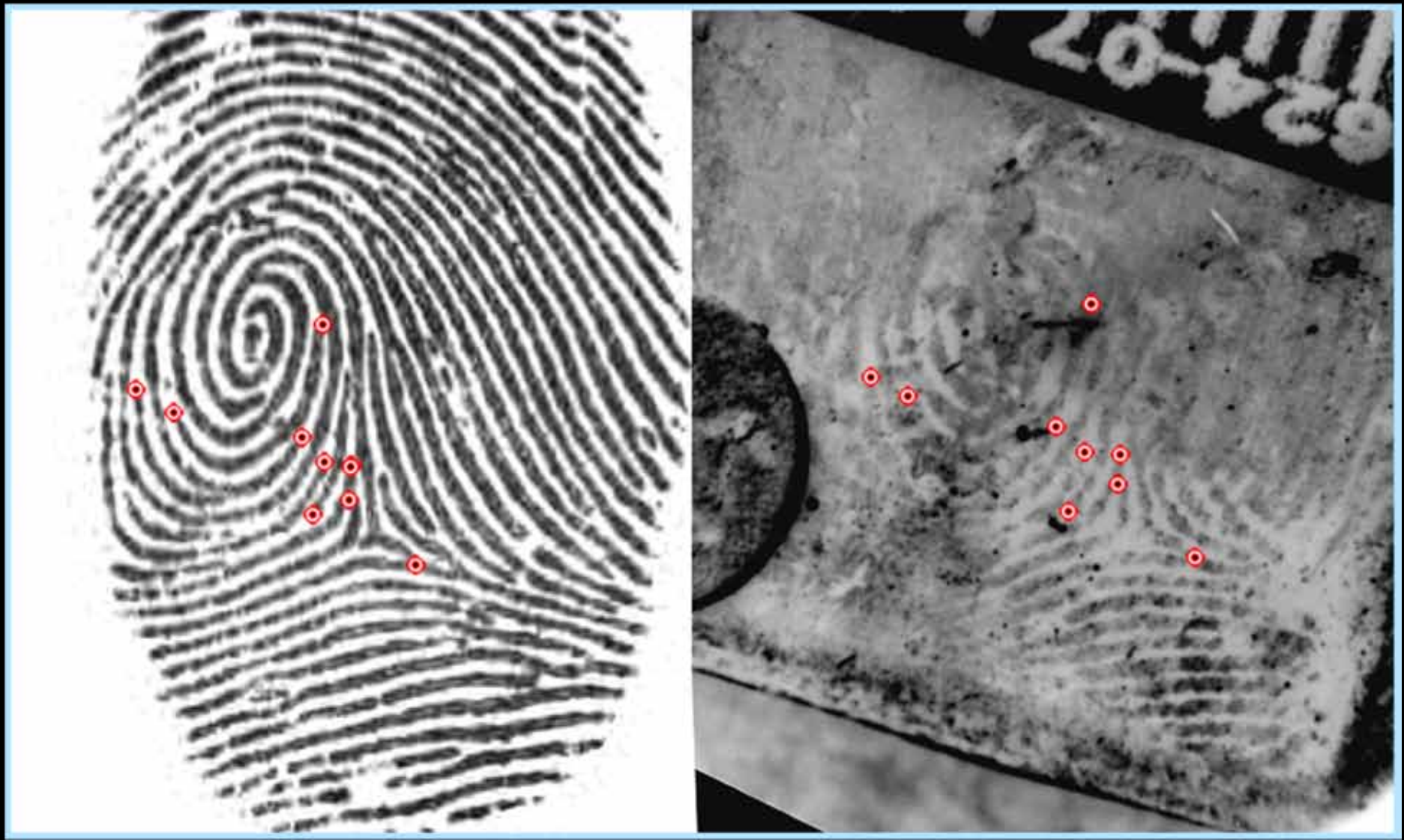
- Level I – ridge flow / pattern
- Level II – major ridge path deviations
- Level III – intrinsic ridge shape, pore structure and location, ridge width, accidental marks

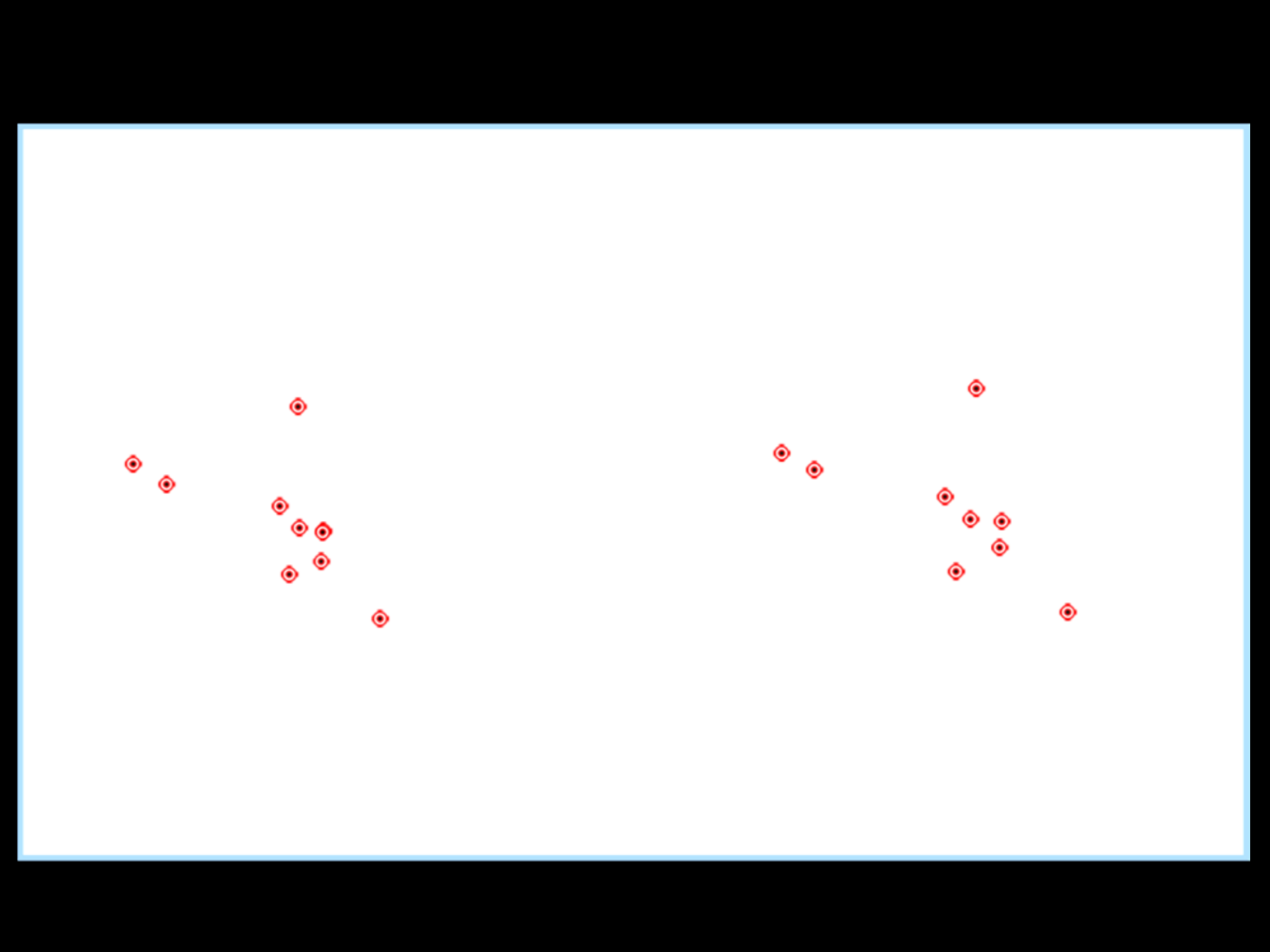
Quantitative Aspects

- Dirty word #1 – *POINTS*
  - Quick assessment of value
  - Administrative uses
    - Training
    - Quality control
  - AFIS
  - 1973 IAI Standardization committee recommendation

Qualitative Aspects

- Clarity: 3D à 2D
  - How much detail is available
  - Relates to deposition
- Tolerance
- Rarity of features
- Spectrum of fingerprint quality/quantity





Methodology: ACE-V

ANALYSIS

COMPARISON

EVALUATION

VERIFICATION

Methodology: ACE-V

- A cognitive evaluative process
- Extension or modification of scientific method
- In 1959, Roy Huber articulated ACE and indicated that verification was needed.
  - "Expert Witness" Criminal Law Quarterly 1959/60
- In 1998, ACE-V gained wide spread recognition after the first Daubert Hearing regarding fingerprint evidence.

Components of ACE-V Methodology

Hypothesis Testing	ACE-V
Collect data	Analysis
Testing phase	Comparison
Conclusion	Evaluation
Peer Review	Verification

Analysis Phase

- “Intelligence gathering” – learn about the print
- Analyze distortions – all prints suffer from some sort of distortion
- Clarity/tolerance
- Determination of value

Comparison Phase

- Compare from least quality to best quality print – *prevent mind-set*
- Look for agreement of friction ridge formations in sequence
- Awareness of the potential impact of bias
- Attempt to falsify hypothesis
- OBJECTIVE

Evaluation Phase

- Two main questions:
  - Is there agreement?
  - If so, is there sufficient information to individualize?

- Dirty word #2 - *SUBJECTIVE*
  - Based on experience, knowledge, and training

Evaluation Phase

- Three possible conclusions
  - Identification
  - Non-identification or exclusion
  - Inconclusive
- No probable conclusions
  - IAI resolution VII (1979)

Verification

- A form of peer review
- Attempt to falsify
- A review of the entire process
- Not to replace adequate training
- It is an industry standard of the fingerprint community for identifications.

What are AFIS and IAFIS?

- Computerized systems to store and search “fingerprint” images

- Best described as a computerized filter system that brings the closest search candidates to the top.

- Uses
  - To verify the identities and criminal history of individuals
  - To help solve questioned identities
  - To identify prints left on evidence and at crime scenes

Alphabet Soup

What is AFIS?

- Automated
- Fingerprint
- Identification
- System

What is IAFIS?

- Integrated
- Automated
- Fingerprint
- Identification
- System

What AFIS systems “see”

- Relies on level one and two detail
  - Minutia and their directionality
  - Spatial relationship of minutia
  - Ridge counts
  - Pattern types
  - Core and deltas
- Fingerprint minutiae can only be encoded if ridge detail is sufficiently clear
- Examiners look at more than just minutiae

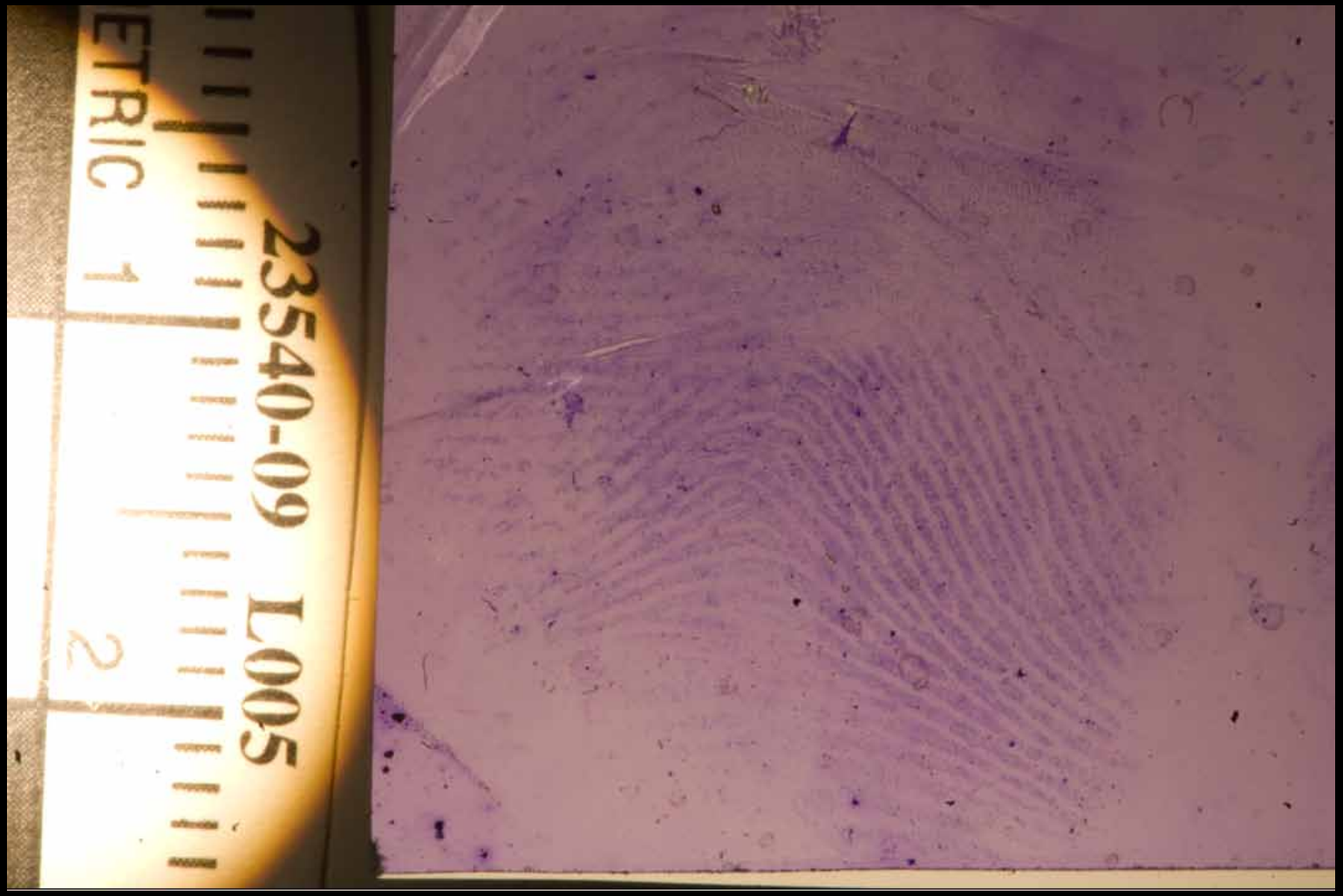
What AFIS systems "see"

- Encodes the spatial relationship between minutiae and uses algorithms that employ fuzzy logic

  - Algorithm: A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps. (The American Heritage Dictionary)

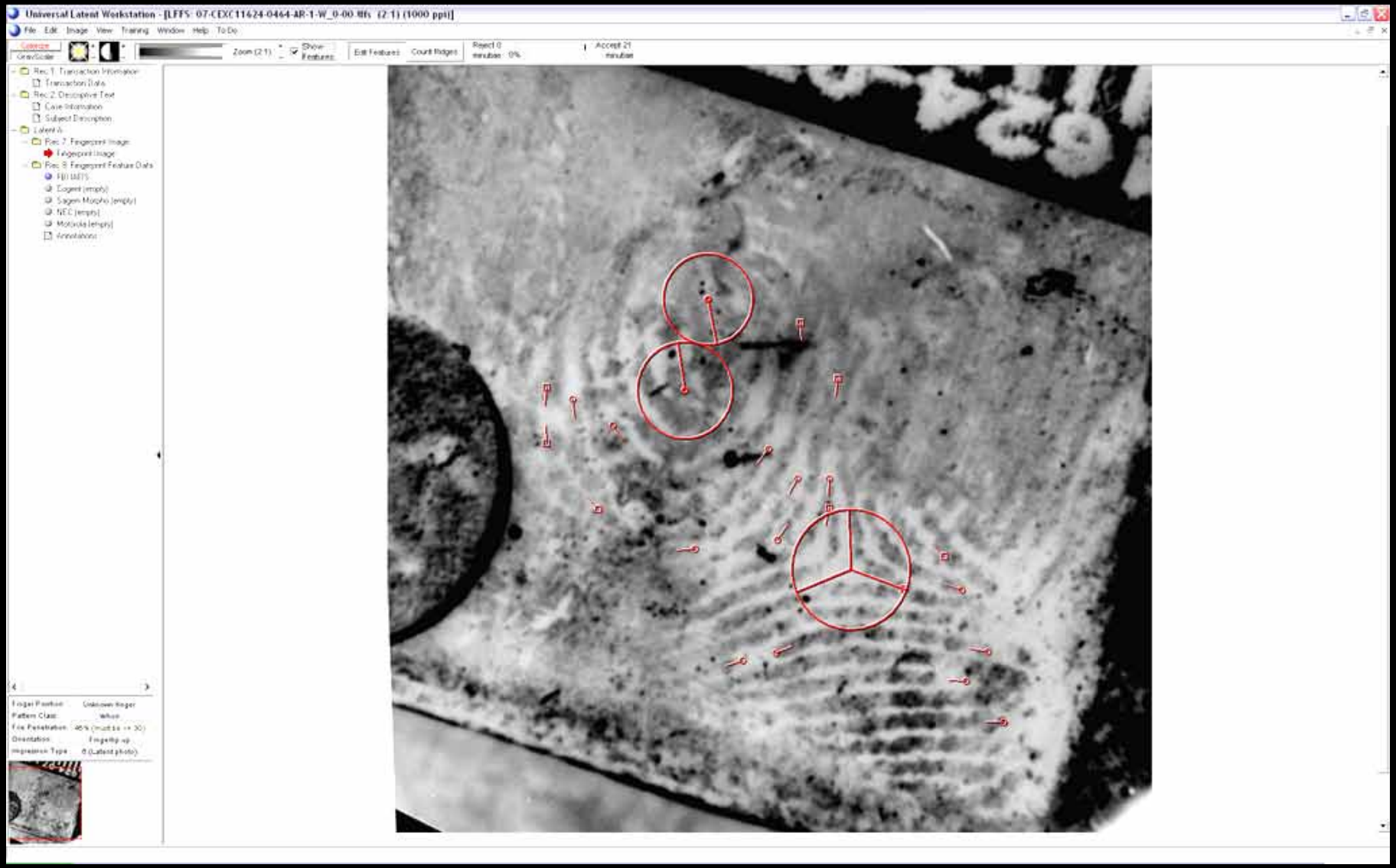
  - Fuzzy logic: A form of algebra employing a range of values from "true" to "false" that is used in decision-making with imprecise data, as in artificial intelligence systems. (The American Heritage Dictionary)

Close-up image of latent print

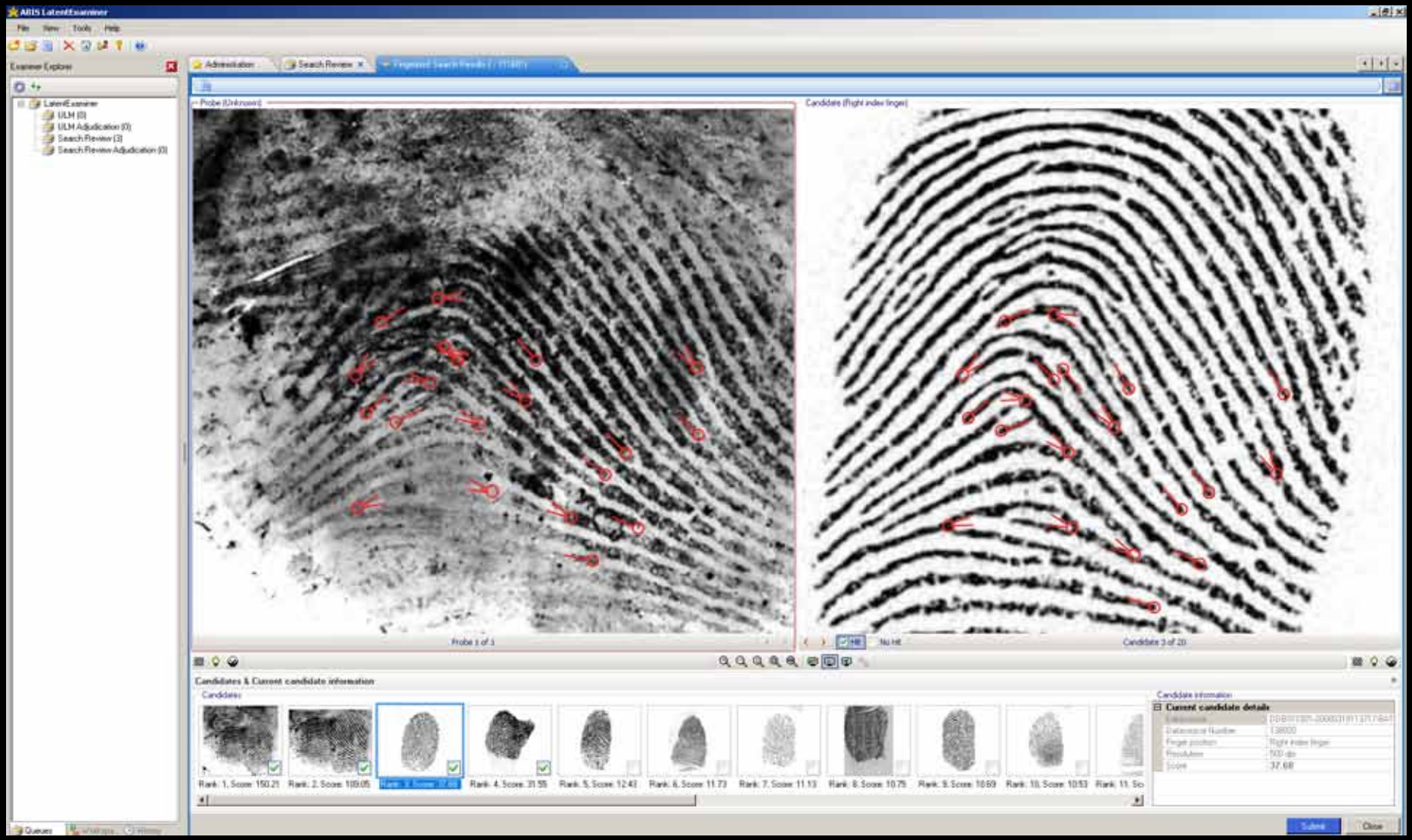


Calibrate and enhance

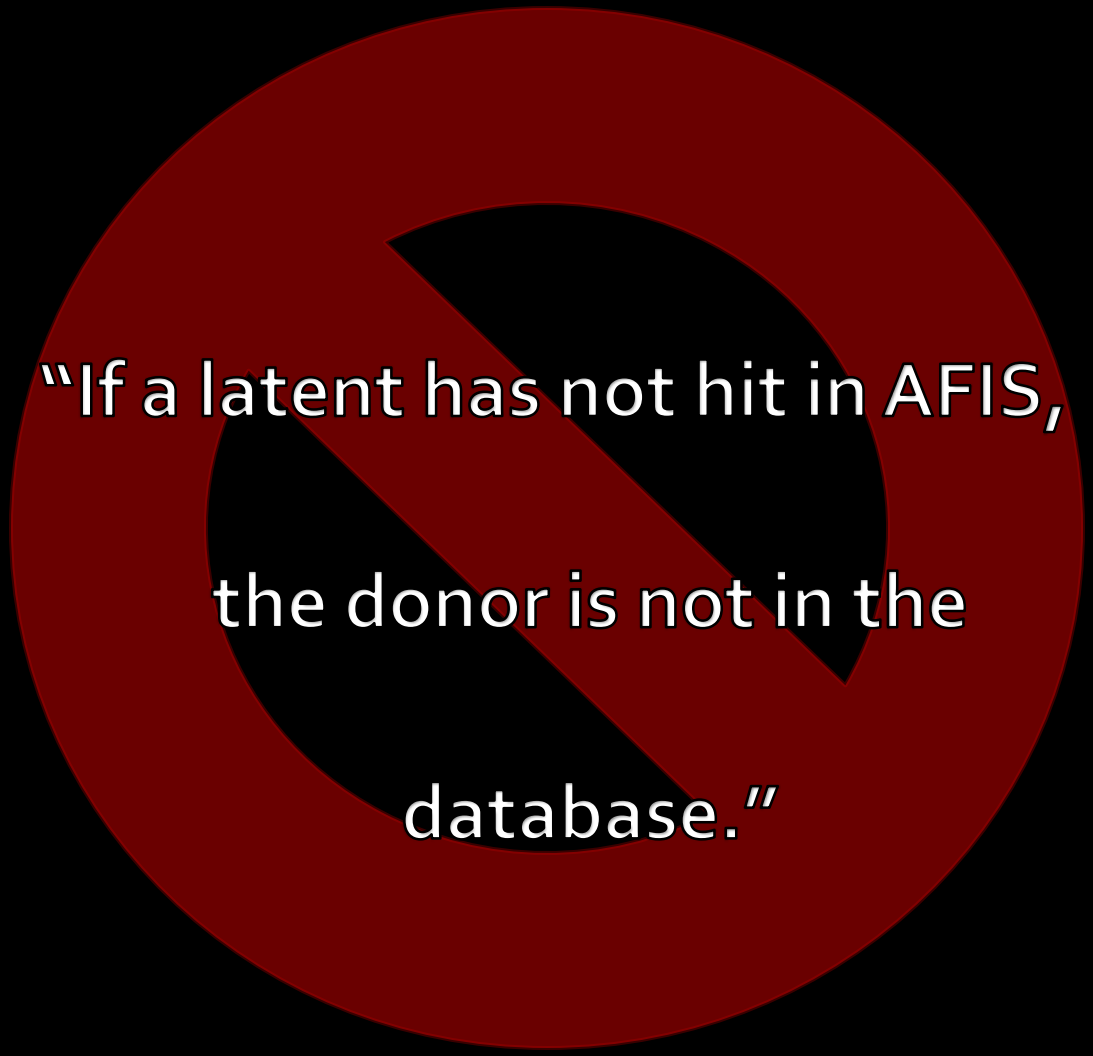
Encode


Universal Latent Workstation - [LFFS: 07-CEXC11624-0464-AR-1-W_0-00.ffs (2:1) (1000 ppi)]
File Edit Image View Training Window Help To Do
Zoom (2:1)
Show Features
Edit Features
Count Ridges
Reject 0
minutiae 0%
Accept 21
minutiae
Rec 1: Transaction Information
Transaction Data
Rec 2: Descriptive Text
Case Information
Subject Description
Latent/s
Rec 7: Fingerprint Image
Fingerprint Image
Rec 8: Fingerprint Feature Data
FBI IAFIS
Cogent (empty)
Sagem Morpho (empty)
NEC (empty)
Motorola (empty)
Annotations

Candidate Comparisons



Latent Print Fallacy



"If a latent has not hit in AFIS,

the donor is not in the

database."

Current state of affairs and what the future holds.

- Blind verification
- Documentation
- Error rates
- Statistical modeling
- Training and education

Training

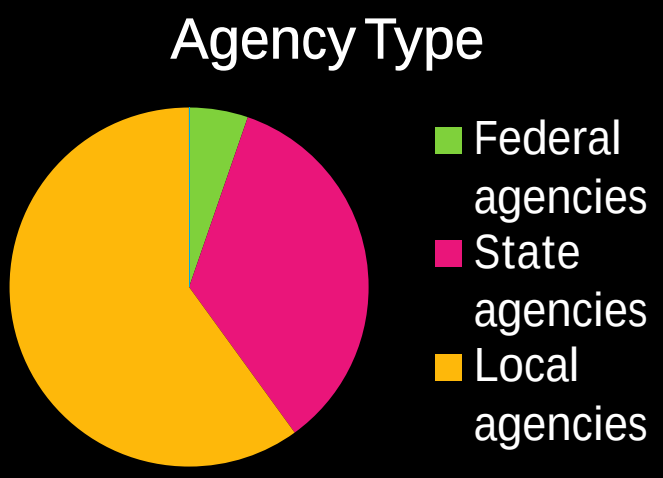
- Despite growth and progress over the 100 year history of fingerprints, training has remained essentially the same
  - On-the job training
  - Mentorship
  - No universal training, training accreditation, or licensure

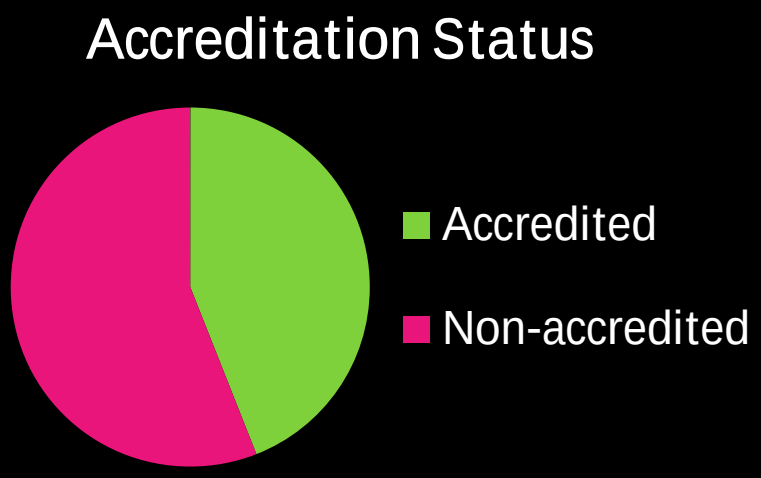
Training Study

- Attempt to gain a base-line understanding of training practices in the United States
  - To determine the prevalence of formal training programs
  - To assess the implementation and interpretation of SWGFAST guidelines as they relate to training
  - To determine the impact of ASCLD/LAB accreditation on training standards

Demographics of Respondents

- Received 75 responses out of 168 requests sent
- Average number of examiners employed per agency was 8, with a range between 1 and 65 employees
- 86.7% do not require IAI certification





Results:

- 75% have a formal written program
- 72% claimed to follow SWGFAST guidelines
  - 35% actually follow the guidelines based on objective criteria
- No consensus regarding:
  - Degree requirements
  - Length of training program
  - Duration of supervised case review
  - Existence of a pass/fail policy
- Accreditation does not appear to be the answer for improved training standards
  - A significant difference between ASCLD/LAB accredited agencies and non-accredited agencies was only found 54% of the time

Questions?

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