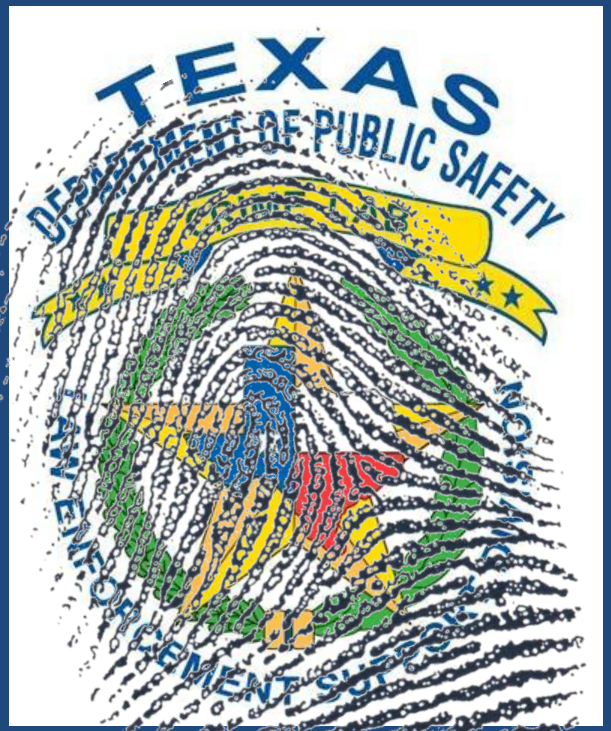


Latent Print Evidence

Bryan Strong
Forensic Scientist
Texas DPS Austin Crime Laboratory

Forensic Science Seminar 2010

Updated 10/2010

Topics

- Latent Print Discipline at the Texas DPS Laboratory
- Science of friction ridge analysis is a reliable means of identifying the source of a print to a single area of friction ridge skin (or excluding it).
  - Testing and Peer Review of Both the Theory and Technique of Friction Ridge Analysis
  - General Acceptance
  - Standards in the Discipline
  - Potential Rate of Error

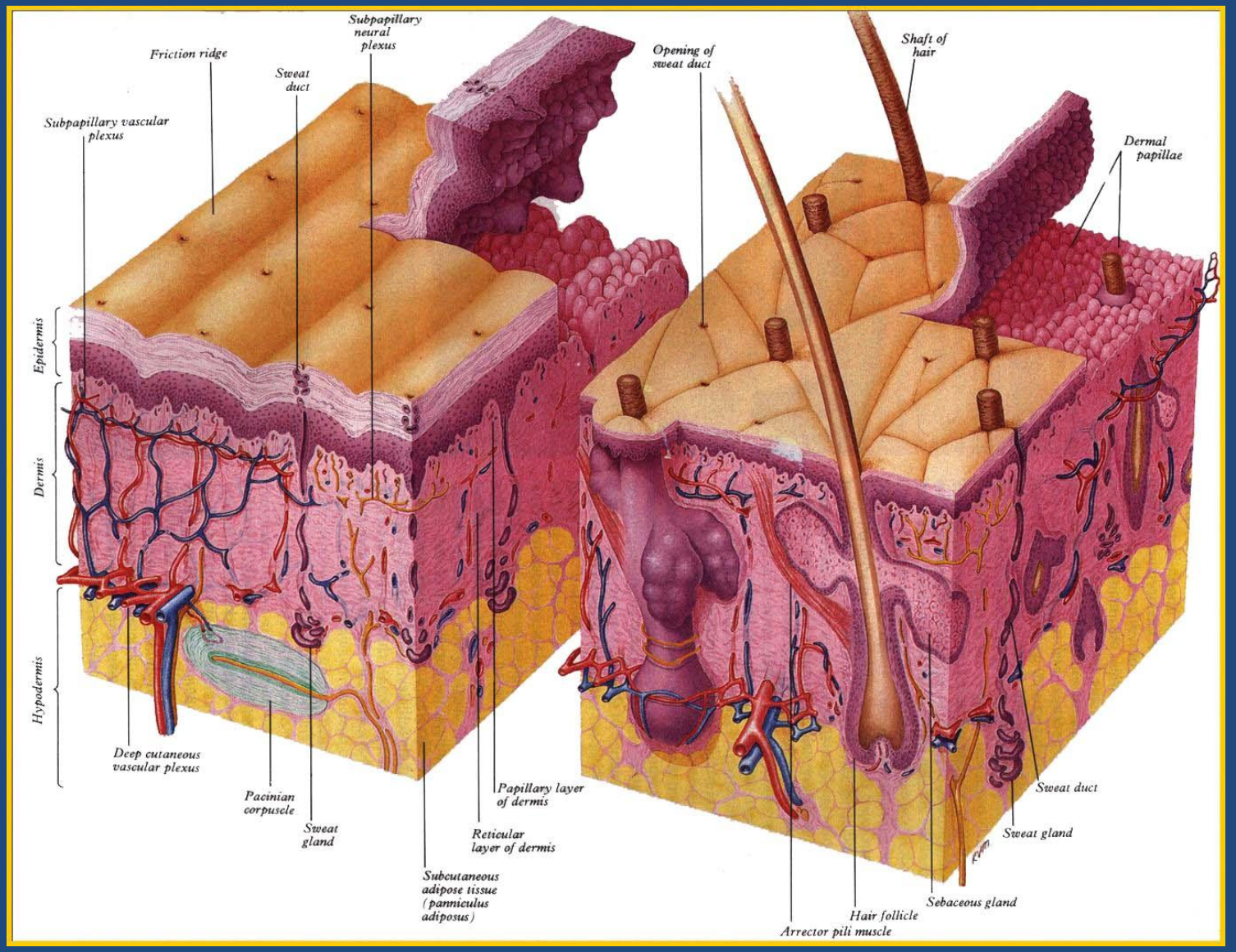
TX DPS Latent Print Discipline

- Austin
  - Latent Print Section Manager
  - + 8 Forensic Scientist FTE's
- Corpus Christi
  - 1 Forensic Scientist FTE (Limited to Latent Print Processing Only)
- McAllen
  - 3 Forensic Scientist FTE's
- Garland
  - 2 Forensic Scientist FTE's

What Makes a Latent Print Examiner

- Requirement: 4-year degree (or experience substitution)
- Training: Thousands of comparisons / Comparison Tests
- Standard: Trained to competency
- Standard: Annually proficiency tested in Latent Print Comparisons

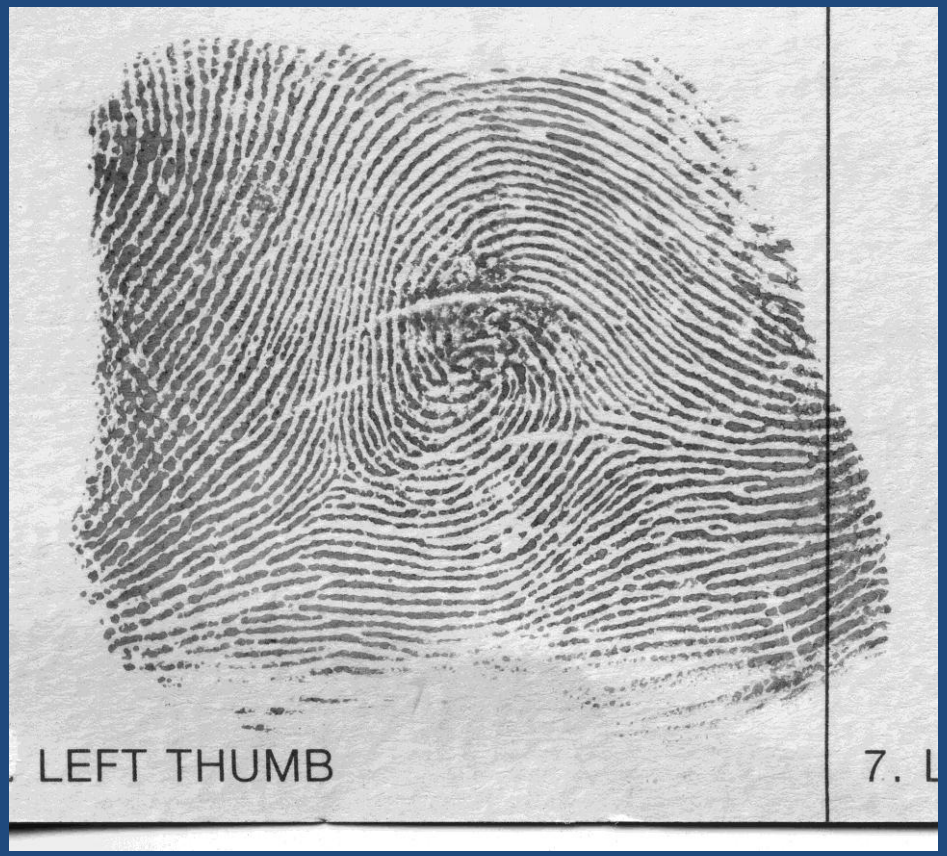
Friction Ridge Skin



Williams et. al. 1989

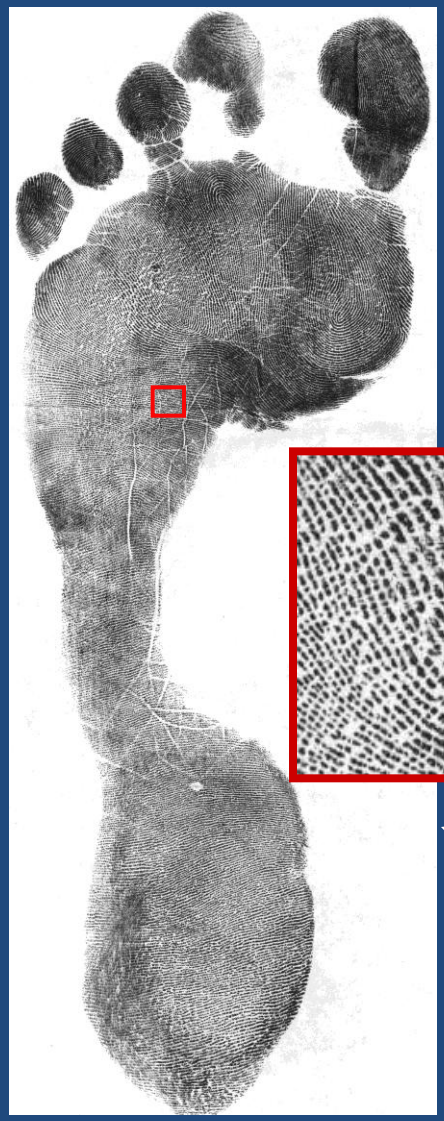
Friction Ridge Skin

Photograph of Friction Ridge Skin

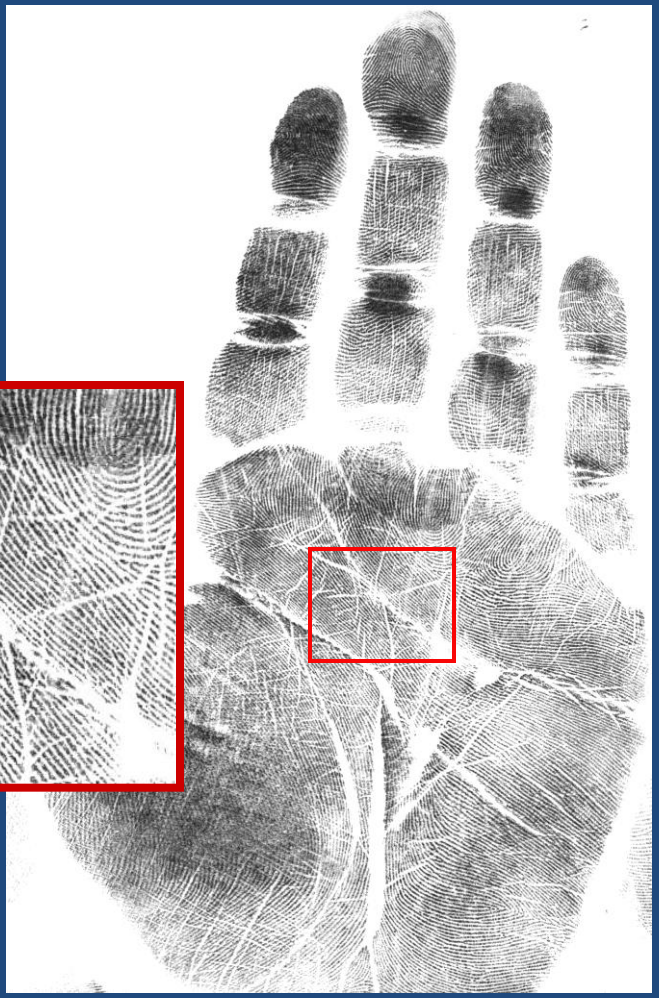


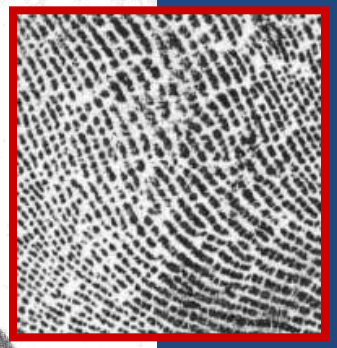
Reproduction of Friction Ridge Skin

Friction Ridge Skin



Palms of the hands





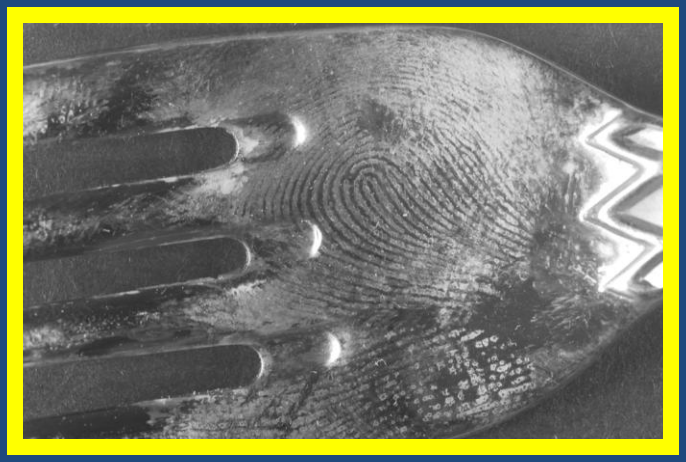
Soles of the feet

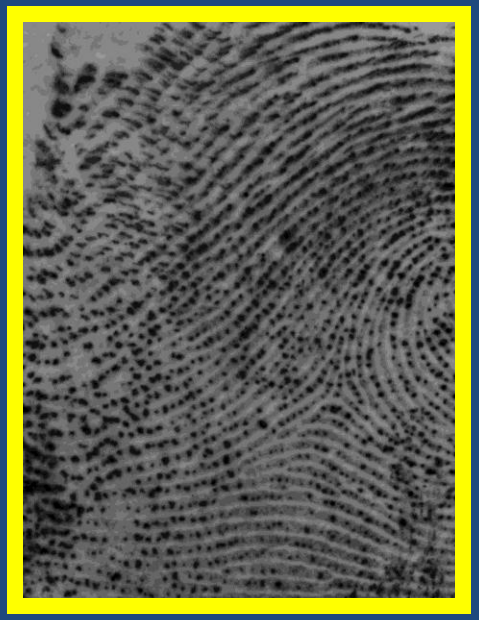
Non-Judicial Applications

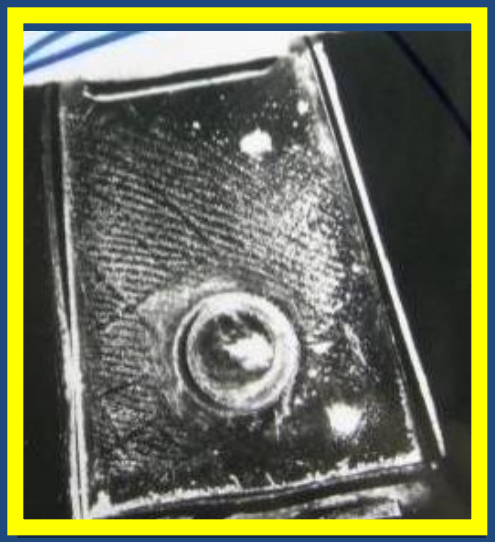
- **Victim Identification**
  - Natural disasters
  - Military
  - Plane crashes
- **Hospitals**
  - Newborns/Parents
- **Biometric devices**
  - Computer security
  - Security
- **Personal Identification**
  - Driver's License
  - Passport
  - Visa
- **Civil Employment**
  - Child Care
  - Teachers
  - Coaches

The use of fingerprints as a reliable means of identification is Generally Accepted in fields other than law enforcement.

Latent Print Examples







Levels of Friction Ridge Detail

- Level 1
  - Overall Ridge Flow or Pattern Type
    - Orientation
    - Focal areas
      - Core, delta
    - Pattern Type
      - Arch, loop, whorl
    - Ridge count

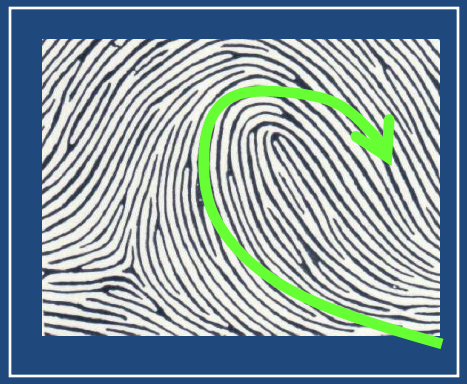
Identifications **cannot** occur at this level of information, however exclusions **can** occur.

Three Basic Pattern Types

(Found on the tips of the fingers)

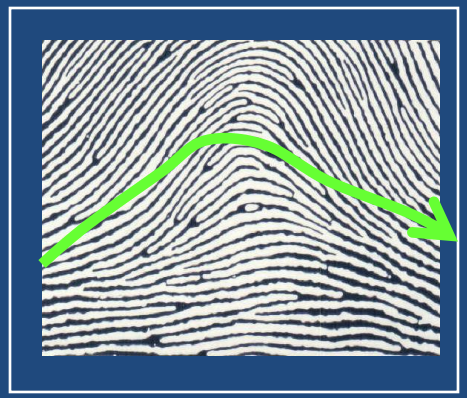
Loop

~60%



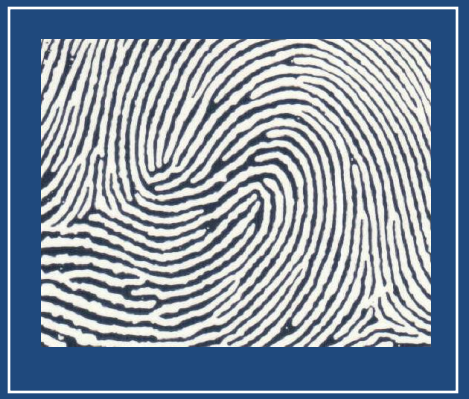
Arch

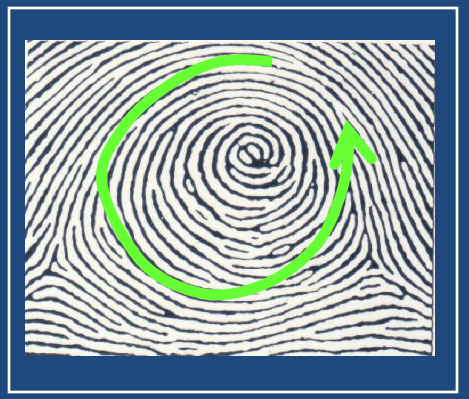
~5%



Whorl

~35%



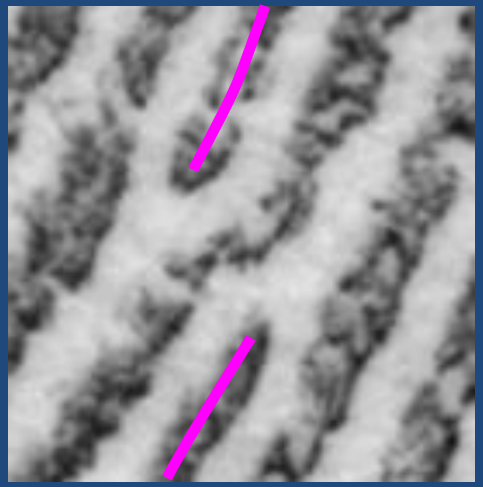


Levels of Friction Ridge Detail

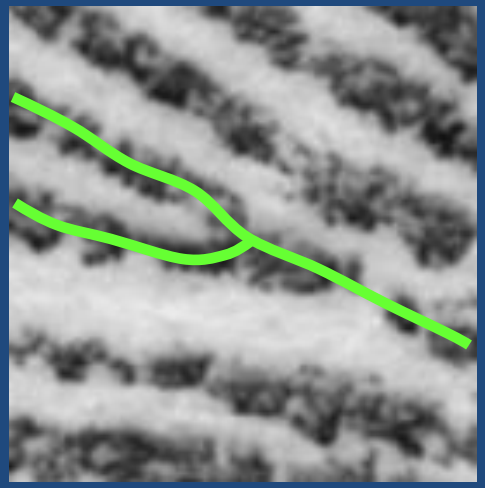
- Level 2
  - Ridge Paths
    - Characteristics (Galton's Details)
      - Ridge Ending
      - Bifurcation
      - Ridge Dot
    - Continuous Ridges
    - Location, type, direction, and relationship

Identifications and exclusions **can** occur at this level of information.

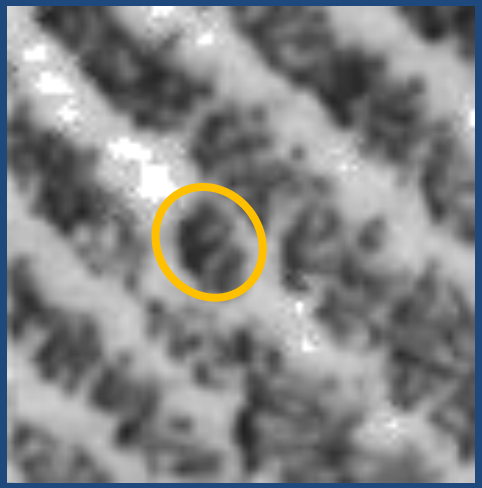
Level 2 Information – Ridge Paths



Ridge Ending

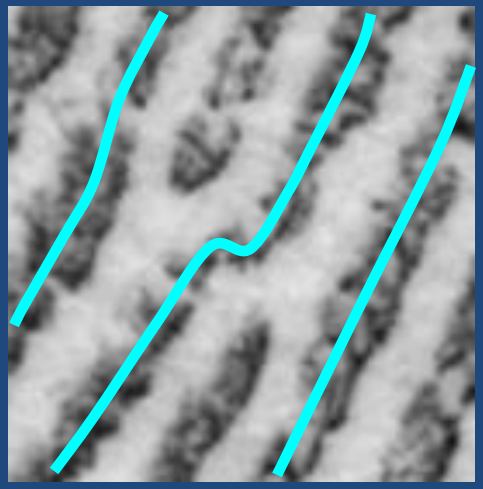
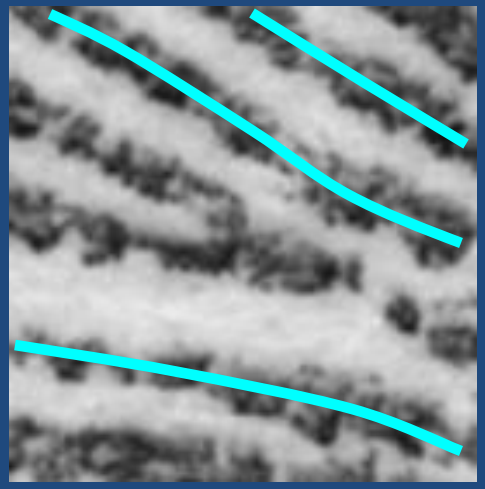
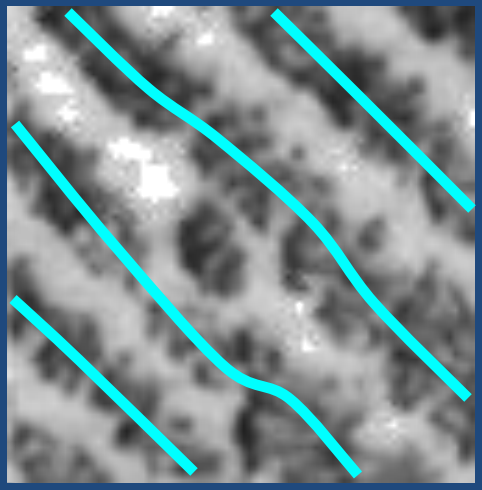


Bifurcation



Ridge Dot

Level 2 Information – Ridge Paths

Continuous Ridges

Levels of Friction Ridge Detail

- Level 3
  - Size and shape of pores and ridges
    - Pores
    - End shapes and angles
    - Edge shapes
    - Width

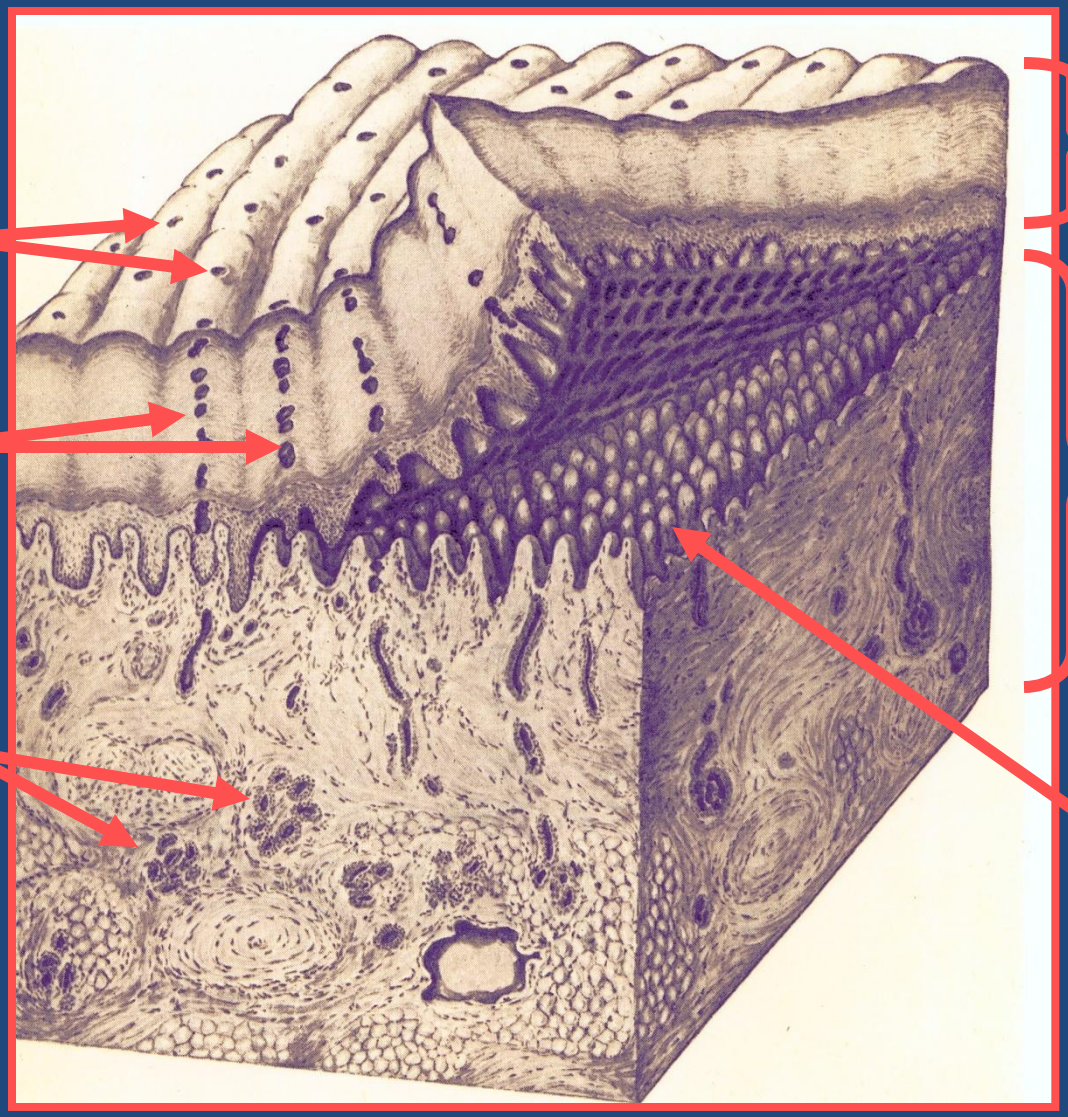
Identification and exclusion decisions **can be supported** at this level of information.

Scientific Basis

- **Permanence / Persistence**
  - The ridge arrangement on every finger of every person is permanent.
  - The ridges are persistent throughout life, barring any skin injury or disease.

- **Uniqueness**
  - The ridges are formed before birth.
  - The ridge arrangement on every finger of every person is unique.
  - Identical/Monozygotic twins have same DNA, but different fingerprints.

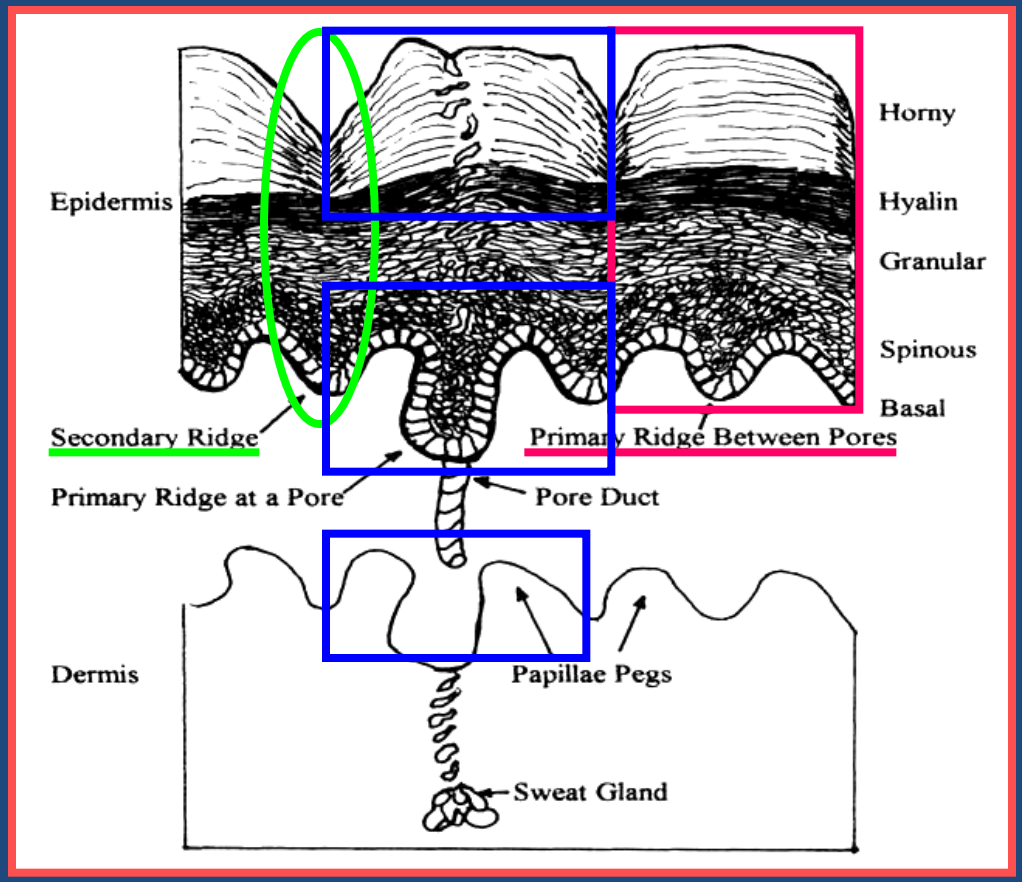
Friction Ridge Skin



Modified from Babler 2005

Friction Ridge Skin

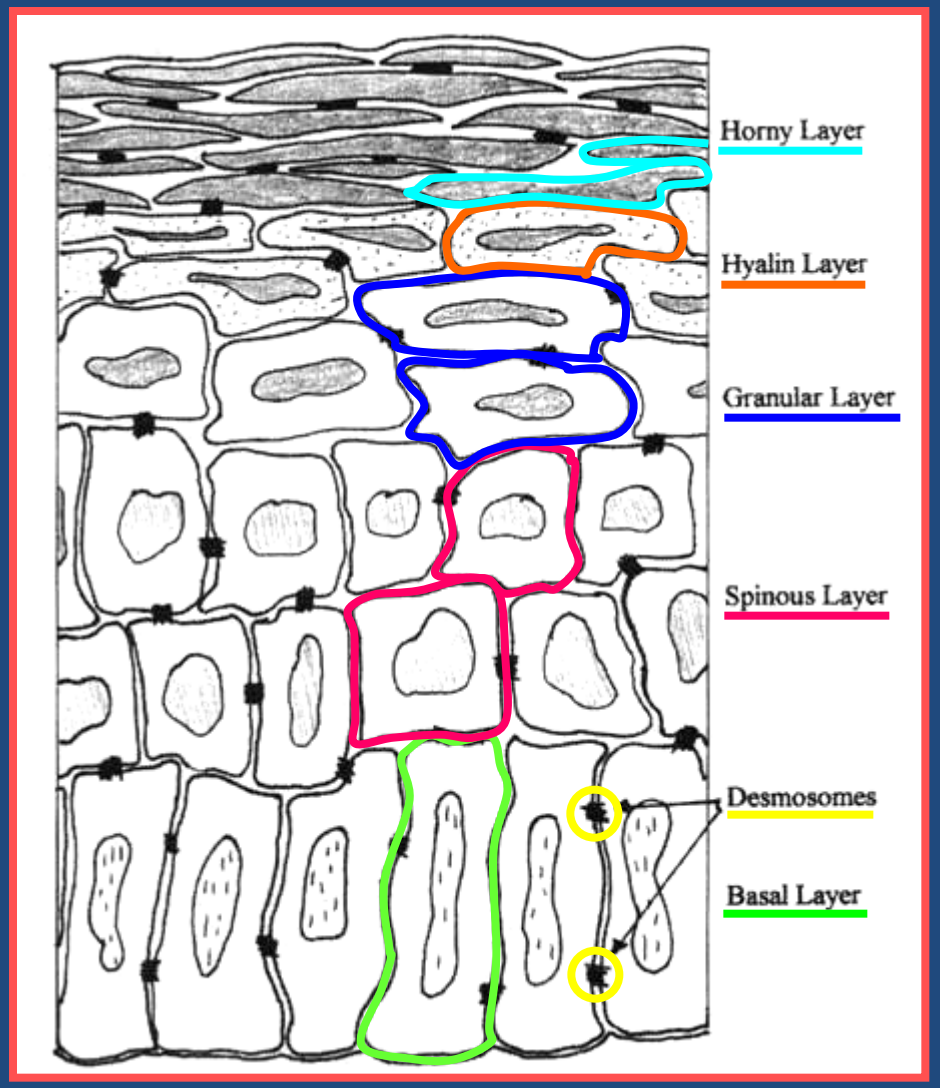
- Primary ridges correspond to friction ridges.
- Primary ridges have pores.
- Secondary ridges correspond to furrows.
- The dermis has double rows of papillae pegs, flanking the primary ridges.
- Forms the template for continued growth



Ashbaugh 1999

Cell Migration Through The Epidermis

- Exfoliation- cells slough off as new cells migrate and replace them
- Desmosome attachment locks cells in place/ surface movement of cells in concert
- Surface Migration
- Cells formed through Mitosis



Ashbaugh 1999

Empirical Studies

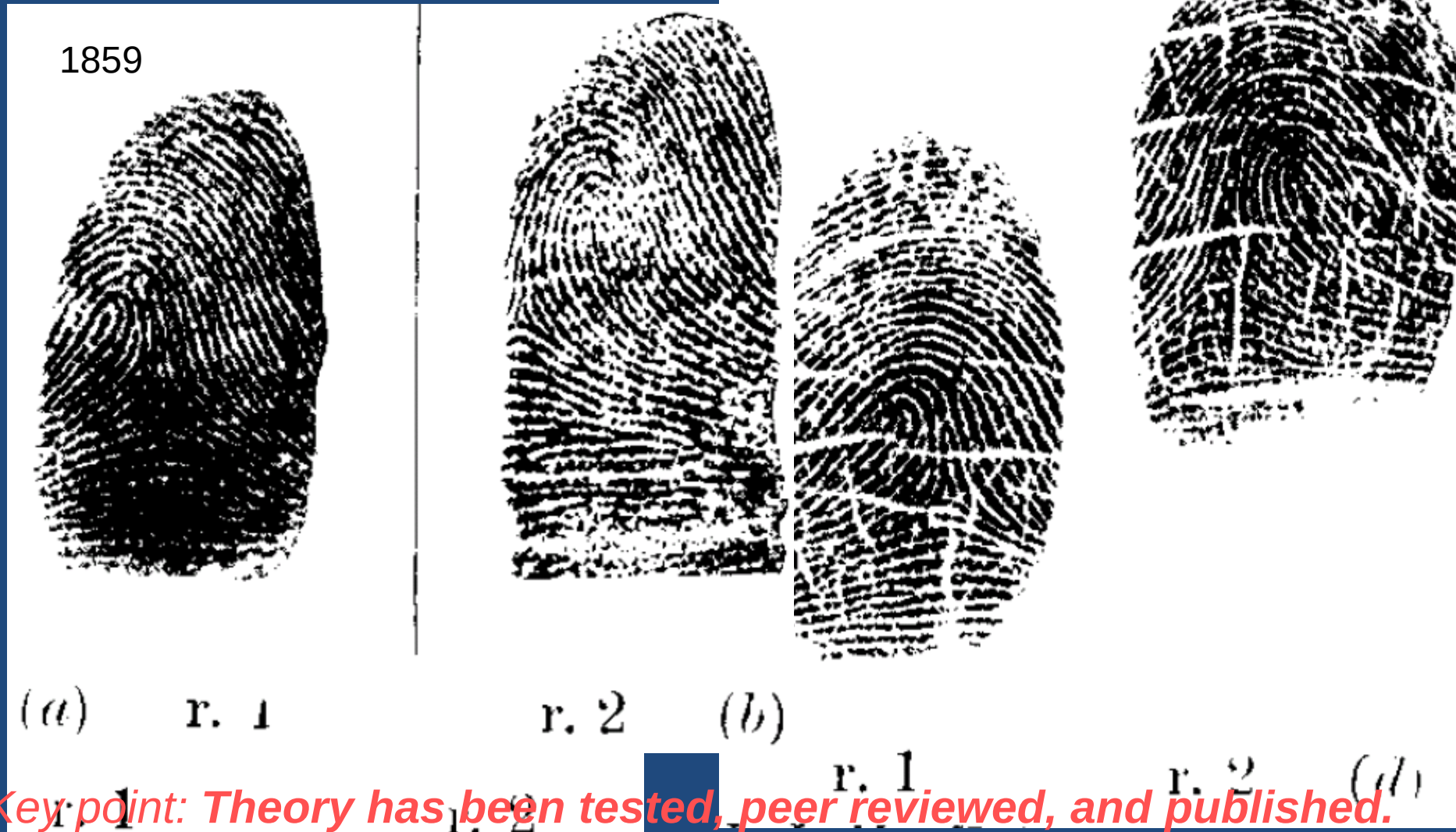
Persistence

18, 39, 57 year intervals

- Sir William J. Herschel

1859

1916



Key point: ***Theory has been tested, peer reviewed, and published.***

Genetics / Epigenetics

Two factors influence the uniqueness of friction ridge skin:

- Genetics - Things we inherit from our parents, our DNA or genetic code.
- Epigenetics - Non-genetic factors
  - Intrauterine environment (often referred to as environmental factors)
  - Differential (or random) growth

Friction Ridge Timeline

- Weeks 5-7
  - Fingers elongate and separate
  - Cartilaginous bones form
- Weeks 7-11
  - Volar pads form
- Weeks 11-17
  - Volar pads regress
  - Primary ridges form
- Weeks 17-24
  - Primary ridge development stops
  - Secondary ridges form between primary ridges
- Weeks 24-27
  - Papillae pegs form
  - Basement membrane joins epidermis to dermis

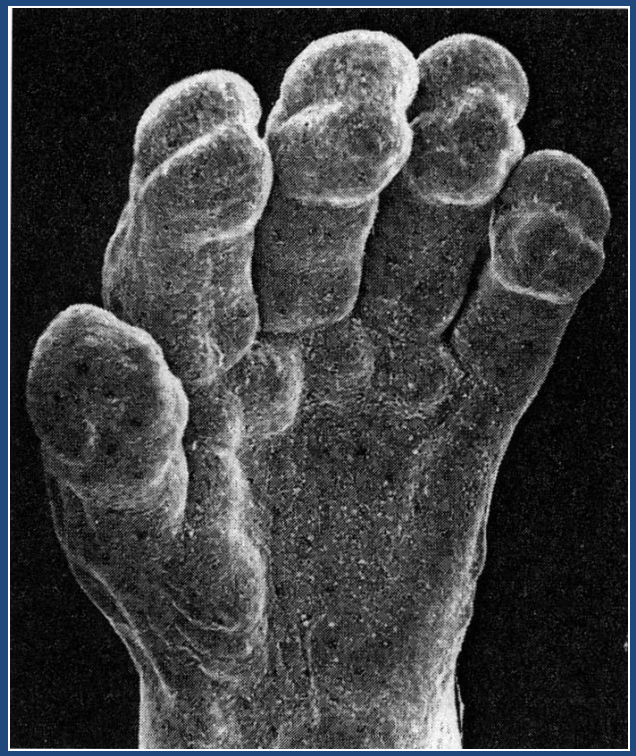
* At 17 weeks, ridges are in their final arrangements

* When secondary ridges form, surface ridges are present for the first time.

* At 24 weeks, friction ridges are fully developed on the surface skin and fixed for life.

Key point: Hundreds of years of study and scientific research published in peer reviewed journals and books.

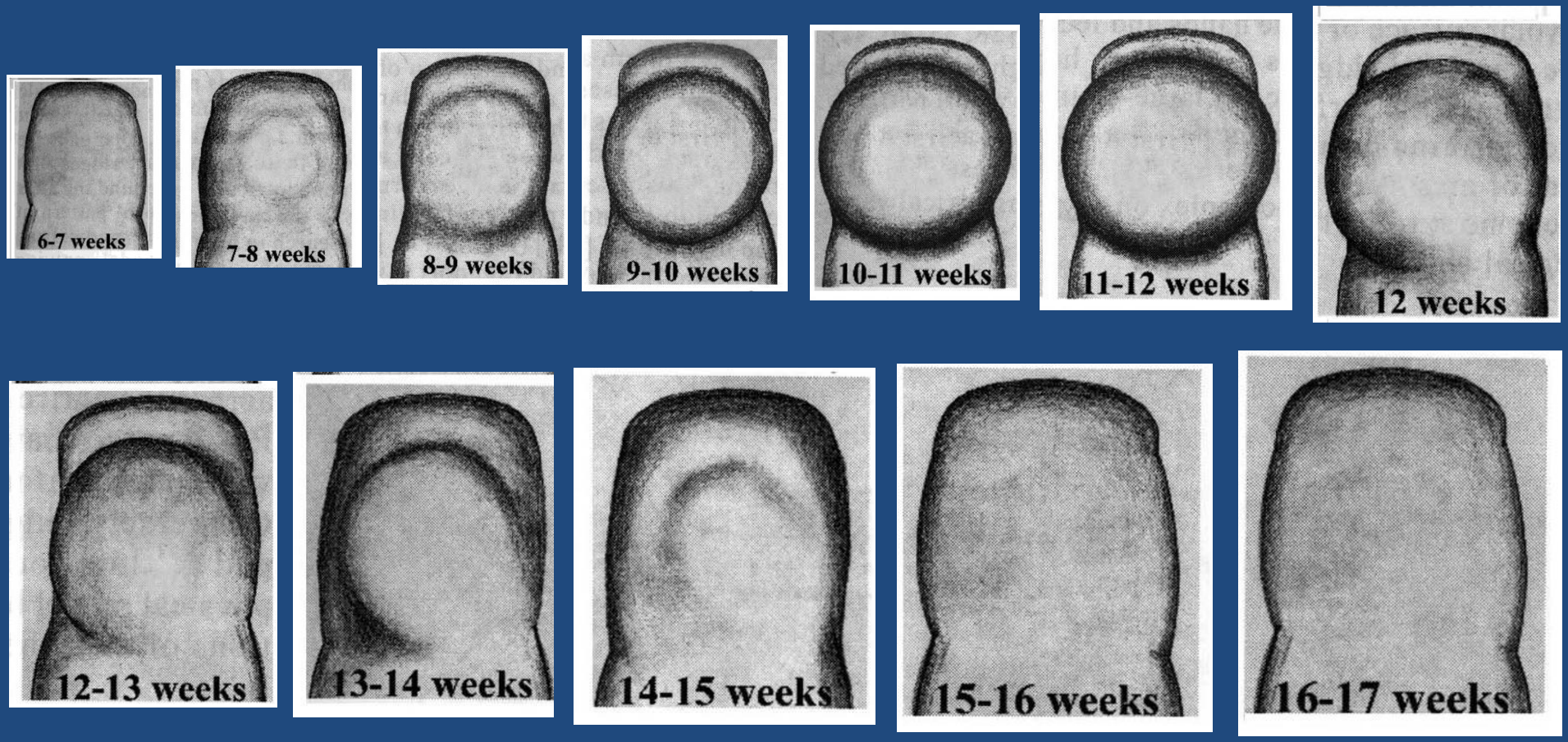
Development 5-7 weeks



Wertheim and Maceo, 2002

- Fingers separate.
- Appearance of volar pads on the palm and interdigital areas (2nd, 3rd, 4th interdigital pads, the thenar and the hypothenar regions)

Development and Regression of Volar Pads



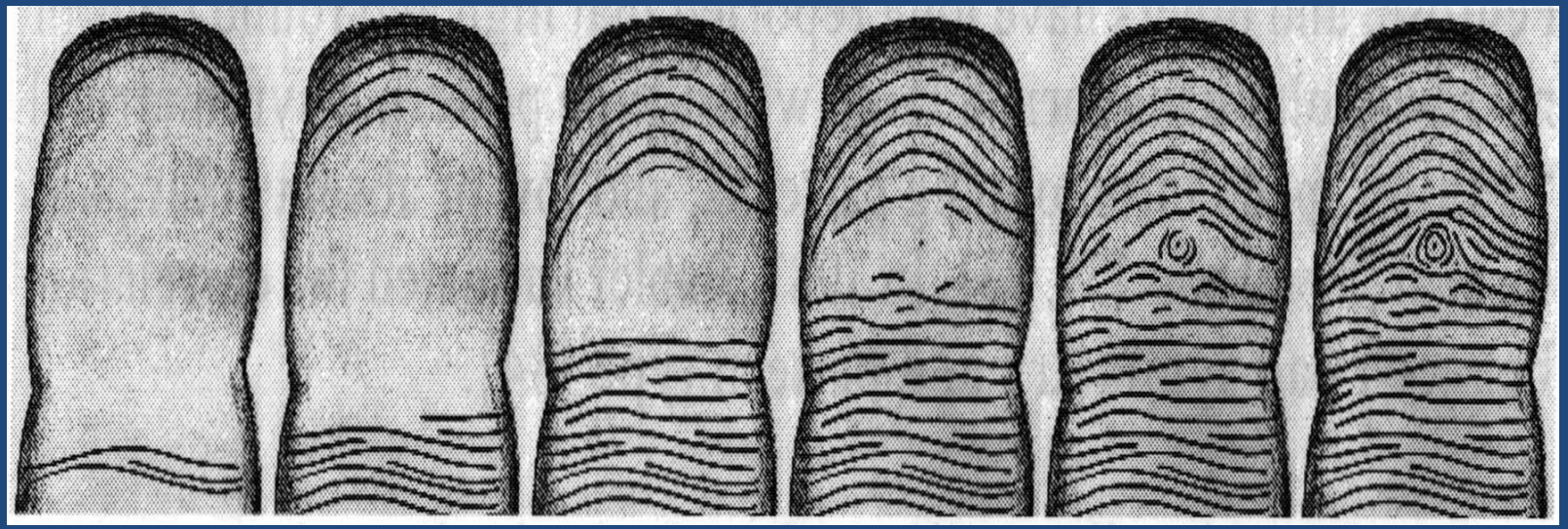
Wertheim and Maceo, 2002

**Volar pad regression – Slowing growth of the volar pad and the simultaneous more rapid growth of the hand/foot around the pad.

Friction Ridge Formation

- Ridges spread across fingers in wave pattern from
  - Apex
  - Fingertip
  - Distal flexion crease
- Convergence of the 3 fields at delta area

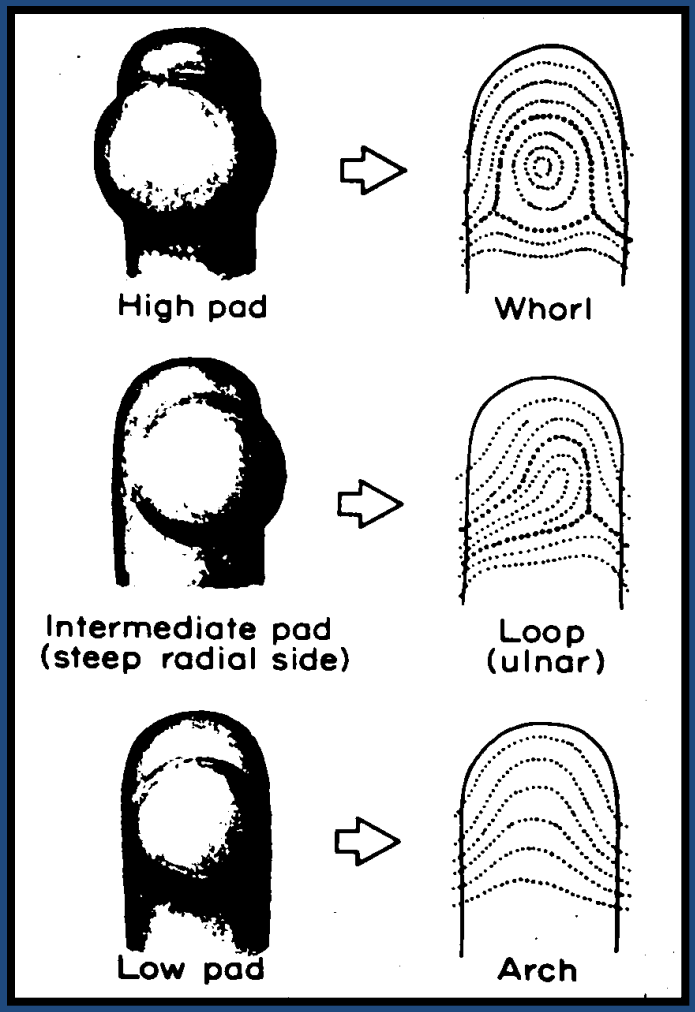
17 weeks → 24 weeks



Wertheim and Maceo, 2002

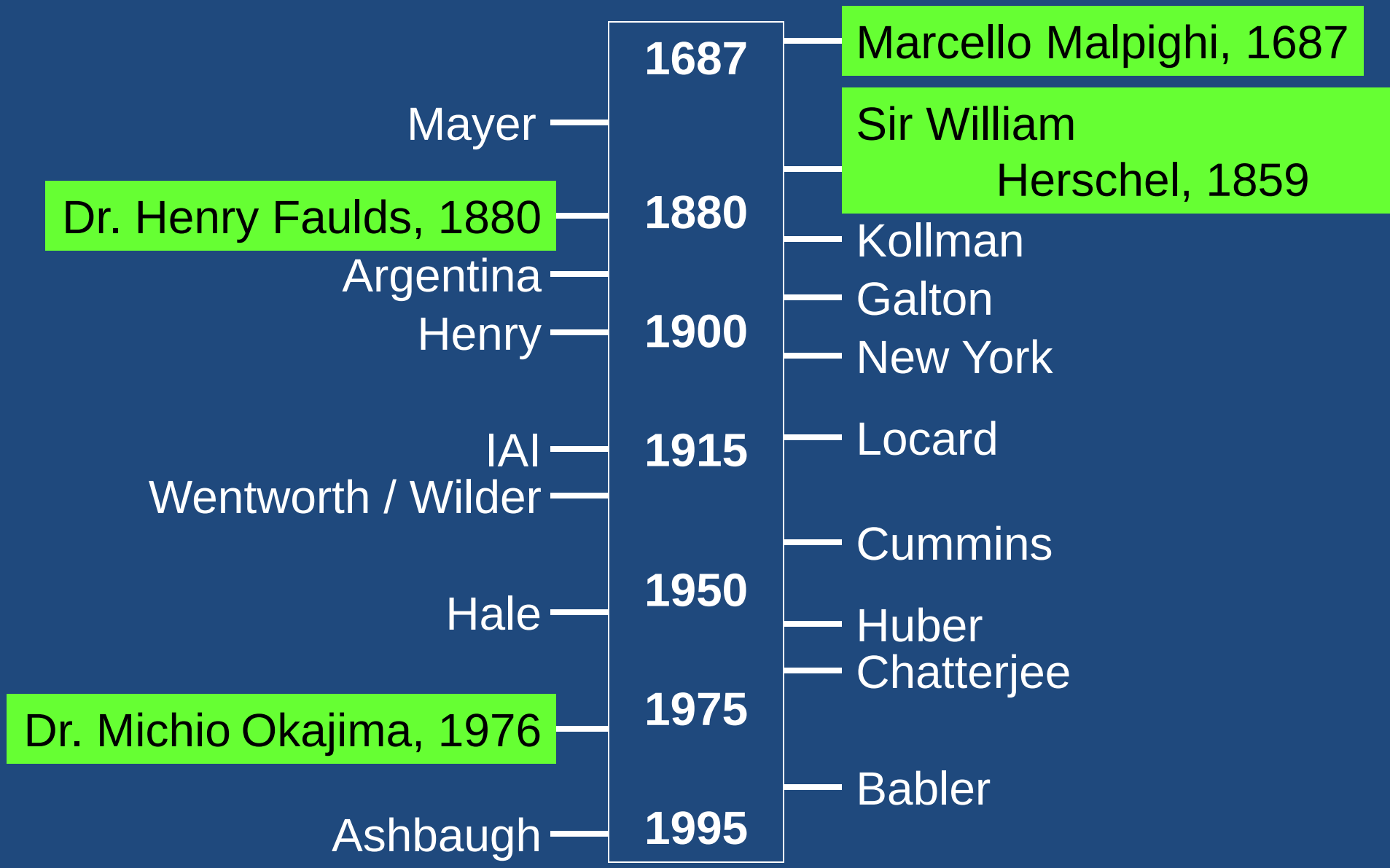
Symmetry and Size of Volar Pads

- The wider and taller the volar pad, the more likely whorls will form.
- These factors primarily determine whorls, arches, and loops.
- Symmetrical patterns = whorls or arches
- Asymmetrical patterns = loops
- A gradient of pattern types and ridge counts

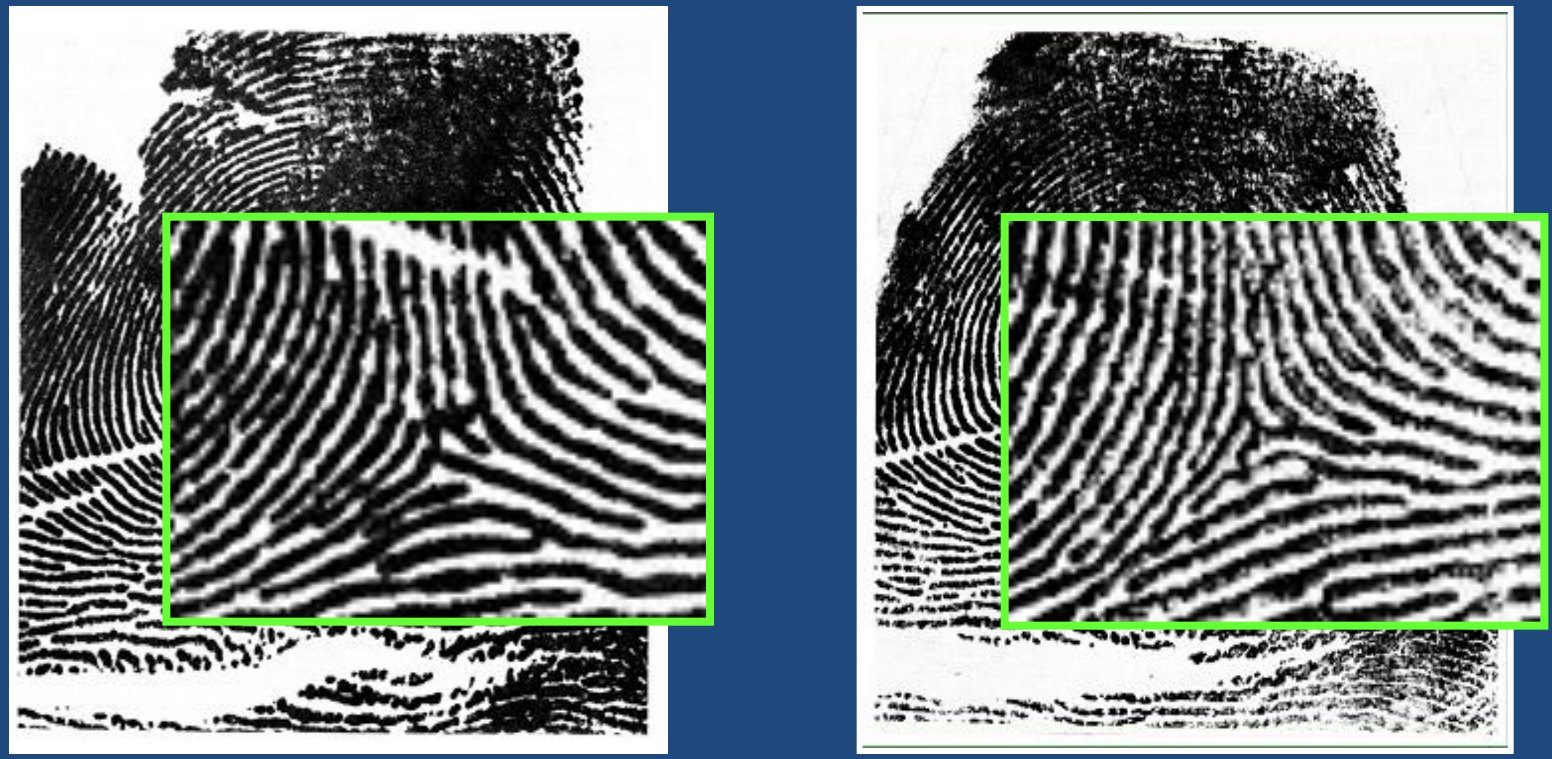


Ashbaugh, 1999

General Acceptance

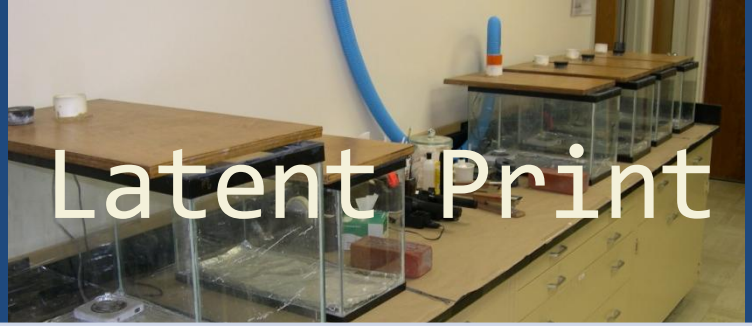


Twin Study - Uniqueness



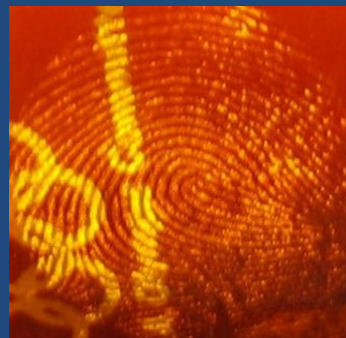
Lin, 1982

From comparison of 1,220 fingers of male monozygotic twins, 940 fingers of female monozygotic twins, 800 fingers of male dizygotic twins, 880 fingers of female dizygotic twins, and 80 fingers of opposite-sex dizygotic twins.



Latent Print Processing

Visual Exam	Evidence				
Type of Surface/ Choose Processing Method or Sequence	Porous	Non-Porous		Adhesive	Bloody
Sequence or Processing Method	Chemical Treatment NIN, IND	SG, FD, LS	SG, BP	SSP	AB
Preservation	Photo	Photo	Lift	Photo	Photo



General Acceptance: No minimum point standard

- 1973 International Association for Identification (IAI) Resolution
- 1995 Ne'urim Declaration
- 2009 IAI Resolution
  - There currently exists no scientific basis for requiring a minimum amount of corresponding friction ridge detail information between two impressions to arrive at an opinion of single source attribution

Comparison and Identification of Latent Print Evidence

Scientific Methodology for Fingerprint Identification

Scientific Method

1. Observation
2. Question
3. Hypotheses
4. Experiment
5. Conclusion
6. Repetition
7. Record Results

Friction Ridge Comparison

ACE-V

1. Impression present

Unknown

2. Who is the source?
3. The print does/does not come from this finger.
4. Analysis, then Comparison

Side by Side

5. Evaluation

Sufficient quantity/quality for ID

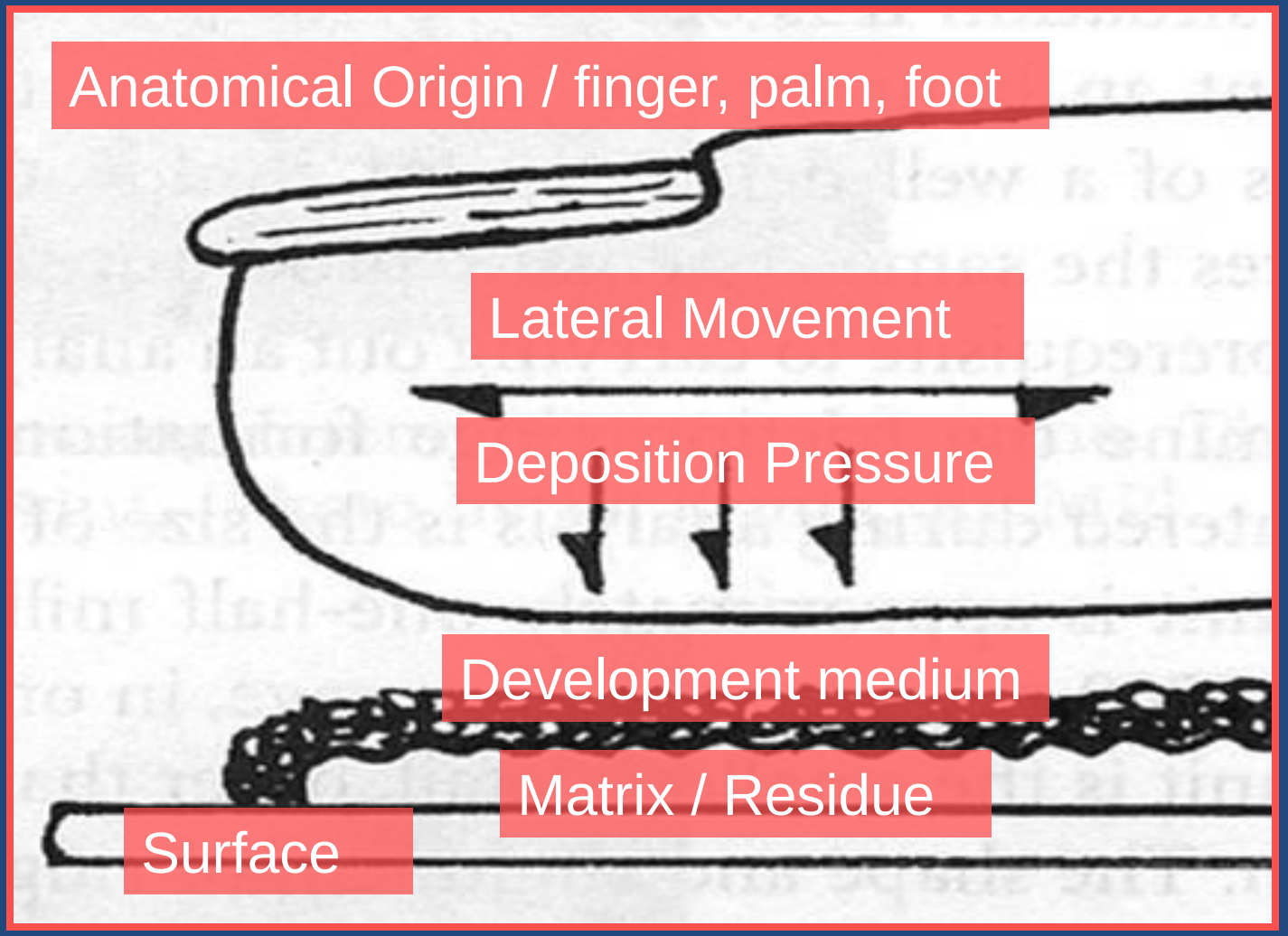
6. Verification

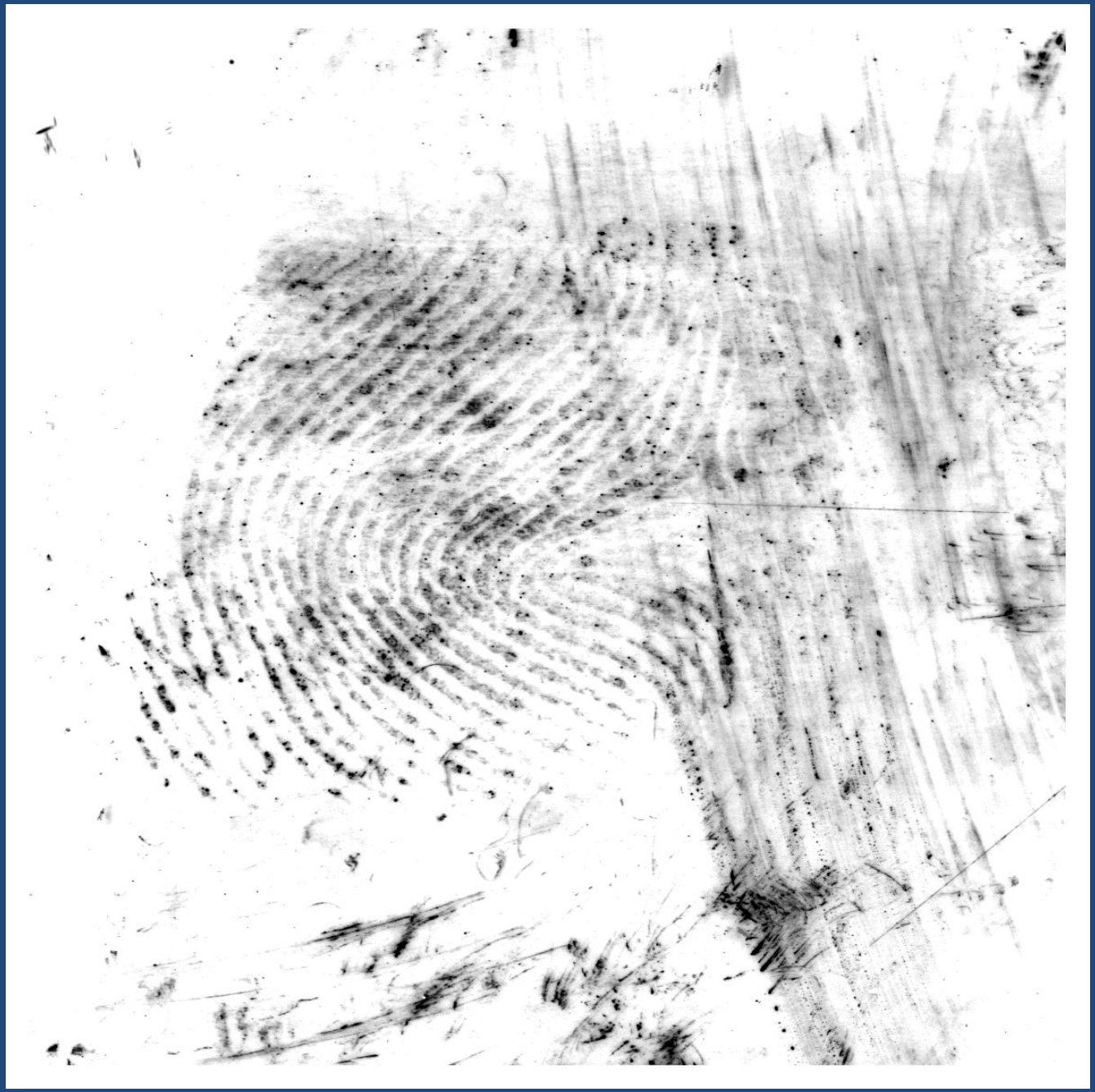
Quality Control

7. Report/testimony

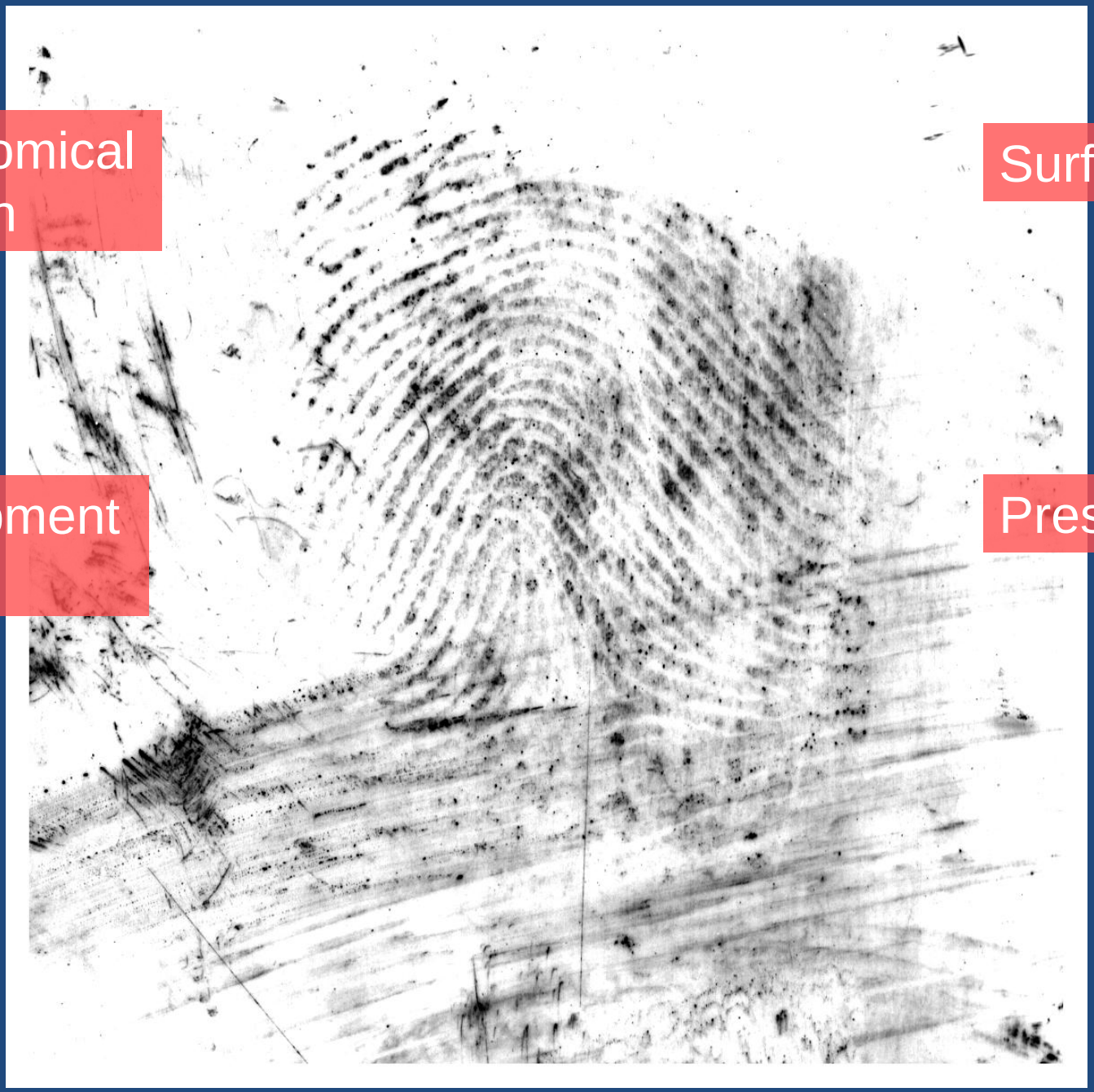
Analysis

3D-2D





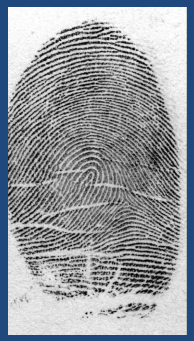
ANALYSIS: Latent Print



ANALYSIS: Latent Print

10-PRINT CARD (KNOWNS)

UNKNOWN



PERSONAL IDENTIFICATION

FINGERPRINTS SUBMITTED BY

FINGERPRINTED BY

Person to be Notified in Case of Emergency

NAME

ADDRESS

See Reverse Side for Further Instructions

1. RIGHT THUMB
2. RIGHT INDEX
3. RIGHT MIDDLE
4. RIGHT RING
5. RIGHT LITTLE
6. LEFT THUMB
7. LEFT INDEX
8. LEFT MIDDLE
9. LEFT RING
10. LEFT LITTLE

LEFT FOUR FINGERS TAKEN SIMULTANEOUSLY

RIGHT FOUR FINGERS TAKEN SIMULTANEOUSLY

10-PRINT CARD (KNOWNS)

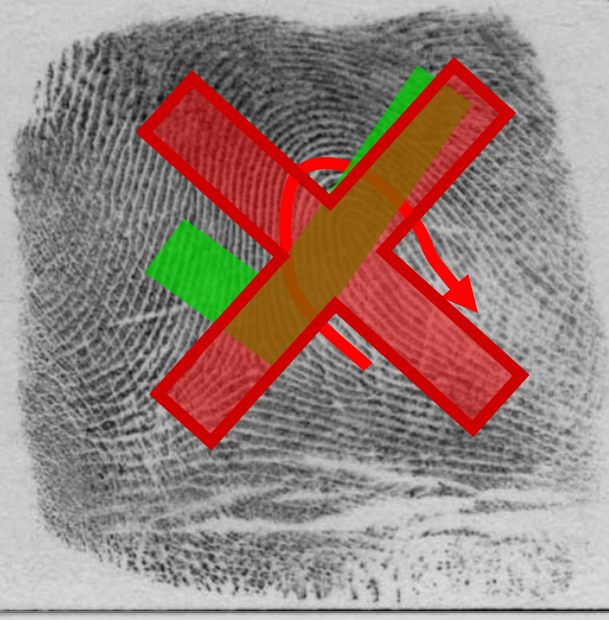
UNKNOWN

PERSONAL IDENTIFICATION

FINGERPRINTS SUBMITTED BY

FINGERPRINTED BY

5. RIGHT LITTLE 13



→ TO EVALUATION

COMPARISON – RIDGE FEATURES

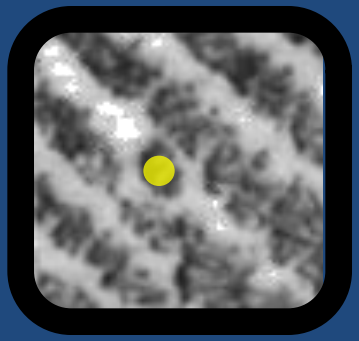
2nd level components of friction ridge impressions include ridges and ridge features

CHARACTERISTICS

Ridge Ending

Bifurcation

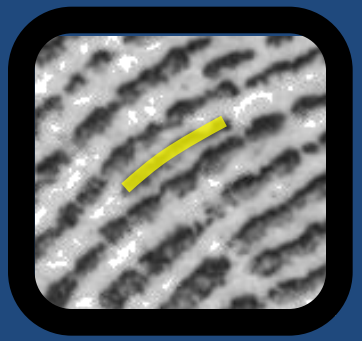
Dot



FORMATIONS

Enclosure

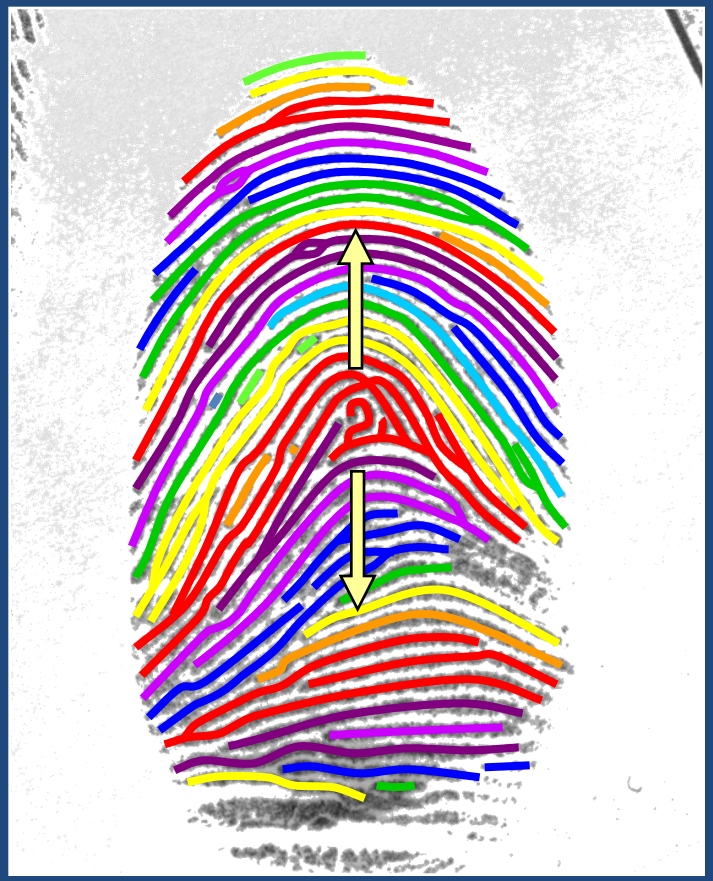
Short Ridge



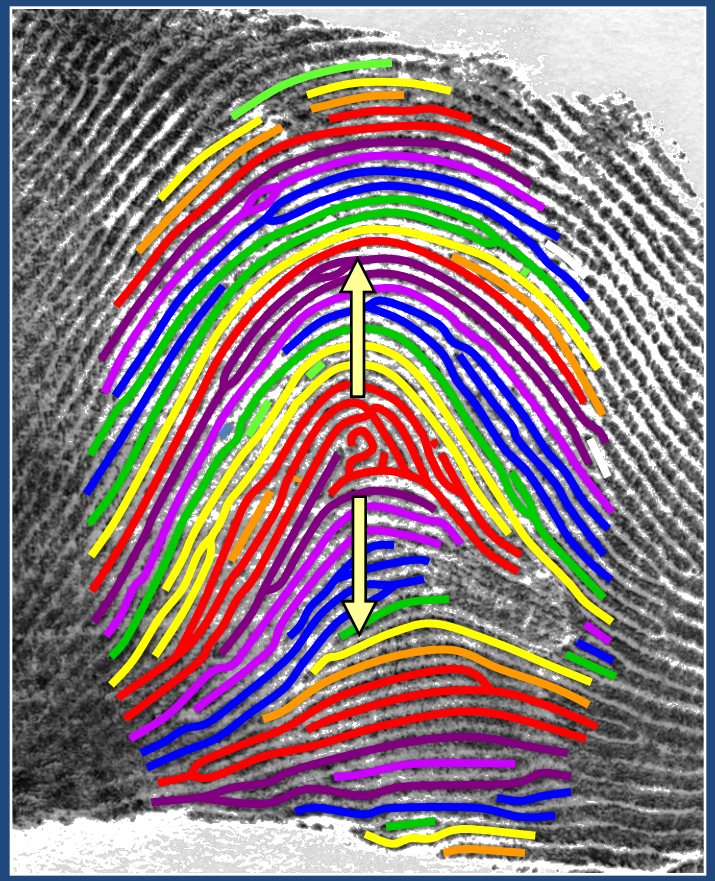
COMPARISON – Ridge Sequence

Comparison of ridges in sequence provides a structured approach to examining the entire print

UNKNOWN



KNOWN



Evaluation

- Identification (Individualization)
  - "The determination of an examiner that there is sufficient quality and quantity of detail in agreement to conclude that two friction ridge impressions originated from the same source."
- Exclusion
  - "The determination by an examiner that there is sufficient quality and quantity of detail in disagreement to conclude that two areas of friction ridge impressions did not originate from the same source."
- Inconclusive
  - "During Evaluation, the conclusion reached that neither sufficient agreement exists to individualize nor sufficient disagreement exists to exclude."

Verification

- All identifications are verified by another qualified examiner applying the ACE methodology.
  - Performs an independent analysis, comparison, and evaluation.

- Serves as QA/QC measure
- Repetition is part of the scientific method

Agency Defined Policy

- Verification and Review Policy
  - Criteria for Verification based on objective criteria
    - May require additional Verifications based on Quality (Clarity) and Quantity of friction ridge detail.

- Blind Verification Policy
  - SWGFAST standard on implementation

Types of Error: **Practitioner Error**

- Administrative
  - Transcription errors
  - Spelling errors
- Technical
  - Erroneous Identifications
  - Erroneous Exclusions (missed identifications)

~~Error rate is zero~~

vs.

Predictive rate of error does not exist

- *No inherent error in ACE-V by itself, but ACE-V needs to be applied by a practitioner. Error rate can not be calculated for the methodology by itself.*
- *Very difficult to calculate a predictive rate of error for the latent print discipline due to many different variables (quality of prints, training of examiner, etc.)*
- ***Error history is not a predictor of future error.*** *Error history could be calculated, but is this necessarily a good predictor of the chance of another error occurring?*
- *Error rate for individual could be calculated regarding Proficiency Tests Completed.*

Supporting the Reliability of Friction Ridge Examinations

- Evett & Williams (1995)
- K. Wertheim, Langenburg, & Moenssens (2006)
- Gutowski (2006)
- Langenburg, Champod, & P. Wertheim (2008)
- Langenburg (2009)

*The **testing** that's been done, while somewhat limited, does support the reliability of conclusions generated from examiners conducting ACE-V.*

SWGFAST Response to NAS: … *studies published in peer reviewed journals, although limited, also tend to suggest that the error rate of friction ridge examination, when conducted by competent examiners, is very low.*

Minimizing Errors

- **Documented SOP's/ Internal and External Audits**

- **Verification** – Check / Re-work of comparisons according to policy (Verification Criteria).
- **Latent Review** – Review of Suitability and to check for any missed identifications. Exclusion and Inconclusive decisions may be verified.
- **Evidence Review** – Check evidence to ensure examiner did not miss any latent prints present.

- **Technical Review** – Check that policy was followed, and that correct procedures (development and comparison) were followed
- **Administrative Review** – Check that all portions of the report are present and grammatically correct.

Summary / Questions

- The underlying theory of persistence and uniqueness of friction ridge arrangements has been studied, peer reviewed, and generally accepted by the scientific community.
- The ACE-V methodology, which functions as part of the scientific method, has been tested by over 100 years of study and application throughout the world. It has been subjected to peer review and is generally accepted.
- Research to date supports reliability of examiners conducting friction ridge examinations.

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