Presented by
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Director of IBIA

IBIA • Biometrics + Identity

Practical Applications of Biometrics

IBIA Identity Matters

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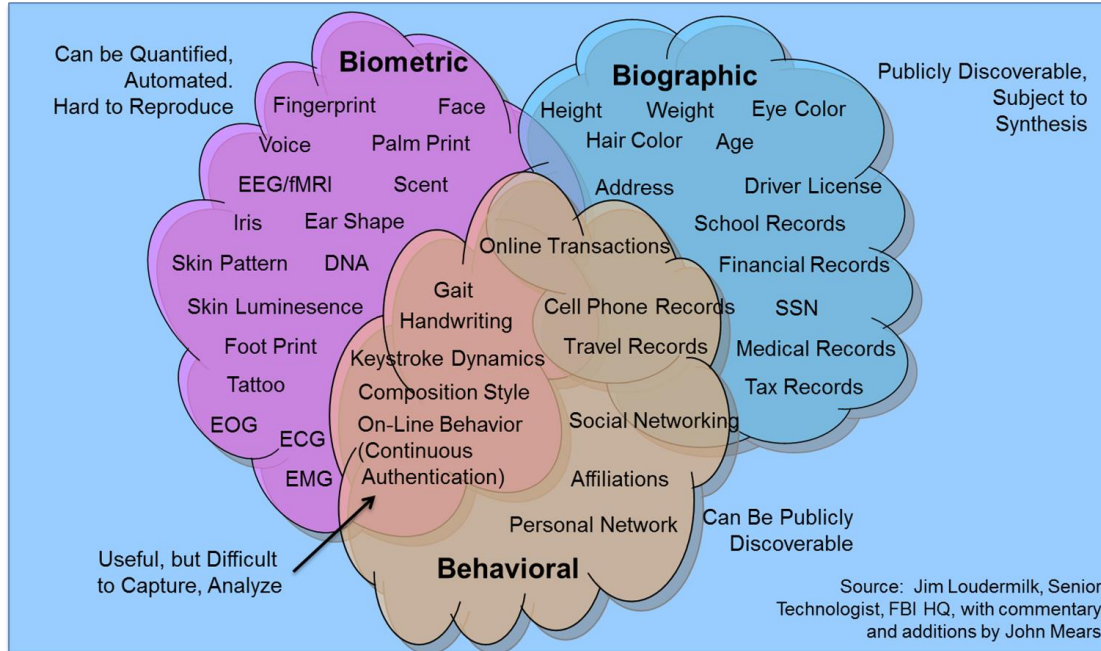# It Isn't Just About Tom Cruise's Eyes
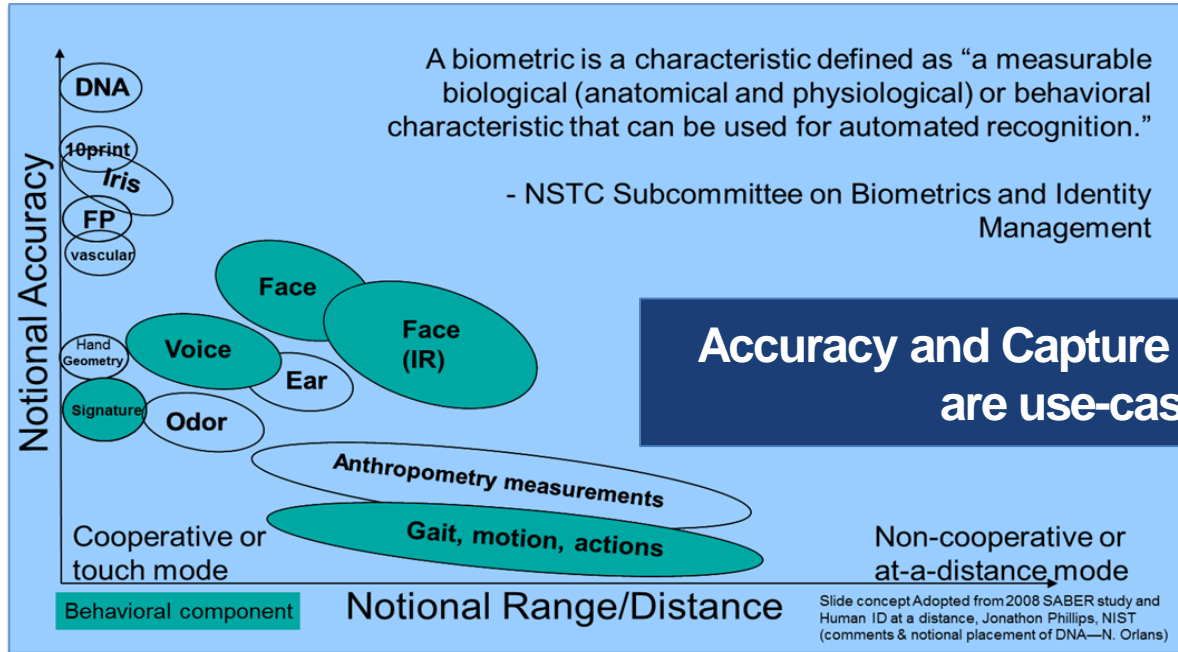
Identity Definition

Identity: who a person is, or the qualities of a person or group that make them different from others.

Source: Cambridge Dictionary

Identity Evolution

Can be Quantified, Automated. Hard to Reproduce

Biometric
Fingerprint   Face
Voice   Palm Print
EEG/fMRI   Scent
Iris   Ear Shape
Skin Pattern   DNA
Skin Luminesence
Foot Print
Tattoo
EOG   ECG
EMG

Biographic
Height   Weight   Eye Color
Hair Color   Age
Address   Driver License
School Records
Financial Records
Cell Phone Records   SSN
Travel Records   Medical Records
Tax Records

Publicly Discoverable, Subject to Synthesis

Online Transactions
Gait
Handwriting
Keystroke Dynamics
Composition Style
On-Line Behavior (Continuous Authentication)
Social Networking
Affiliations
Personal Network

Can Be Publicly Discoverable

Useful, but Difficult to Capture, Analyze

Behavioral

Source: Jim Loudermilk, Senior Technologist, FBI HQ, with commentary and additions by John Mears

Biometric Definition

A biometric is a characteristic defined as "a measurable biological (anatomical and physiological) or behavioral characteristic that can be used for automated recognition."

- NSTC Subcommittee on Biometrics and Identity Management

Notional Accuracy

DNA
10print
Iris
FP
vascular
Hand Geometry
Signature
Voice
Odor
Ear
Face
Face (IR)

Anthropometry measurements

Gait, motion, actions

Cooperative or touch mode

Non-cooperative or at-a-distance mode

Notional Range/Distance

Behavioral component

Slide concept Adopted from 2008 SABER study and Human ID at a distance, Jonathon Phillips, NIST (comments & notional placement of DNA—N. Orlans)

Accuracy and Capture Distance are use-case drivers

Modern Biometric History

Mid-19th century in India

- British magistrate, Sir William Herschel mandated that contracts be "signed" by a handprint AND a signature

- Evolved from a full handprint to the prints of two fingers only

- In the course of observing many contracts, Herschel came to believe that fingerprints were unique to individuals

1880s in France

- Recidivists previously identified by name alone

- Alphonse Bertillon created a system of criminal identification called "anthropometry" or "Bertillonage"

- Bertillon added the concept of body measurements along with photographs

Biometric Applications
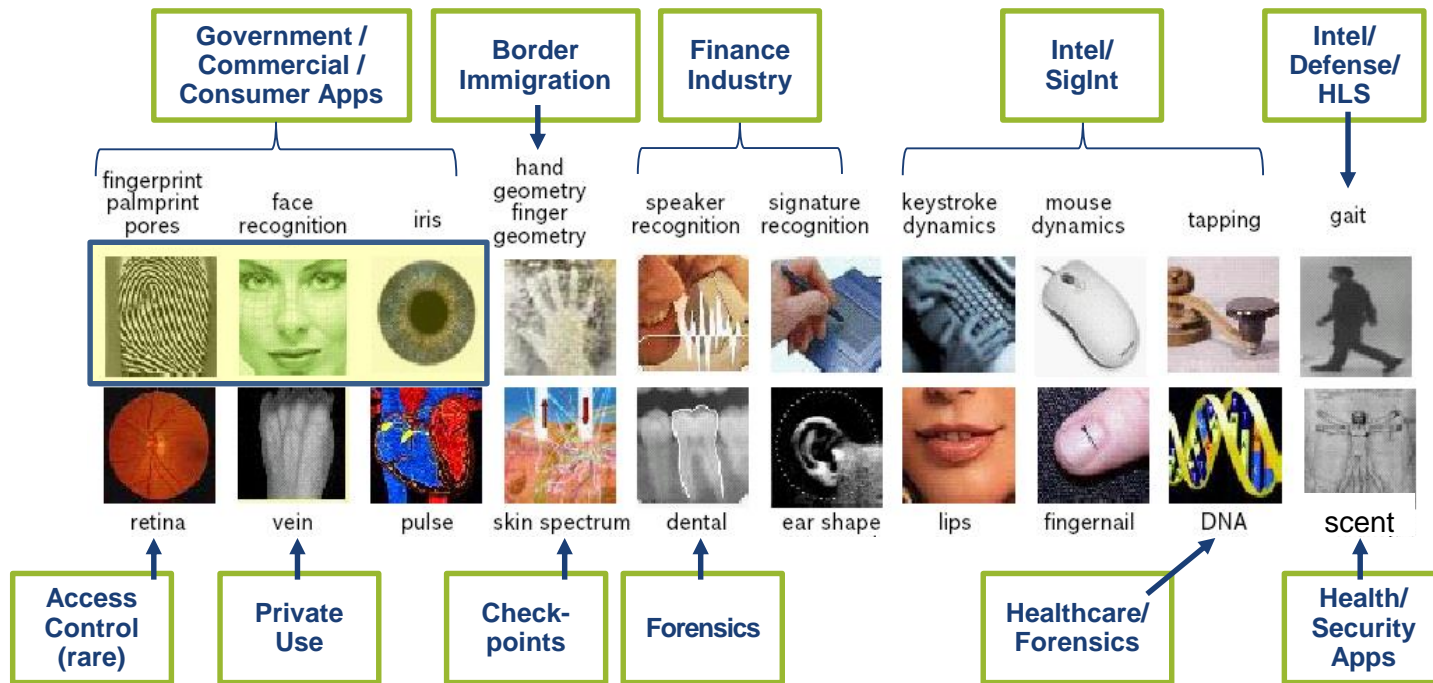
What Makes a Good Biometric?

- Unique

- Permanent

- Easy to use

- Appropriate to the application

- Fast

- Accurate

- Low cost

- Non-intrusive

- Good public acceptance

What Makes a Good Biometric?

Enrollment:

Present biometric → Capture → Process → Store

Store → Compare

Matching:

Present biometric → Capture → Process → Compare

Compare → 🔴🟡🟢
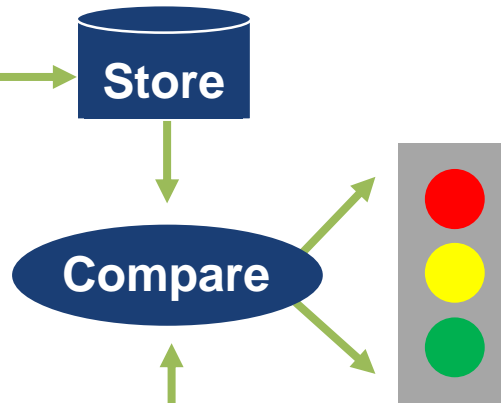
Matching Functions

Verification (one-to-one – 1:1)

– Matching against a single record

– Answers "Is this person who they claim to be?"

– Often used for logical or physical access control

– Often used for border security

Matching Functions

Identification (one-to-many, or "one to N" – 1:N)

- – Searching all "N" records in the database

- – Answers "Do we have a record of this person?"

- – Often used for forensic investigations

- – Also used for border control

Biometric Application Examples

Commercial & Consumer

– Access to facilities and information systems

– Financial transactions

– Healthcare identification

– Mobility

Biometric Application Examples

Civil Government

- – Investigations, background checks

- – Forensic analysis of evidence and crime scenes

- – Border and immigration control

- – Entitlement benefit eligibility screening and verification

- – Voter verification

Biometric Application Examples

Defense and Intelligence

– Identifying Blue Force (our people), Red Force (the enemy), Green Force (allies) and Gray Force (the unknown local populace)

– Forensic analysis of IED fragments

Friction Ridge Biometrics

- Refers to systems that can identify the unique patterns of fingerprints, toe prints, footprints, and palm prints

- Friction ridges are raised layers of skin, formed in the womb, with openings for sweat glands, found on the hands and feet


hair shaft
sweat pore
dermal papilla
Meissner's corpuscle (tactile corpuscle)
stratum corneum
pigment layer
EPIDERMIS
stratum germinativum
stratum spinosum
stratum basale
DERMIS
arrector pili muscle
sebaceous gland
hair follicle
SUBCUTIS (hypodermis)
papilla of hair
nerve fiber
vein
artery
blood and lymph vessels
sweat gland
Pacinian corpuscle
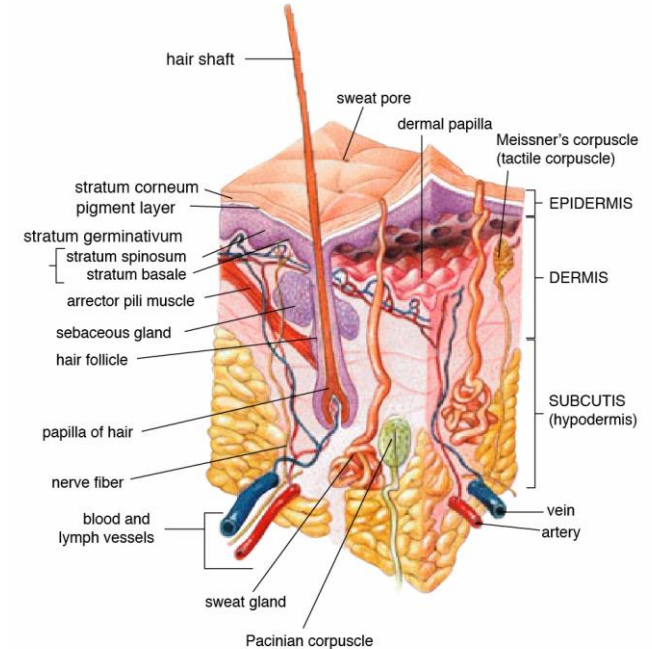
Friction Ridge Biometrics

- Can be:
  - Inked, printed, and scanned
  - Electronically "live-scanned"
    - Contact
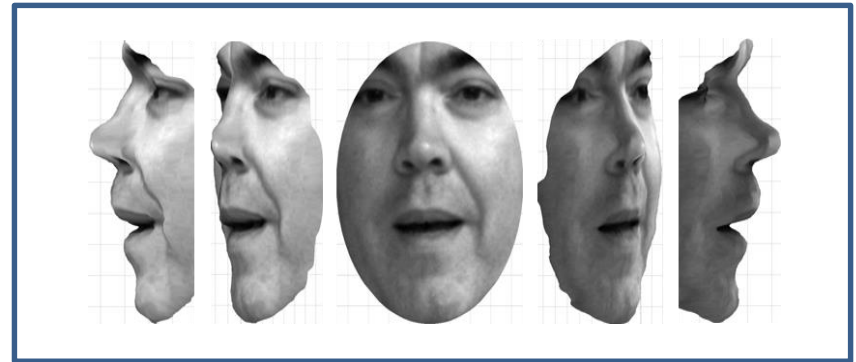   - Contactless "on the fly"
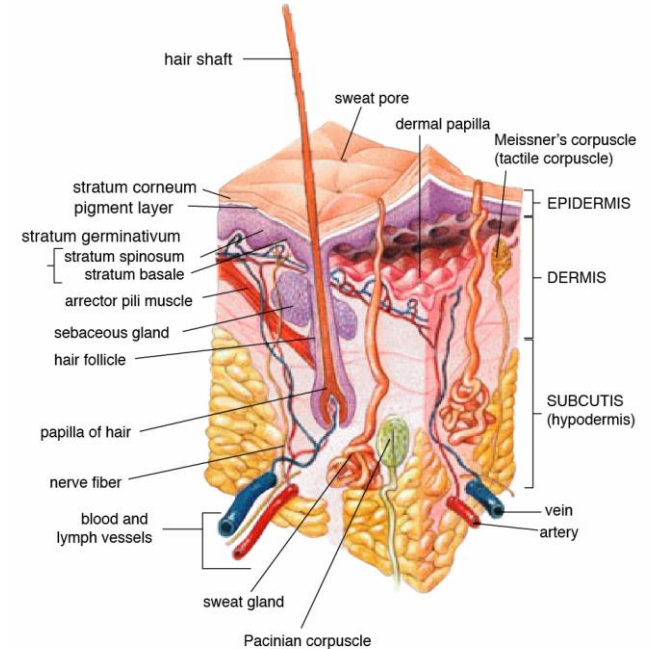
Facial Biometrics

- **Systems that use algorithms to identify a specific individual in a digital image by analyzing and comparing:**

  - Facial features/landmarks, such as relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw

  - Unique lines, patterns, and spots apparent in a person's skin

  - Images captured in visible light or multi-spectral
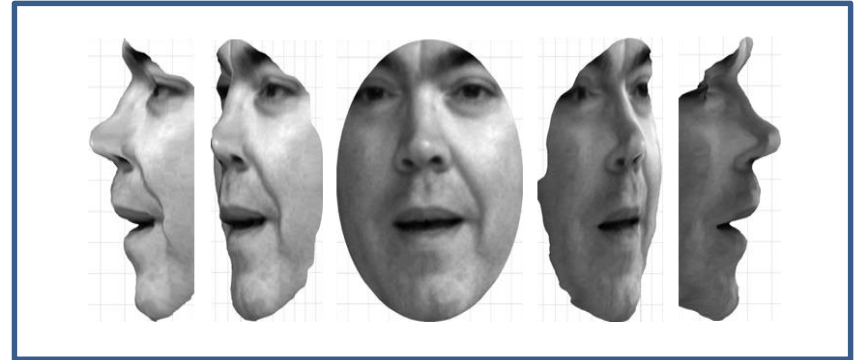
Facial Biometrics

- **Works with 2- and 3-dimensional data**
- **Enables:**
  - Face detection
  - Face tracking (in video streams)
  - Anonymous facial analysis (gender, age, expressions)
 - Face recognition

Ocular Biometrics

Systems that use algorithms to identify a specific individual in eye images by analyzing and comparing:

- Iris features, captured in infrared images
- Ocular vascular patterns, captured in visible light images
  - Scleral vascular patterns
  - Retinal patterns (very uncommon)
  - Subset of vascular pattern biometrics including finger and palm
- Periocular features

Iris

Sclera

Choroid

Aqueous Humor

Cornea

Ciliary Muscle

Lens

Optic Nerve

Retina
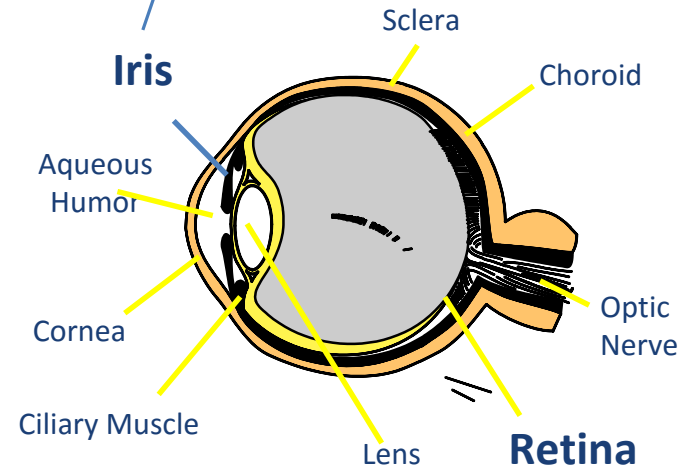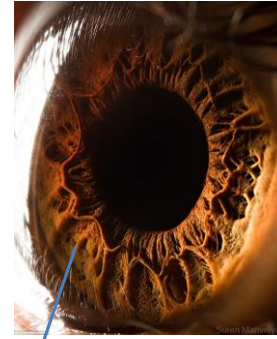
Voice Biometrics

- **Systems that statistically model the speech of an individual so that subsequent instances of that speech can be verified or identified**
  - Based on the unique shape of the vocal tract of each person
  - Requires audio samples to enroll
- **May be captured live, from a phone conversation, or recorded**
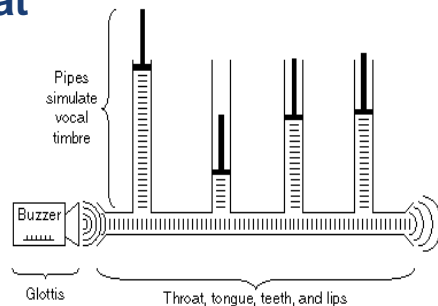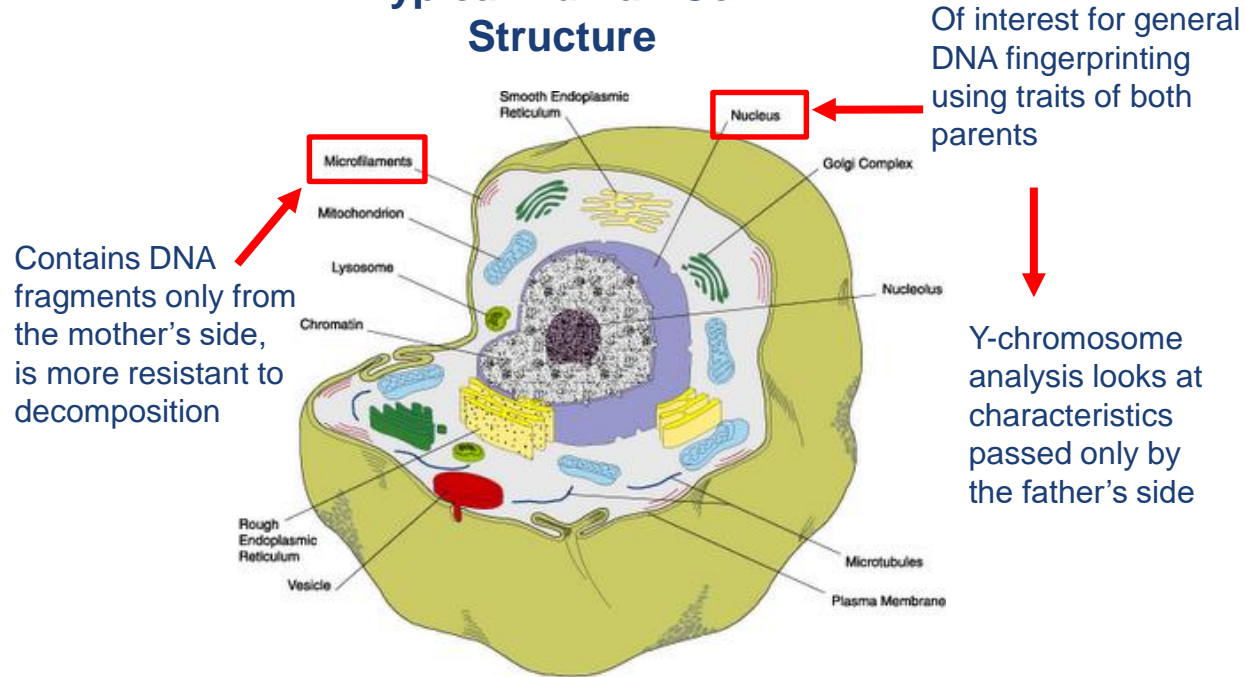

Model of vocal tract
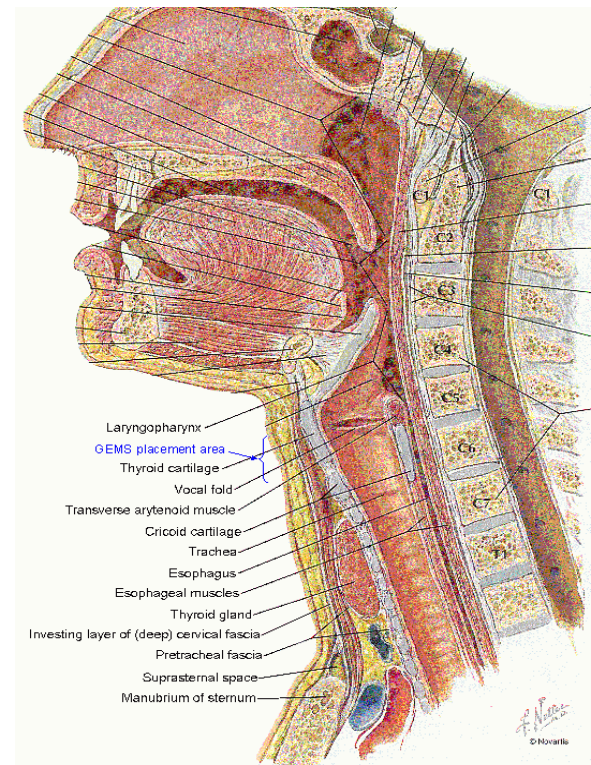
Human vocal tract

DNA Biometrics

- DNA biometrics depends on a few (e.g. 13) short tandem repeat sequences within the genome to achieve very high discrimination

- Only biometric that allows inference of family relationships (other than perhaps face…)

Typical Human Cell Structure

Of interest for general DNA fingerprinting using traits of both parents

Contains DNA fragments only from the mother's side, is more resistant to decomposition

Y-chromosome analysis looks at characteristics passed only by the father's side

Smooth Endoplasmic Reticulum
Nucleus
Golgi Complex
Microfilaments
Mitochondrion
Lysosome
Nucleolus
Chromatin
Rough Endoplasmic Reticulum
Microtubules
Vesicle
Plasma Membrane

For more information please visit
our website: **ibia.org**

Or visit: **biometrics.gov**