Unit 8- Death
"Bodies, Bugs, & Bones"

The Autopsy:
"to see with one's own eyes"

- Not all deaths result in an autopsy - circumstances of death

- 2 Types of Autopsies: Forensic and Medical

2 Types of Autopsies:
Forensic Vs. Medical (Hospital)

Forensic Autopsy

- Performed by a Medical Examiner (usually a Forensic Pathologist)
- Does not require family consent
- Performed in the following circumstances:
  - Sudden, unexpected death
  - Violent death
  - Unattended or suspicious death

Medical Autopsy

- Performed by a Pathologist
- Requires a families consent
- determine the extent of the disease / effects of therapy
- the presence of any undiagnosed disease
  - fewer than 12 % of "regular" deaths are autopsied.

Role of Forensic Pathologists

Medical doctors who perform autopsies & investigate:

- <u>Cause of Death</u>- Reason person died

  ex: shooting, heart attack

- <u>Mechanism of Death</u>- actual change in the body that leads to death (biology)

  ex: blood loss, ashpyxia, sepsis (infection)

- <u>Manner of Death</u> (5)

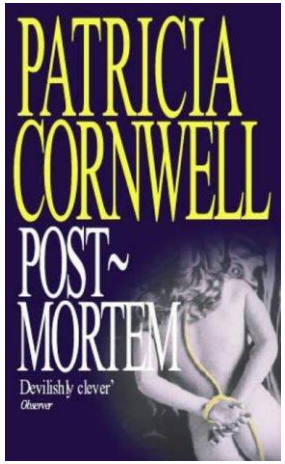
  ex: - Natural (most common) - Accidental
  - Homicidal - Suicide - Unknown

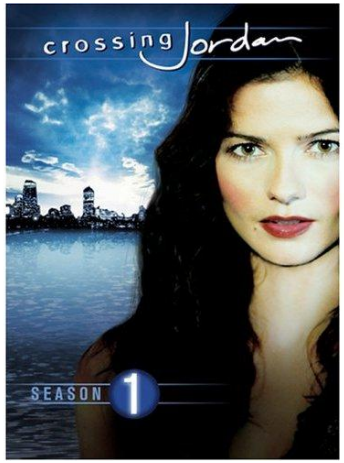
- <u>Time of Death</u>
- <u>Identity</u> of the deceased

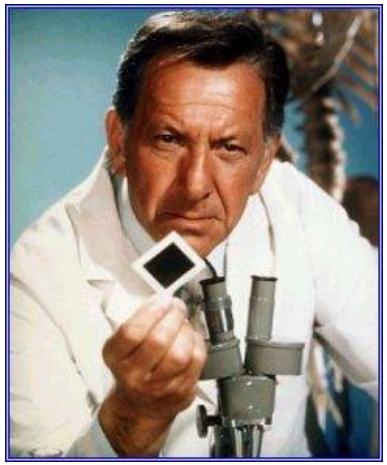
Famous Forensic Pathologists

Michael Baden (HBO)

Dr. G (Discovery Channel)







Training to Become a Forensic Pathologist

After high school you'll have to undertake:

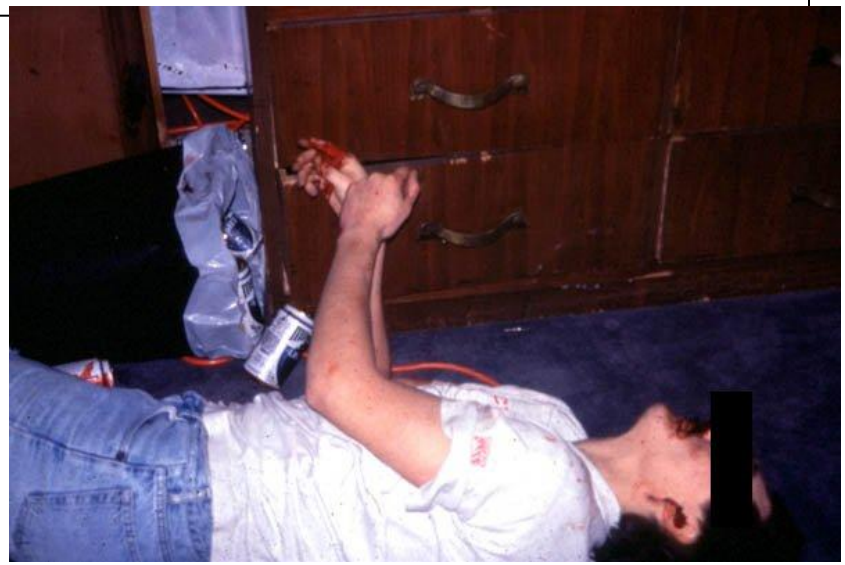
- 4 years of college (BS)
- 4 years of medical school (MD)
- 4 or 5 years of residency (eligible to take the Board exams in pathology)
- 1 or 2 years of specialty forensic pathology fellowship (eligible to take Board exam in forensic pathology)

Determining Time of Death

- done most accurately if the body is found within the first 24 hours of death

- Early Indicators used:
  - Livor mortis
  - Algor mortis
  - Rigor mortis
  - Stomach contents
  - Potassium levels in eye fluids (vitreous humor)
- Late Indicators (after 1-2 days pass):
  - Decomposition/ putrefaction
  - Insect action (entomology)

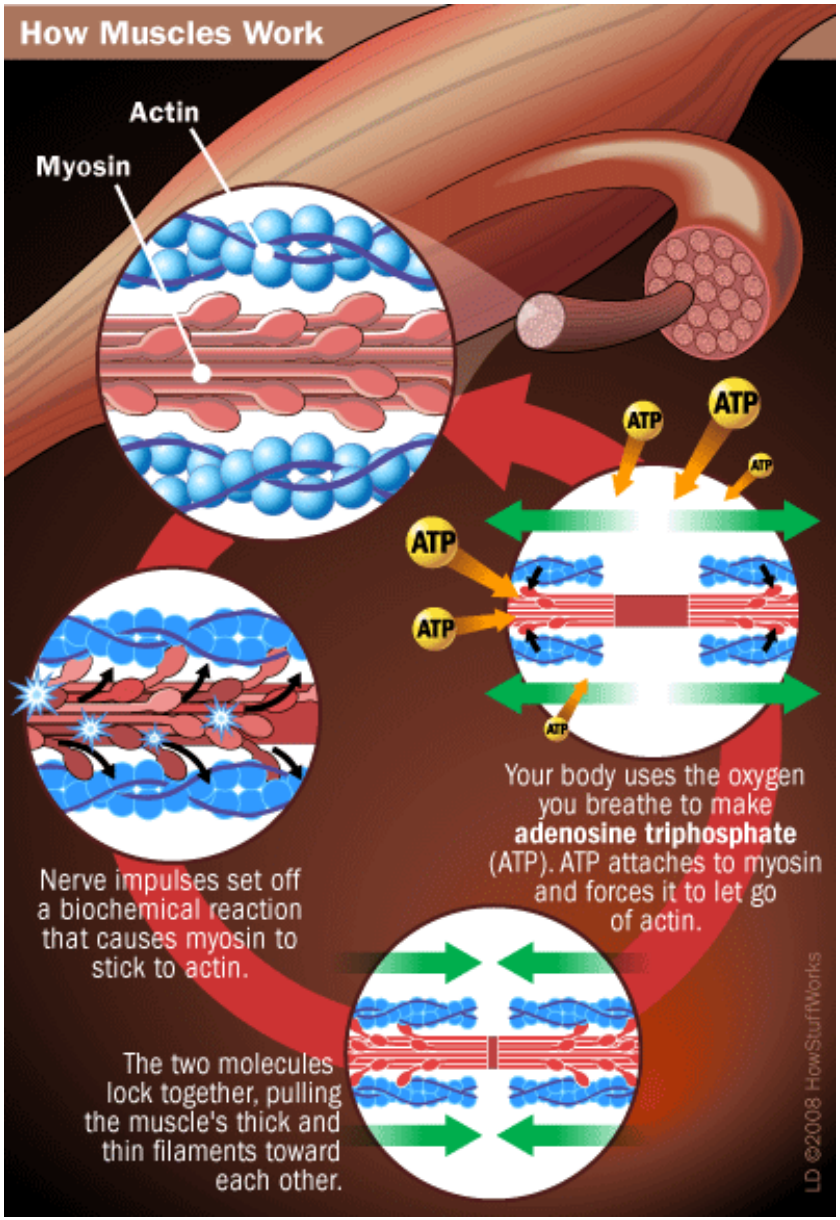
Rigor Mortis- The rigidity of skeletal muscles after death



- Onset = as soon as 10 mins (high exertion)- 2 hours
- Small muscles (face) affected first, then spreads down the body
- Max. stiffness reached around 12-24 hours post mortem.
- The joints are stiff for 1-3 days then ions leak out causing muscles to relax

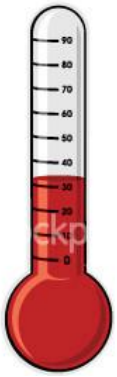
Rigor Mortis- Biochemical Details

- Muscles contract when myosin & actin lock with the help of Ca ions.
- Muscles remain contracted until ATP (which requires O_2 to be made) attaches to the myosin and forces it to let go.
- ATP also pumps Ca out of cell.
- No ATP upon death = muscles stay contracted -- hence rigor mortis.
- Rigor Mortis ends when <u>Autolysis</u> (cell break down) occurs.
- Enzymes leak out & muscles to break down.



<u>Algor Mortis</u>= cooling rate of body after death ("Chill of Death")

- At a crime scene, the body temperature is obtained through:
  - Rectal temperature
  - Liver temperature



- Generally, body cools 1.4 F/ hour (first 12 hours)
- after 12 hours body cools @ 0.7 F/ hour until it reaches the surrounding temperature.

- Influenced by: weather, amount of fat on individual, drugs in body, clothing

Example problem

1. What body temperature would you expect for someone who has been dead for 12 hours?

Step 1: 12 hours x 1.4 F/ hour = ~ 16.8 F lost
(unless other factors need to be considered)

Step 2: 98.6 F - 16.8 F = **81.8 F**

Example Problem

Body's been found with a temp of 67 F, approx. how long have they been dead?

Step 1: 98.6 F – 67 F = 31.6 F lost heat

Step 2: 12 hours x 1.4 F/ hour

= <u>16.8 F</u> lost in 1st 12 hours

Step 3: 31.6 F - 16.8 F = <u>14.8 F</u> lost after 12 hours

Step 4: 14.8 F x 1 hr/ 0.7 F = 21.1 hours

Step 5: 21.1 hours +12 hours = **<u>33.1 hours dead</u>**

<u>Livor Mortis</u>- settling of blood, resulting in red/ purple color pattern ("color of death")

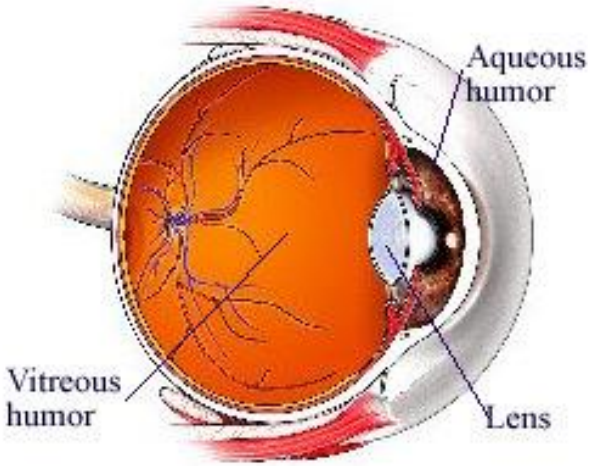
- As body decomposes, blood seeps through tissue & settles @ lowest point
- Begins about 2 hours after death
- Color becomes set between 8-12 hours after death.
- can indicate the position of the body after death or if they were moved.

Pressure points from ground, belts, etc. prevent blood from settling

Stomach Contents/ Vitreous Humor

Stomach Contents

- Food breaks down at a fairly predictable rate
- Not very accurate b/c lots of variables (type of food, body's metabolizing rate, drugs, exercise.



Vitreous Humor

- Potassium levels increase in fluid after death
- relatively stable, less susceptible than other body fluids to rapid chemical changes and contamination

The Body Farm
the place where the dead teach the living

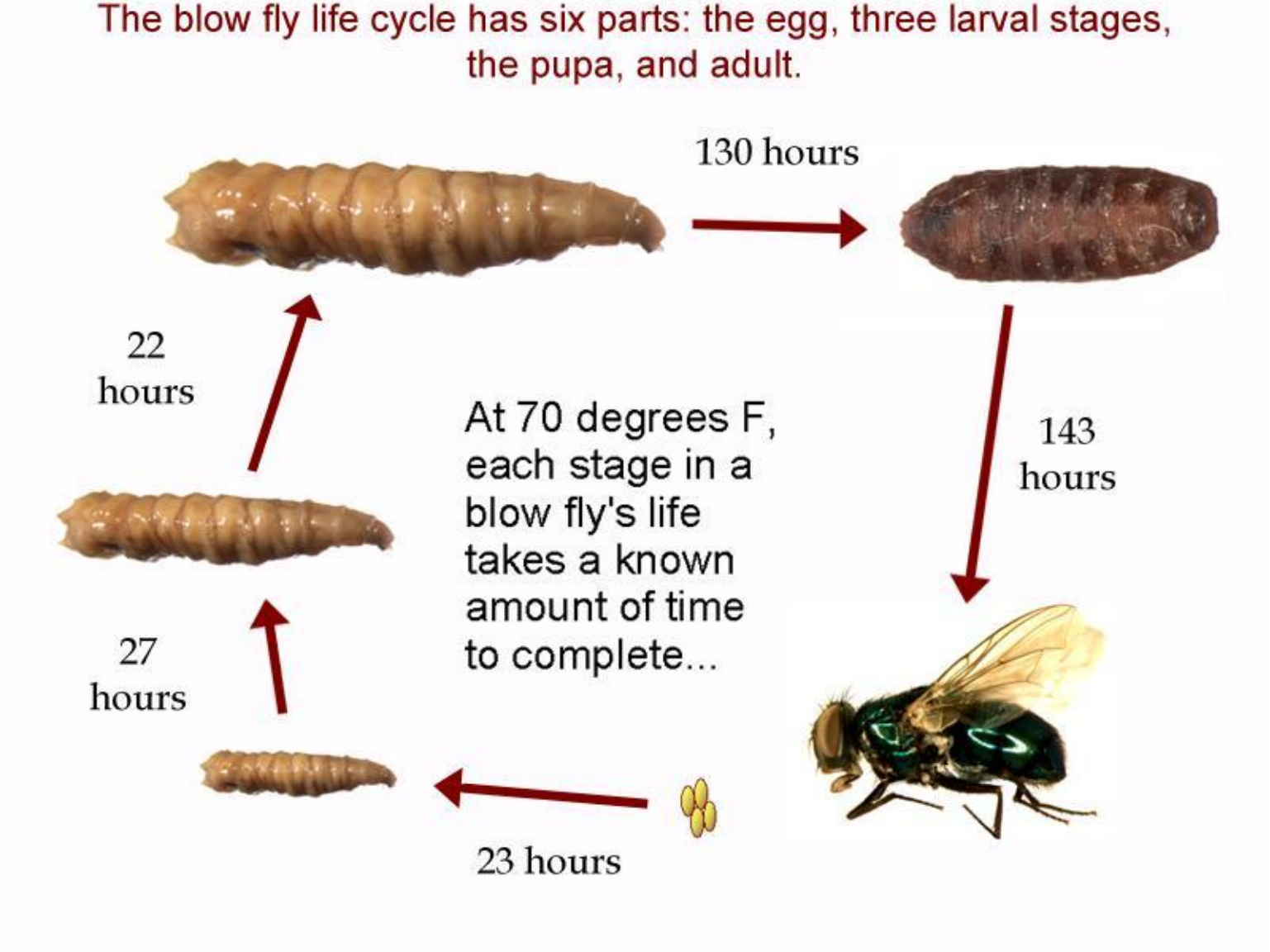
- The nickname of a two and a half acre research facility at University of Tennessee
- developed in 1980 by Bill Bass
- bodies are placed in various conditions and allowed to decompose.
- purpose = observe and understand the processes and timetable of postmortem decay.

Forensic Entomology (Study of insects) & Decomposition:

- 5 main stages of decay
- Most important environmental factors in corpse decay:*
  - Temperature
  - Access by insects
  - Depth of Burial
- insects develop in predictable stages
- Insects arrive to the corpse like clockwork

* Based on study of decay rates of 150 human corpses at U. of Tenn

Blowfly Lifecycle- temp. dependent



Stage 1: Fresh/Initial Decay
(0 to 3 days after death)

Inside:

- Bacteria & body's own digestive enzymes begin decay (autolysis)

Outside:

- flies attracted to corpse & lay eggs around wounds / natural body openings
- eggs hatch and move into the body

Blow fly

Stage 2: Bloat/ Putrefaction
(4 to 10 days after death)

Inside

- Swells due to gases produced by bacteria (putrefaction)

Outside

- flies and maggots feeding in great quantity

Stage 3: Decay/ Black Putrefaction
(10 to 20 days after death)

Inside

- Skin breaks & gases escape
- fluid leaking out
- exposed parts are black in color

Outside

- Maggots are very large on body (and lots of them)
- Horrible odor

Stage 4: Post-Decay
(20 to 50 days after death)

Inside:

- mostly hair, skin, & bones

Outside:

- Most flies are gone (no soft food)
- Beetles feed on the skin and ligaments.

beetle

Stage 5: Dry/ skeletal
(50-365 days after death)

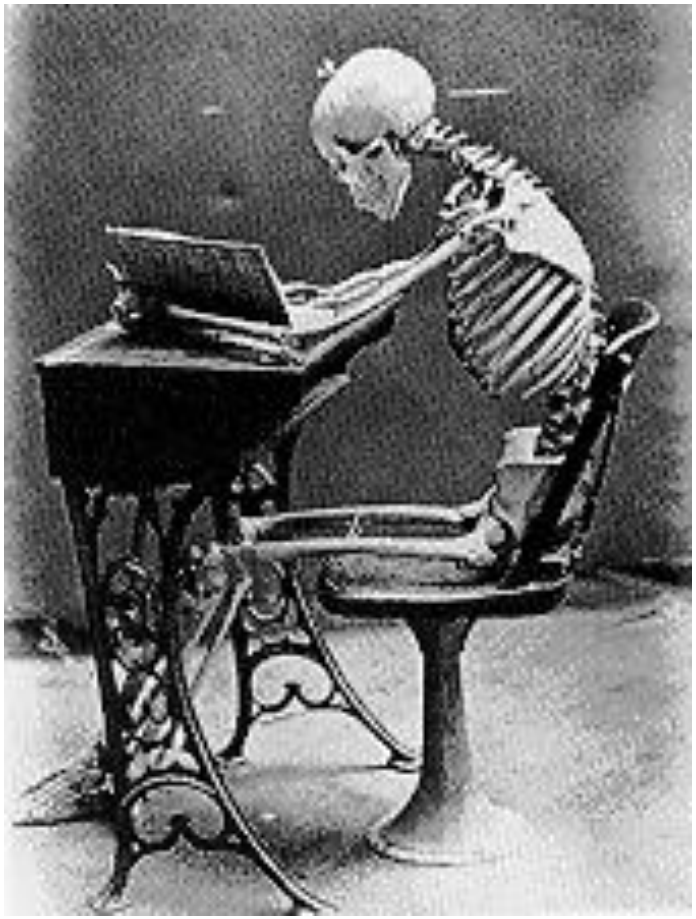
Inside:

- Body is dry
- all the hair disappears leaving the bones only.

Outside:

- Moths feeding on hair

Forensic Anthropology: Studying Bones



"There is a brief but very informative biography of an individual contained within the skeleton, if you know how to read it…"

—Clyde Snow, Forensic Anthropologist

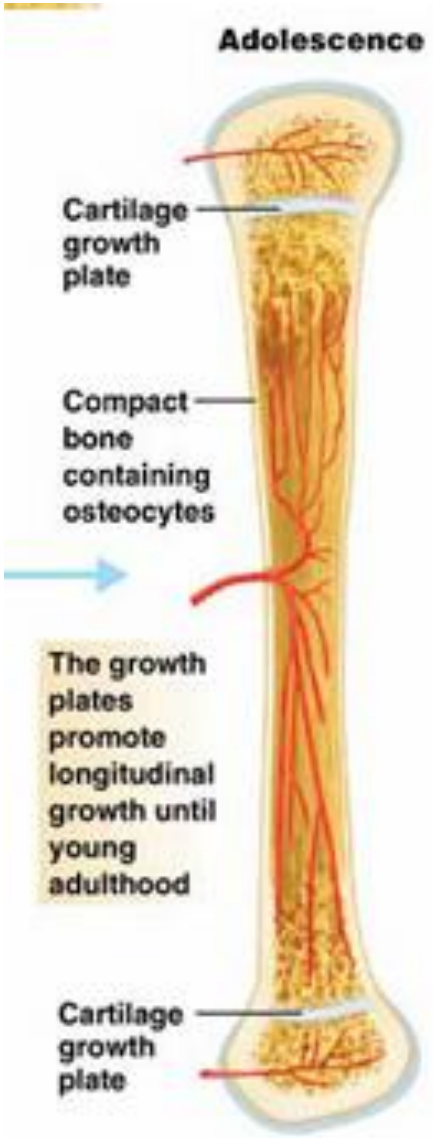
Characteristics of Bones

Cartilage before Bone

- Cells called osteoblasts deposit minerals into center of cartilage and harden it
- Bones are constantly produced and broken down

Growing and Changing

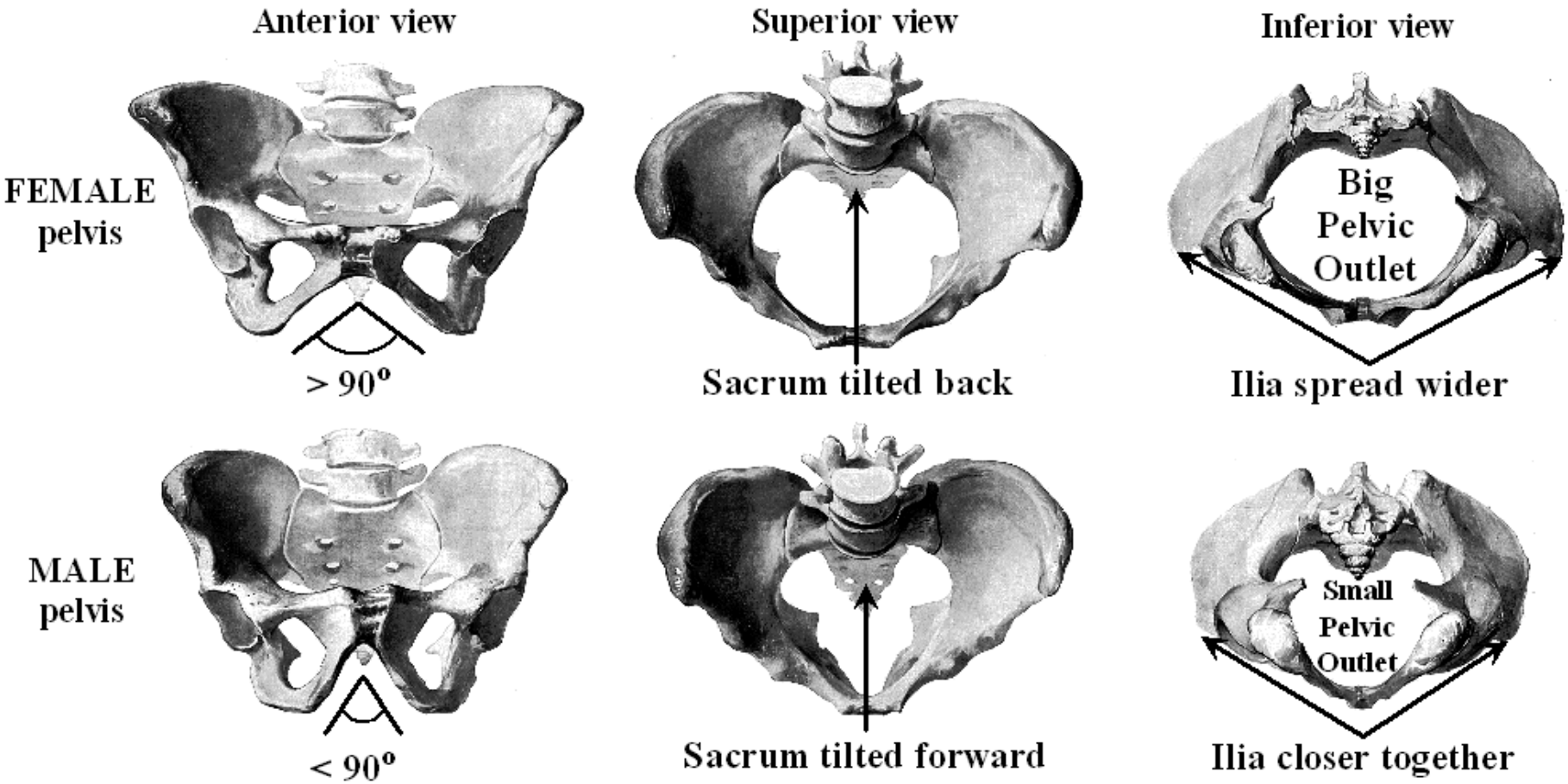
- Babies have 450 bones & adults have 206 bones (they fuse)
- Bones get longer and thicker with age and use
- When cartilage growth plate fuses = no more growth



What We Learn from Bones

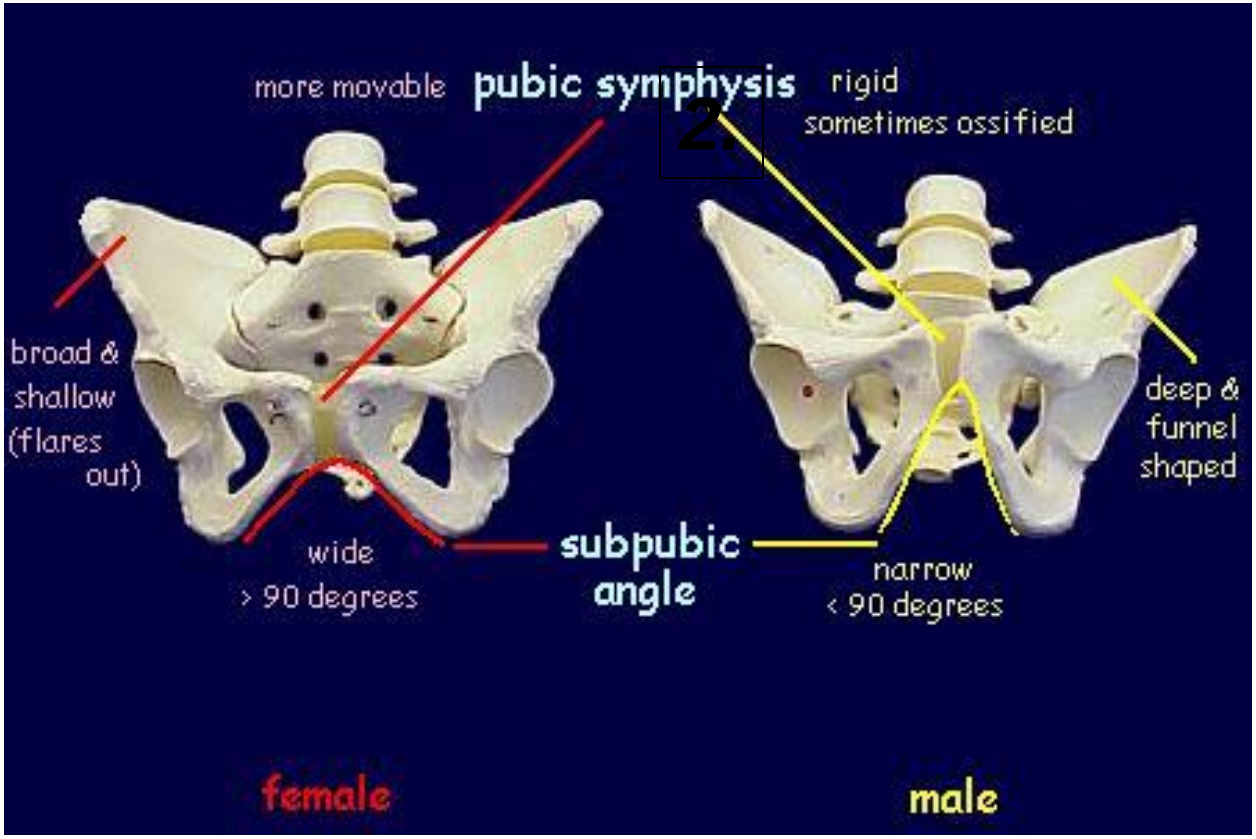
- Human or animal?
- Determination of Sex
  - Pelvis
  - Skull
- Determination of Race
  - Skull
- Approximate Age
  - Teeth
  - Cranial Sutures
  - Epiphyseal (growth plate) fusion
- Approximate Height
  - Length of long bones
- Injuries (Postmortem or antimortem)

Determination of Sex: Pelvis
(differences in childbirth adaptations)



Sex Determination- Pelvis (another view)

1. **females have wider subpubic angle**
2. **females have a flexible pubic symphysis**

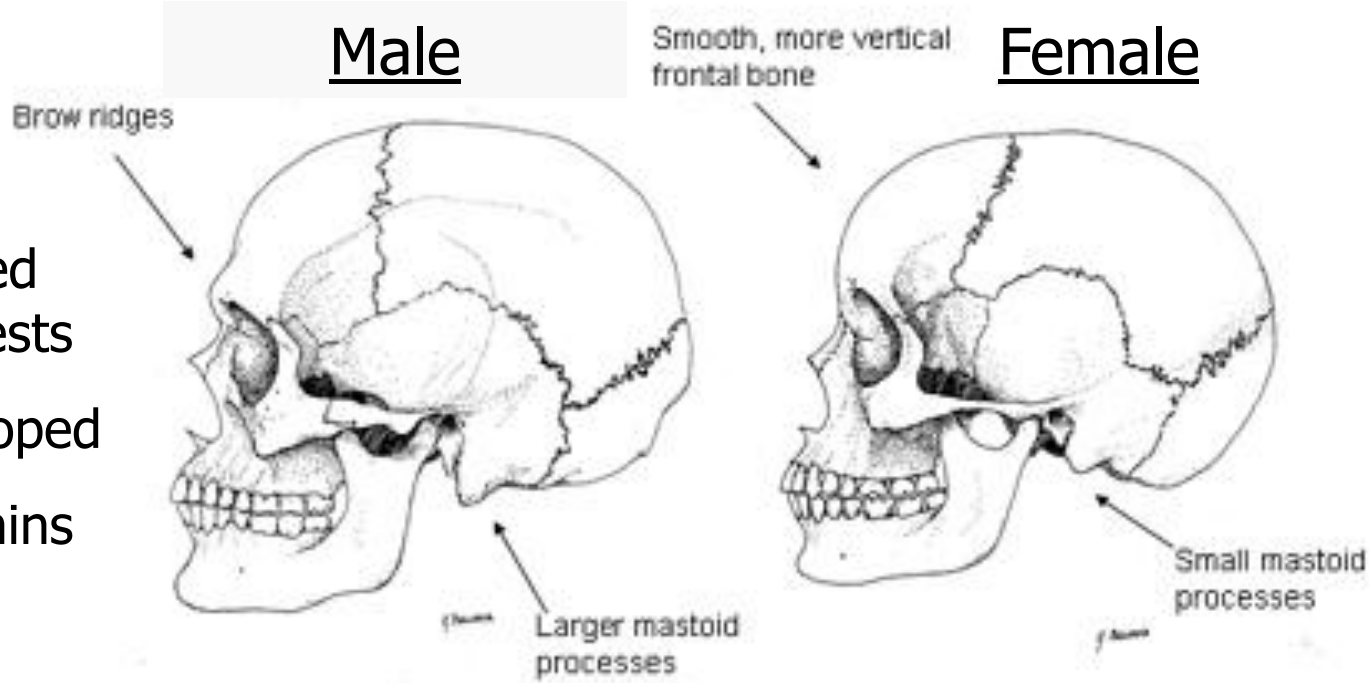


Determination of Sex: Skull

-more pronounced ridges & crests

-Forehead sloped

-Squared chins



Male Skull

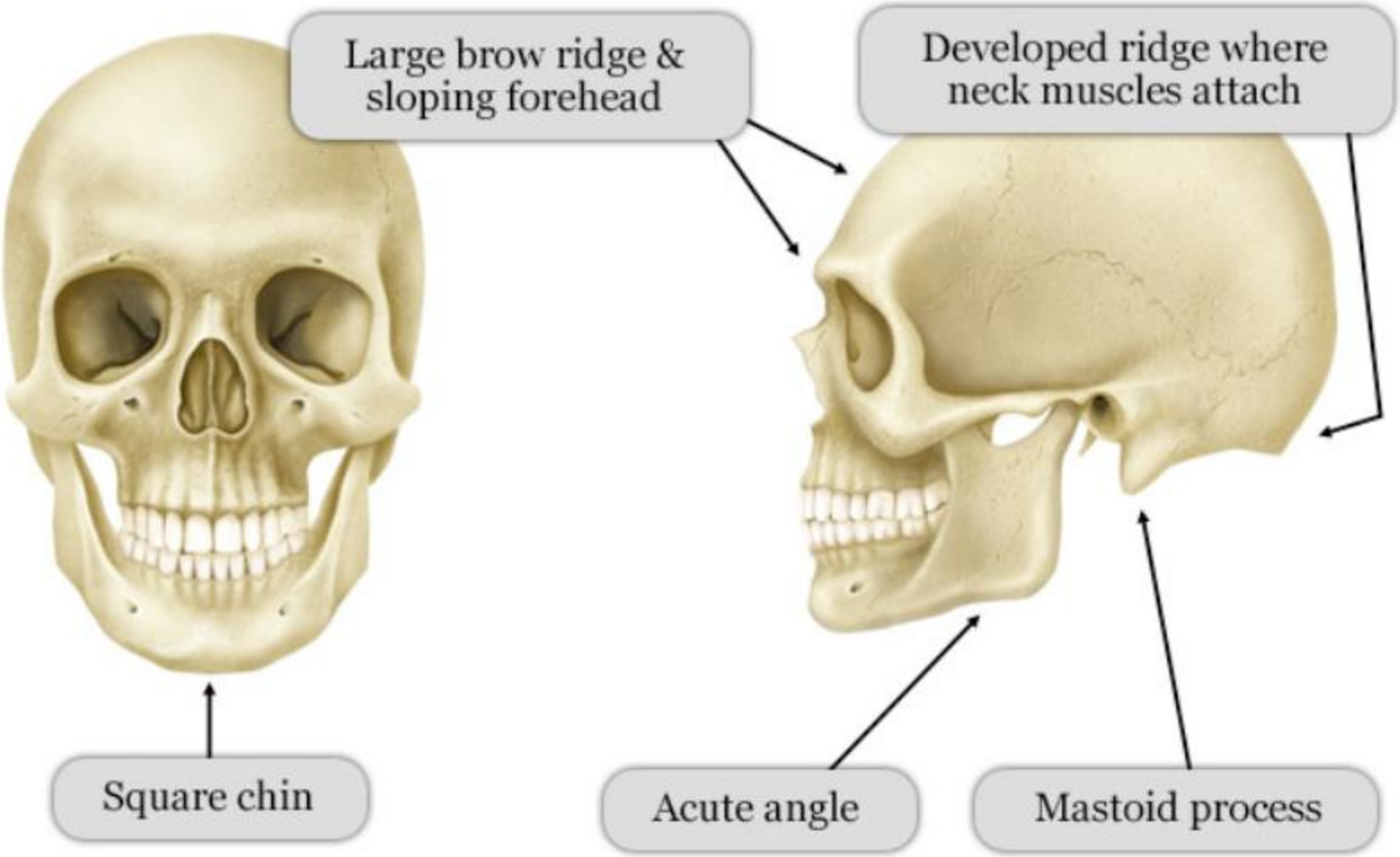


Figure 3. Male skulls. (Source: Smithsonian Institution)

Female Skull

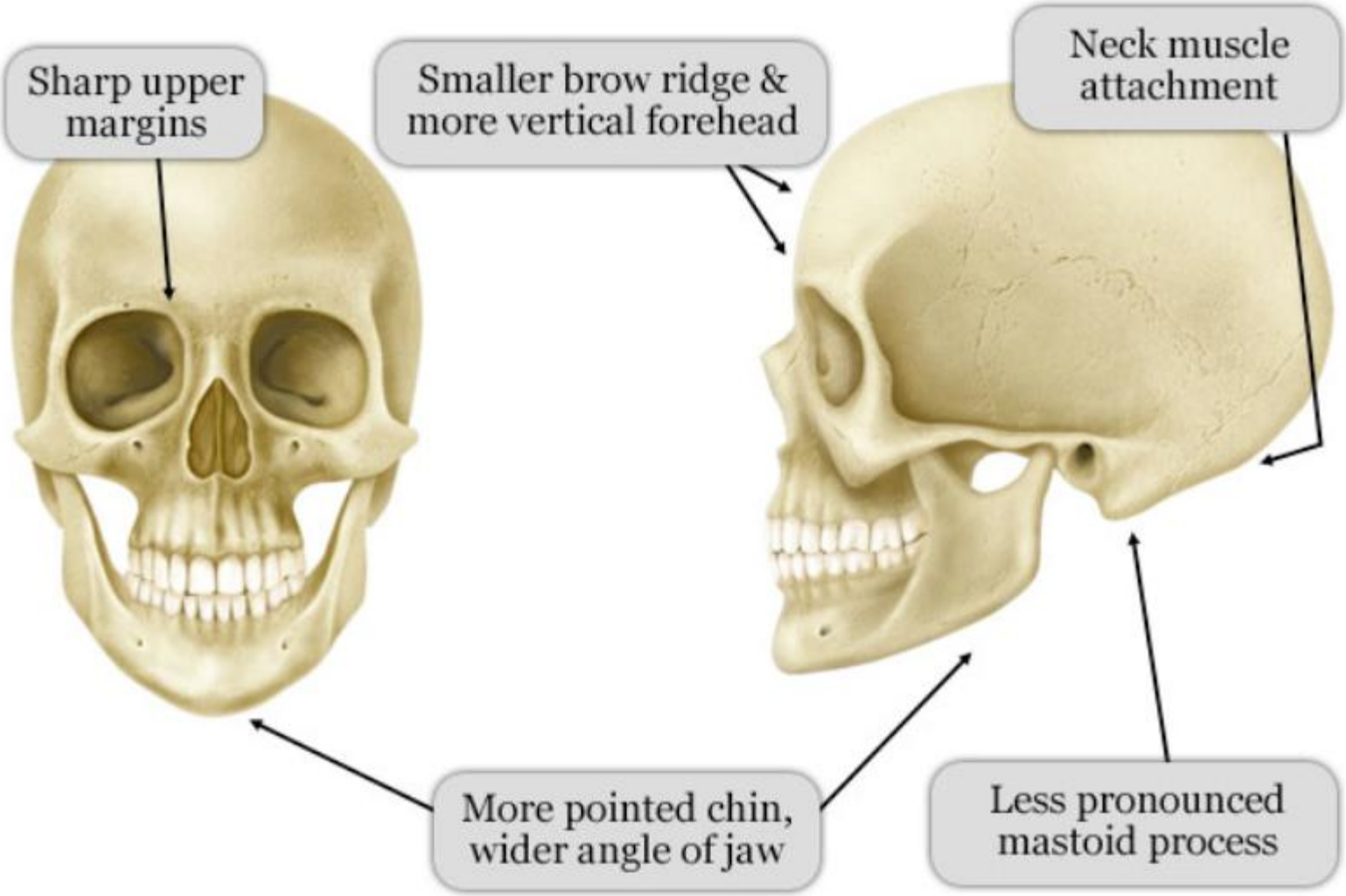
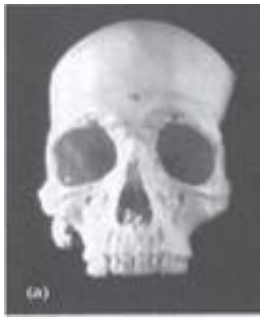


Figure 4. Female skulls. (Source: Smithsonian Institution)

Determination of Race

- difficult to determine especially since pure races are becoming uncommon.
- An experienced forensic anthropologist can generally place skulls into one of 3 groups:
  - **Caucasian**—European, Middle Eastern, and Indian descent (image A)
  - **Negroid**—African, Aborigine, and Melanesian descent (B)
  - **Mongoloid**—Asian, Native American and Polynesian descent (C)



A

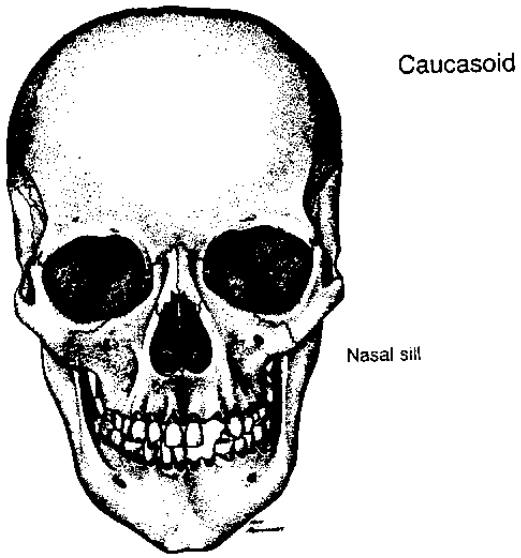
B

C

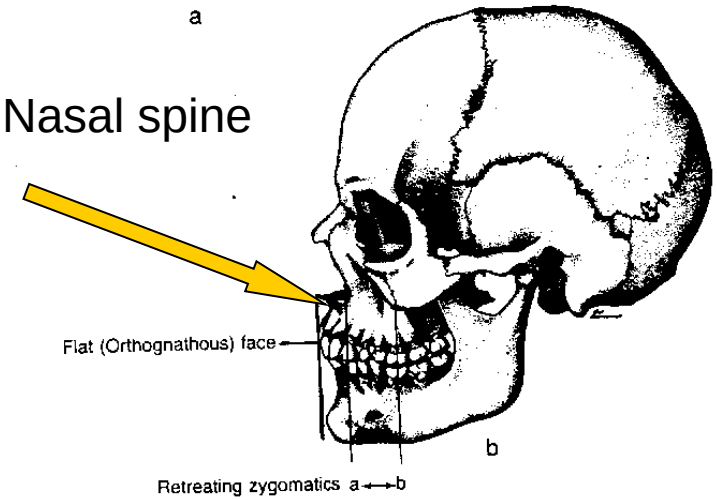
Features of the Skull Used in Race Determination

- **Nasal index**: The ratio of the width : height of the nose, Nasal Spine

- **Prognathism**: extended lower jaw
- **Shape of eye orbits** (round or squarish)



a



General Shapes of the Eye Orbits

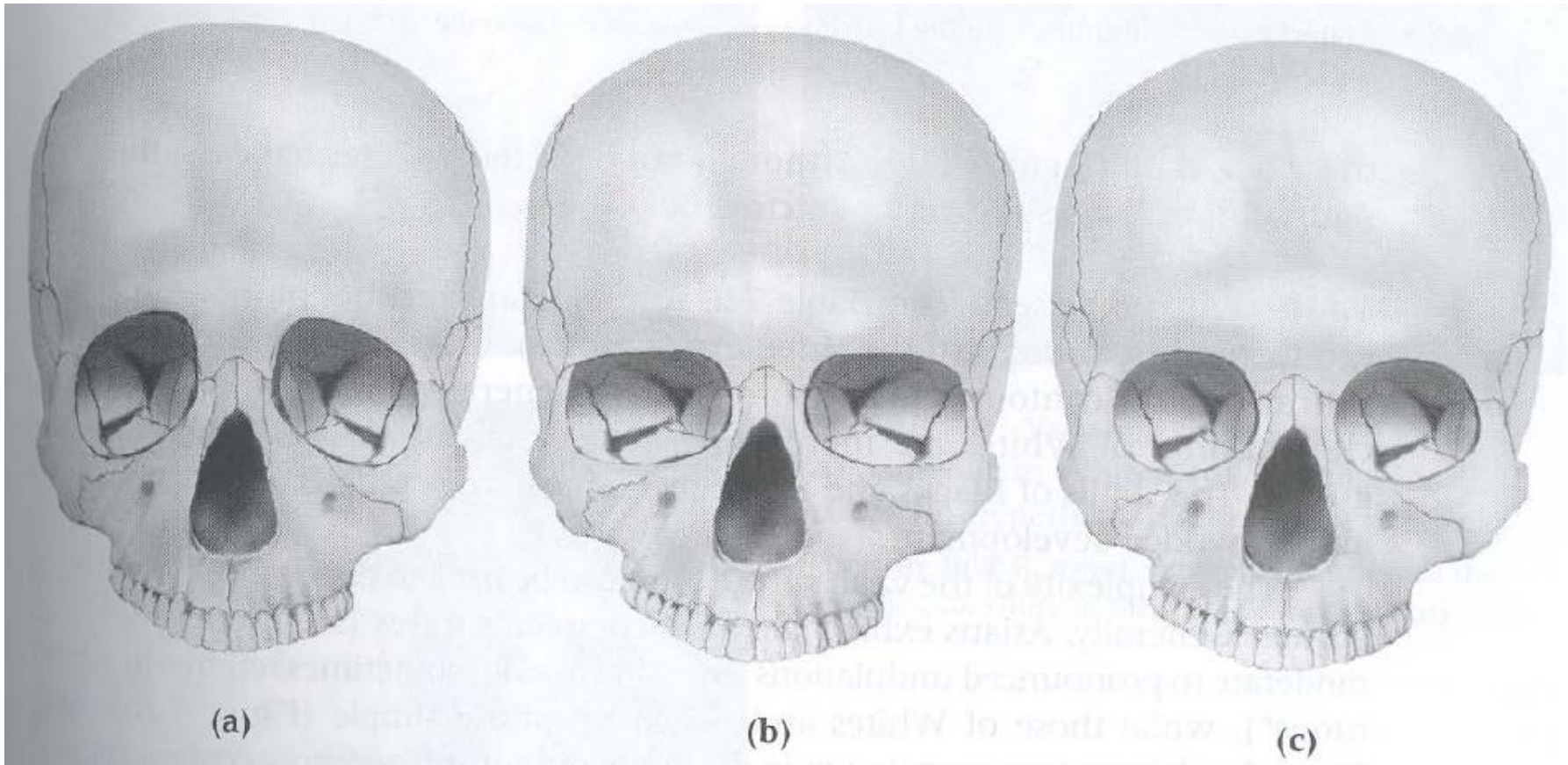


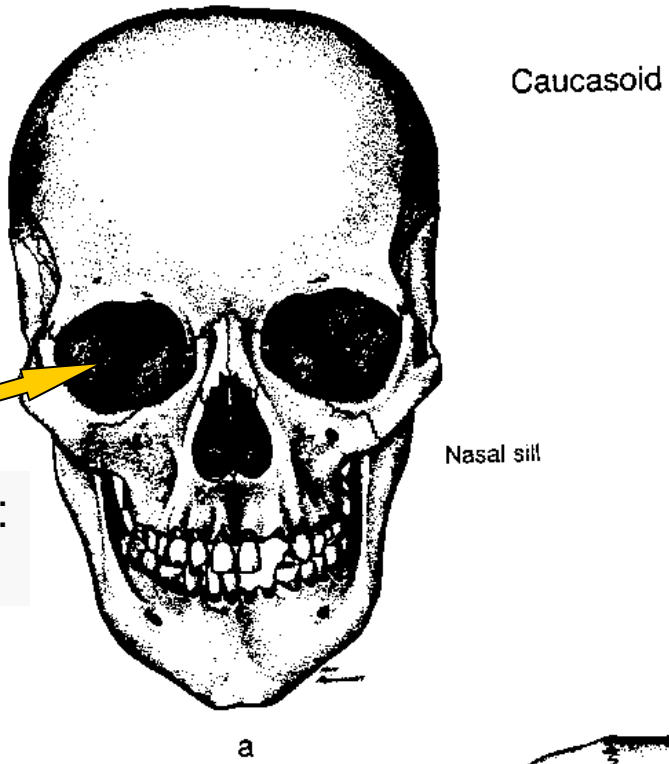
FIGURE 7.6 Different shapes of eye orbits for ancestral groups: **(a)** angular of Whites, **(b)** rectangular of Blacks, and **(c)** round of Asians.

From: Beyers, S.N. (2005). Introduction to Forensic Anthropology

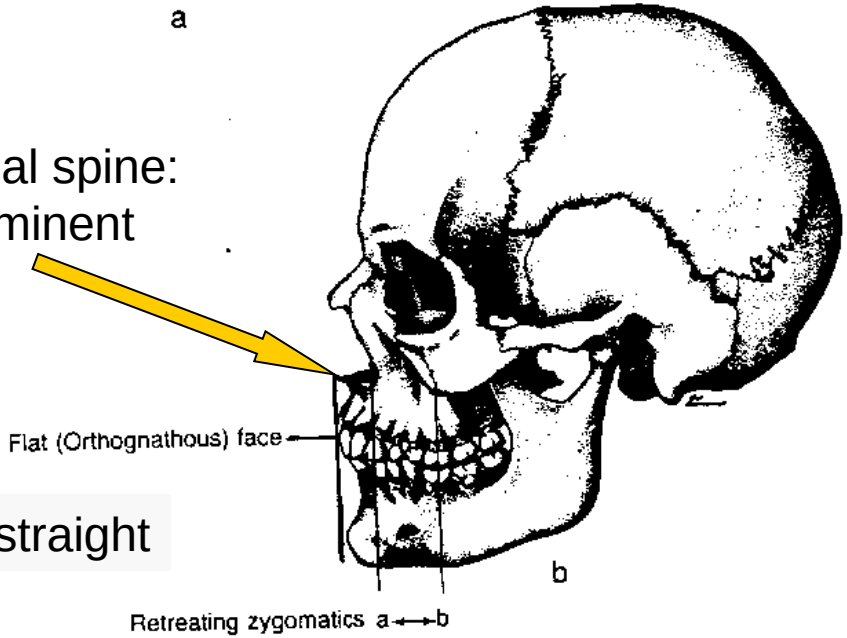
Determination of Race: Caucasian

Trait	
Nasal Index:	<.48
Nasal Spine:	Prominent spine
Nasal Silling / Guttering:	Sharp ridge (silling)
Prognathism:	Straight
Shape of Orbital Openings:	Rounded, somewhat square

Orbital openings: round



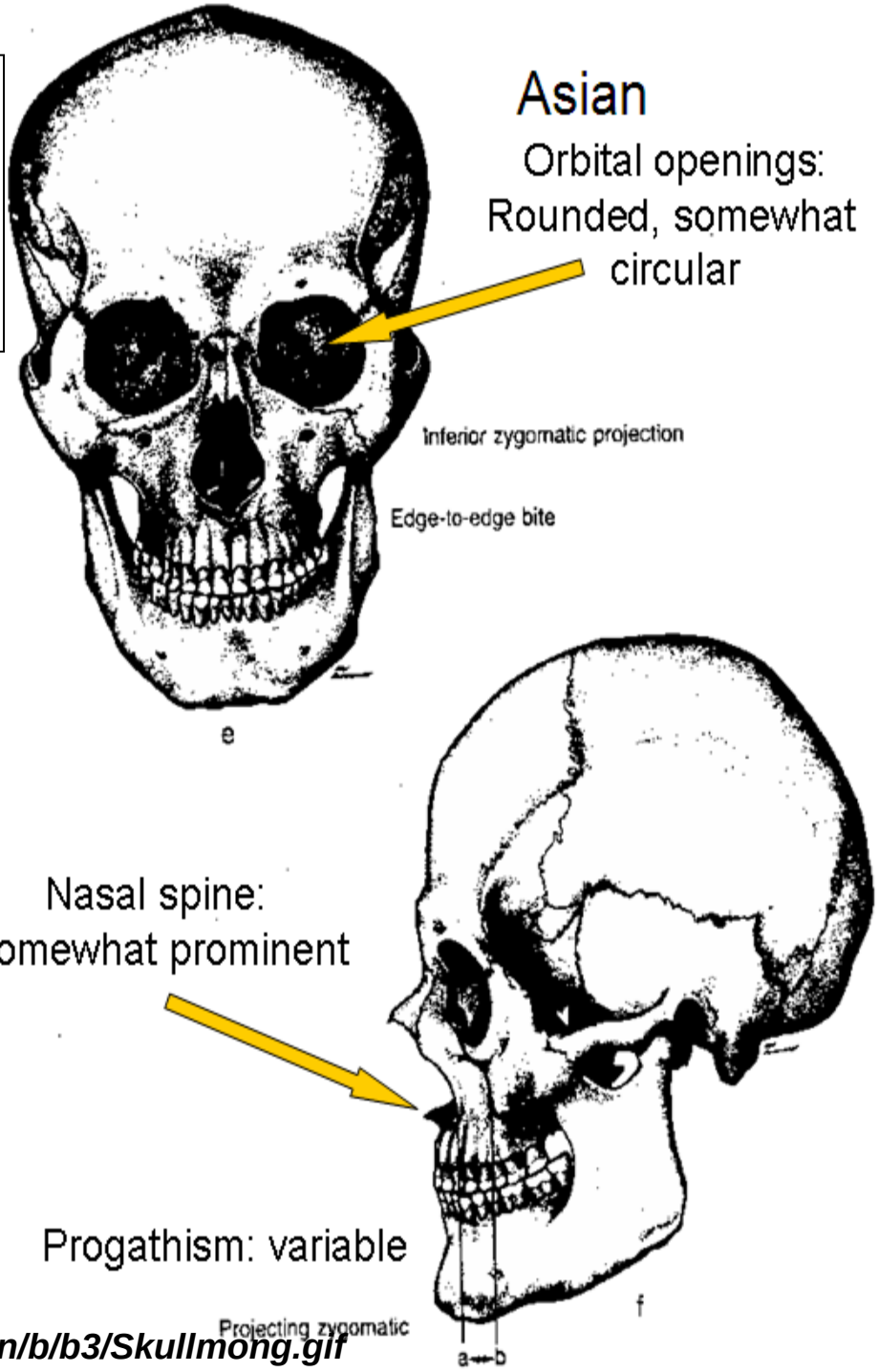
Nasal spine: Prominent



Progathism: straight

Determination of Race: Asian (Asian decent and Native American decent)

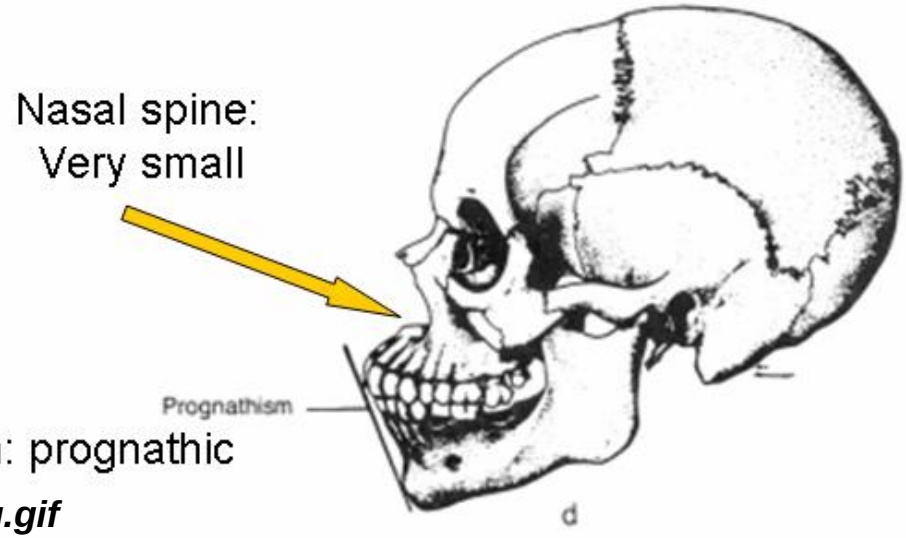
Trait	
Nasal Index	.48-.53
Nasal Spine	Somewhat prominent spine
Nasal Silling/ Guttering	Rounded ridge
Prognathism	Variable
Shape of Orbital Openings	Rounded, somewhat circular



http://upload.wikimedia.org/wikipedia/en/b/b3/SkullMong.gif

Determination of Race: African: (African & West Indian decent)

Trait	
Nasal Index	>.53
Nasal Spine	Very small spine
Nasal Silling/ Guttering	No ridge (guttering)
Prognathism	Prognathic
Shape of Orbital Openings	Rectangular or square



Progathism: prognathic

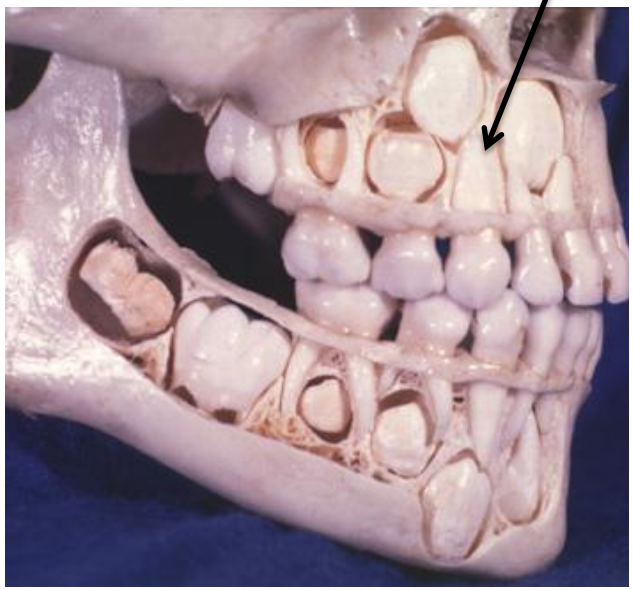
http://upload.wikimedia.org/wikipedia/en/5/5e/Skullneg.gif

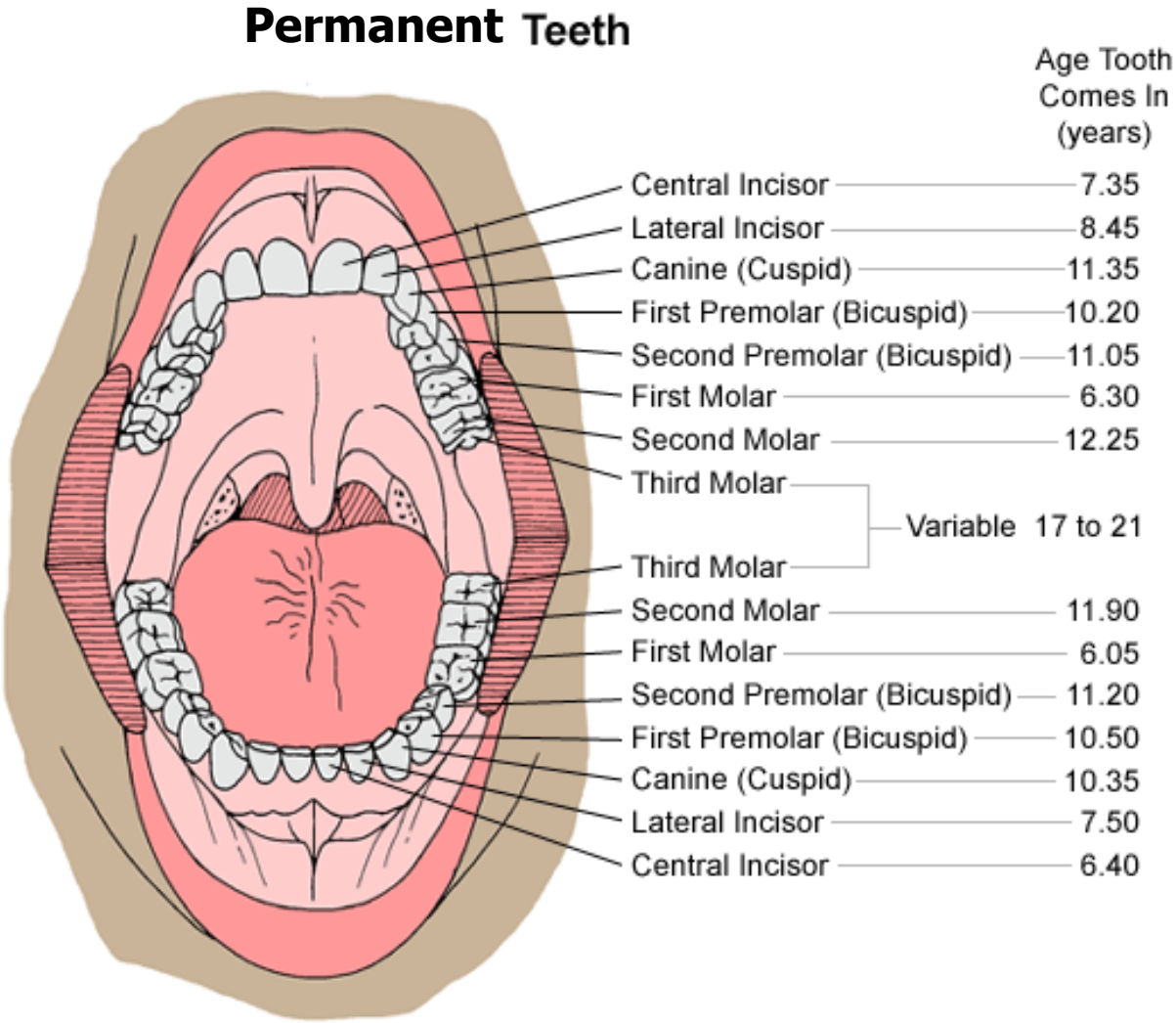
Determination of Age from Bones

- Most accurate estimations from:
  - Teeth
  - Epiphyses (growth plates) fusion
  - Cranial sutures: 3 pieces when young
- Investigators use age range b/c people vary in how they age
  - Adults 25 -40 yrs are very hard to determine
  - Ages 40+: basically wear and tear on bones

Age Determination: Use of Teeth

Teeth waiting to come in

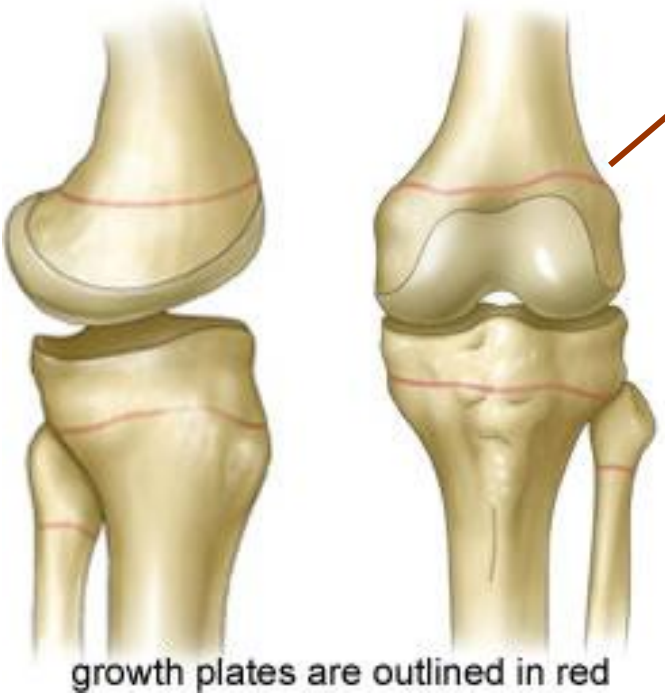




http://images.main.uab.edu/healthsys/ei_0017.gif

http://www.forensicdentistryonline.org/Forensic_pages_1/images/Lakars_5yo.jpg

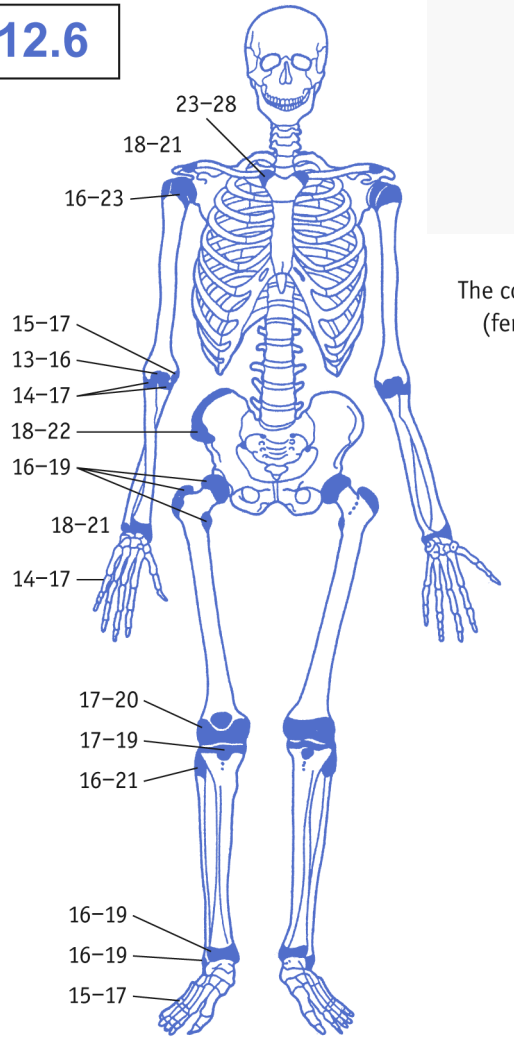
Growth Plates- fuse at predictable time frames



Where new bone forms

OHT 12.6

Epiphyseal (growth plate) Fusion: A General Guide



Approximate dates (years) of epiphyseal union

The commencement and completion of union takes several years. The table is only a guide for male subjects (female slightly earlier) in non-tropical climates; the two dates are partial and complete union (years).

Head of femur	16–19	Acromion	17–19
Greater trochanter	16–19	Distal femur	17–20
Lesser trochanter	16–19	Proximal tibia	17–19
Head of humerus	16–23	Proximal fibula	16–21
Distal humerus	13–16	Distal tibia	16–19
Medial epicondyle	16–17	Distal fibula	16–19
Proximal radius	14–17	Metatarsals	15–17
Proximal ulna	14–17	Iliac crest	18–22
Distal radius	18–21	Primary elements pelvis	14–16
Distal ulna	18–21	Sternal clavicle	23–28
Metacarpals	14–17	Acromial clavicle	18–21

Figure 12.3 A guide to the age of epiphyseal union in the major centres

Source: Knight, B. (1996) *Forensic pathology* (2nd edn) London: Arnold. Reproduced by permission of Arnold.

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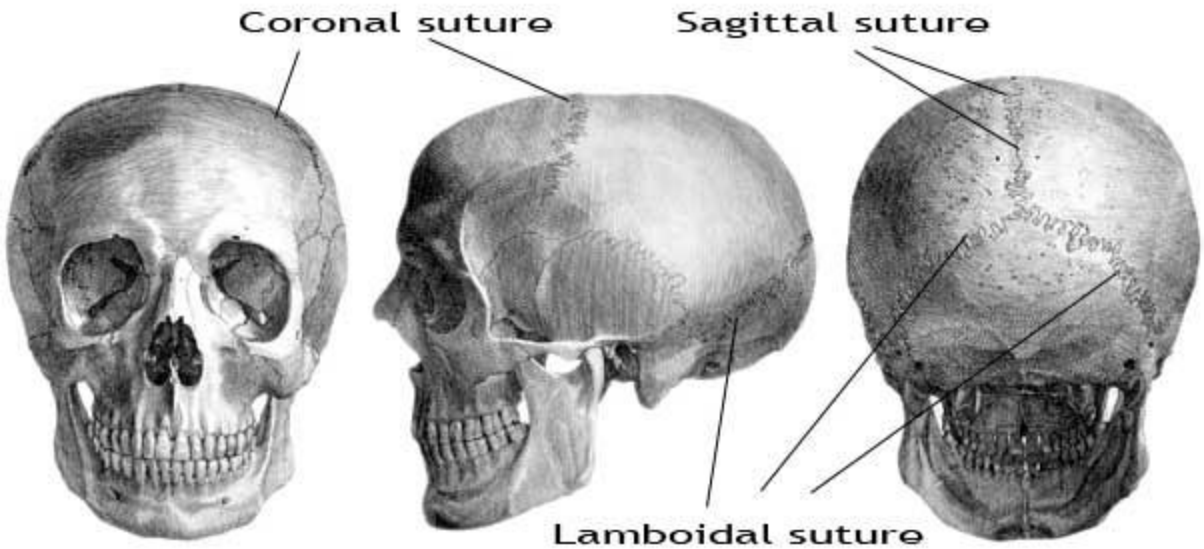
Age Determination Using Cranial Sutures

** not very accurate

- When you are born, skull is in several pieces that fuse together (soft spots) as you age.
- Lamboidal suture closed by 30 yrs (starts closing around 21 yrs)
- Sagittal suture closed by 35 yrs
- Coronal suture closed by 50 yrs



Other Information We Can Get From Bones:

- Evidence of trauma (here GSW to the head)

- Evidence of post mortem trauma (here the head of the femur was chewed off by a carnivore)

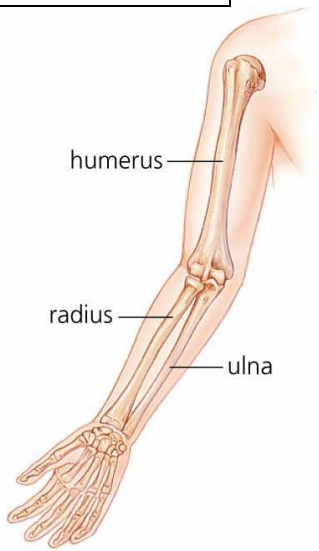
Estimation of Height using Long Bones
(usually +/- 3.5 cm)

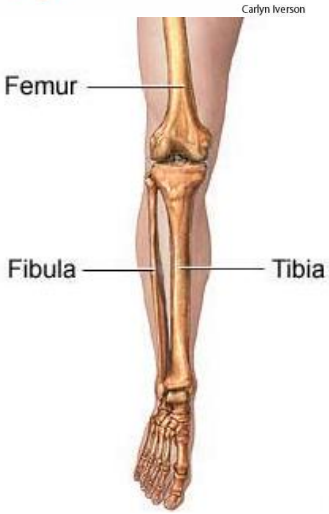
- Use equations below to estimate height (in cm)

TABLE 2: FORMULAS FOR CALCULATING HEIGHT

BONE	RACE	MALE EQUATION	FEMALE EQUATION
FEMUR	CAUCASIAN	2.32 * **length** + 65.53 cm	2.47 * **length** + 54.13 cm
	AFRICAN-AMERICAN	2.10 * **length** + 72.22 cm	2.28 * **length** + 59.76 cm
	ASIAN	2.15 * **length** + 72.57 cm	2.38 * Length + 56.93 cm
TIBIA	CAUCASIAN	2.42 * **length** + 81.93 cm	2.90 * **length** + 61.53 cm
	AFRICAN-AMERICAN	2.19 * **length** + 85.36 cm	2.45 * **length** + 72.56 cm
	ASIAN	2.39 * **length** + 81.45 cm	2.68 * Length + 67.05 cm
FIBULA	CAUCASIAN	2.60 * **length** + 75.50 cm	2.93 * **length** + 59.61 cm
	AFRICAN-AMERICAN	2.34 * **length** + 80.07 cm	2.49 * **length** + 70.90 cm
	ASIAN	2.40 * **length** + 80.56 cm	Not Available
HUMERUS	CAUCASIAN	2.89 * **length** + 78.10 cm	3.36 * **length** + 57.97 cm
	AFRICAN-AMERICAN	2.88 * **length** + 75.48 cm	3.08 * **length** + 64.67 cm
	ASIAN	2.68 * **length** + 83.19 cm	3.22 * Length + 61.32 cm
ULNA	CAUCASIAN	3.76 * **length** + 75.55 cm	4.27 * **length** + 57.76 cm
	AFRICAN-AMERICAN	3.20 * **length** + 82.77 cm	3.31 * **length** + 75.38 cm
	ASIAN	3.48 * **length** + 77.45 cm	Not Available
RADIUS	CAUCASIAN	3.79 * **length** + 79.42 cm	4.74 * **length** + 54.93 cm
	AFRICAN-AMERICAN	3.32 * **length** + 85.43 cm	3.67 * **length** + 71.79 cm
	ASIAN	3.54 * **length** + 82.00 cm	Not Available

*These formulas are calculated for **ADULT** males and females. (from Bass, W.M. (1987) Human Osteology: A Laboratory and Field Manual (3rd ed.). Missouri Archeaological Society, Columbia.)





Height Estimation Example

Asian female femur found measuring 45.5 cm.

Formula: 2.38 * Length + 56.93 cm

Plug in:2.38 (45.5) + 56.93 cm = ~165.22 cm

(1 inch = 2.54 cm)

165 cm/ 2.54 cm = 65 inches = **~ 5 ft 4 in**

Facial Restoration

After determining the sex, age, and race of an individual, facial features can be built upon a skull to assist in identification. Erasers are used to make tissue depths at various points on the skull. Clay is used to build around these markers and facial features are molded.

Read about the John List story
www.crimelibrary.com/notorious_murders/family/list/1.html

Anthropologist at Work

This anthropologist is
hard at work dusting
away material from
these imbedded
bones.

Picture taken at Chicago's Museum of Natural History

More Applications

Forensic experts may be called upon to give information on the life and death
of humans and animals in unique circumstances, including:

- Mass Murder (Oklahoma bombing, plane crashes, World Trade)
- Earlier man (mummies, Iceman, Lindow man)
- Historical Significance (Holocaust, uncertain death of famous people)
- Prehistoric Animals (Dinosaurs)

Animal Facial Restoration

Determining what T Rex looked like using the bone formation.

From this:

To this: