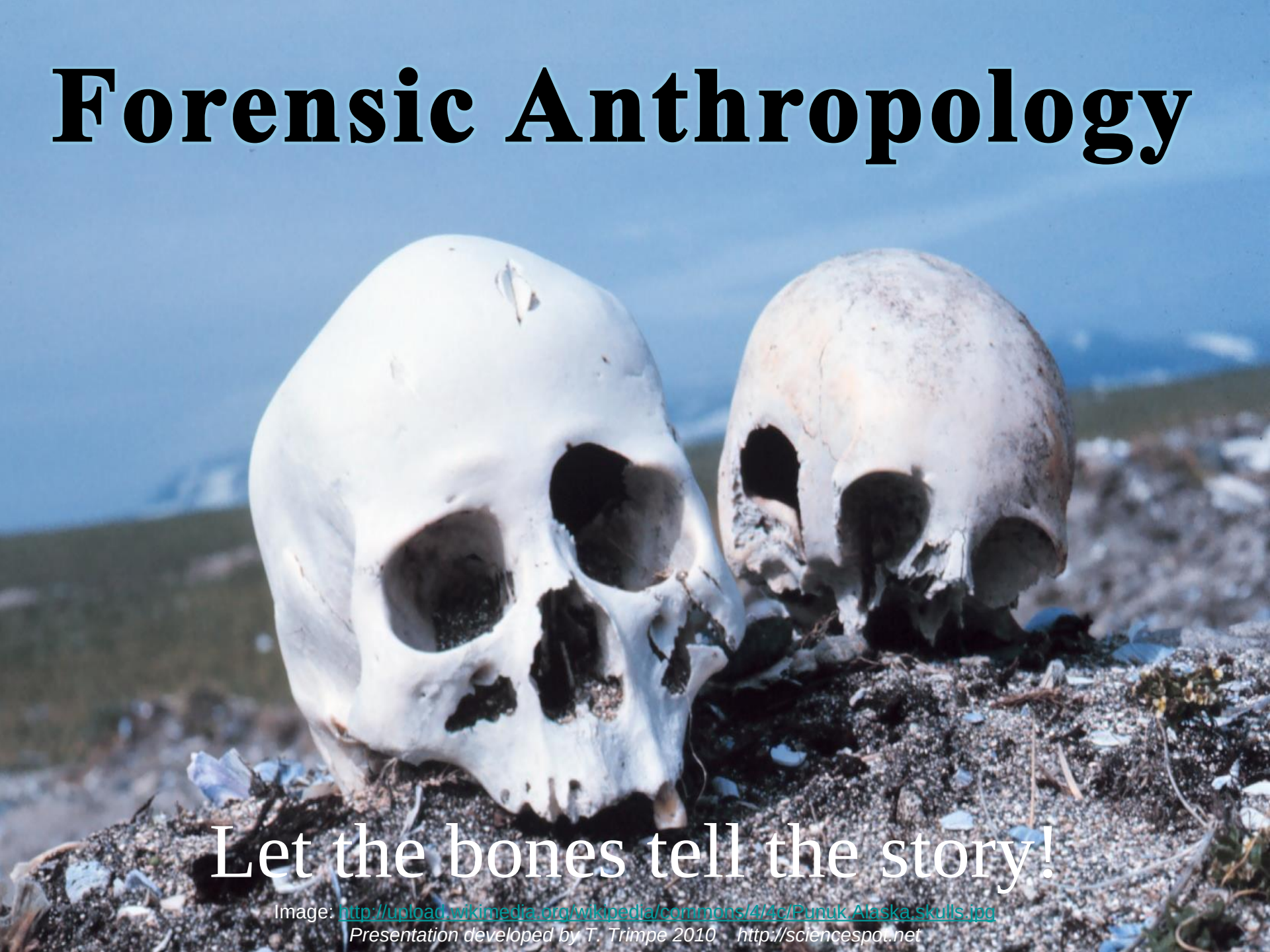
Forensic Anthropology



Let the bones tell the story!

Image: http://upload.wikimedia.org/wikipedia/commons/4/4c/Punuk_Alaska_skulls.jpg

History of Anthropology & Osteology

- In the 1800's, scientists began studying skulls
- In 1932, the FBI opened the first crime lab
- The Smithsonian Institute began working with the FBI on identifying human remains
- Soldiers killed during WWII were identified using anthropological and osteological (study of bones) techniques

Forensic Anthropology

The study of skeletonized human remains and the time of death to try to establish the identity and cause of death of an individual

Forensic Anthropology (continued)

- Can possibly identify the following
- Age
- Sex
- Race
- Height
- Pathologies that may be present
- Whether trauma is evident

Forensic Anthropology (continued)

- When bones are found, the following should be answered:
- Are they really bones or some other type of material?
- Are they human bones?
- Is there only one individual present or more than one?
- How long have the bones been there?
- What is the cause of death?
- Who is this?

Excavation and Preservation of Bones

Video

Inventory bones as they are removed.

Bones should be wrapped in brown wrapping/butcher paper/newspaper and placed in individual bags.

Characteristics of Bone

- Bones are alive
- Marrow—creates blood cells
- Hormones affect the amount of calcium in the blood and bones

Development of Bone

- Osteoblast cells—where bones originate
- Ossification—when osteoblast cells migrate to the center of cartilage production and deposit minerals
- Life cycle—bone is deposited, breaks down, and replaced
- Osteoclasts—the 2nd type of bone cell, specialized to dissolve bone

Development of Bone

- **Osteoclasts**—the 2nd type of bone cell
- Specialized to dissolve bone
- Allows bones to reshape as they grow
- Balances calcium levels in blood
- Removes cellular wastes and debris from bones
- **Osteoporosis**—a deficiency of calcium in the bones

Functions of Bone

Video

Support
- Contribute to shape, alignment and position of body

Protection
- Skull-brain, ribs-heart, lungs

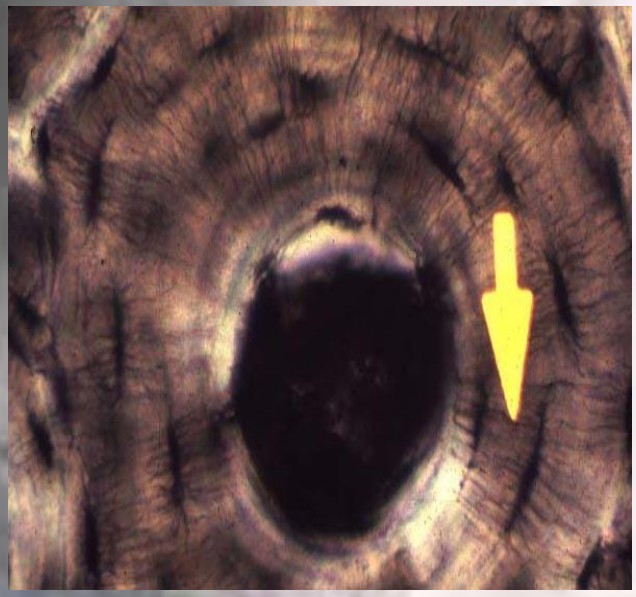
Movement
- Muscles are anchored to bones which act as levers

Mineral Storage
- Reservoir for calcium, phosphorus and other minerals
- Calcium moves into or out of bones to keep blood levels steady

Hematopoiesis
- Blood cell formation, occurs primarily in red marrow

Classification of Bones

- The adult skeleton has 206 bones. A minor has 450 bones.
- Two types of osseous bones
  - Compact -**Dense and looks smooth and homogenous**
  - Cancellous (or spongy) bone
  - Has a good deal of open space (looks spongy)



Types of bones Video

Long Bones
- Long axis with unique shaped articular ends
  - ex: femur (thigh), humerus (arm)

Short Bones
- Cube or box shaped
  - ex: wrist(carpals) or ankle(tarsals) bones

Flat Bones
- Broad and thin with often curved surfaces
- Red marrow is found in some flat bone like the sternum
  - ex: shoulder blades(scapula), breastbone(sternum) and ribs

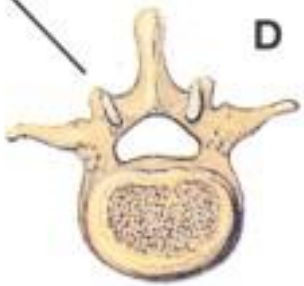
Irregular Bones
- Come in clusters and come in various shapes and sizes
- *Sesamoid bones* are irregular bones that are found alone, kneecap(patella)
  - ex: vertebral bones, facial bones

Long Bones

Flat Bones

Short Bones

Irregular Bones



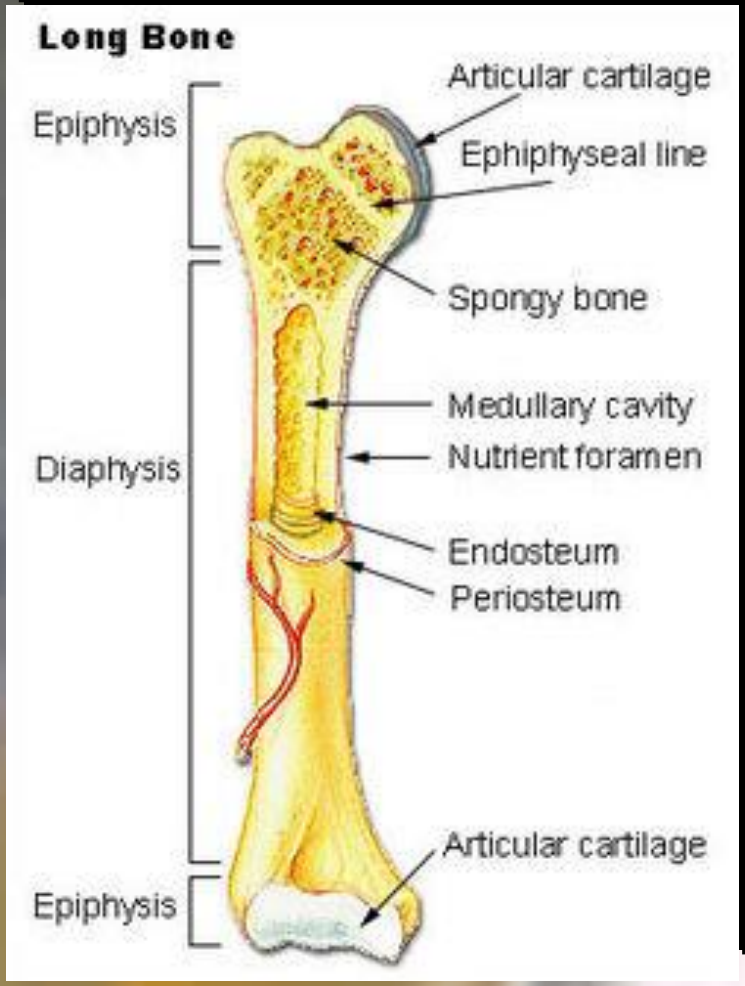
Parts of a long bone

Epiphyses
- end of bones, covered with cartilage and articulate w/ other bones
- Site of muscle attachments
- Made of cancellous tissue filled with red marrow

Diaphysis
- Main shaft portion of bone
- Contains medullary cavity filled with marrow
- Very strong yet light

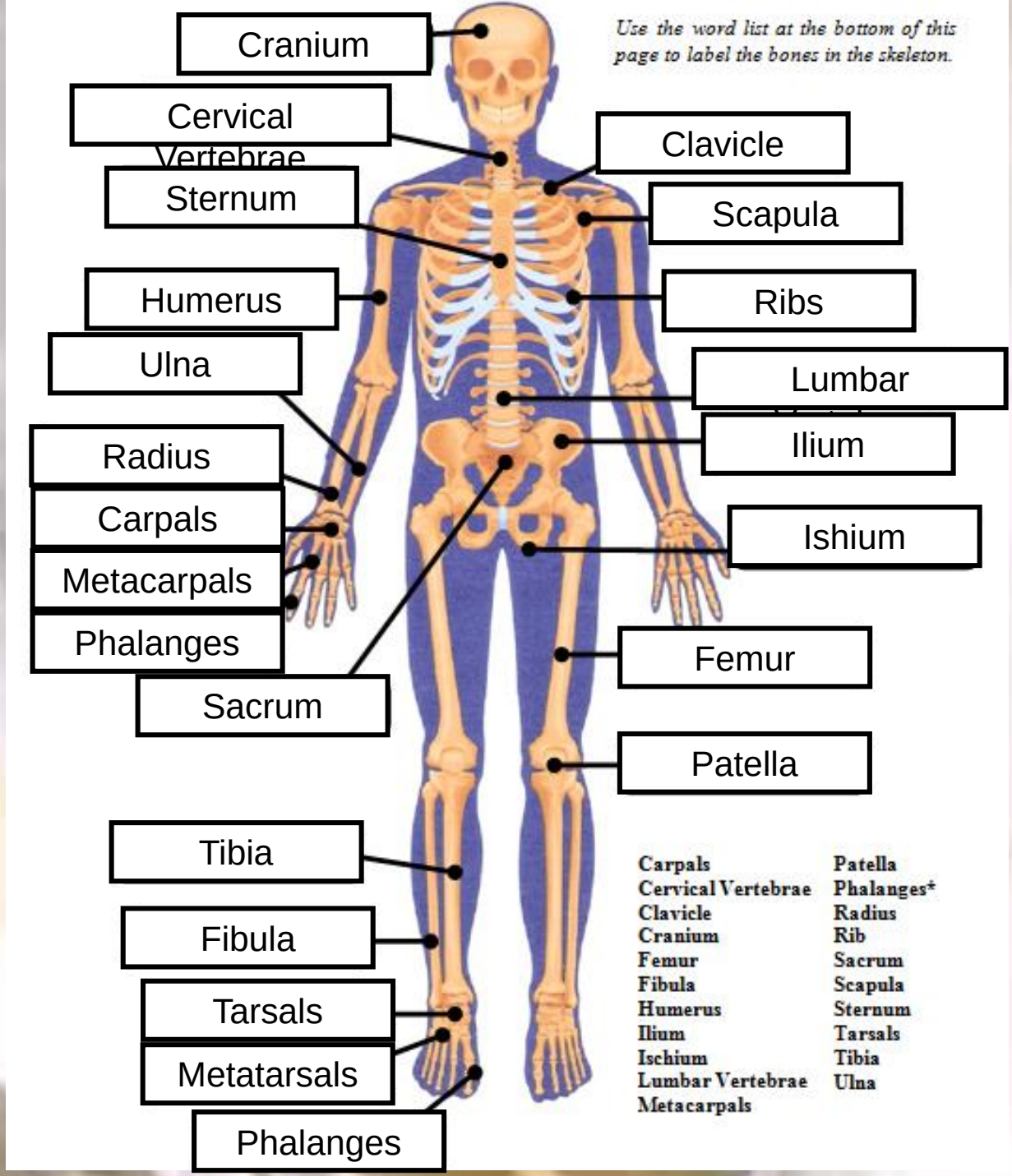
Epiphyseal plate
- layer of cartilage seen in early development
- separates epiphyses from Diaphysis.
- *In mature bone is referred to as the metaphysis*

Articular Cartilage
- Thin layer of hyaline cartilage that covers epiphysis
- Cushions jolts and blows



Directions:
Identify the bones in the skeleton. One label will be used twice!

[The Bone Dance]

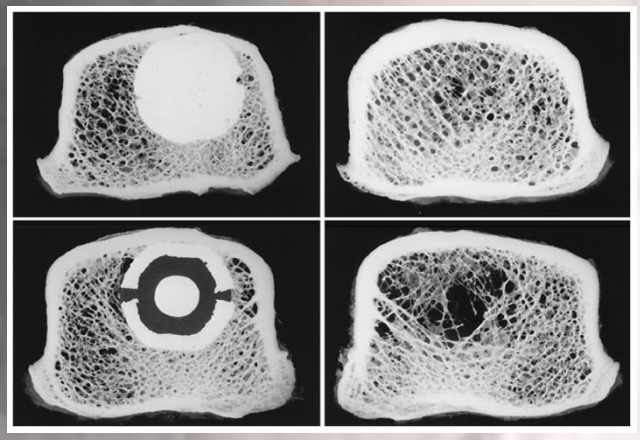


Is it human or animal?

- Humans and animals have different skeletal structures, different bones and differently shaped bones.
- Microscopically, bones contain holes, or osteons, that carry blood. Animal osteons form a regular pattern, while those in humans do not.

Determining if Bones are Human

- Bones contain bumps, grooves, indentations, and other characteristics according to their function in the body and what species they belong to.



- Forensic anthropologists use these features, as well as overall size and thickness, to assess the species of origin.

Human vs Animal

- Still can be difficult:
- Front paw bones of a bear and human hand are similar.

Human vs. Non-human

- Human versus raccoon

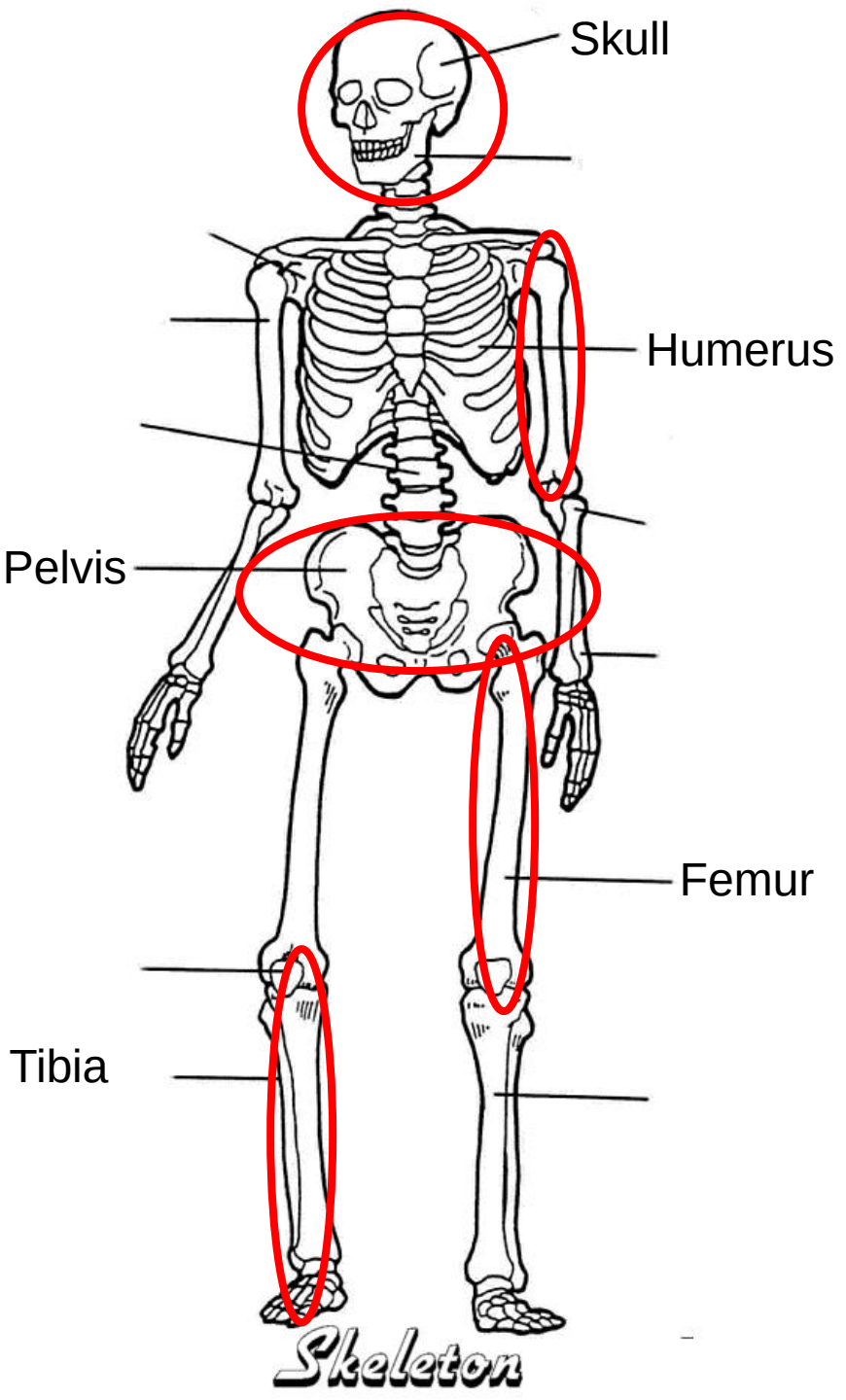
Human or Animal

- Ribs of sheep and deer resemble human ribs

Human Rib Bones

Deer Rib Bones

The bones we're interested in…



Terminology you should know

- Proximal vs. Distal
  - Toward the point of attachment; away from the point of attachment
- Superior vs. Inferior
  - Toward the head; toward the feet
- Supine vs. Prone
  - Lying on the back-side; lying on the belly-side
- Anterior vs. Posterior
  - Front-side; back-side

Physiology of bone

- Bones are held together by:
  a. **cartilage**—wraps the ends of bones and keeps them from scraping one another.
  b. **ligaments**—bands that connect two or more bones together.
  c. **tendons**—connect muscle to bone.
- Until about 30 years of age, bones increase in size.
- Deterioration after 30 can be slowed with exercise

- **Osteobiography** tells much about a person through the study of the skeleton.
- The bones of a right-handed person, for example, would be slightly larger than the bones of the left arm.
- Forensic scientists realize that bones contain a record of the physical life.
- Condition of bones can tell scientists age, health, and calcium intake.

A Caveat

- Informative features about the age, sex, race and stature of individuals based on bones is based on biological differences between sexes and races (males are generally taller and more robust) as well as differences due to ancestry (certain skeletal features of the skull)
- *However*, it is imprecise because so much human variation exists and because racial differences tend to homogenize as populations interbreed
- Still differences *do* exist and the more features you survey, the more precise your conclusions will be

What Can We Learn?

- Determination of Sex
  - Pelvis
  - Skull
- Determination of Race
  - Skull
- Approximate Age
  - Growth of long bones
- Approximate Stature
  - Length of long bones
- Postmortem (after death) or antimortem(after death) injuries
- Postmortem interval (time of death)

http://en.wikipedia.org/wiki/Forensic_anthropology

Forensic Anthropology: Gender Determination

MALE	FEMALE
Narrow pelvic opening	Larger, circular pelvic opening
Long, narrow sacrum	Wide sacrum
Acute (less than 90^0) subpubic angle	Wide subpubic angle (approximately 90^0)
Larger skull overall	Smaller skull
Pronounced brow bone	Diminished brow bone
Overall robust skeleton	Overall slender skeleton

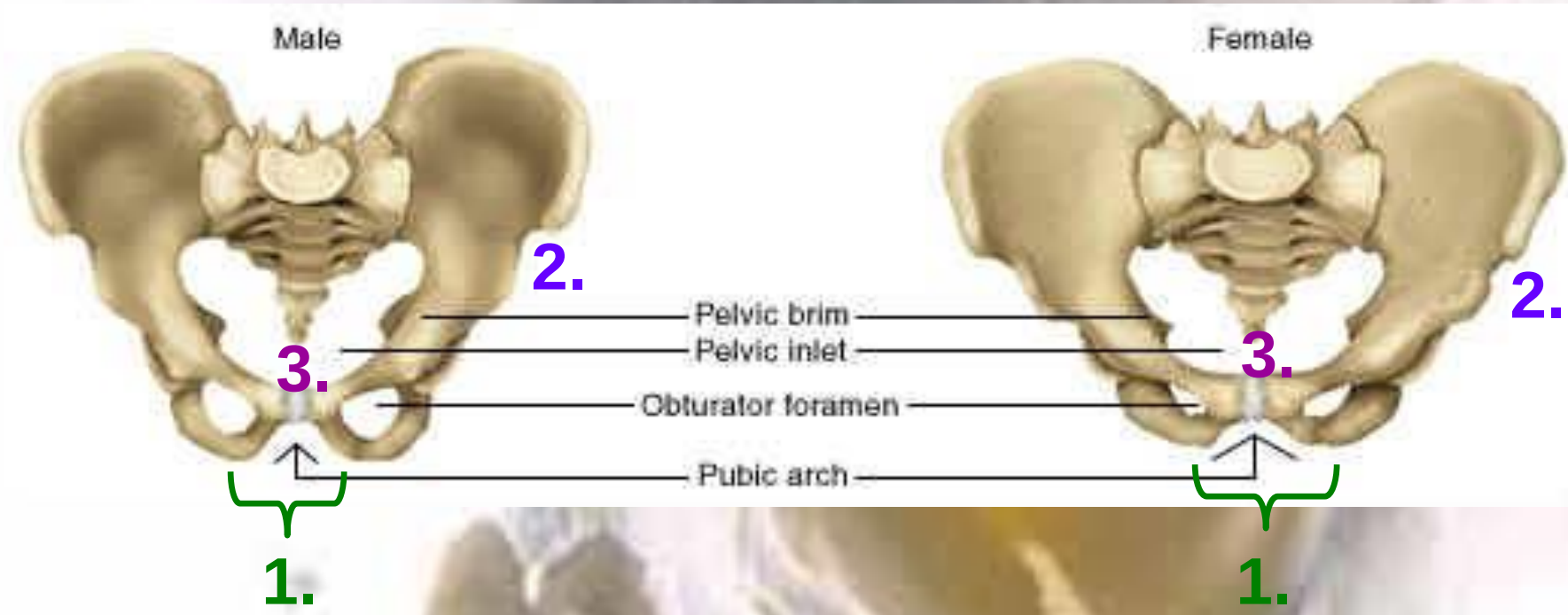
Determination of Sex from the pelvis

- **Pelvis is the best bones (differences due to adaptations to childbirth)**

1. **females have wider subpubic angle**

2. **females have a sciatic notch > 90°**

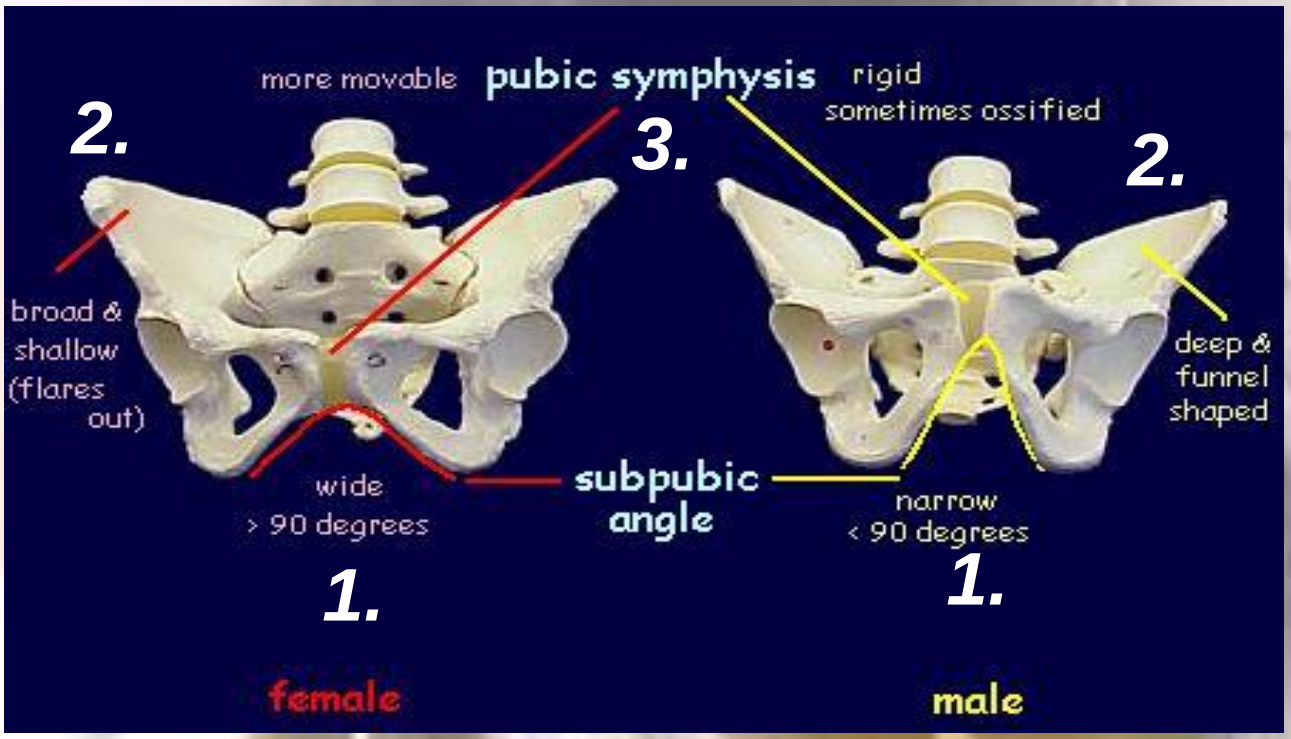
3. **females have a broad pelvic inlet**



1. Determination of Sex

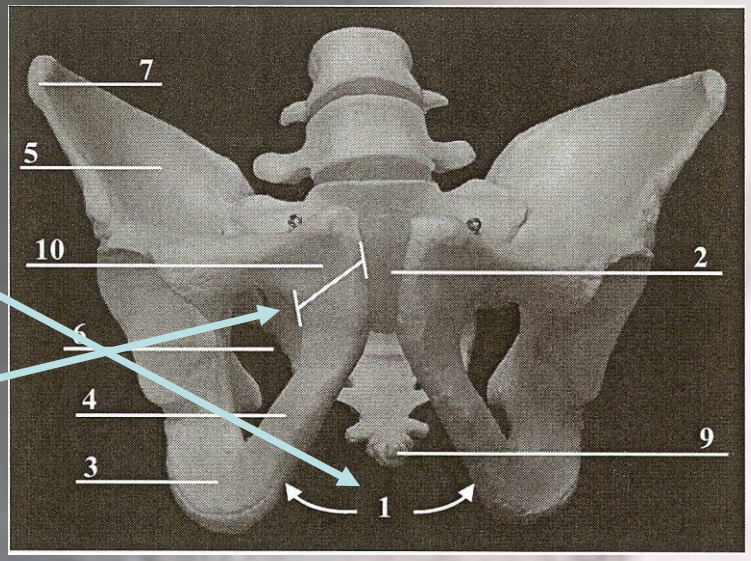
- **Pelvis best (another view)**

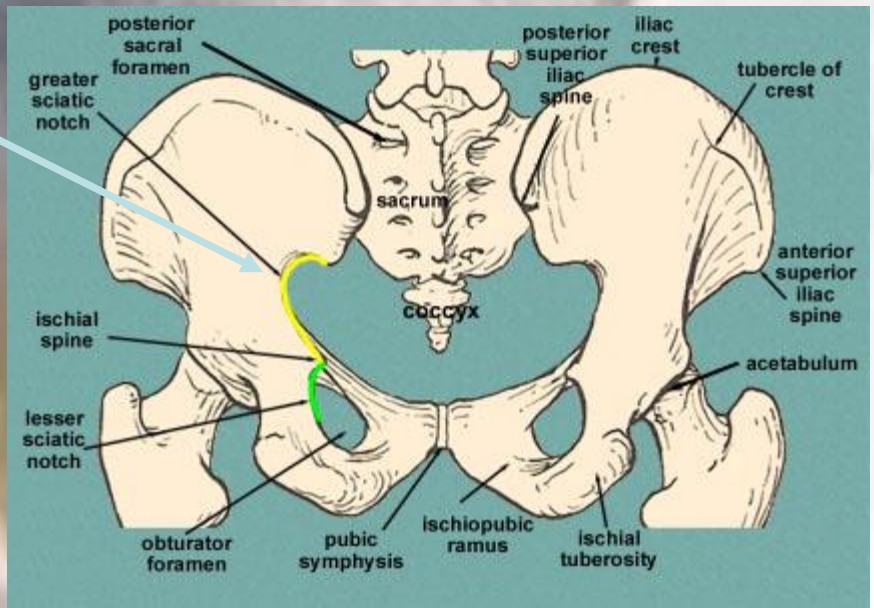
4. **females have a broad, shovel-like ilium**
5. **females have a flexible pubic symphysis**



Sex Determination - Pelvis

- Sub-Pubic Angle
- Pubis Body Width
- Greater Sciatic Notch
- Pelvic Cavity Shape





http://mywebpages.comcast.net/wnor/pelvis.htm

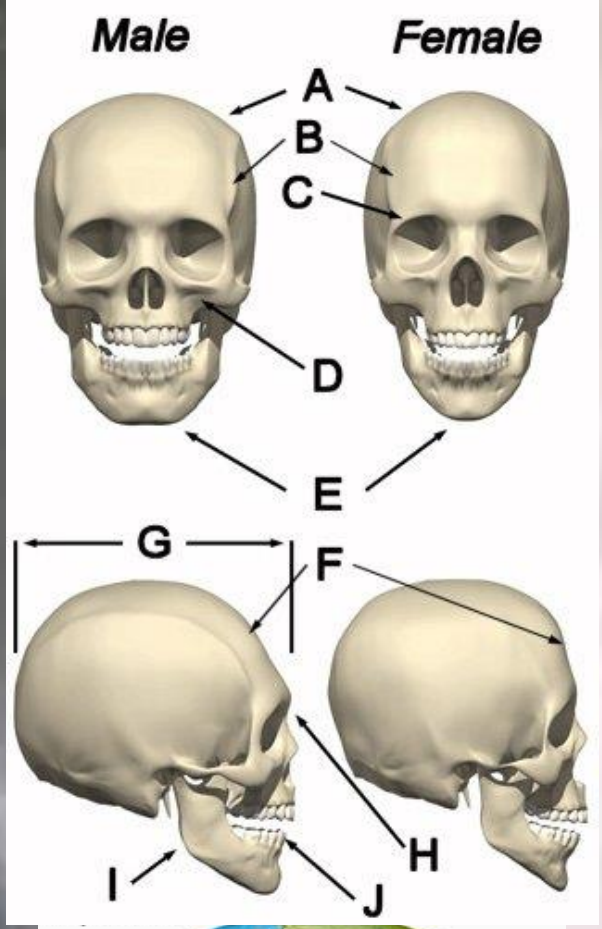
Forensic Anthropology: Gender Determination

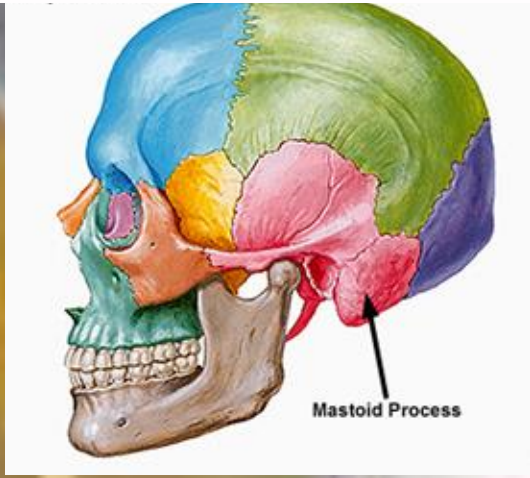
FEMALE PELVIS

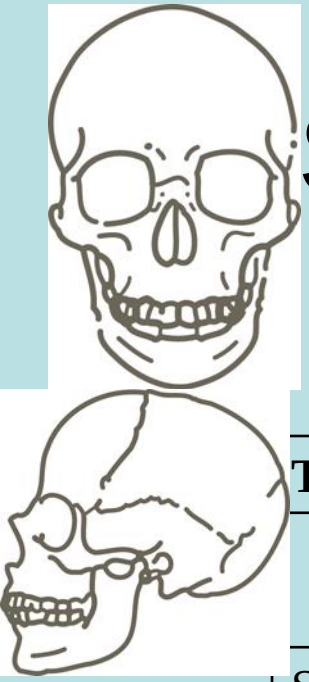
MALE PELVIS

Determination of Sex: Cranium

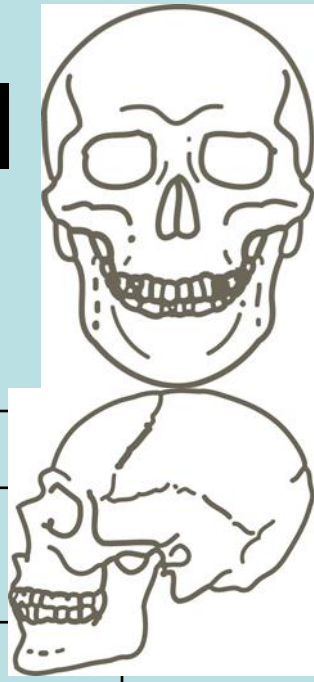
- Crests and ridges more pronounced in males (A, B, C)
- Chin significantly more square in males (E)
- Mastoid process wide and robust in males
- Forehead slopes more in males (F)







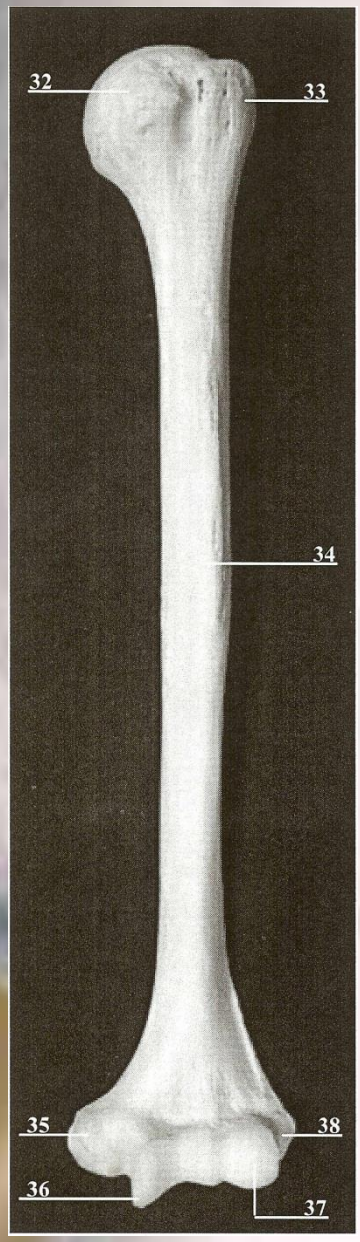
Sex Determination - Skull



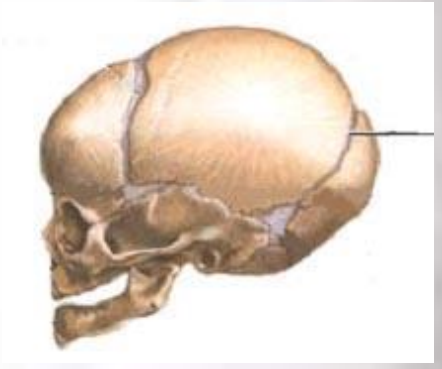
Trait	Female	Male
Upper Edge of Eye Orbit	Sharp	Blunt
Shape of Eye Orbit	Round	Square
Zygomatic Process	Not expressed beyond external auditory meatus	Expressed beyond external auditory meatus
Nuchal Crest (Occipital Bone)	Smooth	Rough and bumpy
External Occipital Protuberance	Generally Absent	Generally present
Frontal Bone	Round, globular	Low, slanting
Mandible shape	Rounded, V-shaped	Square, U-shaped
Ramus of mandible	Slanting	Straight

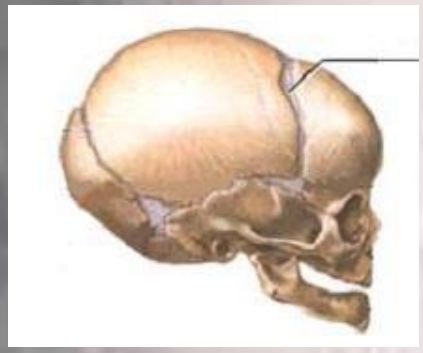
Determination of Sex: long bones

- **Normally, the long bones alone are not used alone to estimate gender. However, if these bones are the only ones present, there are characteristics that can be used for sex determination.**
- ***E.g.* maximum length of humerus in females is 305.9 mm, while it is 339.0 mm in males**



Determination of Age from Skulls



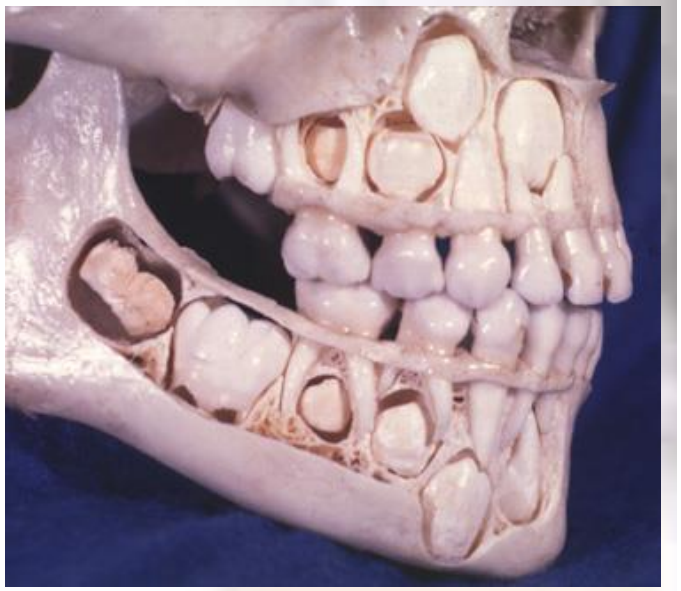


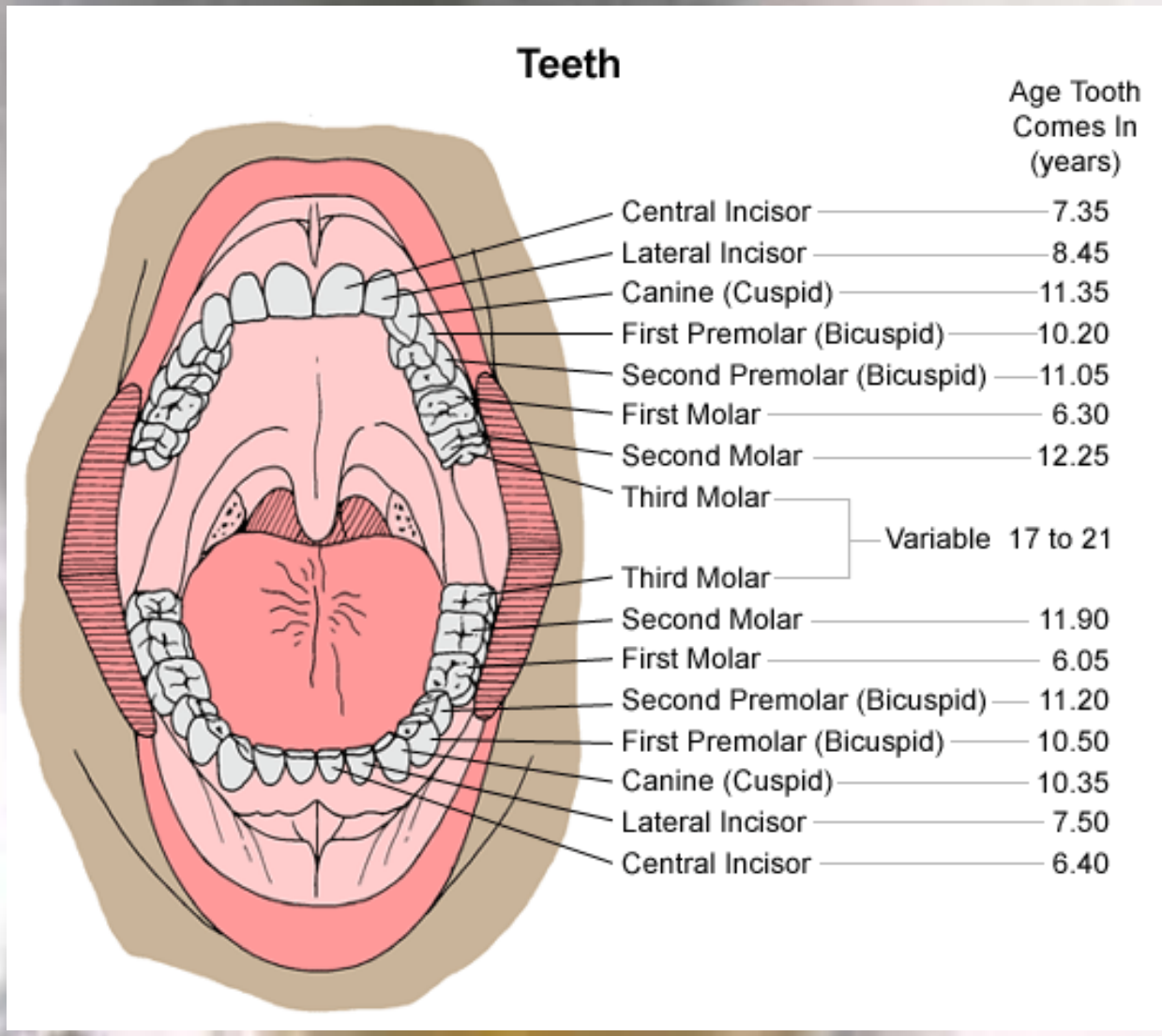
- Suture - Zigzag-like cracks on the skull
- By about age 30, the suture at the back of the skull will have closed.
- By about age 32, the suture running across the top of the skull, back to front, will have closed.
- By about age 50, the suture running side to side over the top of the skull, near the front, will have closed.

Determination of Age from Bones

- **Ages 0-5:** teeth are best – forensic odontology
  - Baby teeth are lost and adult teeth erupt in predictable patterns
- **Ages 6-25:** epiphyseal fusion – *fusion of bone ends to bone shaft*
  - epiphyseal fusion varies with sex and is typically complete by age 25
- **Ages 25-40:** very hard
- **Ages 40+:** basically wear and tear on bones
  - periodontal disease, arthritis, breakdown of pelvis, etc.
- Can also use ossification of bones such as those found in the cranium

Age Determination: Use of Teeth





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

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

Epiphyseal Fusion purpose to lengthen long bones

- The figures below are of the Epiphyses of the femur or thigh bone (the ball end of the joint, joined by a layer of cartilage).
- The lines in the illustrated **Image 1** show the lines or layers of cartilage between the bone and the epiphyses. The lines are very clear on the bone when a person, either male or female is not out of puberty.
- In **Image 2**, you see no visible lines. This person is out of puberty. The epiphyses have fully joined when a person reaches adulthood, closing off the ability to grow taller or in the case of the arms, to grow longer.

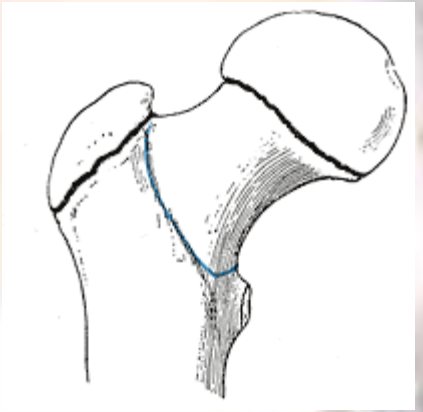


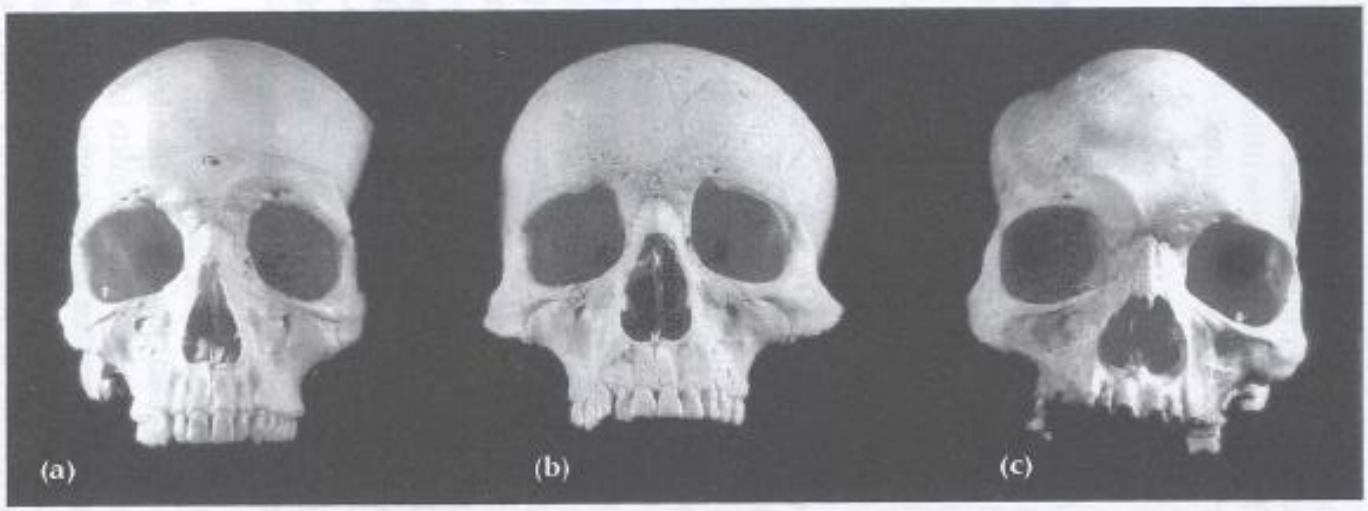
Figure 1.

Figure 2.

Determination of Race

- It can be extremely difficult to determine the true race of a skeleton for several reasons:
  - First, forensic anthropologists generally use a three-race model to categorize skeletal traits: Caucasian (European), Asian (Asian/Amerindian), and African (African and West Indian).
  - Although there are certainly some common physical characteristics among these groups, not all individuals have skeletal traits that are completely consistent with their geographic origin.
  - Second, people of mixed racial ancestry are common.
    - Often times, a skeleton exhibits characteristics of more than one racial group and does not fit neatly into the three-race model.
  - Also, the vast majority of the skeletal indicators used to determine race are non-metric traits which can be highly subjective.
- Despite these drawbacks, race determination is viewed as a critical part of the overall identification of an individual's remains.

White, Asian, African



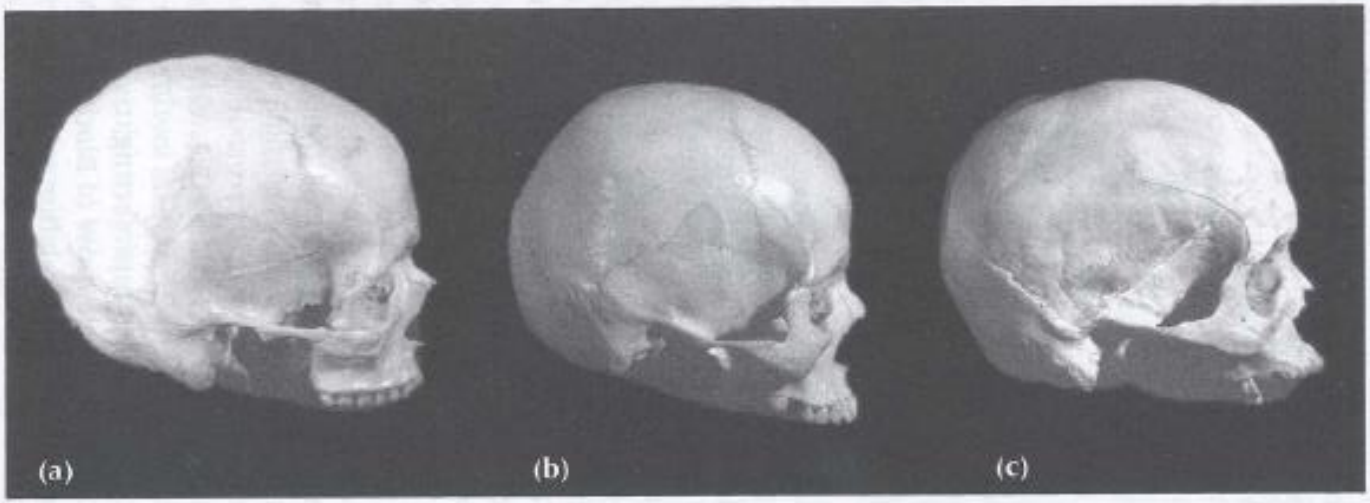
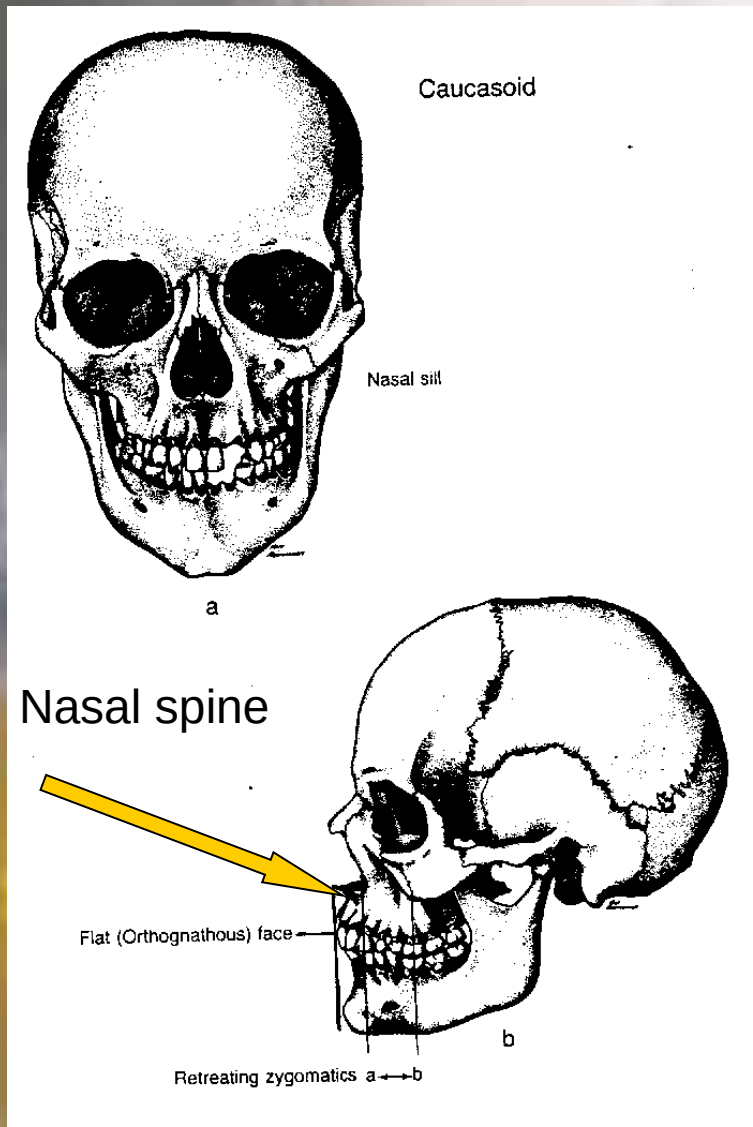


FIGURE 7.1 Skulls of the three main ancestral groups: **(a)** White; **(b)** Asian; **(c)** Black.

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

Features of the Skull Used in Race Determination

- Nasal index: The ratio of the width to the height of the nose, multiplied by 100
- Nasal Spine
- Feel the base of the nasal cavity, on either side of the nasal spine – do you feel sharp ridges (nasal silling), rounded ridges, or no ridges at all (nasal guttering)?
- Prognathism: extended lower jaw
- Shape of eye orbits (round or squareish



Nasal Silling and Guttering

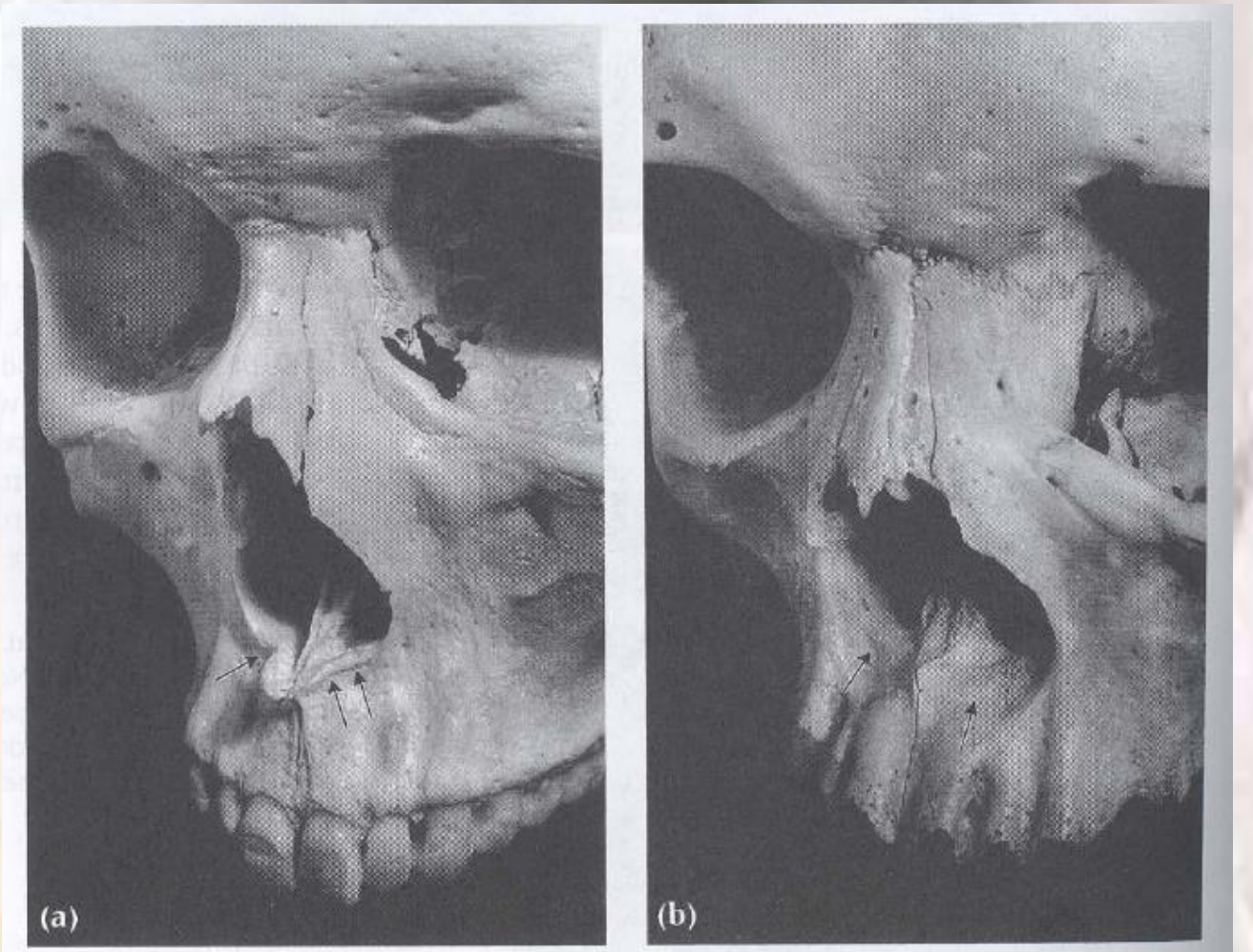


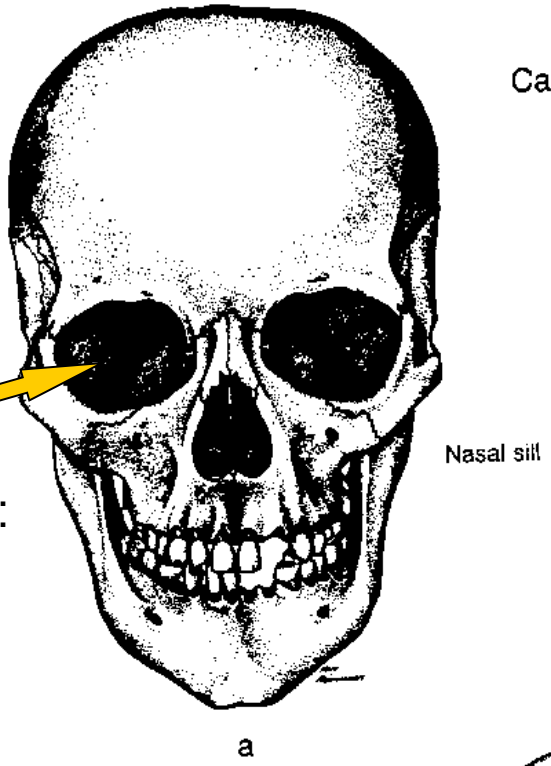
FIGURE 7.5 Variations in the lower border of the nose: **(a)** distinct sill (*arrows*) in Whites; **(b)** indistinct lower border with guttering (*arrows*) on either side of the midline in Blacks.

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

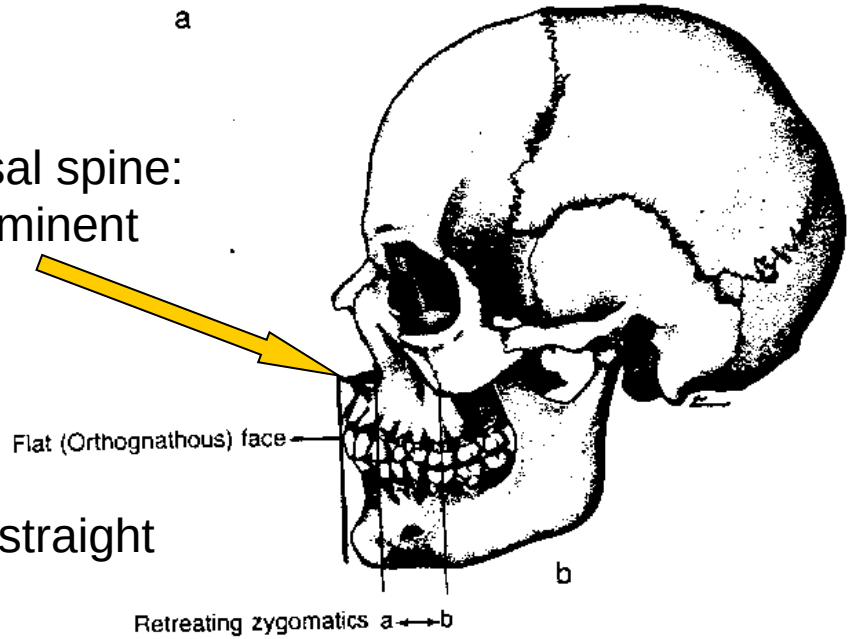
Determination of Race: Caucasian

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

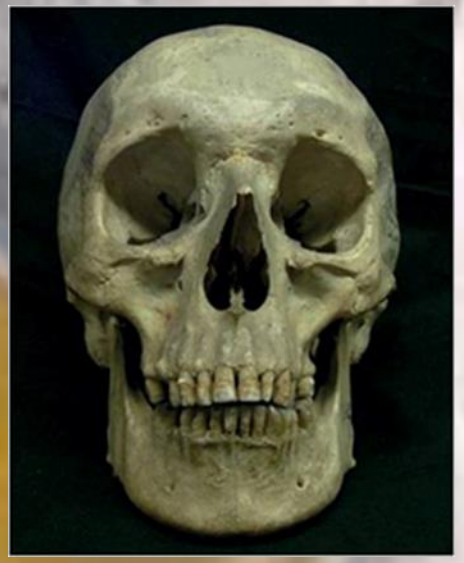


Progathism: straight

http://upload.wikimedia.org/v

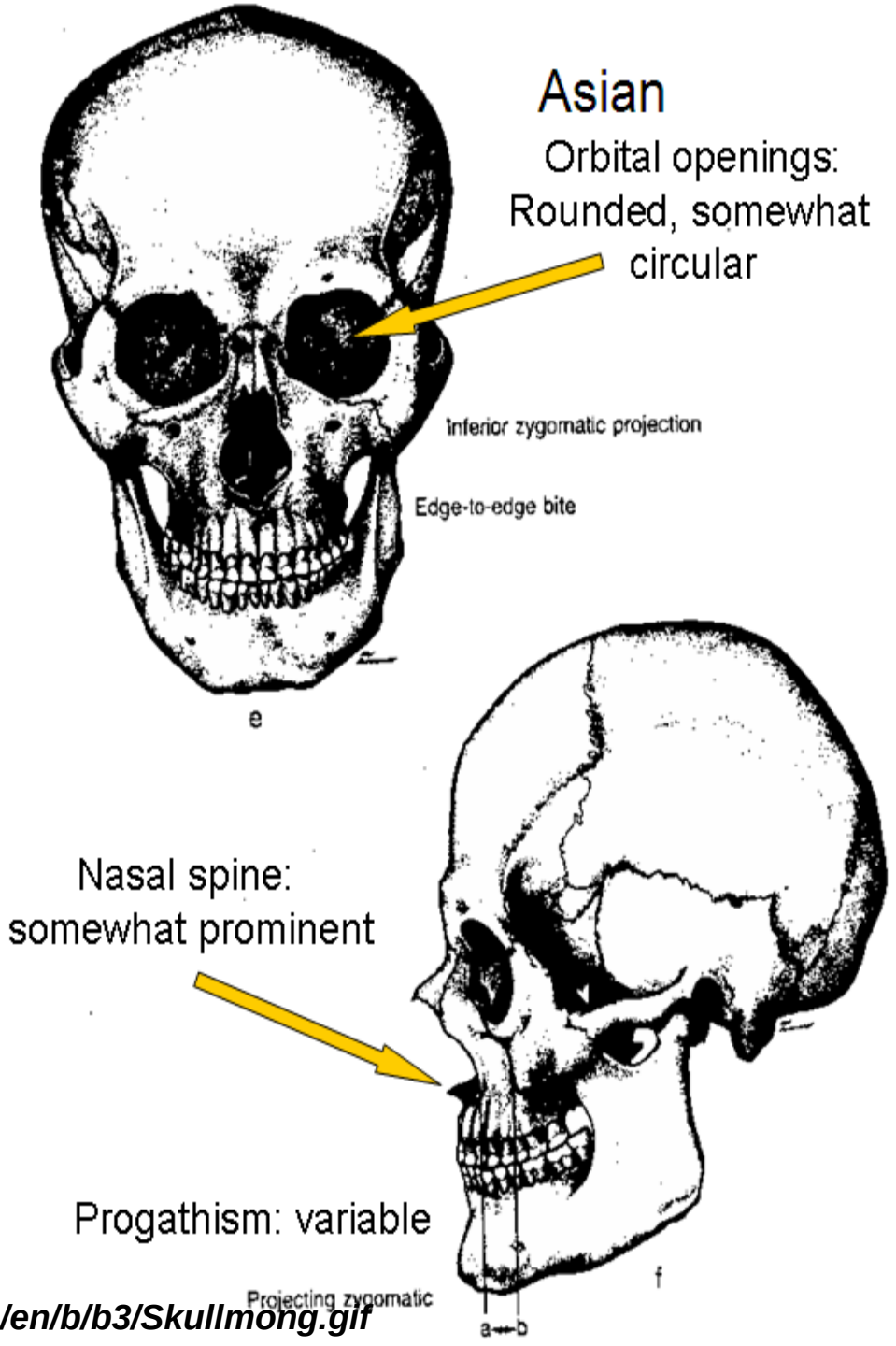
Forensic Anthropology: Race Determination (continued)

- Caucasoid (European)
- Flat cranium
- Long, narrow nasal cavities
- Oval eye orbits



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

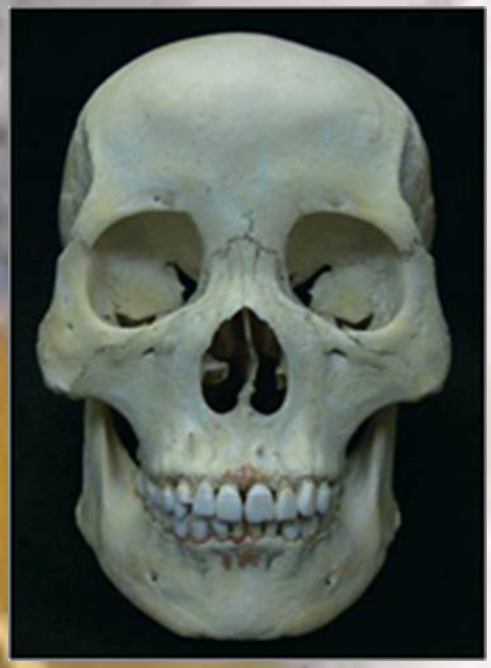
Trait	
Nasal Index	.48-.53
Nasal Spine	Somewhat prominent spine
Nasal Silling/ Guttering	Rounded ridge
Prognathism	Variable
Shape of Orbital Openings	Rounded, somewhat circular



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

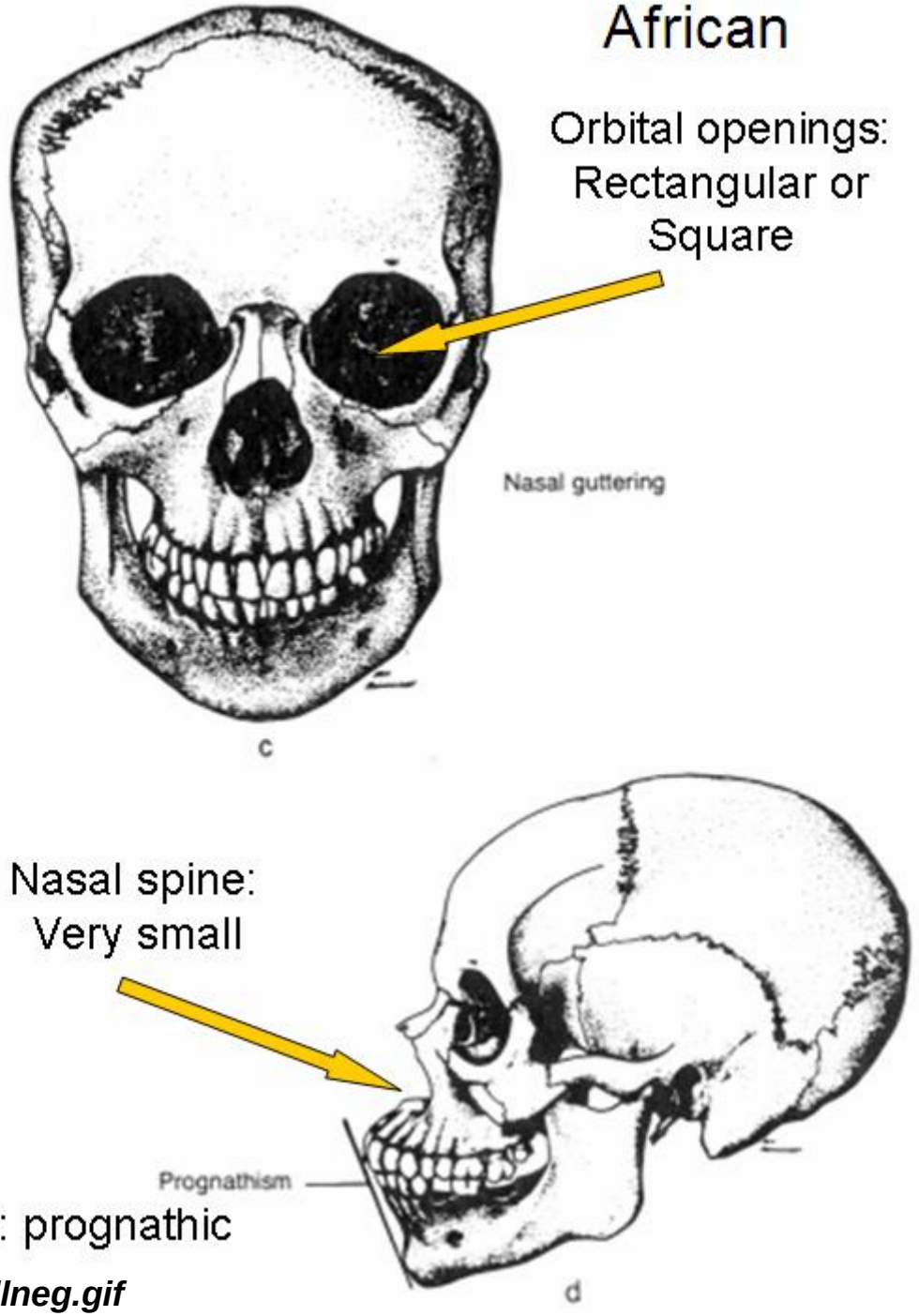
Forensic Anthropology: Race Determination (continued)

- Mongoloid (Asian or Native descent)
- Flat or projected outward frontal plane
- Small, rounded nasal cavities
- Circular eye orbits



Determination of Race: African: (everyone of African decent and West Indian decent)

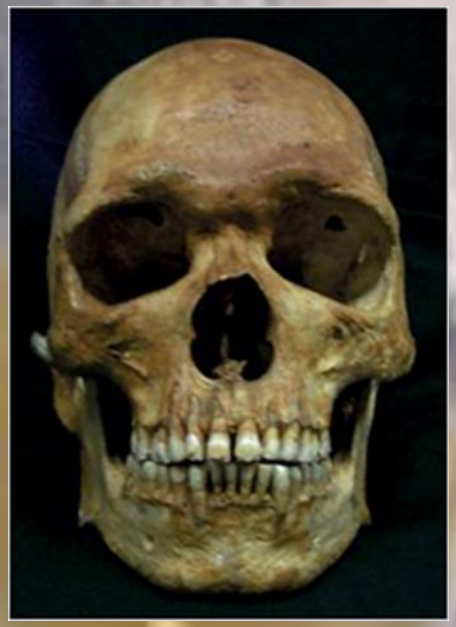
Trait	
Nasal Index	>.53
Nasal Spine	Very small spine
Nasal Silling/ Guttering	No ridge (guttering)
Prognathism	Prognathic
Shape of Orbital Openings	Rectangular or square



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

Forensic Anthropology: Race Determination (continued)

- Negroid (African)
  - Cranium projected outward
  - Wide nasal cavity
  - Square eye orbits

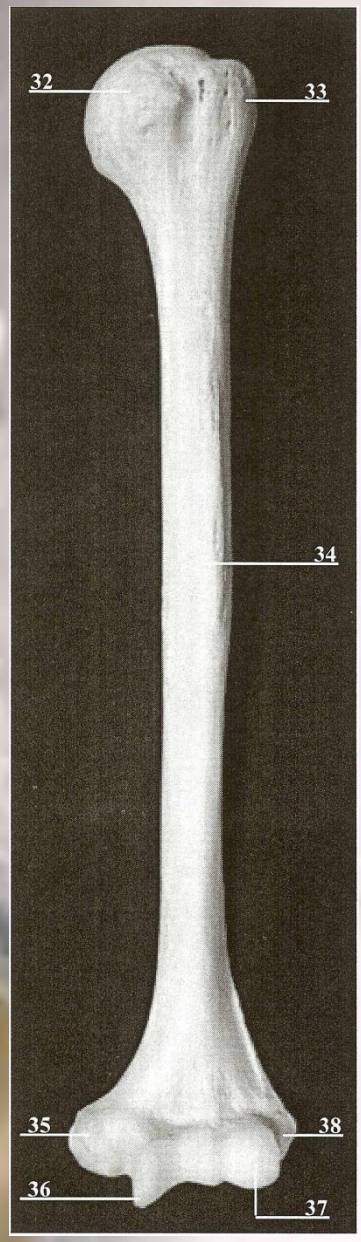


Determination of Stature

- Long bone length (femur, tibia, humerus) is proportional to height
- There are tables that forensic anthropologists use (but these also depend to some extent on race)
- Since this is inexact, there are ‘confidence intervals’ assigned to each calculation.
- For example, imagine from a skull and pelvis you determined the individual was an adult Caucasian, the height would be determine by:
- Humerus length = 30.8 cm
- Height = 2.89 (MLH) + 78.10 cm

  = 2.89 (30.8) + 78.10 cm

  = 167 cm (5’6”) ± 4.57 cm



Forensic Anthropology: Other Determining Factors

- A forensic anthropologist or sculptor may create facial reconstructions from skulls to help identify skeletal remains
- Pathological identities such as past surgeries, and broken bones that show healing and/or scarring
- Trauma may be studied by observing cracks, holes, or tool marks present on bones

Skeletal Trauma Analysis

- Forensic anthropologists determine if damage to bones occurred before or after death
- Distinct patterns exist for damage by
- Environment (weather and/or animals)
- Sharp-force trauma
- Blunt-force trauma
- Gunshot wounds
- Knife wounds

Other Information We Can Get From Bones:

- Evidence of trauma (here GSW to the head)

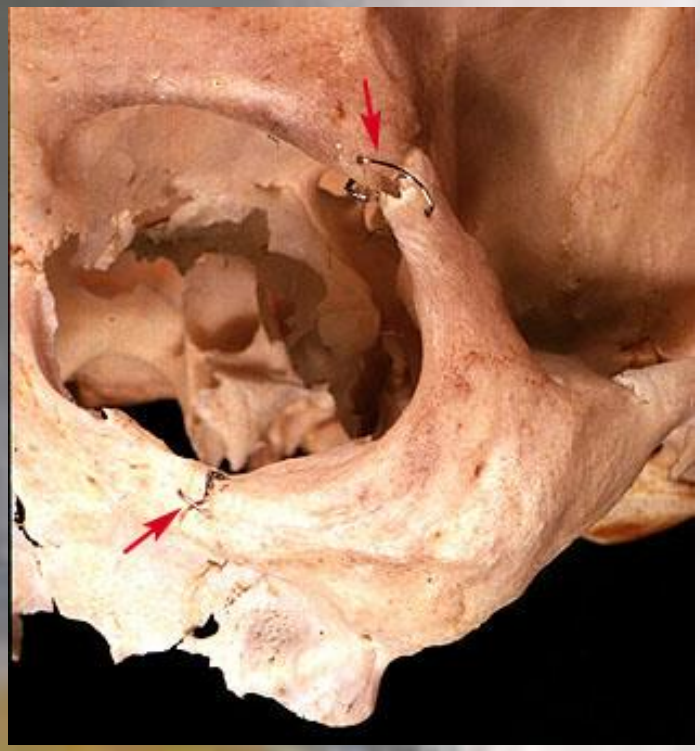
- Video 1
- Evidence of post mortem trauma (here the head of the femur was chewed off by a carnivore)

- Video 2

http://library.med.utah.edu/kw/osteo/forensics/index.html

Signs of wearing and antemortem injury

Occupational stress wears bones at joints



Surgeries or healed wounds aid in identification

http://library.med.utah.edu/kw/osteo/forensics/pos_id/boneid_th.html

Excavation of Skeletal Remains

- These are the guidelines provided to expose and recover remains in order to minimize damage
- Guidelines will differ based on scene conditions

- A dead body that has been exposed to the open elements, such as water and air, will decompose more quickly and attract much more insect activity than a body that is buried or confined in special protective gear or artifacts.

- This is due, in part, to the limited number of insects that can penetrate a coffin and the lower temperatures under soil.

Excavation of Skeletal Remains

- Steps to excavation
- Remove litter and vegetation if present
- Stake out and map the exact excavation area
- Determine the grave outline and remove the soil covering; sift each layer to check for evidence or small bones
- Work in horizontal layers
- Document as work continues with photography, maps, inventory, and measurements
- Once all bones have been exposed, document them again
- Remove each bone separately and bag it individually

Human Death

- If death has occurred, the following must be determined:
- **Cause**
- The disease or injury responsible for initiating the sequence of events that resulted in death
- Examples
  - Excessive/fatal bleeding
  - Drug overdose
  - Cardiovascular disease

- **Manner of Death**
- The “reason” the cause of death occurred
- Categories
  - Accidental
  - Homicide
  - Natural
  - Suicide
  - Undetermined

Mechanism of Death

- is the actual physiological change, or variation in the body's inner workings, that causes the cessation of life.
- Examples
  - Hemorrhage
  - Cardiac arrhythmia
  - gunshot wound
  - Stabbing
  - bleeding ulcer
  - bleeding lung tumor

Forensic Odontology

- Odontology is the study of teeth and bite marks for individual identification
- Can estimate age by observing deciduous teeth in children and wear patterns in older adults
- Best method for identifying remains.
- Can be compared to dental records
- May contain DNA
- Teeth are harder to destroy in fire than bone
- Can be used with bite mark identification