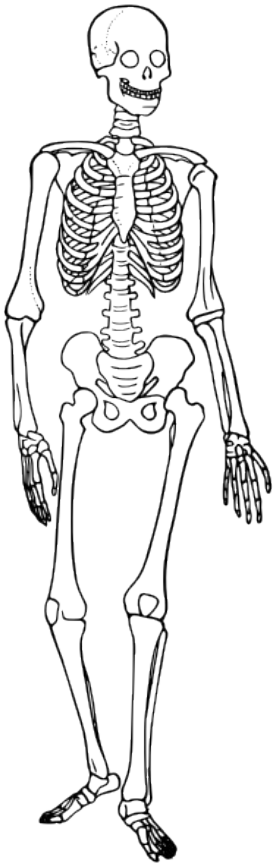
# Anth 250 Forensic Anthropology

# Human Osteology Terms and Images



W2026

Katie Waterhouse

You will need to refer to these terms and images during our human osteology labs. Please have these available to you for every human osteology lab. There is no need to print these if you work digitally but this file is designed for double sided printing if you like to work with a hard copy.

If printing I recommend the Camosun printshop- it's an affordable printing service available for students and they can hole punch and double side etc. You can find the Camosun printshop in the Fisher building- enter the building with the bookstore on the right and the cafeteria on the left, just before you hit F100 go left and down a hallway next to the CCSS offices. The printshop is on the right of the hallway.

# Orientation to the lab

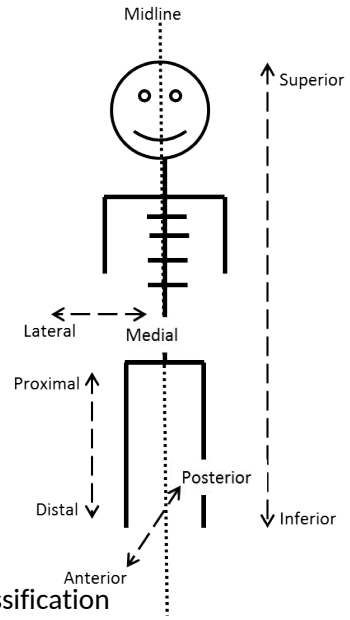
## Introduction to lab decorum and handling of human skeletal remains

The Camosun College Anthropology lab is very fortunate to have a human skeletal collection. The number of skeletons is very important for a course in forensic anthropology. The reason is that every skeleton is different, the only copy of a "book" of unique information. Because of the uniqueness of every skeleton, you can learn something about human variability and about how anthropologists can make a biological and sometimes a personal identification of an individual from his or her skeleton. Bones and teeth have the potential, if read correctly, to tell us something about the living people they once belonged to. Along with the privilege of learning from this collection we also have a responsibility to care for them appropriately. These were once living people, they have families, relations and social networks. We need to honour these individuals and treat their gift to us with the upmost care and respect. Considering this, there are strong protocols around working with our collections.

### Lab Protocols:

- No food or drink
- No photography
- Always place the bone on the foam mats or supported surfaces.
- Always place bones on trays to move them around the room, or better yet, move living people not bones
- Be careful of thin areas and small protrusions on the bones; some of these are so fragile that a finger could punch through them or snap them off.
- Be careful not to let teeth strike against anything, including each other.
- Some lab skulls have springs in them to hold the jaw closed. Never open the jaws while the springs are engaged – if you slip, the springs will close the jaw hard enough to crack the teeth. Instead, detach the springs as soon as you start to work with a skull, and put them back when you're finished.
- Always use a non-marking pointer to point at a bone.
- Do not remove the bones from the lab/classroom for any reason.
- Only people taking the course are allowed to handle the bones. Please do not allow anyone from outside the course to handle them.
- Please treat all casted material with the same care as real bones; casts are fragile too.

# Anatomical Terminology




## General Terms

**Anatomical directions**

Anterior (or ventral) / posterior (or dorsal)  Medial / Lateral

Superior / Inferior  Proximal / Distal

**Skeletal units**

Cranial Skeleton: the cranium, the mandible and the ear ossicles

Axial Skeleton and thorax: vertebral column and rib cage

Appendicular Skeleton: the bones of the arms, legs, shoulder and pelvis

**Bone parts**

Diaphysis: the long relatively straight main body of a long bone. A region of primary ossification

Epiphysis: the end regions of bones. A region of secondary ossification

Epiphyseal plate: the thin sheet of bone marking the fusion of epiphysis to diaphysis

## Bone Terminology

These terms may help your understanding of the bony features you will be learning. Do not memorize this list of terms but use it as a reference guide.

| | |
|---|---|
| *process* | A relatively large projection or prominent bump. |
| *articulation* | The region where adjacent bones contact each other—a joint |
| *articular process* | A projection that contacts an adjacent bone. |
| *eminence* | A relatively small projection or bump. |
| *tuberosity* | A projection or bump with a roughened surface. |
| *tubercle* | A projection or bump with a roughened surface, generally smaller than a tuberosity. |
| *trochanter* | One of two specific tuberosities located on the femur |
| *spine* | A relatively long, thin projection or bump. |
| *suture* | Articulation between cranial bones. |
| *malleolus* | One of two specific protuberances of bones in the ankle |
| *condyle* | A large, rounded articular process. |
| *epicondyle* | A projection above a condyle but not part of the joint. |
| *line*, *ridge* | A long, thin projection, often with a rough surface.(also *torus*) |
| *crest* | A prominent ridge. |
| *facet* | A small, smooth articular surface. |
| *foramen* | An opening through a bone. |
| *fossa* | A broad, shallow depressed area. |
| *canal* | A long, tunnel-like foramen, usually a passage for notable nerves or blood vessels. |
| *meatus* | A short canal. |
| *sinus* | A cavity within a cranial bone. |

# The Skull

## Bones of the Skull

Frontal

- Glabella
- Supraorbital margin
- Temporal line
- Coronal suture

Parietal, R and L

- Temporal line
- Coronal suture
- Sagittal suture
- Lambdoid suture
- Squamosal suture

Occipital

- External occipital protuberance
- Occipital condyles
- Foramen magnum
- Lambdoid suture

Temporal, R and L

- Zygomatic process
- Mandibular fossa
- External auditory meatus
- Mastoid process
- Supramastoid crest
- Squamosal suture

Maxilla, R and L

- Frontal process
- Zygomatic process
- Palatine process
- Infraorbital foramen
- Incisors, Canines, Premolars and Molars

Zygomatic, R and L

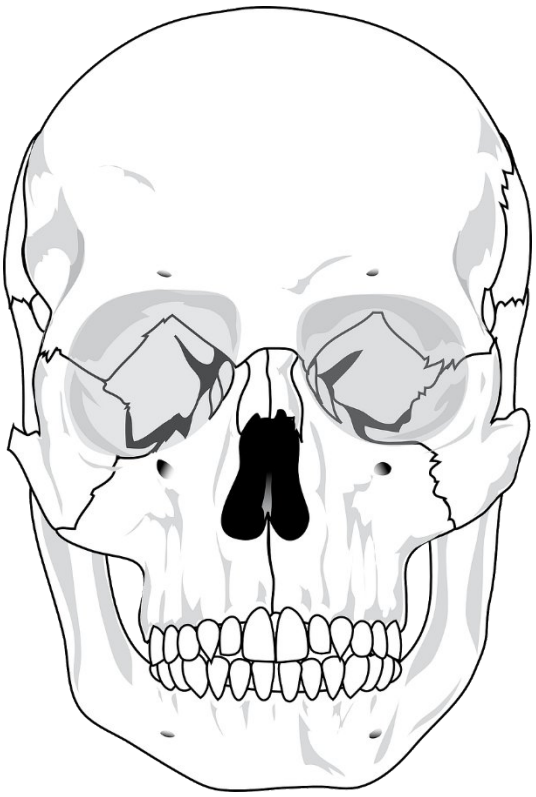
- Frontal process (in articulation)
- Maxillary process (in articulation)
- Temporal process (in articulation)

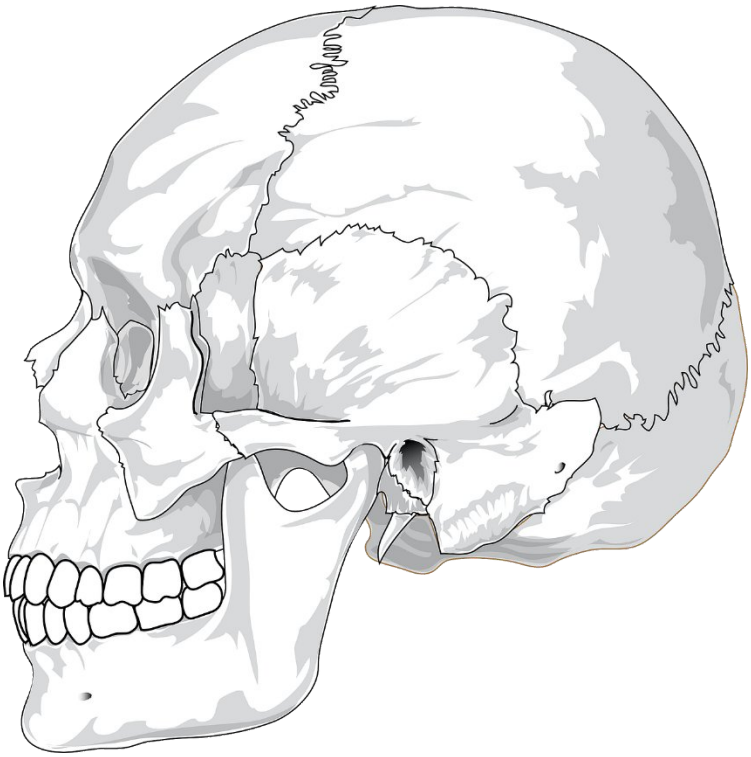
Mandible

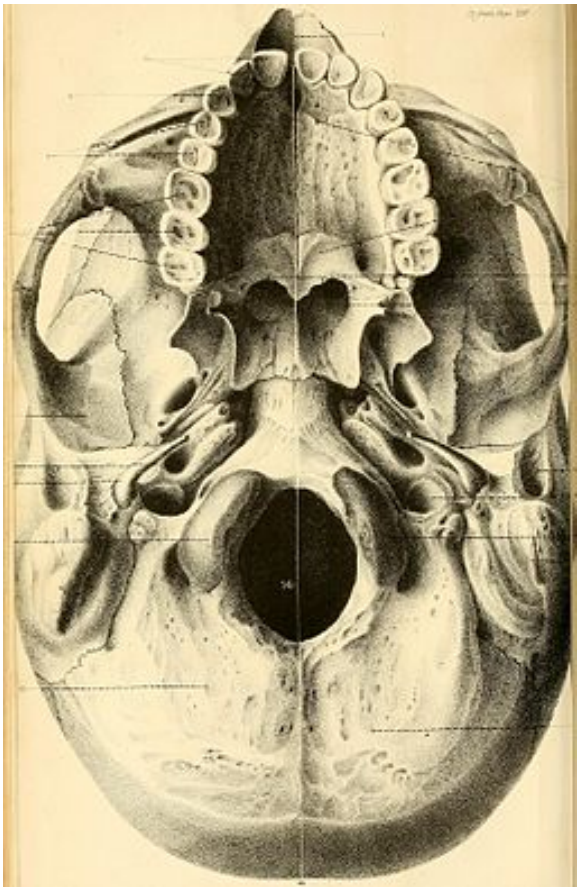
- Ascending ramus
- Mandibular condyle
- Mental protuberance
- Mental foramen
- Gonial angle
- Incisors, Canines, Premolars and Molars

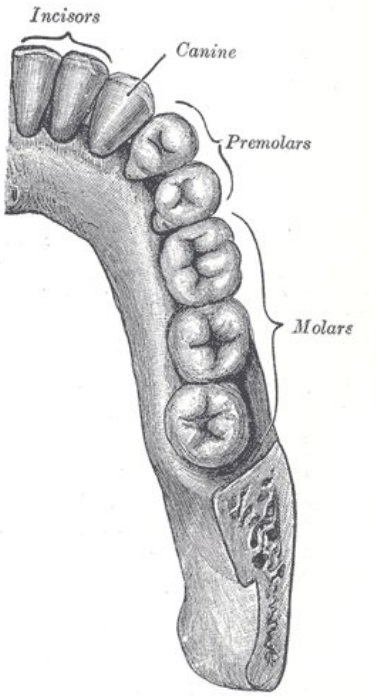
In addition to the above bones, you must identify the following minor bones in an articulated cranium:

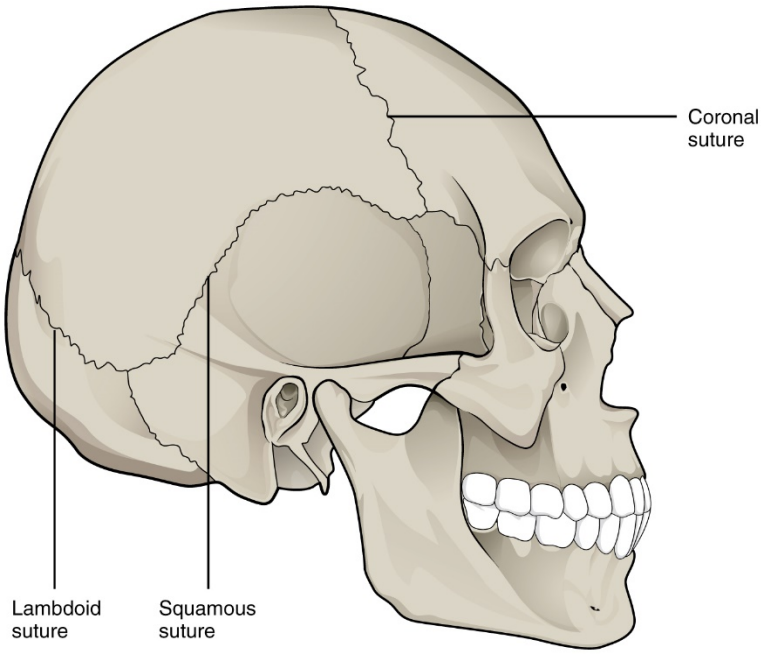
- Ethmoid
- Lacrimal
- Nasal
- Palatine
- Vomer
- Sphenoid








Incisors
Canine
Premolars
Molars


Coronal suture
Lambdoid suture
Squamous suture

# Skull Exercise (Self study)

These are practice questions like you will see on the osteology bell ringer exam

Question 1

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 2

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 3

Name this bone _____

Name Feature A_____

Name Feature B _____

Name Feature C _____

Question 4

Name this bone _____

Name tooth A_____

Name Feature B_____

What articulates at feature B _____

# Pelvic Girdle and Lower Limb

## Bones of the pelvic girdle

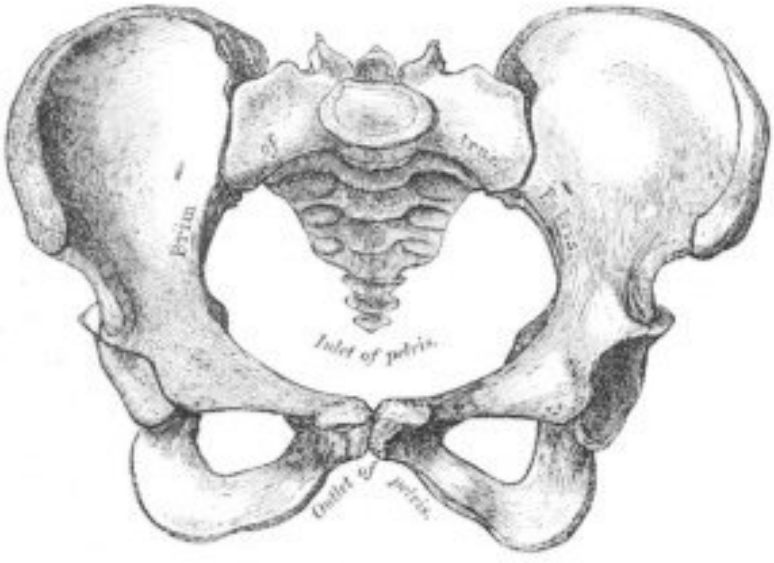
Os Coxa (Os Coxae plural), R and L

- Bone region- ilium
- Bone region- ischium
- Bone regions- pubis
- Pubic symphysis
- Ischiopubic ramus
- Obturator foramen
- Iliac crest
- Greater sciatic notch
- Auricular surface
- Acetabulum

Sacrum

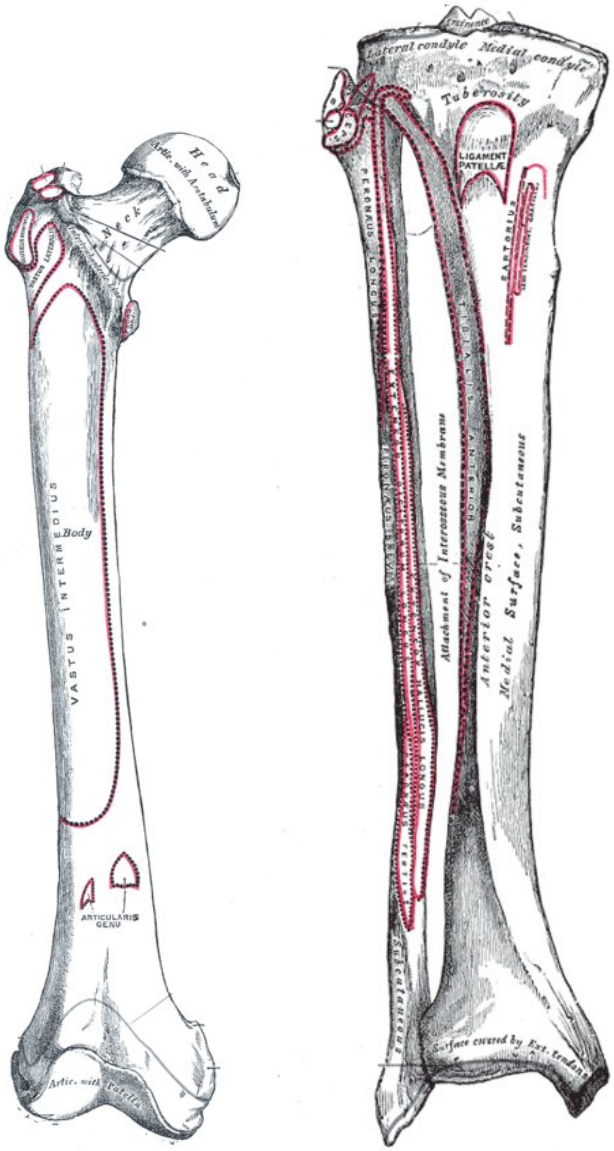
- Sacral promontory
- Auricular surface
- The sacrum is typically consisted of 5 fused vertebrae (S1-S5) and articulates with each of the right and left os coxa bones at the sacro-iliac joints.

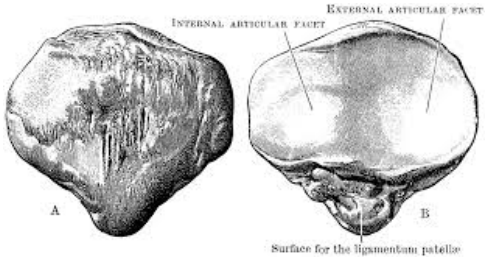
Coccyx

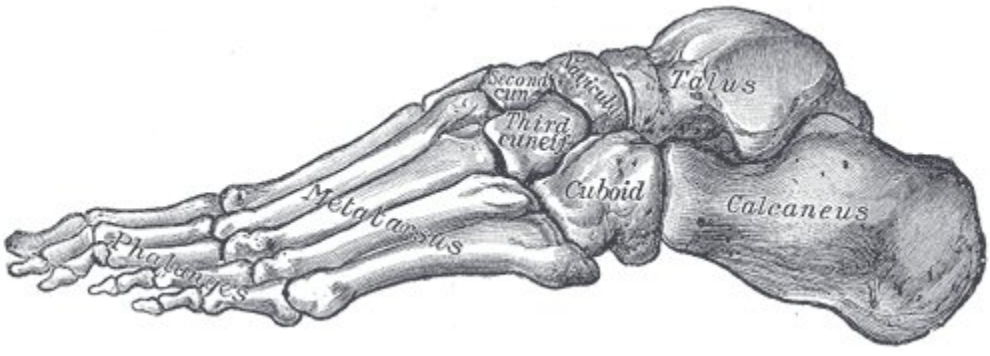


## Bones of the Lower Limb

- Femur, R and L
    - Head
    - Fovea capitis
    - Neck
    - Greater trochanter
    - Lesser trochanter
    - Linea aspera
    - Medial condyle
    - Lateral condyle
    - Patellar surface
- Patella, R and L
- Tibia, R and L
    - Medial condyle
    - Lateral condyle
    - Tibial tuberosity
    - Anterior crest
    - Medial malleolus
    - Superior fibular articular facet
- Fibula, R and L
    - Head
    - Malleolar fossa
    - Lateral malleolus
- Foot and ankle
    - Tarsals
    - Metatarsals
    - Phalanges (Phalanx singular)
        - Proximal
        - Intermediate
        - Distal


Head
Neck
VASTUS INTERMEDIUS
Body
ARTICULARIS GENU
Lateral condyle
Medial condyle
Tuberosity
LIGAMENT PATELLÆ
TIBIALIS ANTERIUS
Attachment of Interosseous Membrane
Anterior crest
Medial Surface, Subcutaneous


INTERNAL ARTICULAR FACET
EXTERNAL ARTICULAR FACET
A
B
Surface for the ligamentum patellæ


Second cuneif.
Third cuneif.
Talus
Cuboid
Calcaneus
Metatarsus
Phalanges

## Pelvic Girdle and Lower Limb (Self study)

These are practice questions like you will see on the osteology bell ringer exam

Question 1

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 2

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 3

Name this bone _____

Name Feature A_____

Name Feature B _____

Name Feature C _____

Question 4

Name bone region A _____

Name bone region B_____

Name Feature C_____

Name Feature D_____

# Shoulder Girdle and Upper Limb

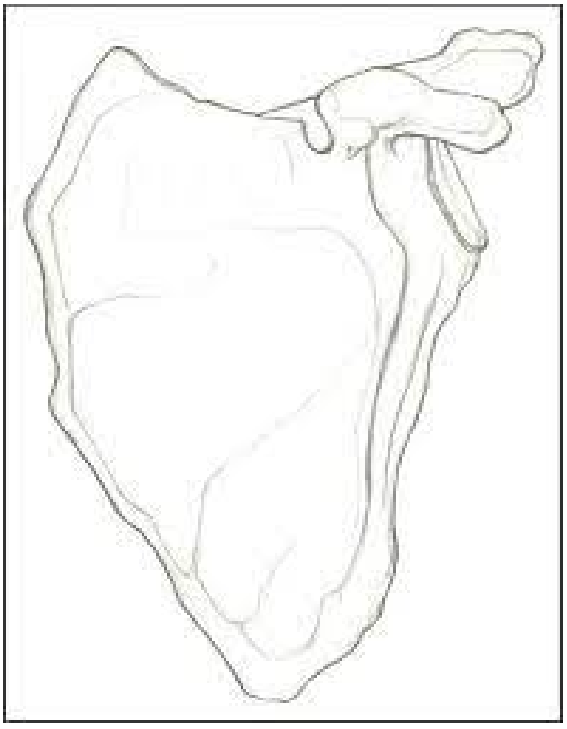
## Bones of the shoulder girdle

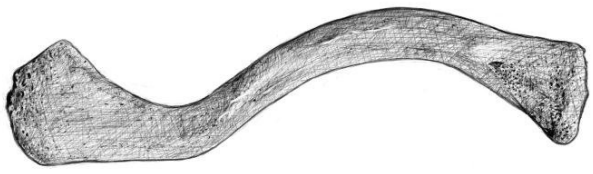
Scapula, R and L

- Body
- Coracoid process
- Spine
- Acromion
- Glenoid fossa

Clavicle, R and L

- Acromial end
- Sternal end





## Bones of the Upper Limb

Humerus, Rand L

- Head
- Greater tubercle
- Lesser tubercle
- Deltoid tuberosity
- Olecranon fossa
- Trochlea
- Capitulum

Radius, R and L

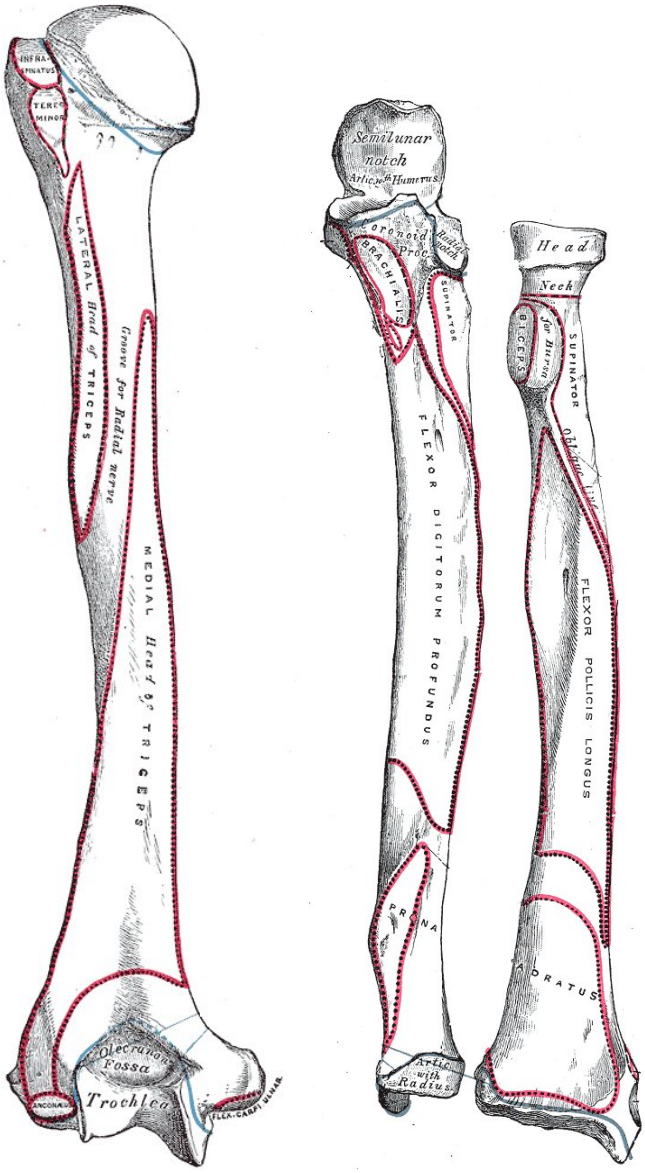
- Head
- Radial tuberosity
- Ulnar notch
- Dorsal tubercles
- Styloid process

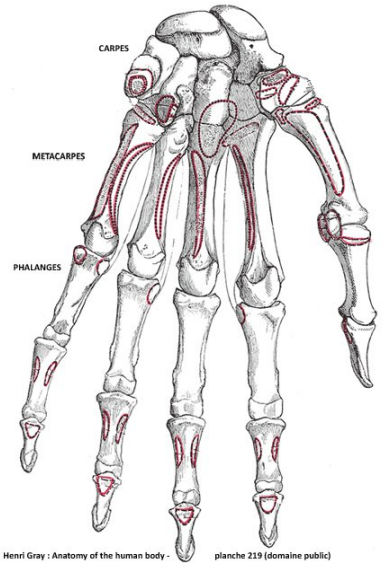
Ulna, R and L

- Olecranon process
- Radial notch
- Head

Hand and wrist- identify classes of bones only

- Carpals
- Metacarpals
- Phalanges (Phalanx singular)
    - Proximal
    - Intermediate
    - Distal




Henri Gray : Anatomy of the human body - planche 219 (domaine public)

## Shoulder Girdle and Upper Limb (Self study)

These are practice questions like you will see on the osteology bell ringer exam

Question 1

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 2

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 3

Name this bone _____

Name Feature A_____

Name Feature B _____

Name Feature C _____

Question 4

Name bone class A _____

Name bone class B_____

Name bone class C_____

How many of bone class C exist in one hand? _____

# Axial Skeleton

## Bones of the thorax

Vertebrae

General features

- Body
- Spinous process
- Transverse processes
- Superior articular facets
- Inferior articular facets
- Vertebral foramen

Cervical vertebrae --7

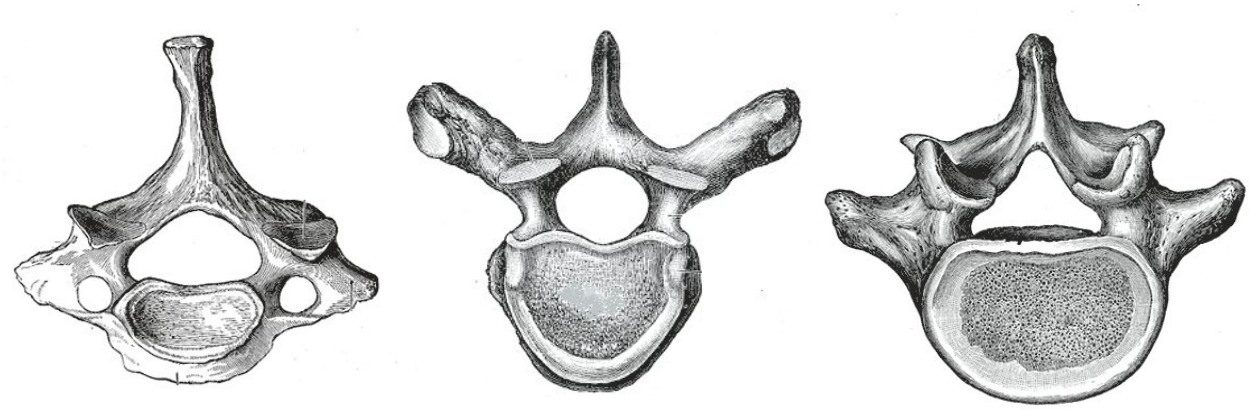
- Transverse foramen
- C1 or atlas
- C2 or axis
  - Dens

Thoracic vertebrae --12

- Costal pits
- Flat superior and inferior articular facets

Lumbar vertebrae --5

- Curved superior and inferior articular facets



Sternum

- Manubrium
- Clavicular notches
- Body
- Xiphoid process

Ribs, R and L, you only need to side ribs 3 through 10

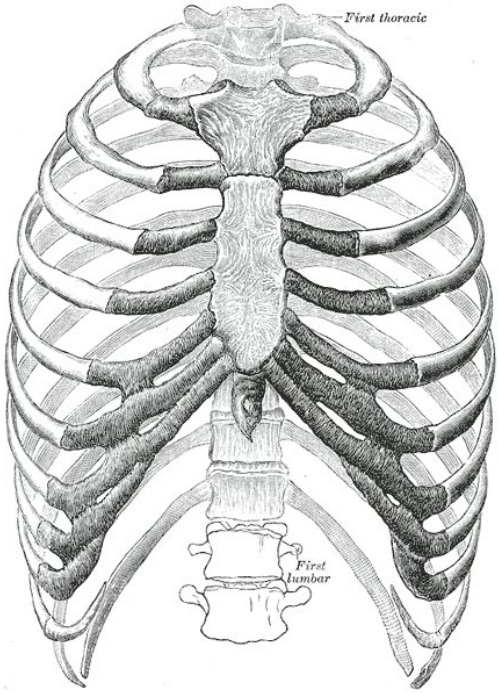
- Head
- Tubercle
- Sternal end
- Costal groove
- True rib  s- pairs 1-7
- False ribs- pairs 8-10

Rib 1

Rib 2

Ribs 11 or 12

- Floating rib



## Axial Skeleton (Self study)

These are practice questions like you will see on the osteology bell ringer exam

Question 1

Name this bone _____

Name Feature A_____

Name Feature B _____

Name Feature C _____

Question 2

Name this bone _____

Side this bone_____

Name Feature A_____

Name Feature B _____

Question 3

Name this bone _____

Name bone part A_____

Name bone part B _____

What articulates at feature B _____

Question 4

Name bone A _____

Name bone B_____

What group is bone B part of_____

Name Feature C_____

# Osteology Practice Tests

Use this space for the practice osteology stations at the start of each lab.

**Week 2:**

Name Bone A _____

Name Feature B _____

Name Bone C _____

Name Feature D _____

**Week 3:**

Question 1

Name Bone A _____

Name Feature B _____

Name Bone C _____

Name Feature D _____

Question 2

Name Bone A _____

Name Feature B _____

Name Bone C _____

Name Feature D _____

**Week 4:**

Question 1

Name Bone A _____

Name Bone B _____

Name Bone C _____

Name Feature D _____

Question 2

Name Bone A _____

Name Feature B _____

Name Feature C _____

Name Feature D _____

Question 3

Name Bone A _____

Name Feature B _____

Name Bone C _____

Name Feature D _____

# Osteobiography from the Skull

## Lab Hints and Tips

Make sure to practice all the skills in this lab. While your role may be report writer for what is handed in this week the lab quiz will evaluate your ability to estimate the age and skeletal sex of skull and your group mates won't be able to help you.

Make sure to practice on several skulls. Every individual is different and how things look on one is not the same as how they will appear on another. Get comfortable with the natural variation of the human skull.

## Skeletal Sex Estimation

Several traits on the skull have been identified as sexually dimorphic. Generally, these traits are considered less reliable than pelvic traits and non-metric traits for skeletal sex estimation so when evaluating skeletal sex from multiple methods, skull traits can be considered less significant.

A visual guide outlining the expression of five traits useful for skeletal sex estimation was developed in 1994 by Buikstra and Ubelaker. This chart outlines sexually dimorphic differences in the **nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge and the mental eminence**. Each trait can be scored on a scale of 1-5 with 1 indicating definite skeletal female and 5 indicating definite skeletal male. See the lab guide for a description and diagram of the stages.

In addition to these traits other general morphological features have been recognised as sexually dimorphic. These include the supramastoid crest, chin shape and the gonial angle (Rosing et al. 2007). Overall Rosing et al. (2007) have identified the following as the most reliable traits: **Supraorbital ridge; Supraorbital margin; Supramastoid crest**.

### Skull Skeletal Sex Estimation Practice

**Determine the skeletal sex for one of the practice skulls.**

| Buikstra and Ubelaker (1994) traits: | | |
|---|---|---|
| **Trait** | **Score** | **S.Sex** |
| Nuchal crest | | |
| Mastoid process | | |
| Supra-orbital margin | | |
| Supra-orbital ridge /Promontory of glabella | | |
| Mental eminence | | |

| Other morphological traits (Rosing et al. 2007) | | |
|---|---|---|
| **Trait** | **Observation** | **S.Sex** |
| Supramastoid crest | | |
| Angle of the mandible/ Gonial region | | |
| Chin shape | | |

Any other relevant observations:

Case report write up: *see page 5 for guidance. Use additional paper if needed

## Adult Age Estimation

Age estimation from the skull often relies on an assessment of cranial suture closure. While attempts have been made to develop robust methods the natural variation in the rate of suture closure means this approach to age estimation remains very inaccurate, with some chronologically young individuals have very fused sutures, and some chronologically old individuals having very open sutures. This method is useful when all we have available is the skull.

### The Meindl – Lovejoy Cranial suture closure method

This method relies on an assessment of the degree of ectocranial (outer) suture closure at several specific cranial landmarks/locations. Suture closure is scored on a scale of 0-3 and then the scores are summed to get a composite score. Composite scores for the vault region and the lateral anterior region are each associated with standard age ranges to provide age estimations. Meindl and Lovejoy (1985) state the **lateral anterior region is a better predictor than the vault region**. Descriptions of locations, suture closure levels, how to calculate composite scores and age ranges are given in the lab guide.

Meindl – Lovejoy Cranial suture closure practice

**Determine the age for one of the practice skulls**.

| Site | Vault Score | Site | Lateral-Anterior Score |
|---|---|---|---|
| 1 Midlambdoid | | 6 Midcoronal | |
| 2 Lambda | | 7 Pterion | |
| 3 Obelion | | 8 Sphenofrontal | |
| 4 Anterior-sagittal | | 9 Inferior sphenotemporal | |
| 5 Bregma | | 10 Superior sphenotemporal | |
| 6 Midcoronal | | | |
| 7 Pterion | | | |
| **Total** | | **Total** | |

Vault score: _____ Lateral anterior score: _____

Vault age range: _____ Lateral anterior age range: _____

Overall all estimation: _____

Case report write up: *see page 5 for guidance. Use additional paper if needed

## Juvenile Age Estimation

Age estimation in juveniles is much more precise than age estimation in adults. For example, one may be within 6 months of the correct age for an infant or child under 12 years but for an adult over 30 years an age range of 10 years is more common. This is because we use growth and development changes when aging juveniles which are relatively more robust and vary less between individuals.

It is advisable to use as many age indicators as possible given the skeletal elements available. The use of several age indicators is called multifactor aging and we often use a **range chart** to determine a final age range.

Juvenile age estimation in the skull focuses on the development and eruption of the dentition. We cannot observe dental formation without Xray's or removing teeth from the bone, however eruption and occlusion can be evaluated macroscopically without causing damage.

Standard ages for dental eruption phases have been developed by many researchers and currently the most used data set and method were developed in 2010 as the London Atlas Method of age estimation. To complete the method, you must observe the teeth that are present, making sure to differentiate deciduous and permanent dentition, then observe the level of occlusion before comparing this data with the published chart to find the best match.

**Look over these examples and see how you did.**

**Juvenile dentition aging practice**

Dental set number: _____ Age range: _____

Dental set number: _____ Age range: _____

Dental set number: _____ Age range: _____

## Report writing

Clearly reporting your conclusions is a vital part of forensic anthropological analysis. You need to be able to clearly explain how you came to your conclusions and what you based these conclusions on. As a general guide your write up must include:

- the bone (including side) that you assessed,
- how you assessed it (visual inspection of morphology (shape), metric (measurements) analysis),
- what your observations were (raw data),
- what your conclusions are, and
- what research is this based on (citation).

You can change the order, and the way you express this information, but it should all, always be included.

**Example report for skeletal sex estimation**

Data collection was by visual inspection of non-metric traits on the complete cranium and mandible. All bones were in good condition with no visible deformities.

I evaluated all five Buikstra and Ubelaker (1994) traits according to their published scale and all but one trait scored a four or five indicating the skull matched features of a biological male. The mental eminence score was three (indeterminate) which can be explained by normal variation within biological males. See table one for further information on the appearance and skeletal sex conclusion for each trait based on descriptions in Buikstra and Ubelaker, 1994.

In addition, I evaluated three Rosing et al. (2007) traits, the supramastoid crest, the gonial angle and the chin shape. All traits appeared to match the form seen in biological males as indicated in table one. Rosing et al (2007) argues these three traits are the most reliable sex estimation traits on the skull.

Based on the data collected I concluded the skeletal sex of the individual to be male.

*I tend to use the term skeletal male/female when describing the skull I am trying to evaluate as all we have to work with is the skeleton. I use biological male/female when referring to the reference standards as these were developed from known biological sex individuals.

# Lab 1 Hand in Sheet

Estimate the age and skeletal sex of one of the sets of adult remains and report on your findings. Feel free to use the tables below but also use others from the lab guide if you prefer!

**Case #: _____**

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

**Skeletal Sex Assessment**

| Buikstra and Ubelaker (1994) traits: | | |
|---|---|---|
| **Trait** | **Score** | **S.Sex** |
| Nuchal crest | | |
| Mastoid process | | |
| Supra-orbital margin | | |
| Supra-orbital ridge /Promontory of glabella | | |
| Mental eminence | | |

| Other morphological traits (Rosing et al. 2007) | | |
|---|---|---|
| **Trait** | **Observation** | **S.Sex** |
| Supramastoid crest | | |
| Angle of the mandible/ Gonial region | | |
| Chin shape | | |

Any other relevant observations:

**Age Assessment**

| Site | Vault Score | Site | Lateral-Anterior Score |
|---|---|---|---|
| 1 Midlambdoid | | 6 Midcoronal | |
| 2 Lambda | | 7 Pterion | |
| 3 Obelion | | 8 Sphenofrontal | |
| 4 Anterior-sagittal | | 9 Inferior sphenotemporal | |
| 5 Bregma | | 10 Superior sphenotemporal | |
| 6 Midcoronal | | | |
| 7 Pterion | | | |
| **Total** | | **Total** | |

Vault score: _____ Lateral anterior score: _____

Vault age range: _____ Lateral anterior age range: _____

Overall all estimation: _____

**Case report write up**

# Osteobiography from the Post Crania

## Lab Hints and Tips Reminder

Practice all the skills- the osteological methods quiz will test you on all of them as an individual. Practice on lots of examples- get comfortable with variation.

## Report writing reminder

Remember your write up must include:

- the bone (including side) that you assessed,
- how you assessed it (visual inspection of morphology (shape), metric (measurements) analysis),
- what your observations were (raw data),
- what your conclusions are and
- what research is this based on (citation).

## Skeletal Sex Estimation

The **pelvis is thought to be the most accurate way** of determining skeletal sex. Typically, morphological assessment of the pelvis correctly scores skeletons more commonly than metric methods or morphological assessment of the skull. The pelvic dimorphism reflects the functional difference between the male and female pelvis: females give birth and males don't. The os pubis is the most important bone of the pelvis for skeletal sex determination with many major sex indicators. **If present, it should be studied first, and your conclusions verified by examining other traits.**

It is common to find a mixture of biological male and biological female traits in any one skeleton or even pelvic girdle. Also, within any given population you can see a wide variation in biological male and biological female traits: robust females or gracile males, for example. Furthermore, a trait that is considered a biological female trait in one population may be a biological male trait in another, so it helps to know the population of origin for the skeleton you are analyzing.

There are several different methods or systems which can be used to estimate skeletal sex from the pelvis, we are going to focus on: General morphological traits; the Phenice method; and the greater sciatic notch. All these methods are summarised in Table 8.1 Traits of the female and male pelvis (Christensen, Passalacqua & Bartelink, 2014) in the lab guide.

**General Morphological Traits**

These traits are generally recognised differences between biological males and biological female pelvic girdles based on different locomotion patterns and the requirement for birth in females. Several different tables of general morphological traits can be found in the lab guide. Use whichever table makes the most logical sense to you but make sure you cite it correctly.

**The Phenice Method**

The Phenice method was published in 1969 and relies on the observation of 3 separate traits of the os pubis bone: **the ventral arc, the sub-pubic concavity and the medial aspect of the ischiopubic ramus**. This method has reported accuracy rates of around 96%. Instructions on observing the Phenice traits are given in the lab guide.

**The Greater Sciatic Notch**

Observations in the greater sciatic notch width were studied by Walker (2005), and a visual scale has been developed grading the width from 1-5, definite biological female to definite biological male. **This trait is more useful for identifying skeletal males as while biological males may occasionally have a wide notch, biological females do not have a narrow notch**. Instructions on observing the greater sciatic notch are given in the lab guide.

**Another notable element: Pre auricular sulcus**

In addition to the above traits, it is argued the bone lesions resulting from parturition (birth) can also be helpful in estimating skeletal sex. The preauricular sulcus is often considered in this category although research has shown that women who have not been pregnant and men may show the preauricular sulcus. Generally, however the trait is most often seen in women who have given birth so it can be a useful indicator of skeletal sex. **Be aware though that the absence of this trait does not necessarily indicate that an individual is skeletal male as skeletal females before pregnancy would also lack the trait**.

**NOTE**: if you didn't use a trait because it can't be observed or if the area on the bone is broken, don't conclude "indeterminate"; say "not used" and explain why. Indeterminate has a specific meaning indicating you assessed the trait, and it did not clearly match biological males or biological females in morphology.

Turn over for the sex estimation practice tables.

Pelvic Skeletal Sex Estimation Practice

**Examine one of the practice os coxa bones and determine the skeletal sex of the individual from assessing the following features.**

**Traits of the female and male pelvis**

| Trait | Observation | S. Male/Female/Indeterminate |
|---|---|---|
| Ilium | | |
| Pelvic inlet | | |
| Obturator foramen | | |
| Sub pubic angle | | |
| Greater sciatic notch | | |
| Preauricular sulcus | | |
| Sacral shape | | |
| Pubic shape | | |
| Sacral dimensions | | |

**Phenice traits**

| Trait | Observation | S.Male/Female/Indeterminate |
|---|---|---|
| Ventral arc | | |
| Subpubic concavity | | |
| Medial aspect of the ischiopubic ramus | | |

**Other relevant observations:**

Case report write up: Use additional paper as needed

## Adult Age Estimation

Post cranial age estimation in adults often focuses on joint deterioration. The most used systems look at joints in the pelvis, but methods have been developed for other joints, such as the sternal end of rib 4. In this lab we are going to be focusing on the pubic symphysis joint deterioration method, however information on the auricular surface and sternal rib 4 methods are included in the lab guide for your information.

**Suchey- Brooks Age Determination System Using the Pubic Symphysis**

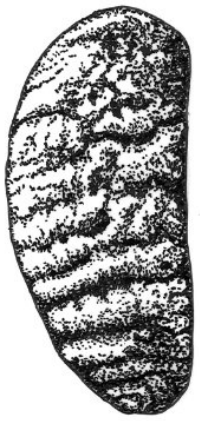
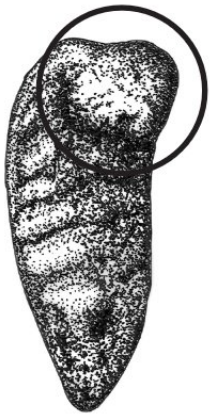
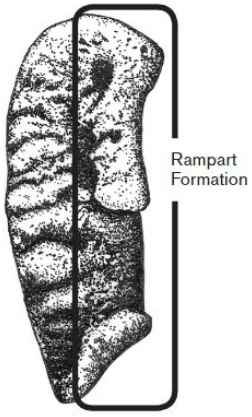
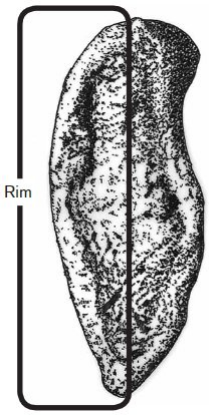
The Suchey-Brooks method is based on a large modern sample collected at autopsies between 1977 and 1979 for whom legal documentation of age is provided by death and/or birth certificates. This sample includes a variety of ages and ancestral backgrounds (Brooks and Suchey, 1990).

The Suchey-Brooks method has six defined phases with detailed descriptions of how the pubic symphysis appears in each phase. Each phase is also correlated with a mean age and age range allowing the phase descriptors to be used as an age estimation method. The phase descriptors and age data is given in the lab guide.

It is essential when applying this method **to read the phase descriptors precisely** and to **look very closely at the casts** depicting classic examples of each phase. There are four key areas to assess (**the ventral margin, the dorsal margin, the superior demiface and the inferior demiface**) and you must make sure to observe all of them. You then match your unknown individual to the appropriate phase.

The descriptor diagrams for the six phases are given in the lab guide. The following terminology and images may also help in your determinations.

- Billowing: transverse ridging
- Dorsal plateau: a lipped rim along the dorsal (posterior) margin of the symphysis
- Ventral rampart: a bony bridge which begins at the superior and inferior extremities and grows together on the anterior margin
- Granularity: appearance of compact find structure on the surface of the symphyseal face; a heavily “grained” surface has the appearance of sandpaper.
- Porosity: perforations ranging from barely visible to 10 mm in diameter.
- Crenulations: “lacy edgings”

| | | | |
|---|---|---|---|
|  |  |  |  |
| Billowing | Ossific nodule | Ventral rampart | Dorsal Rim |

To start your evaluation, compare the unknown pubic symphysis to the classic examples and the pictures and decide which phase is the closest match. Then read the description for the phase you have decided is a match- do you observe these elements on the unknown symphysis? Read the descriptions for the phases above and below your match- are either of these a better fit for the unknown symphysis? Document what you observe in the documentation table as the evidence you have seen that supports the phase determination you have made. Remember you must document what you see and not what you would expect to see- normal variation means not every element will match all parts of the phase descriptors.

I have simplified this process for you by creating data collection tables with suggestions of areas to make notes on but depending on the phase you are looking at some areas are more relevant than others. You should, however, never leave a box in a table blank as then anyone reading the table doesn't know if you intentionally left it blank or forgot to fill it in. Always write NA, or unobservable, or something else relevant if you have completed observations.

Pelvic Age Determination Practice

Choose at least two pubic symphyses to practice on- remember you need to get used to seeing diversity. Complete your analysis and then check your answer on the answer/phase descriptor sheet.

| **Bone #** | | **Observations** | **Phase** | **Age Range** | **Mean Age** |
|---|---|---|---|---|---|
| | Symphyseal face: | | Do not write here. You decide on one phase (and then age range and mean age) for the entire pubic symphysis based on the observations you note down. | | |
| | Upper and lower margins: | | | | |
| | Ventral rampart: | | | | |
| | Dorsal plateau: | | | | |
| | Rim: | | | | |
| **Final Conclusions:** | | | | | |

Case report write up: Use additional paper as needed

| **Bone #** | | **Observations** | **Phase** | **Age Range** | **Mean Age** |
|---|---|---|---|---|---|
| | Symphyseal face: | | Do not write here. You decide on one phase (and then age range and mean age) for the entire pubic symphysis based on the observations you note down. | | |
| | Upper and lower margins: | | | | |
| | Ventral rampart: | | | | |
| | Dorsal plateau: | | | | |
| | Rim: | | | | |
| **Final Conclusions:** | | | | | |

Case report write up: Use additional paper as needed

## Juvenile Age Estimation

There are many different systems of assessing age in juveniles and the method we will be focusing on in lab is **epiphyseal union**.

This method is the method most used for adolescents between 13 and 20 years and relies on an observation of the degree of fusion of the epiphyses to the diaphysis. Stages of union are recorded as: open (no union), partial union and complete union:

- When an epiphysis is open or in the non-union stage then the epiphysis is separated from the diaphysis.
- In partial union the fusion area shows a visible line and sometimes a thumbnail width crack.
- In complete union the fusion line is almost, if not, invisible and can't be observed with ease.

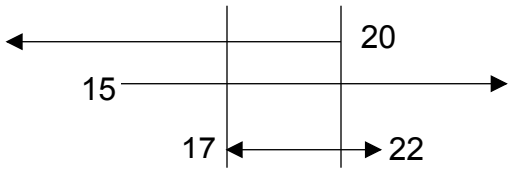
Different reference charts have been compiled which document the ages of union for different epiphyses. For this lab we will be using data from Schaefer et al. 2009 (see lab guide). Note that this data includes separate charts for males and females- if you do not know the sex of your individual you will need to combine the data for the maximal age range (take the youngest for males and females and the oldest for males and females).

Epiphyseal age estimation conclusions are often based on the use of **range charts**. The more bones you have the better of an age estimation you can have. To make a range chart for each epiphysis you assess draw a solid line determining the possible ages. Your final age will result from where all the lines overlap.

EG. For a male individual, based on Schaefer et al. 2009

| **Location** | **Degree of Fusion** | **Age estimation** |
|---|---|---|
| Proximal humerus | Open | Under 20 |
| Distal humerus | Closed | Over 15 |
| Scapula inferior angle | Partial | 17-22 |

Range chart:




Age range is 17-20 based on proximal humerus and scapula inferior angle

**For practice** use this theoretical data to draw a range chart for a female individual.

| **Location** | **Degree of Fusion** | **Age estimation** |
|---|---|---|

| | | |
|---|---|---|
| Humerus proximal | Partial | |
| Humerus distal | Complete | |
| Radius proximal | Complete | |
| Radius distal | Partial | |
| Femur proximal, greater trochanter | Complete | |
| Femur distal | Partial | |
| Fibula proximal | Partial | |

**For practice**

Look at the various lab examples of open, partially and completely fused epiphyses.

# Osteobiography from the Post Crania Hand in Sheet

Adult case

Estimate the skeletal sex and age of one of the sets of adult remains and report on your findings. Feel free to use the tables below but also use others from the lab guide if you prefer!

**Case #: _____**

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

**Age Assessment**

| **Bone #** | | **Observations** | **Phase** | **Age Range** | **Mean Age** |
|---|---|---|---|---|---|
| | Symphyseal face: | | | | |
| | Upper and lower margins: | | | | |
| | Ventral rampart: | | | | |
| | Dorsal plateau: | | | | |
| | Rim: | | | | |
| **Final Conclusions:** | | | | | |

**Skeletal Sex Assessment**

**Traits of the biological female and biological male pelvis**

| Trait | Observation | S.Male/Female/Indeterminate |
|---|---|---|
| Ilium | | |
| Pelvic inlet | | |
| Obturator foramen | | |
| Sub pubic angle | | |
| Greater sciatic notch | | |
| Preauricular sulcus | | |
| Sacral shape | | |
| Pubic shape | | |
| Sacral dimensions | | |

**Phenice traits**

| Trait | Observation | S.Male/Female/Indeterminate |
|---|---|---|
| Ventral arc | | |
| Subpubic concavity | | |
| Medial aspect of the ischiopubic ramus | | |

Any other relevant observations:

**Case report write up**

Juvenile case

Estimate the age of one of the sets of juvenile remains by observing the degree of epiphyseal fusion and making a range chart. Write up your conclusions.

**Case #: _____**

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

# Osteobiography using Metrics

## Introduction to osteometric instruments and their use.

There are three osteometric instruments that you are responsible for learning to use and accurately read the scales of: **the sliding calliper, the spreading calliper and the osteometric board**.

Most osteometric methods use measurements taken from a standardised set of measurements which have been developed and well defined. As the methods have been developed using these exact measurements it is essential that when you are applying the methods you measure from **exactly** the same landmarks or skeletal points. Descriptions of the landmarks and the measurements are detailed in the lab guide. You are not required to memorise the measurement points **but make sure you are totally clear on how to find and apply the correct measurement instructions.**

Note on measurements: Always use the lab guide to determine which landmark you are supposed to be measuring from and to. You can find your measurement on the pictures and then read the written description for the measurement as well- **ALWAYS DO BOTH** (the number on the image refers to the measurement number of the written descriptions). The lab guide will also instruct you on how to take the measurement and which tool to use. 'Maximal' measurements are often instrumentally determined- this means that the location of where you measure from/to is determined by where the maximum distance is- this determined by measuring/the instrument.

### Error

Despite the strict instructions on measurement taking, we still encounter error when taking measurements. This error can be classified as either intra-observer error or inter-observer error.

Intra-observer error occurs when one person takes the same measurement several times and comes up with a different measurement each time. Although these measurements should not be wildly different, they still beg the question: Which measurement is correct? One way to deal with this problem is to take, for example, three measurements and average them to achieve the measurement that you will record.

Inter-observer error occurs when two or more individuals measure the same thing and come up with different measurements. If the measurements are very different, then you need to re-measure. When they are close, again, you can use an average of 3 – 5 measurements.

## Stature Estimation

Stature determination from skeletal remains is possible because there is a relationship between skeletal dimensions and stature. Some stature estimation methods require the full skeleton to be rearticulated and the height of each skeletal element recorded. These methods are often relatively accurate but impractical.

Other methods, known as regression methods, have been developed which are based on the mathematical relationships between bone dimensions and stature. Stature regression methods always include an error range. This is to account for the fact that the linear regression is a line of best fit or average of different individuals**. Make sure to include the error range in your stature estimations**.

Several regression models have been developed for different bones, different populations and different bioloigcal sexes- make sure you use the appropriate data for your remains (see lab guide). **The femur is the most accurate bone to use as it contributes the most to stature.** Other leg bones are also good.

**Practice taking the following measurements and determining the stature**. Try taking repeated measurements and having others measure the same bone until you are confident in your measurement abilities.

Maximum femur length: _____**cm** (NOTE: I expect accuracy to within 3mm)

**Stature** estimation in **cm**.:_____

Maximum femur length: _____**cm** (NOTE: I expect accuracy to within 3mm)

**Stature** estimation in **cm**.:_____

If you measure the same bone three times and get three different measurements what type of error is this?

If you and your teammates all measure the same bone and get different measurements what type of error is this?

## Skeletal Sex estimation

Skeletal sex estimation based on metric observation relies on the observed differences in size and shape between biological males and biological females. The **more reliable methods** use **post-cranial long bones**, especially weight bearing elements of the skeleton. Most methods have been developed by looking at large samples of known biological sex individuals and determining the 'sectioning points' which is partway between the average biological male and average biological female measurement.

Each sectioning point also has a classification rate (usually out of 1) which indicates how often the sectioning point is correct. EG. A classification rate of 0.8 indicates that 80% of individuals will be correctly sexed using that sectioning point. This also tells us that 20% of individuals will not be correctly sexed. This **information is important to consider when making your final conclusions**.

It is also important to consider how close to the sectioning point a measurement is. Sectioning point data often include the mean measurements for males and females as well as the sectioning point and this data can help you form a judgement on how comfortable you are with your skeletal sex estimation. Note that **this is a judgement call that you need to make and be prepared to justify.**

**Practice taking the following measurements to estimate sex.** Try taking repeated measurements and having others measure the same bone until you are confident in your measurement abilities.

*make sure your units are logical and match the reference data

| Measurement location | Measurement | S.Sex Estimation |
|---|---|---|
| Femur max head diameter | | |
| Scapula max height | | |

| Measurement location | Measurement | S.Sex Estimation |
|---|---|---|
| Femur max head diameter | | |
| Scapula max height | | |

## Population affinity

Cranial measurements can used to determine population affinity by using measurements to determine the overall shape of a skull. Typically, many measurements are taken for a complex computer-based discriminant function analysis so for this lab we are going to practice taking some of the measurements that would be used by fordisc. We don't have access to fordisc unfortunately so won't run the ancestry analysis.

**Practice taking the following measurements from the skull**. Note these are challenging measurements to take with accuracy and precision.

Make sure each person takes each measurement a few times on several skulls- everyone needs to know how to take these measurements and know how to work with the natural variation of the skeleton.

| Measurement name | Location | Practice skull 1 | Practice skull 2 |
|---|---|---|---|
| Maximum cranial breadth | Euryon to euryon | | |
| Maximum cranial length | Glabella to opisthocranion | | |
| Nasal breadth | Alare to alare | | |
| Nasal height | Nasion to nasospinale | | |
| Maximum height of the face | Nasion to gnathion | | |
| Maximum width of the face | Zygion to Zygion | | |

# Ostebiography using Metrics Hand in Sheet

Choose one of the test cases and estimate the population affinity, skeletal sex and stature of the remains. Write up your conclusions.

**Case #: _____**

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

Population affinity:

| **Measurement name** | **Location** | **Measurement** |
|---|---|---|
| Maximum cranial breadth | Euryon to euryon | |
| Maximum cranial length | Glabella to opisthocranion | |
| Nasal breadth | Alare to alare | |
| Nasal height | Nasion to nasospinale | |
| Maximum height of the face | Nasion to gnathion | |
| Maximum width of the face | Zygion to Zygion | |

This data has been run through fordisc and this indicates the individual is of African ancestry.

Skeletal Sex:

| **Measurement location** | **Measurement** | **S.Sex Estimation** |
|---|---|---|
| Femur max head diameter | | |
| Scapula max height | | |

Stature:

Maximum femur length: _____

Stature estimation:_____

**Case report write up**

# Trauma and Pathology

There are a variety of diseases and other factors that cause changes to bones but a corresponding limited number of symptomatic features. We will concentrate on three basic types of lesions:

- **Lytic** lesions involve abnormal removal of bone
- **Proliferative** lesions involve abnormal addition of bone
- **Deformative** lesions involve abnormal shape of bone

Most of the time, it will be extremely difficult to accurately diagnose the cause of the pathology and any reliable interpretations are only as good as the observations on which they are based! In recording alterations to the bone because of pathological conditions, trauma or occupational stress, you must **describe what you see accurately and in detail using correct anatomical terms**. Also note **where** you see the alterations (what bone, location on the bone). Making your inferences, the diagnosis, is the second step and is based on your observations so the description of your observations is key.

Stations have been set up around the lab with skeletal materials that illustrate these pathological conditions as well as examples of trauma and a variety of other skeletal alterations. Work through the stations looking at the examples and getting comfortable with your ability to identify these types of changes in bone.

You should be able to identify and describe these conditions and variations for the osteological methods quiz so make sure to take notes.

## Pathologies

### Osteoarthritis

Osteoarthritis is the degeneration of the cartilage and the sub-chondral (beneath the cartilage) bone at load-bearing joints. Features of osteoarthritis include the growth of **osteophytes** (**proliferative lesions**) around the perimeter of cartilage at these joints.

### Osteomas

**Osteomas (proliferative lesions**) are benign tumors usually no bigger than 2 centimeters in diameter. They are composed of dense, thick bone. Osteomas are found most on the skull. Most osteomas are asymptomatic and therefore cause no problems for the individual. If osteomas occur on the mandible, in the eye orbit or in sinus cavities, they may lead to medical problems (headaches, sinusitis, mechanical and cosmetic problems, defects in vision).

### Periostitis

Periostitis is a non-specific infection of the periosteum membrane that covers bone surfaces. New woven bone (**proliferative**) is deposited at the site and can be seen as new bone deposits on the bone surface.

Cribra orbitalia

Cribra orbitalia are localised porotic hyperostosis lesions found on the superior aspect of the eye orbit. These lesions are very irregular and have been linked to many different potential conditions such as iron deficiency anemia. While hard to know a specific diagnosis they are likely a good indicator of physiological stress of some kind. They are a good example of **proliferative and lytic** deformities as the diploe expands causing resorption of the compact bone.

Rickets

Rickets is a **deformative** lesion where a lack of Vit D results in bone weakness and bowing.

## Anomalies

Non-fusion anomalies - Spina bifida- non-fusion of the sacral vertebrae

Accessory bones - Wormian bones and other additional sutural bones

Accessory foramen - Septal aperture

## Trauma

In analyzing trauma, it is necessary to **describe** the trauma, determine the **type** of trauma (blunt force, sharp or projectile) and determine the **timing** of the injury (antemortem, perimortem, postmortem).

Blunt force trauma - Healed (thus antemortem)

- Colles' fracture is a specific type of fracture illustrated by this distal radius. This type of fracture comes about when a person puts out their arm to break a fall leading to the jamming and fracturing of the bones of the wrist.
- Simple fractures of the ribs near the vertebral end.
- Simple fracture of the clavicle near the acromial end
- Healed fractures of the tibia and fibula

Blunt force trauma- Unhealed (thus peri or post mortem)

This exhibit shows the trauma resulting from blunt force trauma, being struck by a moving vehicle. Note the trauma to the cranium, mandible and femur. This trauma would be considered peri-mortem based on the fracture morphology.

Sharp trauma

Punctures, chop marks and incisions help to distinguish marks made by bladed instruments from tooth marks, for example.

- Cutmarks from a bladed instrument such as a knife or hatchet made the wounds in photos a and b. Note that none of the marks in photo b appear to have perforated the skull.
- Saw marks leave characteristic striations on the cut end of the bone as seen here on the exhibit bone. Different types of saws and different individual saws leave characteristic idiosyncratic signatures.

To determine the timing of sharp force trauma evaluate the cut surfaces to see any evidence of healing (ante-mortem), or colour differentiation (post-mortem).

Projectile trauma

The skull of a seventeen year old male exhibiting two gunshot wounds.

Cranial gunshot wounds are easily differentiated from blunt trauma by the presence of gunshot **entrance and exit wounds**. Note the distinctive characteristics of the entrance wounds and exit wounds. The bullet passes relatively cleanly through the outer plate of bone upon entrance, leaving a smooth, round perforation. However, the inner table of bone shows a bevel as pieces of the cortical bone have been lifted off by the tensile stress on the inner table. The exit wound shows the opposite effect: the inner table shows a smooth, round hole and the outer table shows the beveling effect.

How many times was this individual shot?

Can you work out the trajectory of each shot?

# Trauma and Pathology Hand in Sheet

Choose **two** of the test cases and assess the ante-mortem conditions and trauma. Write up your conclusions.

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

**Case #: _____**

Group roles:

Data collection expert:

Data interpretation/analysis expert:

Report author:

Reference and continuity quality assurance checker:

**Case #: _____**