TABLE OF CONTENTS

p. 17-18 http://www.sciencelearn.org.nz/Contexts/Ceramics/Sci-Media/Images/Human-bone-structure (fig)
p 20 http://www.endotext.org/parathyroid/parathyroid1/parathyroid1.html
p21-22 http://www.csus.edu/anth/physanth/image18.htm
p23-24 http://www.leeds.ac.uk/chb/lectures/anatomy3.html
p28, p34:
Kapit, W & Elson, L 1977 The Anatomy Colouring Book New York: Harper and Row. ISBN: 0064539148 plates 11-12, 15, 14, 20 p29, 35,36,77-79, 111-112,154-160
p.30,32,33,62-3, 108-110, 174-5:
Evan W Matshes Human osteology & skeletal radiology an atlas and guide Boca Raton : CRC Press, c2005. ISBN: 978-0-203-49214-7
pp100,110,130,126,164,180,182,192:
Bass, W 1971 Human Osteology: A Laboratory and Field Manual of the Human Skeleton Missouri: Missouri Archaeological Society LOC: 77-172091
p41-44:
Whitehead, P et al. 2005 A Photographic Atlas for Physical anthropology Roca Baton: McGraw-Hill. ISBN 0895825724
p47-48,88,94-97, 116-127:
Buikstra, J and Ubelaker, D 1994 Standards for Data Collection from Human Skeletal Remains Fayetteville: Arkansas Archeological Survey Research Series No 44. ISBN 1563490757 pp.22-38
p52 http://npskeletal3.wikispaces.com/Axial#vertebralregionsstructure
p53 ,54 http://emedicine.medscape.com/article/94387-media
p55-7 Gray's anatomy
p57-61 http://www.wsiat.on.ca/english/mlo/back.htm
p87: Brickley, M., J. I. McKinley, B. A. f. B. Anthropology, Osteoarchaeology, and I. o. F. Archaeologists. 2004. *Guidelines to the standards for recording human remains*: BABAO, Dept. of Archaeology, University of Southampton
p91-94 www.ni.edu

WORKING WITH HUMAN REMAINS

During these labs you will be largely working with cast materials but at times we will be using real human bones and animal bones to demonstrate the range of human variation. If you wish to avoid handling human bone or teeth do so, if you want to wear gloves these will be provided.

The human remains in the teaching collection are primarily (but not exclusively) purchased teaching skeletons which were bought up until the mid-1980s by anatomical departments and medical students for teaching purposes. This trade in skeletons was outlawed in the early 1980s and we have no purchased skeletons from after that date (although you can still see bones occasionally up for sale on ebay or similar sites the trade is outlawed). Skeletons were purchased through established medical supply companies and India in particular was a major place where the bone trade took place. The individual skeletons when purchased did not come with any information about the deceased person but even though these people are now anonymous we need to treat them as individuals with respect, care and dignity. This means handle them carefully, don't wave any bone (plastic or real) around, don't paste their images up on social media, or treat them as a source of funny jokes. Treat them as respectfully as the people they once were.

In discussion with previous classes we have decided upon a set of principles in the care of these individuals:

Don't handle them roughly

Use mats

Don't mark or damage the bone

You may photograph for the purposes of study but don't use those photographs for uses outside of your personal study

Don't belittle these individuals by giving them names

Make sure any identifying information in with the remains stays with them (e.g. sometimes there are receipts, old fixings etc) – all of these are clues as to who this person was or where they came from.

If during the course of this class you can think of other principles we should add let me know.

Anthropology 367: The anthropology of human remains

Second Semester 2018

Course Description: Human remains reflect the lives of the dead as well as the lives of those who buried them. In this course you will be introduced to the various ways in which we study the dead. The course will cover three areas: the interpretation of mortuary practices, the interpretation of past lives from human remains, and the practice of burial archaeology in the southern hemisphere. The course is designed for students intending to do further study in archaeology or biological anthropology. It focuses upon the reality of archaeological practices including an extensive introduction to human osteology through lab exercises explicitly associated with the six issues addressed routinely to bioarchaeologists: is it bone?, is it human?, is it a child or adult?, is it male or female?, is it normal?, what is the burial context? In addition we will discuss archaeological practice, particularly in relation to this part of the world.

COURSE DETAILS

Course value: 15 points

Lectures:
Wednesday 3-5 pm

Tutorials/Labs:
One one-hour lab per week starting in Week 2

Human Sciences Building
Room 706

Course Staff

Convenor:
Prof Judith Littleton
j.littleton@auckland.ac.nz

Office hours: 2-3 Wednesday; 10-11 Friday.
Room 722
Human Sciences Building

Tutors:
Caitlin Smith
Csmi874@aucklanduni.ac.nz

Course Aims

In this course we aim to:

- Introduce you to the area of bioarchaeology and the analysis of both human and mortuary remains;
- Give you an opportunity to undertake independent research in this area;
- Demonstrate how different research questions and theoretical perspectives lead to different outcomes;
- Understand how assumptions underlie different analyses and learn how to identify them.
- Learn the basics of human osteology and the excavation of human remains.

Learning Objectives:

By the end of this course, you will be equipped with the tools to:

♦ _Explain the limitations and promises of the analysis of human remains;
♦ _Evaluate analyses of human remains and mortuary practice;
♦ _Apply the first principles of analysis of human remains within an archaeological context;
♦ _Identify and explain what constitutes best practice in relation to human remains;
♦ _Master and demonstrate research skills including development of research questions; and
♦ _Write coherent evaluations of research and concepts relevant to course content.

Employability:

Able to analyse – undertaking independent research, identifying and using theoretical frameworks and concepts, use reference databases effectively to identify relevant sources.
Practical skills for cultural resource management and archaeology – including appreciation of legislation, ethics, and the excavation and recording of burials and human remains. Use first principles in working with human remains and burials.
Communication skills: presenting work in a written format concisely and accurately; able to debate sensitive issues
Social and environmental skills: awareness of ethical issues and the multiple responsibilities of a researcher, cultural sensitivity.

COURSE TEXTS

Recommended: For each lecture there are three articles for you to read to have a background in the topic. These are available through links on Canvas. We expect you to do these readings prior to class and to quickly revise them after class.

Course Requirements:
Lectures will be the primary learning venue for this course. Attendance at lectures is not required but is strongly advised, as material from lectures may not be reproduced elsewhere and may be included in course examinations. You are required to enrol in a *lab stream* – these labs are held weekly and will involve you undertaking a set of practical tasks related to burial archaeology and human remains.
Assigned *readings* are required, unless otherwise noted, and should be completed prior to the day for which they are assigned. All *tests, assignments* and take home exams are mandatory course components.

LECTURES Wednesday 3-5 pm.

Tutorial: Lab sections are designed to give you the practical skills to accompany your lectures.. Studying human remains is about learning to observe and analyse, including interpreting what others have written, as well as learning to make your own observations. Toward that end, you will have opportunities to learn through various means. Labs also provide opportunities to clarify and discuss topics covered in lecture that you find interesting or confusing. Lab is intended to be dynamic, useful and often fun. There will be 10 one hour lab sessions. Your observations will be recorded within a lab book which includes specific tasks undertaken in labs.

Lab Times: Labs will be one hour long and weekly from Week 2 to week 12 (except during mid-semester break and as otherwise noted in the course outline) in the biological anthropology laboratory, HSB 706 unless otherwise advised.

Readings: The readings are listed attached to each week and are provided through the course website on Canvas as an electronic reader.

Assessment

Task	Value	Due Dates
Reading quizzes	10% (1 mark per quiz)	Question will be asked in Wednesday's lecture – one quiz per week commencing week 3
Annotated bibliography and essay statement	10%	Due 15/8 on Canvas by 3pm
Essay (3000-3500 words)	30%	19/9 on Canvas by 3pm
Practical lab test	20%	12/10 in Lab
Take home exam (2 essays – 3-5 pages each)	30%	Handed out on Friday 20 October, due 26 October, 3pm on Canvas.

Lecture quizzes (10%)
Starting at the beginning of Week 3 on each Wednesday, there will be a brief quiz. The aim of the quizzes is to check that you are keeping up with the readings, understand concepts and to prepare you for the final exam.

The essay

You will be responsible for writing a 3000-3500 word essay about some aspect of human remains and evaluating a body of research. Formal guidelines for essays will be given in class.
Specific criteria and goals of the essays will be given with the assignments. In the meantime, we encourage you to take advantage of available resources beginning as early as possible. Familiarise yourself with the library, edited volumes on human bioarchaeology, and the many peer-reviewed journals that are available electronically. You are encouraged to collaborate with your peers in locating sources and discussing essay topics (though you will be responsible for turning in your own essay).

ANNOTATED BIBLIOGRAPHY AND ESSAY STATEMENT

To get you started so that you can get your essay researched and even drafted over the mid-semester break, you are asked to submit an essay statement and annotated bibliography of ten relevant sources by 15 August, 2018. Submissions will use a template available on Canvas. We will work hard to make sure you have feedback on these proposals before the mid-semester break.

Essay Purpose is to demonstrate that:

- You can undertake research using primary sources
- You can identify and analyse an issue
- · You can write coherently and logically and organise your thoughts

Essay content:

You choose your issue this can be framed in particular ways:

a) e.g. as a hypothesis -

The bioarchaeology of Wairau Bar reflects the characteristics of a colonising population.
The Neanderthals. did practise deliberate burial.
Higher status is reflected in better health of human remains.

b) As an analysis:

I am going to analyse the Auckland War Memorial Museum as reflecting attitudes to social identity.
I am going to analyse the role of sentiment and its expression at the Symonds St Cemetery.
An analysis of the use of stable isotope techniques to identify past migration patterns.

c) As a question:

Can radiocarbon be used to identify recent post-mortem interval and what is its limitations.
What are the differences between forensic anthropology and bioarchaeology and what is their significance for practice?

THINGS TO BE CLEAR ABOUT:

Avoid generalisations or descriptions so a good essay answer to the question of radiocarbon dating will not be an extensive description of the method but an evaluation of how useful the method is -what does it assume, where might it be applied, Where won't it be useful. In every instance use specific data, examples, detail to demonstrate your point. E.g. if you are working on higher status and better health for example then use a couple of case studies to analyse and then make your general point.

HOW TO PROCEED

Give yourself a week to just browse through the literature thinking about what interests you and once you have that identifying a question, hypothesis or analysis..
Then write a short paragraph detailing what you are going to do in your essay e.g.:

THE NEANDERTALS DID PRACTISE DELIBERATE BURIAL. IN THIS ESSAY I AM GOING TO COMPARE THE POSITIONS OF ... AND ..... I AM GOING TO SET UP CRITERIA FOR IDENTIFYING DELIBERATE BURIAL AND THEN EXAMINE

.... SITE AND SEE IF THERE IS SUFFICIENT EVIDENCE TO SUPPORT MY HYPOTHESIS.

Then look for the information you need – make sure you cover the necessary bits. At this stage you may have to shift your topic slightly or pick a different case study. Start taking notes, following leads. Identify at least five sources and explain in your annotated bibliography what the main point is in relation to your essay question and how you are going to use this reference.

THIS CONSTITUTES THE ANNOTATED BIBLIOGRAPHY AND ESSAY STATEMENT.

Having done that much then start to think about what you have read and start making a plan to organise your material. Find the extra sources you need (remember a 3000 word essay really requires more literature coverage 10 references would be a fairly minimal beginning). Start writing, identify the gaps, fill them, draft and redraft.

Plagiarism

The University of Auckland will not tolerate cheating, or assisting others to cheat, and views cheating in coursework a serious academic offence. The work that a student submits for grading must be the student's own work, reflecting his or her learning. Where work from other sources is used, it must be properly acknowledged and referenced. This requirement also applies to sources on the world-wide web. A student's assessed work may be reviewed against electronic source material using computerised detection mechanisms. Upon reasonable request, students may be required to provide an electronic version of their work for computerised review. Your attention is also drawn to the University of Auckland's position on Academic Honesty and Plagiarism, and to specific guidelines for the Conduct of Coursework and Conduct of Research. This information can be found on the University's website at: https://www.auckland.ac.nz/en/about/the-university/how-university-works/policy-and-administration/teaching-and-learning/students/academic-conduct-statute.html

Due dates, late work

All coursework should be submitted by the due date and time. IF YOU ARE ILL OR HAVE SOME OTHER FORM OF EMERGENCY THEN CONTACT JUDITH AS EARLY AS POSSIBLE TO ARRANGE AN EXTENSION. Assignments will be accepted up to 48 hours late, with a penalty of 10% points per 24-hour period.

Attendance

University courses are about learning a wealth of material in a short period of time, with the goal being able to think critically about the topic at hand. Therefore, attendance at lectures will generally increase your ability to understand the course material. Lecture recordings, while undertaken, are not a replacement for attendance.

Labs are designed to get you practicing what you have learnt in a small, hands-on environment to facilitate your comprehension of the material. As such, each student is enrolled in a lab class which will run from Week 2 of the class. These are compulsory since 20% of your marks comes from work undertaken or discussed in these classes.

Having Problems?

University work is difficult and sometimes life gets in the way. The main thing is don't let issues compound. Adopt as a matter of course the practice of talking to Judith and Caitlin during your labs, during our office hours, seeing us not just when things are wrong but when things are going right. At all times come and see us (contact details next page) as soon as things start to slide. We are interested in ensuring that you all do well in this course to take advantage of us and our expertise.

If you need help with developing your writing skills or your ability to take effective notes, sign up with the Student Learning Centre. The Student Learning Centre is located in Room 320 of the Kate Edger Information Commons, and their hours are 9am to 5pm, Monday to Friday. More information about their workshops and other services can be found online at www.library.auckland.ac.nz/student-learing/. You might also wish to go to the English Language Enrichment (ELE) in the Kate Edger Information Commons. They state " If you think your English is holding you back from getting better grades, communicating effectively or participating confidently in university life, ELE on campus is a great place to be. You can use English language resources (DVDs, CDs, digital recordings, magazines, newspapers and books), get advice about your English (whatever your subject area), and participate in language learning groups. You can also use ELE computers in any way that supports your English language development".

Tuakana Arts Undergraduate Mentoring Programme

Tuakana Tutors are available to help Maori and Pacific Island students and others through a range of opportunities such as study groups, skill based workshops, and one-on-one assistance. Your Tuakana tutor for this course will be introduced both in person (in class) and via Canvas early on in the course.

Disabled students

If you have a disability that affects your capacity to participate in this course, please contact the convenor as soon as possible. Additional information for disable students can be found at the **University of Auckland Disability Services** website

WK	Date	Lecture topic	Readings	367 Lab
1	**18/7**	**Introduction to bioarchaeology and the human skeleton** ***What is bioarchaeology?*** ***The human skeleton and information we gain from it, ethics – what do we mean by ethics and why do they matter.***	Parker Pearson 1999 The Archaeology of Death and Burial College Station: Texas A&M University Press Pp 1-20 ISBN 1-58544-099-X Mays, S 2010 The Archaeology of Human Bones. London: Routledge. Pp1-14 Turner, B. L., Toebbe, D. S., & Armelagos, G. J. (2006). To the science, to the living, to the dead: Ethics and bioarchaeology. In *Symposia-Society For The Study Of Human Biology* (Vol. 45, p. 203). Cambridge University Press.	
2	**25/7**	**Mortuary landscapes** ***SYMMONDS ST CEMETERY – an introduction to mortuary archaeology***	Tarlow, S. (1997). An Archaeology of Remembering: Death, Bereavement and the First World War. *Cambridge Archaeological Journal*, *7*(1), 105-121. doi:10.1017/S0959774300001499 Mytum, H. 2006. Popular attitudes to memory, the body, and social identity: The rise of external commemoration in Britain, Ireland and New England. *Post-Medieval Archaeology*, 40(1): 96–110.	**The nature of bone and anatomical terms**
3	**1/8**	**Finding and analysing human remains in the archaeological and forensic record** ***Human burials and burial practices, forensic anthropology, taphonomy and preservation***	Stodder, A 2008 Taphonomy and the nature of archaeological assemblages. In Biologicaal Anthropology of the Human Skeleton, Wiley, p71-114 Knüsel, C. J., & Robb, J. (2016). Funerary taphonomy: An overview of goals and methods. *Journal of Archaeological Science: Reports*, *10*, 655-673.	**The shoulder and chest**

			Castex, D and Blaizot, F 2017 Reconstructing the Original Arrangement, Organisation and Architecture1 of Burials in Archaeology In *Taphonomy of Human Remains: Forensic analysis of the dead and the depositonal environment.* Johnwiley. P277-295	
4	**8/8**	**Children and death** ***Identifying child remains, historic causes of death, canaries in the coalmine? Or liminal people***	Halcrow, S and Tayles, N 2008 The bioarchaeological investigation of childhood and social age: problems and prospects. J Arch Method and Theor 15(2):190-215 Moore, A *2009* Hearth and home: the burial of infants within Romanp-British Domestic contexts. Childhood in the Past 2(1):33-54 *Perry, M. A. (2005).* Redefining childhood through bioarchaeology: Toward an archaeological and biological understanding of children in antiquity. *Archeological Papers of the American Anthropological Association, 15(1), 89-111.*	**The vertebral column**
5	**15/8**	**Embodying inequality** ***Identifying inequality in the bioarchaeological record – what do we mean by inequality, status, and identity, status and graves, status and health***	Knudson, K. J., & Stojanowski, C. M. (2008). New directions in bioarchaeology: Recent contributions to the study of human social identities. *Journal of Archaeological Research*, *16*(4), 397-432 Joyce, R. A. (2005). Archaeology of the body. *Annu. Rev. Anthropol.*, *34*, 139-158. *Quinn, C.P. ; Beck, J. (2016)* Essential tensions: A framework for exploring inequality through mortuary archaeology and bioarchaeology *Open Archaeology, January 2016, Vol.2(1), pp.18-41*	**The arm and hand ANNOTATED BIBLIOGRAPHY DUE 15/8 3pm on Canvas**
6	**22/8**	**Gender, labour and violence** ***Sexing adult remains, sex vs gender, trauma and violence***	Hollimon, S 2011 Sex and gender in bioarchaeological research: theory method and interpretation In Social Bioarchaeology edited by S Agrawal and B Glencross, Wiley-Blackwell, p.149-182	**The cranium**

			Stone, Pamela 2012 Binding women: ethnology, skeletal deformations, and violence against women. Int J Paleopath 2: 35-50 *Jordan, A. M. (2016). Her mirror, his sword: unbinding binary gender and sex assumptions in Iron Age British mortuary traditions. Journal of Archaeological Method and Theory, 23*(3), 870-899.	
		MID SEMESTER PERIOD		
7	**12/9**	**Exploiting the environment – movement and diet** ***Stable isotope analysis, aDNA, mobility versus migration, diet versus nutrition versus subsistence***	Bramanti, B The Use of DNA Analysis in the Archaeology of Death and Burial *The Oxford Handbook of the Archaeology of Death and Burial* Edited by Liv Nilsson Stutz and Sarah Tarlow p.99-122. Wilson, A. S., Taylor, T., Ceruti, M. C., Chavez, J. A., Reinhard, J., Grimes, V., ... & Worobey, M. (2007). Stable Isotope And Dna Evidence For Ritual Sequences In Inca Child Sacrifice. *Proceedings Of The National Academy Of Sciences*, *104*(42), 16456-16461. *Kinaston R et al. 2013 The First New Zealanders: Patterns of Diet and Mobility Revealed through Isotope Analysis PLOSOne :8 iss:5 pg:e64580 doi:10.1371/journal.pone.0064580*	**NO LAB THIS WEEK – FINAL WORK ON ESSAY!**
8	**19/9**	**Disease, disability and inequality** ***Palaeopathology possibilities and problems, disability?, care***	Dettwyler, K 1991 Can paleopathology provide evidence for Compassion? Am J Phys Anth 84(4):375-84 Tilley, L. (2012). The bioarchaeology of care. *The SAA Archaeological Record*, *12*(3), 39-41.	**The hip T** **ESSAY DUE 19/9 3PM ON CANVAS**

			Robbins Schug, G 2016 Begotten of corruption? Bioarchaeology and the othering of leprosy in South Asia. Int J Paleopath 15:1-9	
9	**26/9**	**Was agriculture the worst idea?** *Agricultural transitions, sedentism, stress, health, coevolution*	Stock, J. T., & Pinhasi, R. (2011). Introduction: Changing Paradigms in Our Understanding of the Transition to Agriculture: Human Bioarchaeology, Behaviour and Adaptaion. *Human Bioarchaeology of the Transition to Agriculture*, 1-13. Larsen, C 2006 The agricultural revolution as environmental catastrophe: implications for health and lifestyle in the Holocene. Quaternary International 150(1):12-20 *Littleton, J., Allen, M. S., & McFarlane, G. (2015).* Multi-species Perspectives on Anthropogenic Environments: Dental Pathology Patterns, Marquesas Islands (Polynesia). *The Journal of Island and Coastal Archaeology, 10(2), 277-301.*	**P he leg and foot**
10	**3/10**	**Colonial contagion: colonisation, depopulation and change** *Colonialism, immunological naievity, depopulation, thinking beyond the germs, other areas of change.*	Dobyns, H. F. (1993). Disease transfer at contact. *Annual Review of Anthropology*, *22*(1), 273-291. Murphy, M. S., & Klaus, H. D. (2017). *Colonized bodies, worlds transformed: Toward a global bioarchaeology of contact and colonialism*. University Press of Florida.p7-30 *Klaus, H. D., & Tam, M. E. (2009). Contact in the Andes: bioarchaeology of systemic stress in colonial Mórrope, Peru. American Journal of Physical Anthropology, 138(3), 356-368.*	**Palaeopathology and trauma Taphonomy, excavation, normal variation?**

11	**10/10**	**The importance of bodies: post-mortem manipulation of the deceased.** ***The body politic, the value of bodies, cannibalism, moving bodies.***	Arnold, B 2014 Life after life: bioarchaeology and postmortem agency. Cambridge Archaeological Journal 24(3):523-9 Hutchinson, D and L Aragon 2008 Collective burials and community memories: interpreting the placement of the dead in the Southeastern and mid-Atlantic United stated with reference to ethnographic cases from Indonesia. Arch Papers of the Am Anth Associ 11:27-54	**PRACTICAL TEST In Friday's lab 12/10 October.**
12	**17/10**	**Ethics and best practice in New Zealand** ***Ethics, legislation, ideas of the body, collaboration.***	Ashby, Edward. "Forensic archaeology in New Zealand: Review and future directions." *Australian Journal of Forensic Sciences* 45.1 (2013): 25-35. Historic Places Trust 2010 Archaeological Guidelines Series No. 8 Koiwi Tangata/Human Remains. ISBN 978-0-908577-98-9 (online)	**Debating ethics and thinking about the exam.**

WEEK TWO. THE SKELETON: ANIMAL, HUMAN?

a. the nature of bone
b.. anatomical terminology
c. identifying skeletal elements

Aim: By the end of this class you should have an idea about how to recognize human from the most common animals (and other sources of confusion) and what characteristics to look for to help in identification.
Task: You will be given a bone at the end of the class and asked to identify whether it is human or animal, and give an idea of where it comes from. Results will be presented in the next week's class.

A. THE NATURE OF BONE:

BONE FUNCTION

Bones play both a structural function (acting as a support) and a physiological function (e.g. blood cell formation in the marrow).

Structurally bone provides protection (e.g. the rib cage protects the lungs) while movement is facilitated by the attachment of muscles to bone (e..g tendons) which provide a series of levers the muscles can use to move the body.

Blood cell formation takes place within the marrow cavities of bone., in red marrow. The other sort of marrow – yellow marrow is mostly fat cells. Mineral storage takes place in bone when there is an abundance of minerals in the diet. These minerals are mobilized when there is a shortage. Therefore the bones of the skeleton are implicated in the general functioning of the body by producing blood cells, storing fat and key nutrients (especially calcium and phosphorous).

THE SKELETAL SYSTEM AND BONE TISSUE

Bone and cartilage are both connective tissue. Cartilage is flexible connective tissue found in many parts of the body including the joints, the nose. As an ambryo the skeleton is almost entirely cartilage that is replaced by bone during growth and development.

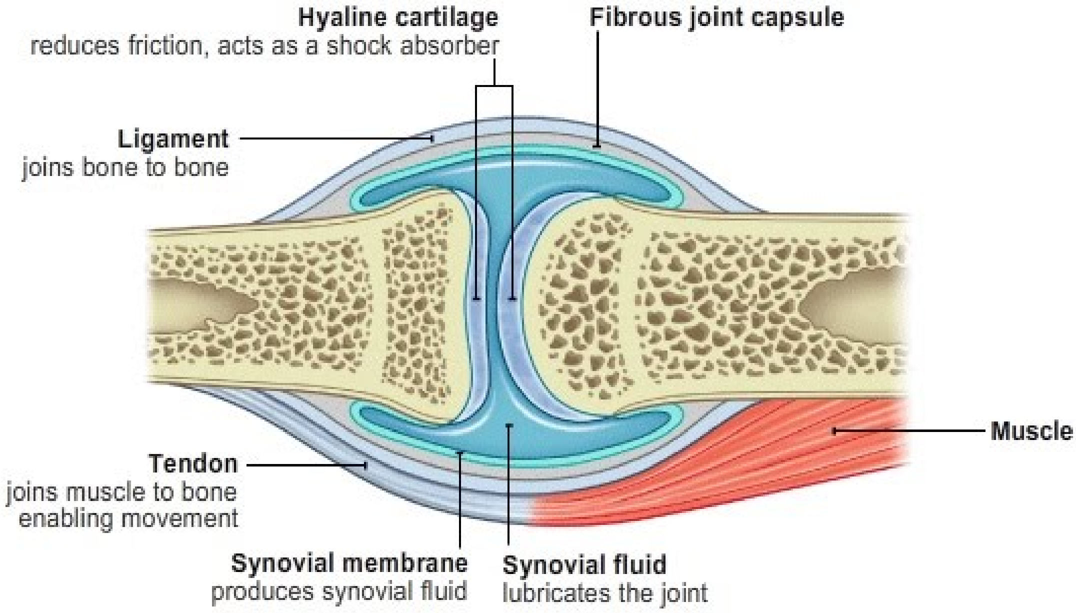
At the joints the articular surfaces of each bone are smooth and separated from each other by a layer of cartilage. This helps the joint withstand impact and movement.

Joints are of different types the main being fibrous joints, cartilaginous joints and synovial joints.

Fibrous joints are united by short fibrous connective tissue allowing little or no movement (e.g. between the bones of the skull).

Cartilaginous joints are united by cartilage allowing a little movement (e.g. the inter-vertebral discs)

Synovial joints are mobile and held together along their outer surfaces by ligaments and dense irregular connective tissue that forms an articular capsul around it. There is a small gap between the two articular surfaces of the bone this is filled with a slippery lubricant called synovial fluid.



https://sites.google.com/site/thealevelbiologistyourhub/_/rsrc/1497109221484/topics/wjec-a2-topics/synovial-joint-structure/syno.jpg

The diagram below shows the structure of a long bone which is divided into three zones:

The diaphysis or shaft of the bone which contains a medullary cavity (in which there is marrow)

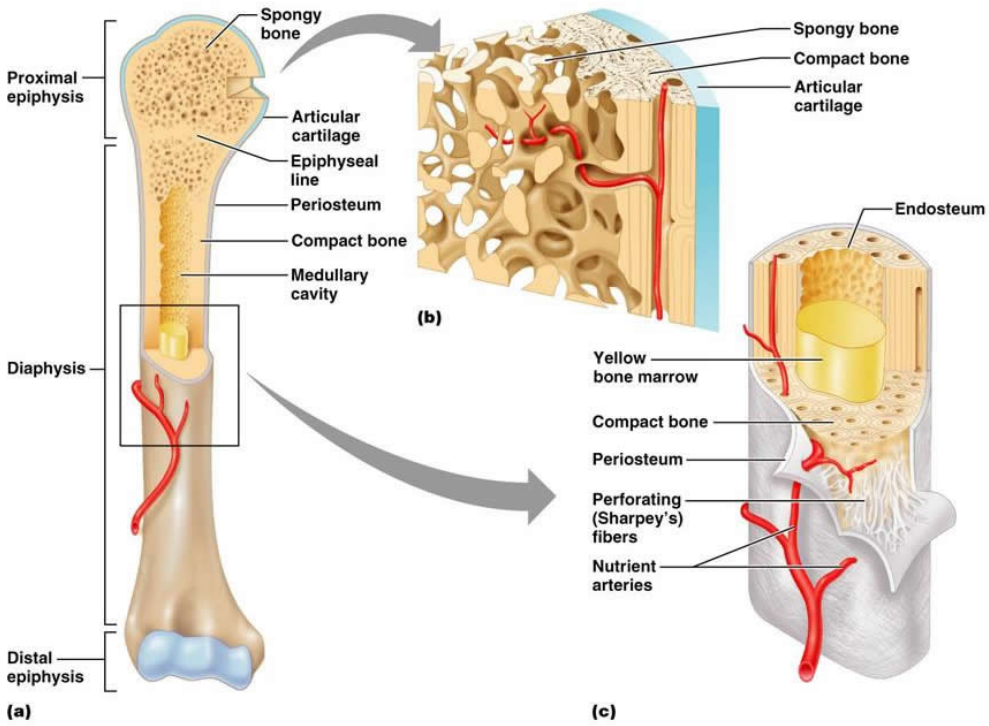
The proximal epiphysis the end of the bone closest to the cranium and comprising the joint.

The distal epiphysis the end of the bone furtherest from the cranium.

The outer surface of the shaft is covered with a periosteum – a thin fibrous sheaf of connective tissues over the bone covering the bone's cortex (or outer surface) and connected to it by small fibres – Sharpey's fibres.

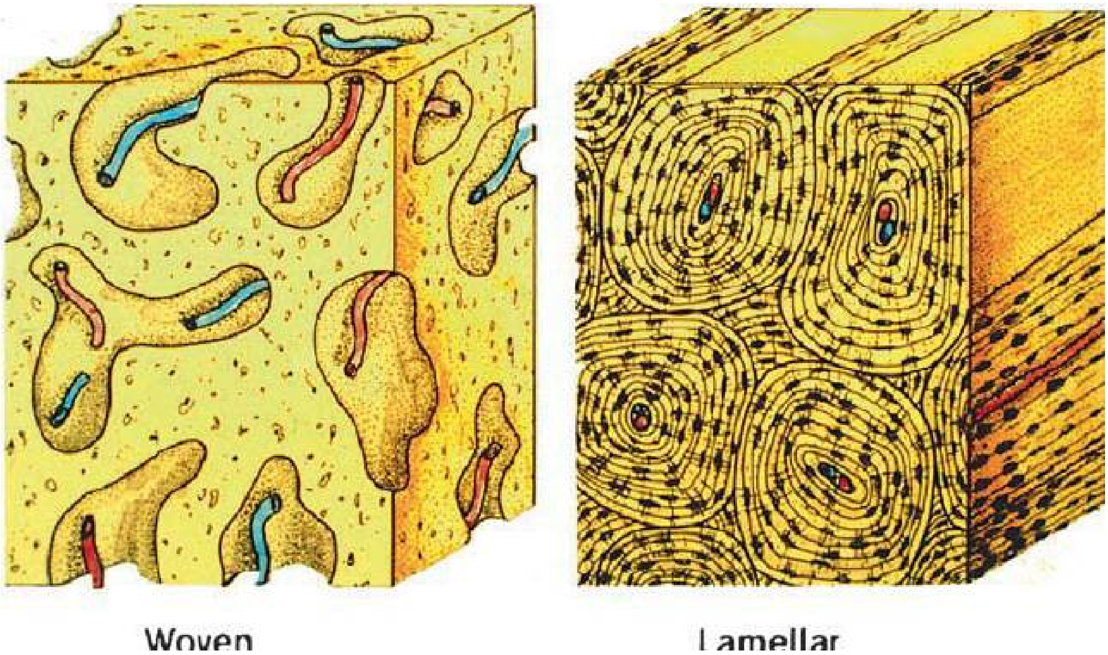
The inner surface of the shaft is the endosteal surface.

The bone is nourished by blood vessels which enter the bone through a small hole or nutrient foramen. Identifying the nutrient foramen is often very important for identifying a bone and siding it.



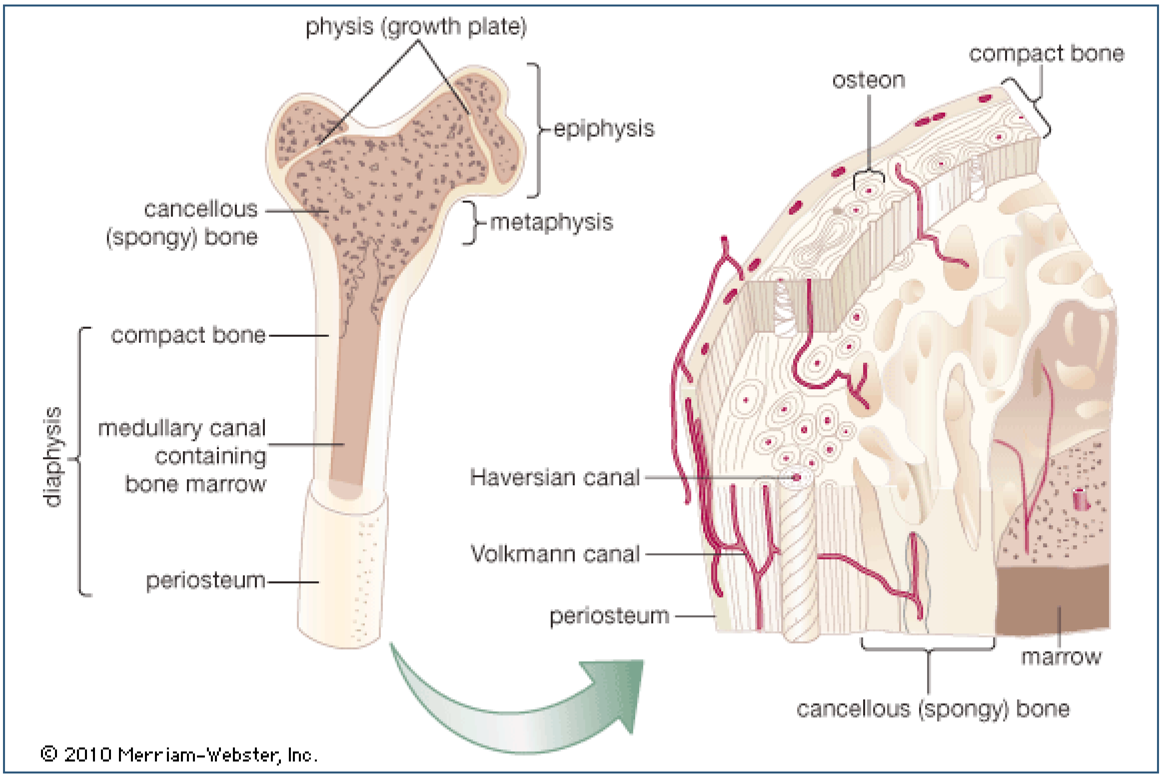
<u>Structure of a bone</u>
Periosteum
Cortical Bone and cortex
Cancellous bone (spongy, trabecular)
Medullary canal
Endosteum
Articular cartilage
Foramen

BONE MICROSTRUCTURE
Bone is comprised of organic material (about a third of the bone's components) including proteins like collagen which help to make up the matrix surrounding the bone cells. The remaining two-thirds are inorganic components primarily carbonated apatite made up of calcium, phosphate and fluoride.
There are two main types of bone: woven bone (unorganized bone primarily seen in immature bone (as in a child or as a bone is healing from trauma); and lamellar bone which is mature bone.



https://www.researchgate.net/profile/Samir_Abdelmagid/publication/224929158/figure/fig2/AS:302569151844353@1449149515382/Diagram-of-immature-and-mature-bone-Immature-woven-bone-displays-a-disorganized.png

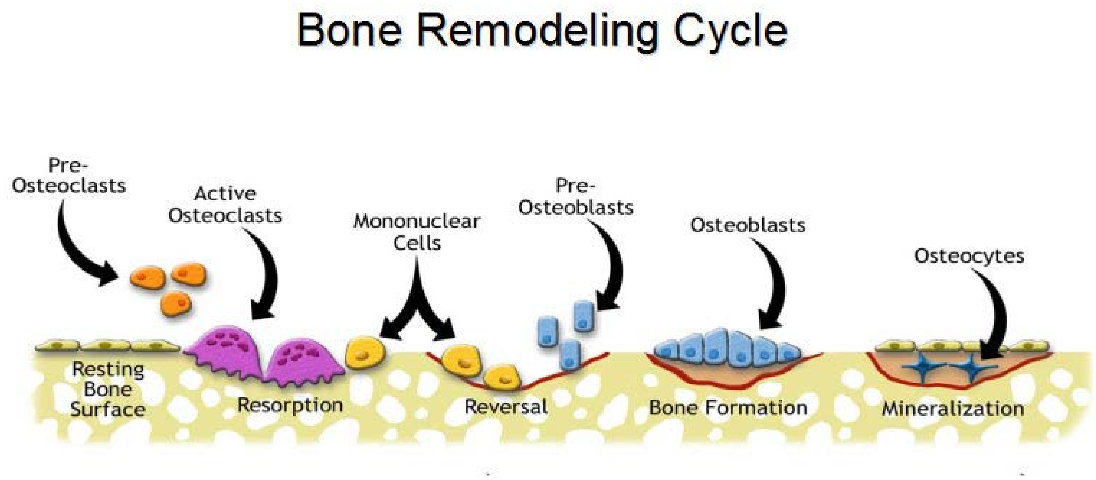
Within lamellar bone there are two types of bone tissue: compact bone (also called dense bone) forming the bone cortex and cancellous bone (also known as trabecular or spongy bone)..



http://www.sciencelearn.org.nz/Contexts/Ceramics/Sci-Media/Images/Human-bone-structure

There are three main types of bone cells:
Osteoblasts – which form bone
Osteocytes – responsible for bone maintenance and

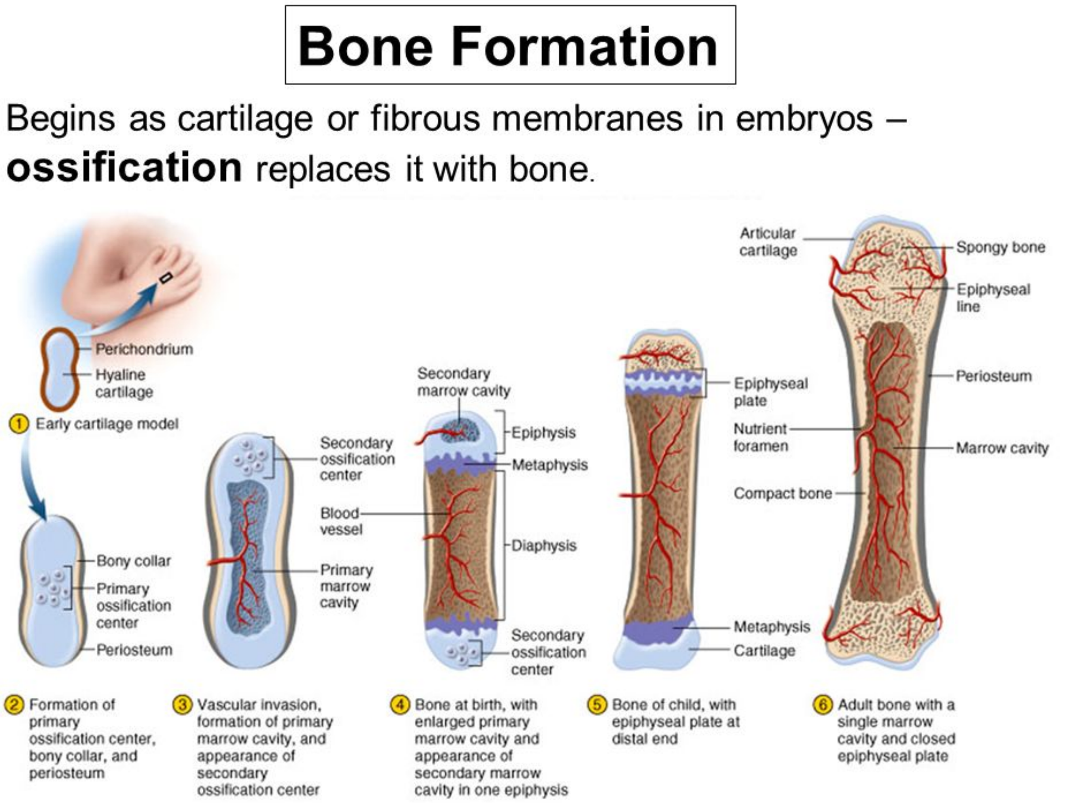
Osteoclasts – which remove bone.
The constant working of these bone cells is called bone remodeling. This process allows for growth and development, the extraction of important nutrients from the skeleton, the repair of damage to bone, and finally to meet the functional and biomechanical challenges of bone. Bone that is subject to repeated strain due to muscle use will grow bigger, in contrast muscles that are not used become smaller as does the underlying bone (use it or lose it). This underlies the asymmetries seen between left and right hands and arms for instance and is captured by -**Wolff's law**: "the form of the bone being given, the bone elements place or displace themselves in the direction of the functional pressure and increase or decrease their mass to reflect the amount of functional pressure (Wolff 1892 q. in Mays 1998, p.3)



https://www.orthopaedicsone.com/download/attachments/71434800/bone+remodel.png?version=1&modificationDate=1389455440000

HOW BONES GROW

There are two basic ways for bone to form and develop.
The first is intramembranous ossification where the bone is ossified between two membranes or within a cartilaginous model. This is how bones of the skull, pelvis and scapula form.
The second is endochondral ossification within a cartilaginous model. This is how long and short bones form.



https://slideplayer.com/7480510/24/images/1/Bone+Formation+Begins+as+cartilage+or+fibrous+membranes+in+embryos+–+ossification+replaces+it+with+bone..jpg

B. CLASSIFICATION AND DESCRIPTION OF BONES

The skeletal system is described and classified by several different systems: location, size and shape, origin and by structure.

By location

The axial skeleton is the base to which the appendicular skeleton is attached. It is comprised of:

The skull – the multiple bones of the cranium with the mandible
The hypoid – the small U-shaped bone beneat the mandible
The vertebrae – forming the backbone
The sternum – the manubrium, the body of the sternum and the xiphoid process
The ribs – 12 pairs

The appendicular skeleton is attached to the axial skeleton. All of the appendicular skeleton is paired and comprises the following:

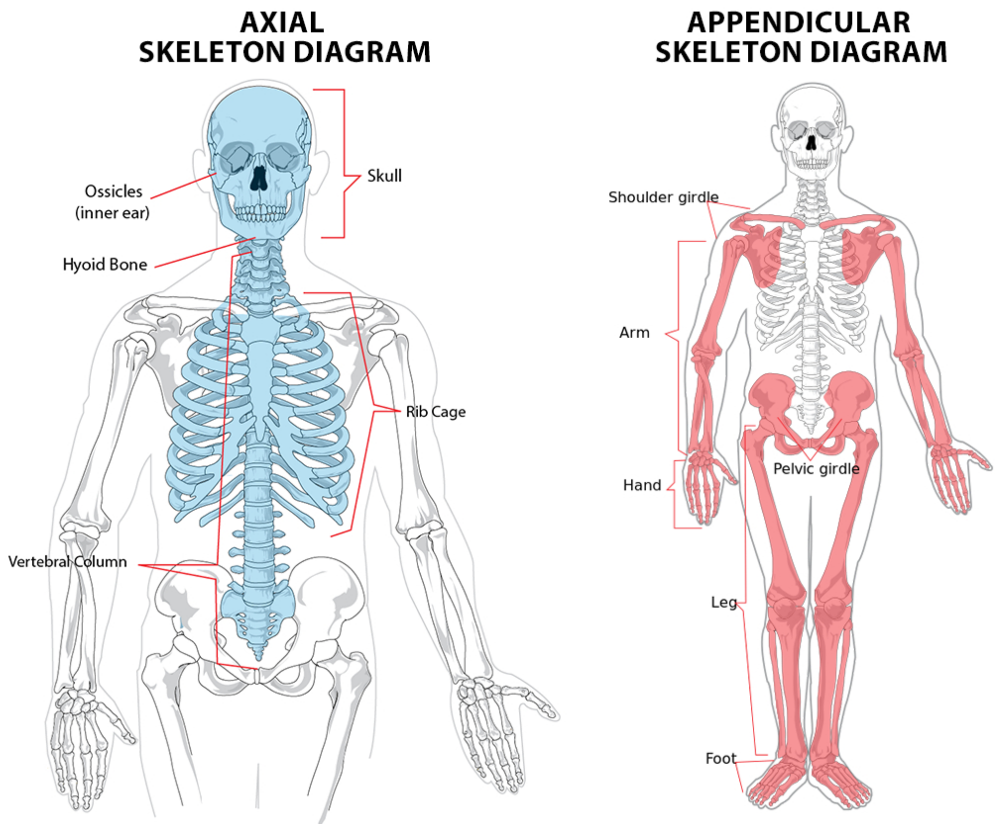
The pectoral girdle – the scapula and clavicle
The arm – the humerus, radius and ulna
The hand – the carpals, metacarpals, phalanges
The pelvic girdle – the innominate bones (or os coxae)
The leg – femur, patella, tibia and fibula
The foot – the tarsals, metatarsals andphalanges

By size and shape

Long bones are much longer than wide. The arm, legs, metarcarpals/tarsals, phalanges are all long bones.

Short bones are small rounded bones. The carpals in the wrist and the tarsals of the

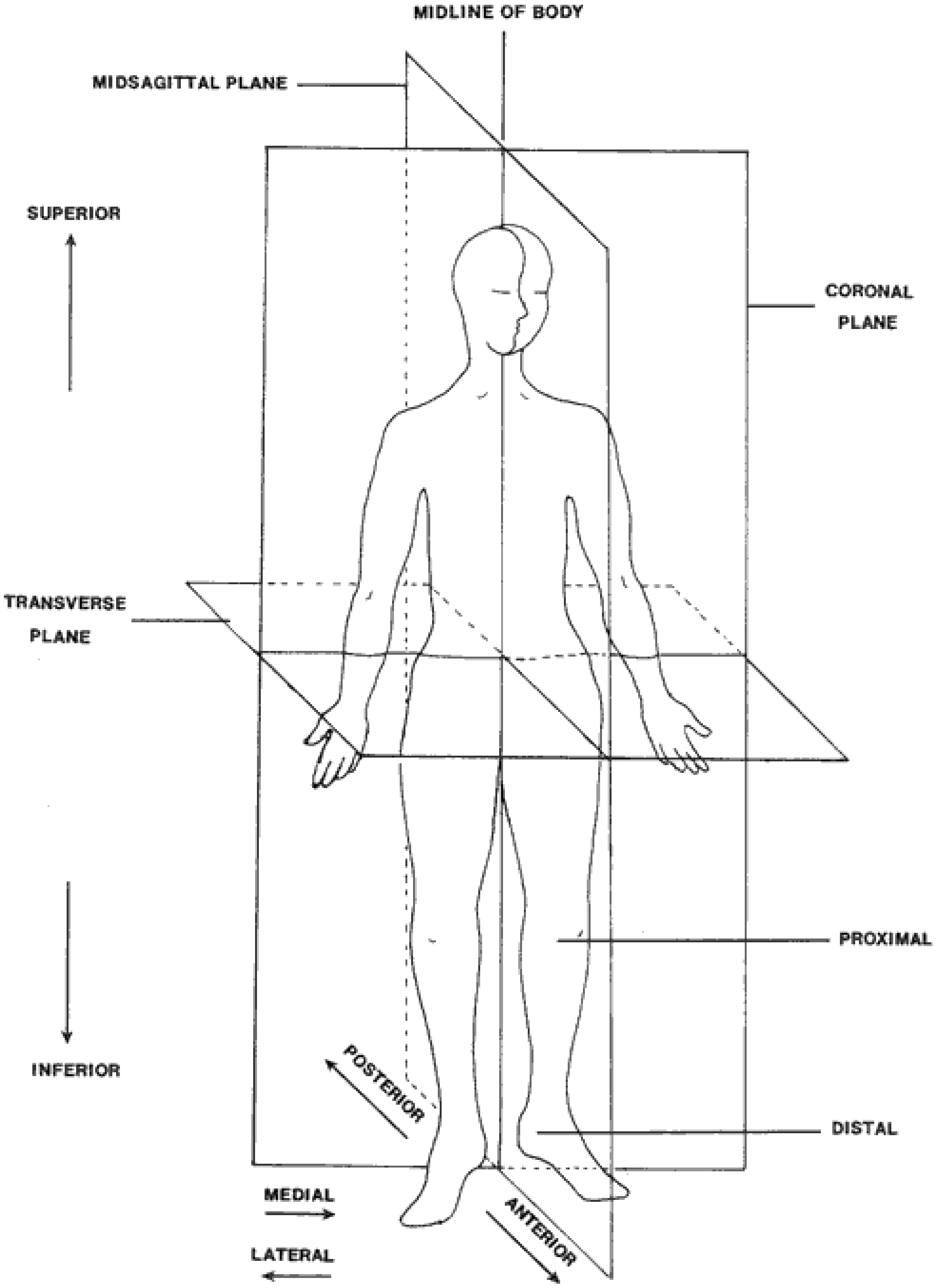
ankle are short bones.
Flat bones include the bones of the skull, pelvis and should blade.
Irregular bones are the bones of the spine.



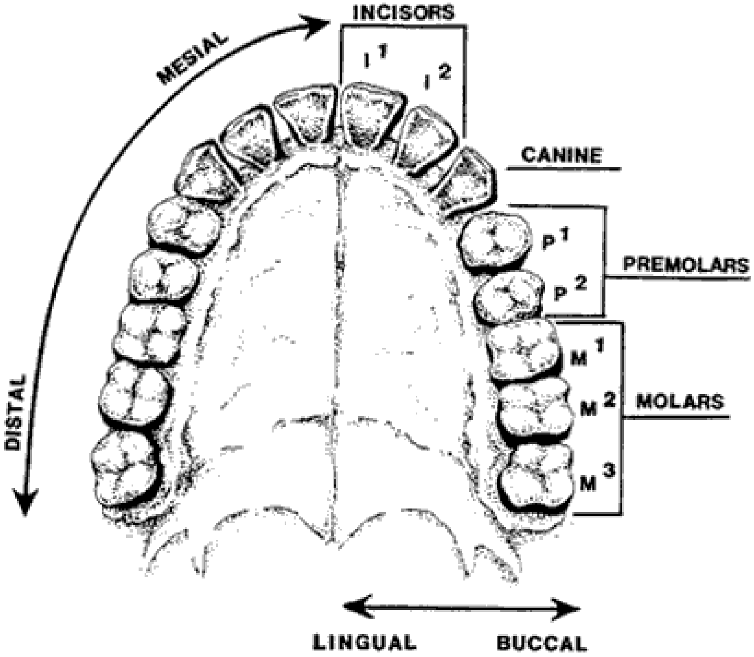
https://detiina.com/wp-content/uploads/2018/06/skeletal-system-appendicular-skeleton-1-1-the-skeletal-system-ib-sehs-notes.png

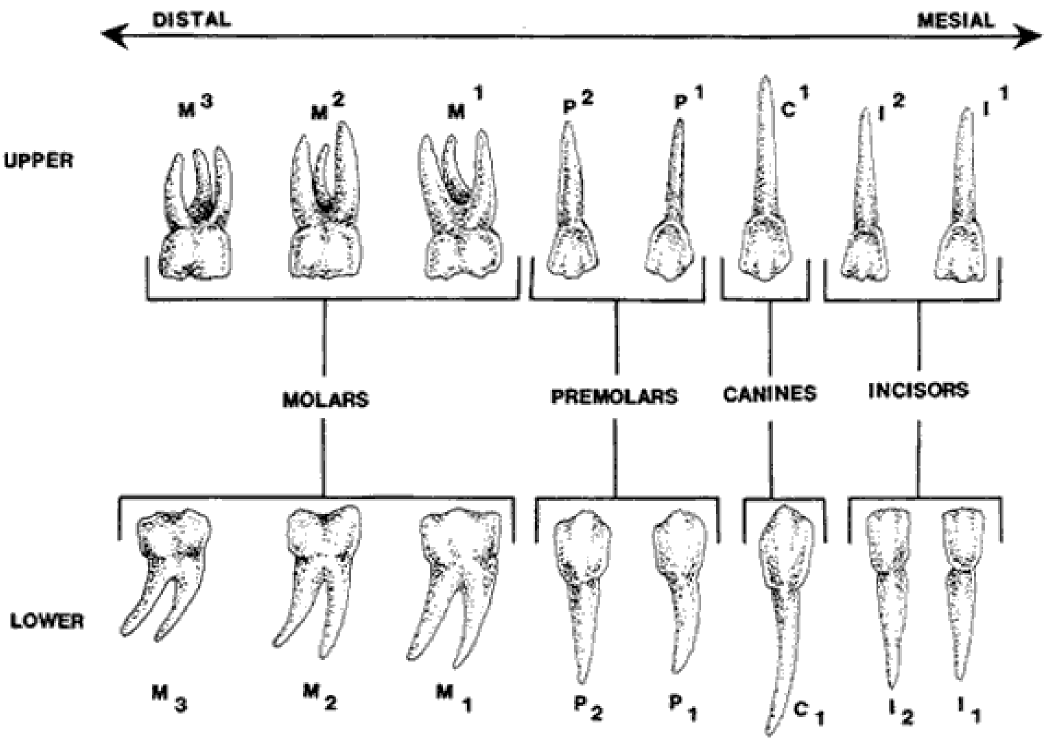
C. Anatomical terminology

Working with human bones means that you need to be able to use anatomical terminology properly in order to avoid misunderstandings . Begin by talking with your lab partners. Use the terms and names. Practice the new vocabulary.
http://www.csus.edu/anth/physanth/image18.htm



Dental Anatomy and Tooth Formation





D. SURFACE MARKINGS OF BONE.

We can often glean clues about what is going on around a bone from its surface. In places, like joint surfaces, the bone will be covered with smooth articular cartilage. This falls off in preparation but leaves the underlying bone smooth too. Bone is constantly growing or being reshaped, and this takes place on the surface. At high magnification we can see, in a dried bone, what it was up to the point of death. This picture shows a hole for a blood vessel, a foramen. Around roughly half its diameter the collagenous bone is rough, the other half smooth. The rough is resorbing bone, being eaten by large osteoclasts which leave pits and the smooth is depositional, bone being formed. This indicates that the foramen was on the move as the bone grew. Other areas also show deposition and resorption: these would be building up and hollowing out respectively. On a macroscopic scale these effects can be seen as points of attachment to the bone - of ligaments, tendons or the fibrous insertions of muscles. All these structures transmit forces, and demand a well organised junction. Any part of this structure which has deposited calcium will appear as a bit of bone. Within the bone we often see rows of trabeculae or thick ropes of collagen, Sharpey's fibres running across the marrow cavity to insert in the cortical bone opposite. Blood vessels and nerves similarly have canals.

The various lumps for fixing things to have different names according to shape, usually derived from a dead language. There are lots of these, but common ones are:

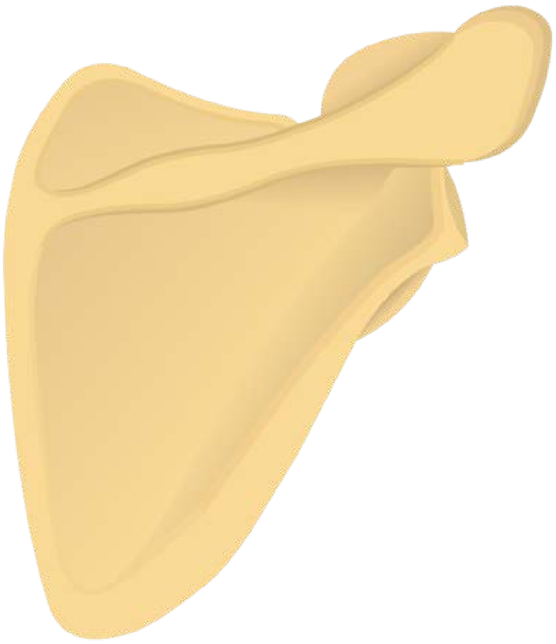
- lumps and bumps
- process
- spine - if sharp
- tubercle - if rounded
- cornu - if horn shaped
- hamulus - if hooked
- crest - ridge
- line - low ridge
- depressions and holes
- sulcus - groove
- canal - tunnel
- foramen - hole
- fossa - depression
- articular surfaces
- facet - if small
- condyle - if rounded
- epicondyle - if near a condyle
- trochlea - if pulley shaped

LAB EXERCISES

In order to make you familiar with the skeleton overall as well as using directional terms, use the articulated skeletons and identify the following:

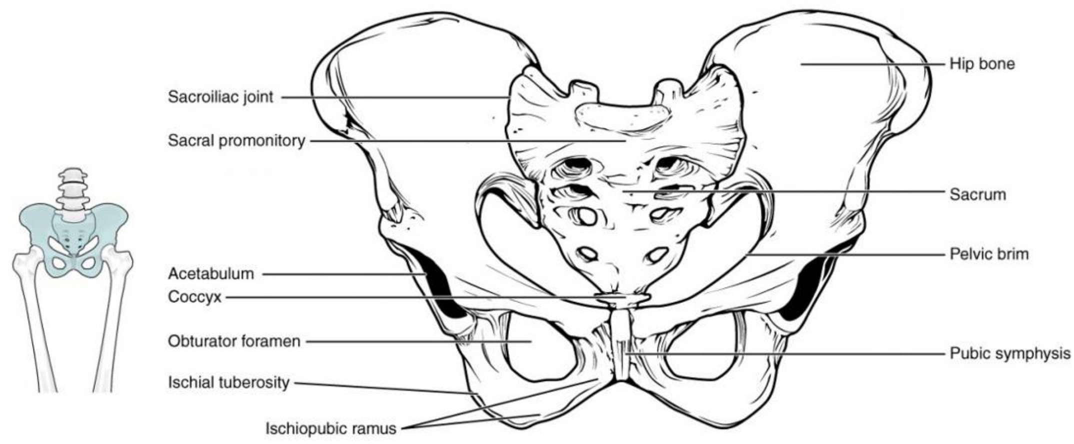
1. **Anatomical directions**

A. The right scapula - This is the ________________ view and the long relatively straight edge is the ______________ border, while the sharply curved lower end is the ________________ border.



B. The left tibia (shown below with the right) is _________________ to the fibula and _______________ to the femur. Its _____________ epiphysis forms part of the knee which is a _______________ joint. The diaphysis of the tibia is linked to the diaphysis of the fibula by an interosseous membrame which is on the _____________ border of the tibia and the _________________ of the fibula.

C. Below is a diagram of a articulated pelvic girdle. With reference to the hanging skeletons identify the following directions: anterior/posterior, superior/inferior, medial/lateral.

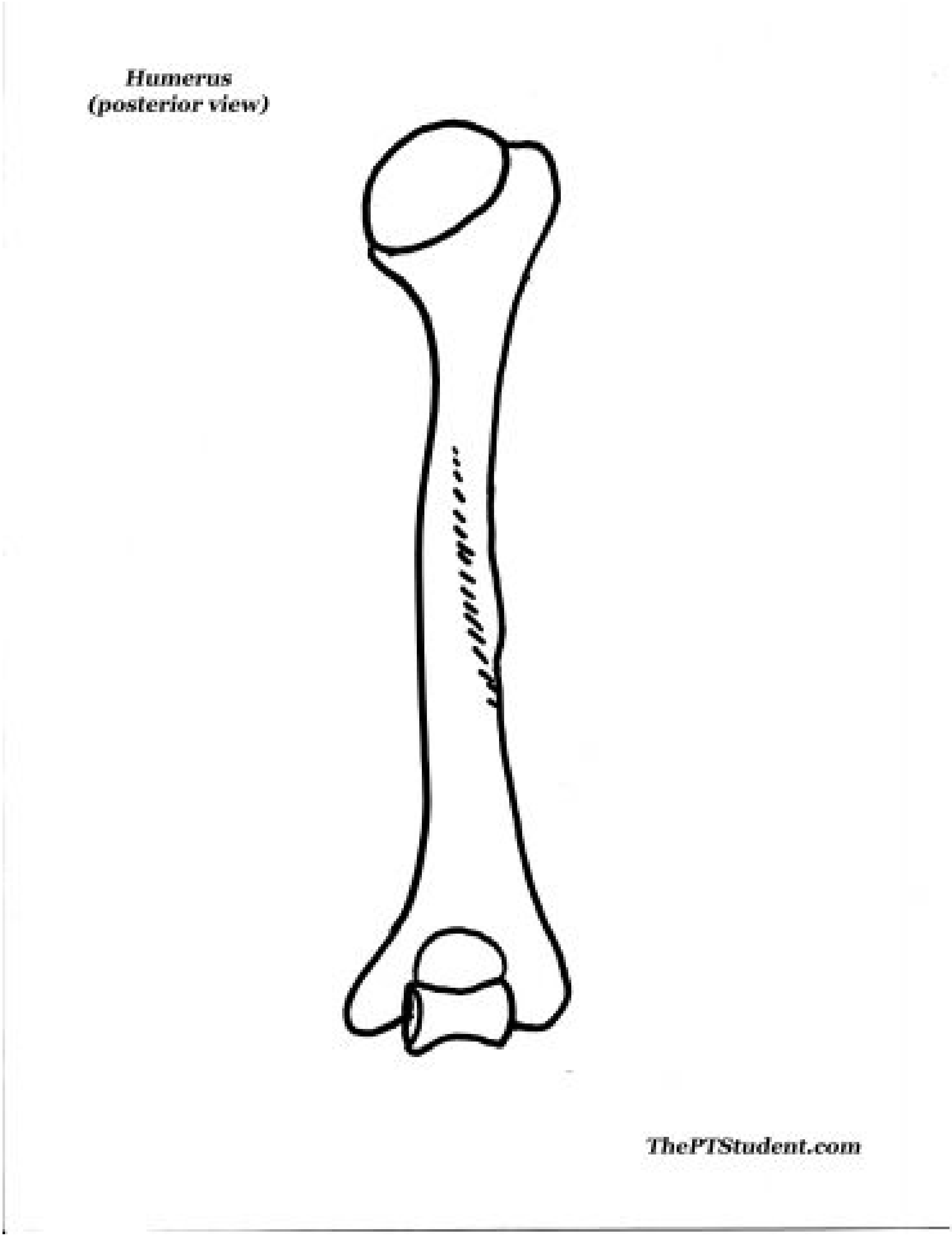


D.

2. BONE STRUCTURE

Lying on the table is a humerus. Use the outline drawing below to indicate the following structures:

The diaphysis,
The proximal and distal epiphyses
the nutrient foramen
the edges of the articular capsules
any apparent muscle insertions
The location of the periosteum
The extent of cancellous bone


Humerus
(posterior view)
ThePTStudent.com

WEEK THREE: THE POSTCRANIUM: THE SHOULDER AND CHEST

a. the bones of the shoulder and the chest
b. ageing used the sternal ends of ribs

Aim: By the end of this class you should be able to identify these bones and lay them out to side. You should also be able to explain how to undertake age estimation using sternal ends of the ribs and understand the nature of different age ranges.

SHOULDER, ARM AND HAND BONES AND FEATURES

THE SHOULDER GIRDLE

This forms the suspension system for the arms. The scapula and the clavicle wrap around the upper part of the chest and the arms hang from this 'girdle' allowing both stability and a huge range of flexibility. The girdle is incomplete across the back. Bony articulations only occur at two points on each side. The medial articulation is between the claviciles and the manubrium of the sternum. The laternal articulation is between the clavicles and the acromion process of the scapulae.
The main articulation of the humerus is at the glenoid fossa of the scapula – this a very small bony socket allowing less weight bearing than the hip but greater flexibility.

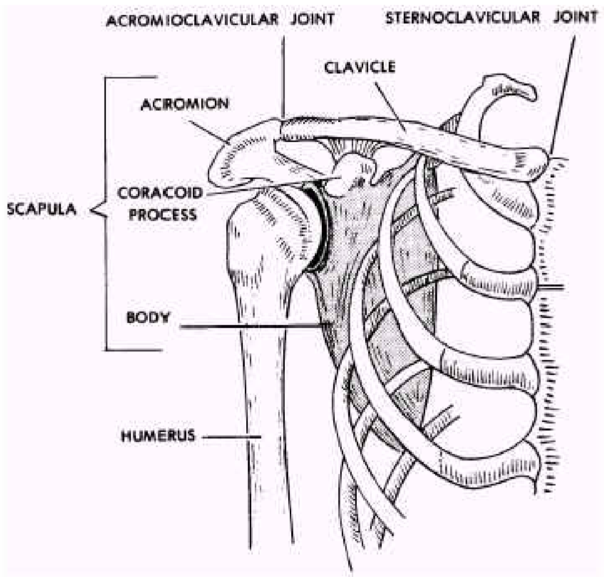
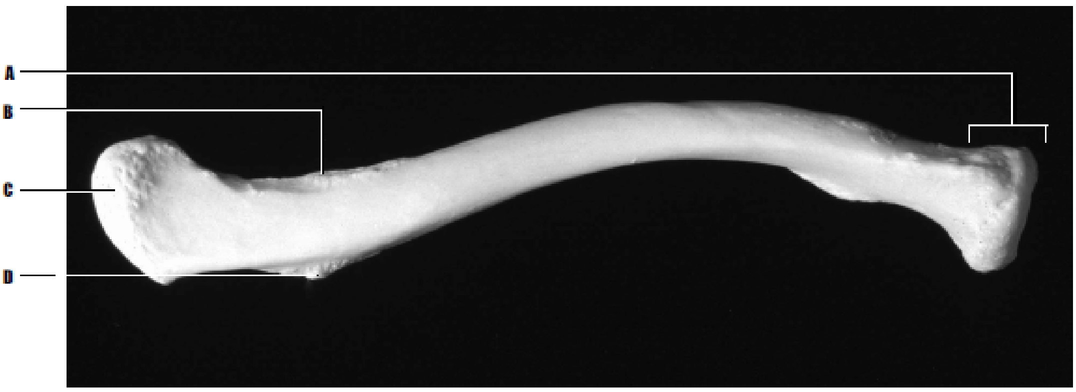


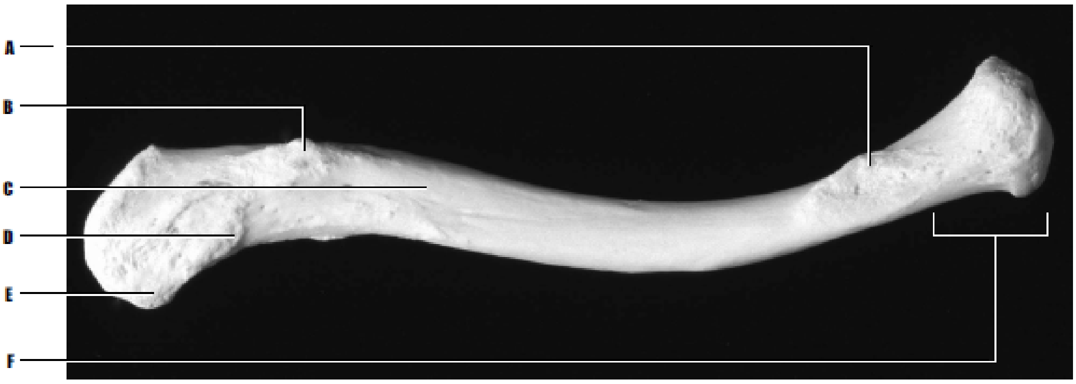
Figure 4-8. The human scapula and clavicle (pectoral girdle).
http://www.sweethaven02.com/MedTech/Anatomy01/fig0408.jpg

THE CLAVICLE

The clavicle or collar bone is an S shaped log bone. The medial end articulates with the manubrium of the sternum. The lateral end is compressed and spatulate. It articulates with a small area of the acromion process of the sternum. From the medial end the clavicle curves anteriorly and then posteriorly towards the lateral end. So for working out if you have a left or right clavicle determine the superior from the inferior surface. The Superior surface is flatter with no obvious grooves or tuberosities. The inferior surface has at the medial end a groove (sometimes very marked) where the costoclavicular ligament attaches and on the lateral end there is a ridge called the trapezoid ridge, This surface is also more angular than the flatter superior surface. Having sorted out superior from inferior, place the inferior surface on the table so that the superior surface is up. Then move the bone so that the major curve (towards the medial end) is away from you look at the side to which the lateral end is pointing – this is the side of the bone. I always side the clavicle by feeling my own clavicle.

The medial clavicular epiphysis is the last epiphysis to fuse in the body so it is really useful in adult aging. This fusion is normally around the mid-twenties but the total range is 15-32 years.



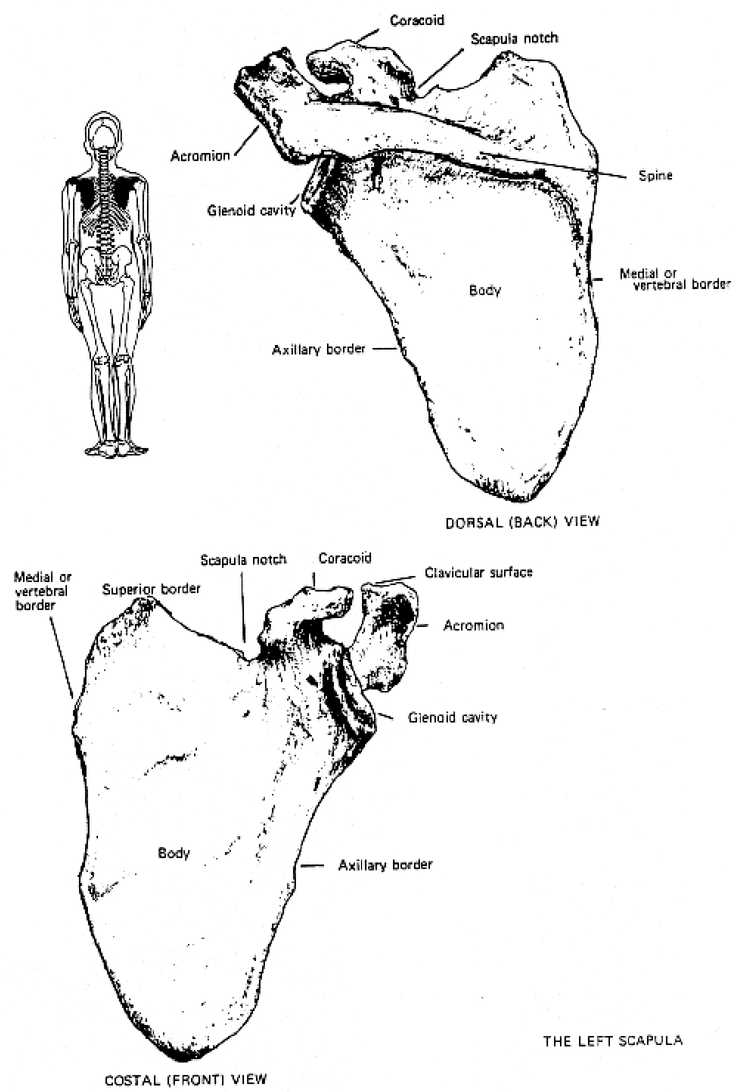


Superior view:	**Inferior view**
A. Sternal (medial) end	**A.** Costoclavicular groove/ Tuberosity
B. Deltoid tuberosity	**B.** Coronoid tubercle
C. Acromial (lateral) end	**C.** Subclavian groove
d. Coronoid Tubercle	**D.** Trapezoid line
	E. Acromial end
	F. Sternal end

THE SCAPULA

The scapulae are flat bones lying against the upper part of the back (the shoulder blade). The body is the large flat triangle (the blade). The flat side of the body lies against the ribs while the spine is

posterior. The coracoid process curls close to the anterior superior part of the upper arm while the acromion process swings higher and wider and articulates with the clavicle. The glenoid fossa is the articular surface for the humerus so that articulation between the acromion and the clavicle protects the upper part of the shoulder joint.
The scapula originates from eight centres of ossification. Of particular value for ageing the acromion fuses at c18-19 yrs while the medial and distal borders are fused by age 20-21. For further details of these ages see Scheuer and Black Juvenile Osteology.



THE LEFT SCAPULA

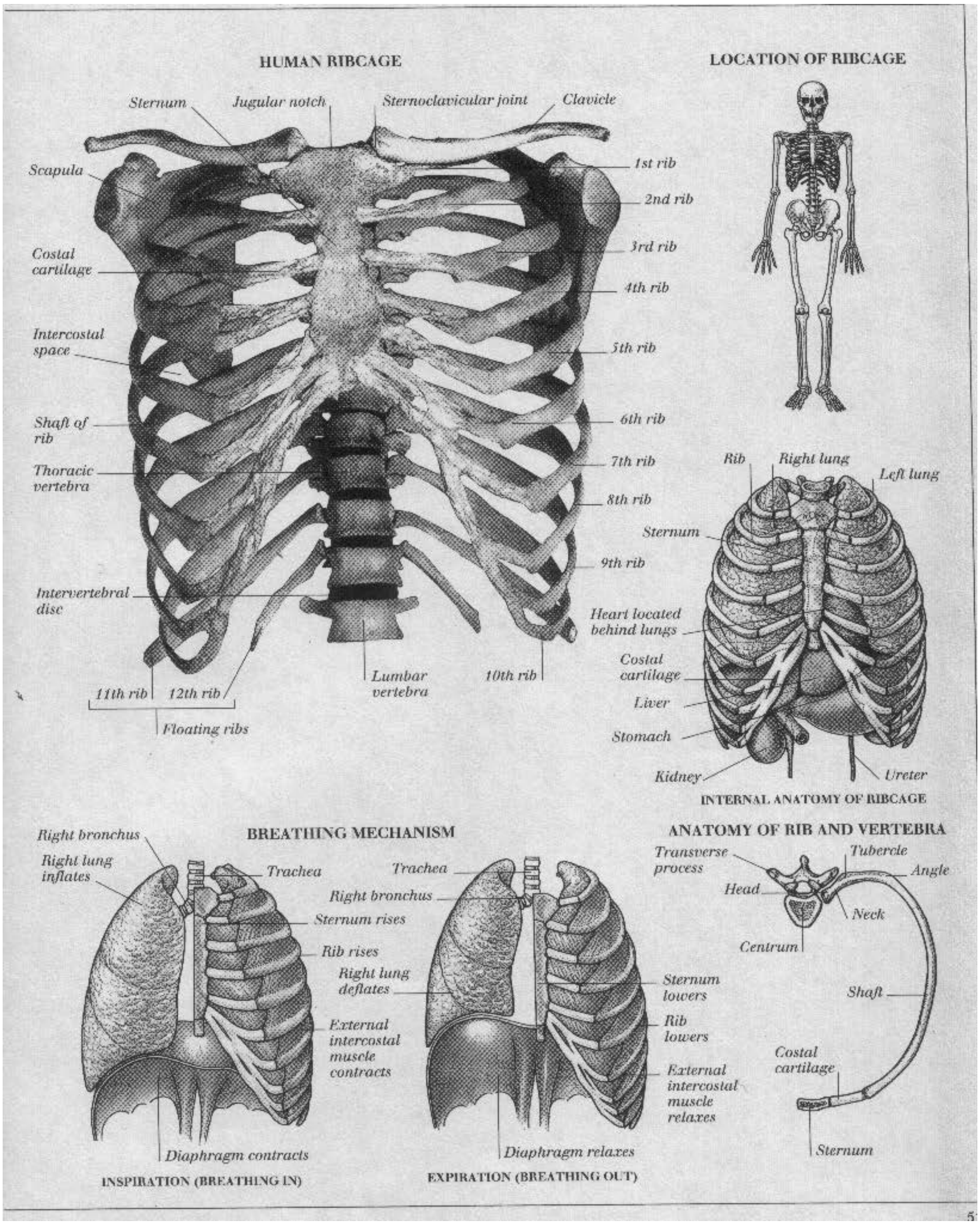
B. RIBS, ASSOCIATED BONES AND FEATURES

BONE	VIEWS	FEATURES	BONES
one true rib (R1 to R7)	inferior	head neck vertebral articular surfaces sternal articular surface	(not applicable)
one false rib (R8 to R10)	inferior	head neck vertebral articular surfaces sternal articular surface	(not applicable)
one floating rib (R11 or R12)	inferior	head neck vertebral articular surfaces	(not applicable)
sternum	anterior	all costal (rib) notches	manubrium body (gladiolus) xiphoid process

The rib cage houses the heart and lungs. In forensics therefore careful examination of the ribs may provide evidence for the determination of the manner of death: cuts trauma, even signs of infection can be identified. But of course, using that evidence depends upon being able to side the ribs and to determine their order

The ribs begin to ossify in about the 8th week intra-uterine. The centre lies near the angle of each rib. Ossification is rapid so that by the end of the fourth month the rib is ossified up to the costal cartilage (joining the rib to the sternum). There are secondary centres for the head and the articular part of the tubercle. These appear around puberty and according to McKern and Stewart fused between 18-24 years of age (Bass 1986).

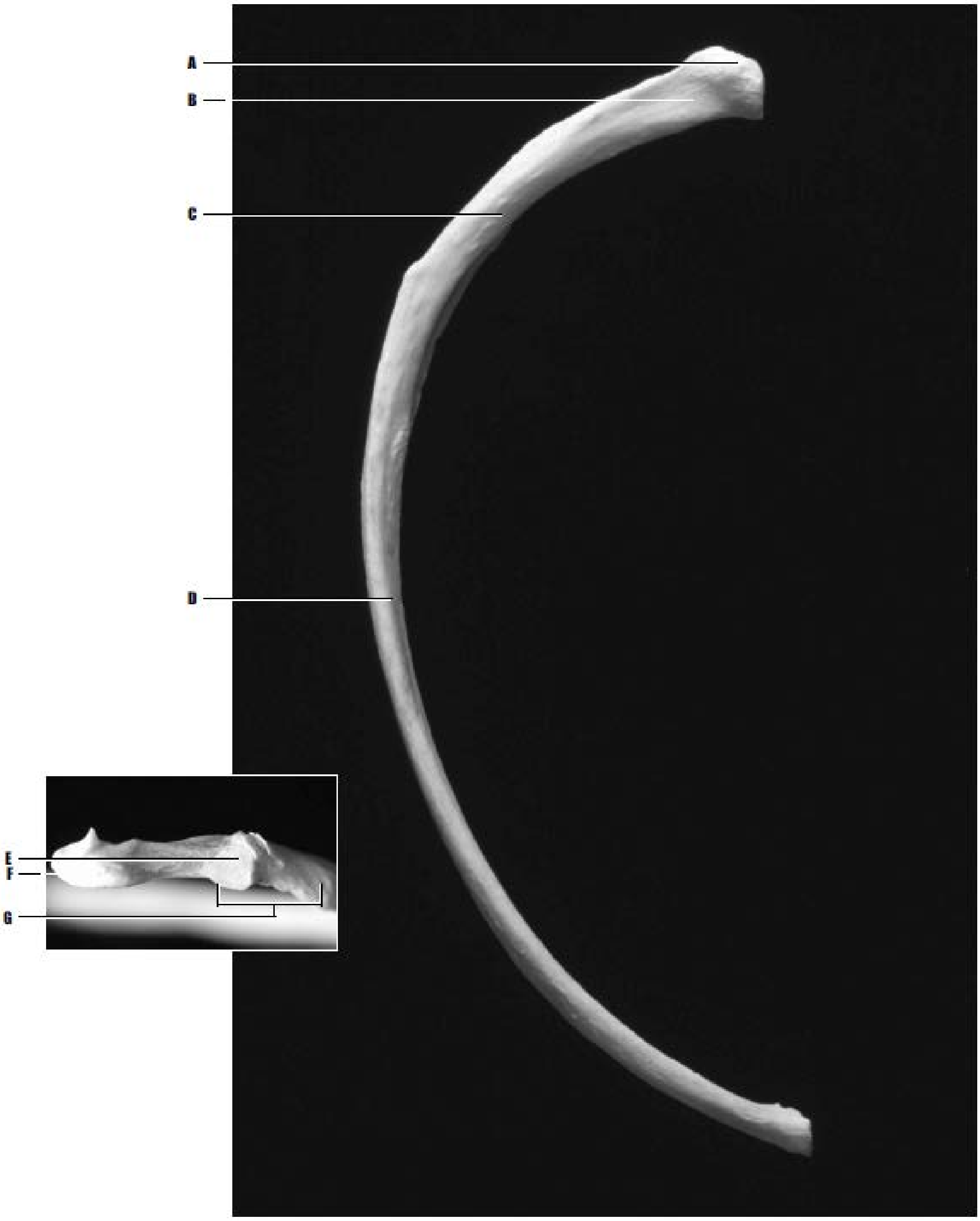
The ribs lie in 12 pairs and are narrow flattened bones which posteriorly articulate with the thoracic vertebrae. At the anterior end the upper seven articulate with the sternum through cartilage (true ribs). Rib 8-10 have cartilage which connects ventrally with the cartilage of the ribs above (false ribs with a vertebrochronral articulation) and the 11-12th ribs are called floating ribs because the ventral extremities do not articulate at all.



The ribs increase in length from the first to the 7th then decrease in length from the 8th to the 12th forming a barrel shaped rib cage.
So a typical rib like the sevent includes:
A vertebral extremeity including a

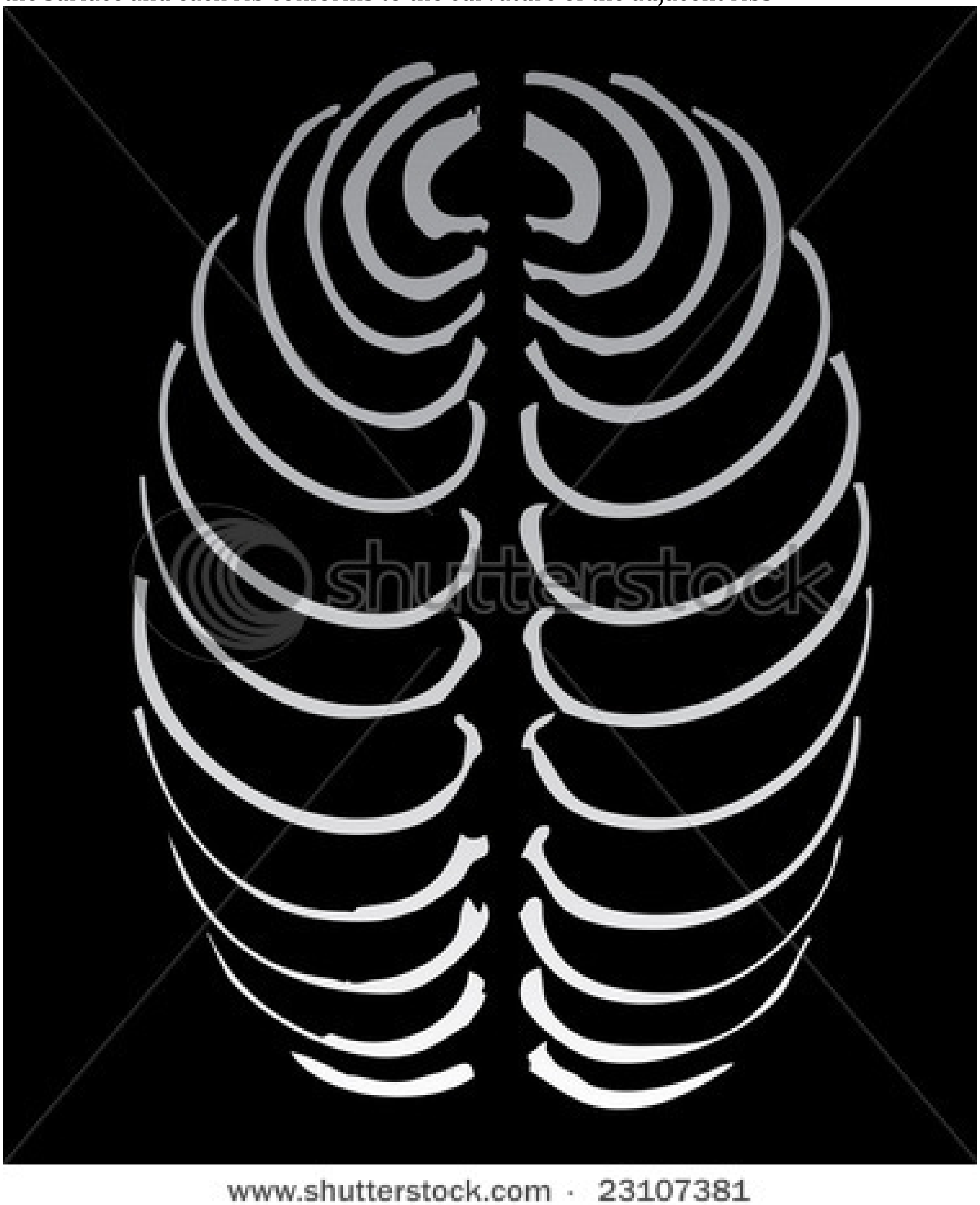
- Head
- Neck
- Tubercle

A shaft or body
A sternal extremely.
The cranial or superior surface is convex and usually fairly smooth (no insertions). The interior or caudal side of the rib is concave and has the costal groove on the lower edge. The cranial edge of the ridge is blunt and rounded while the caudal edge is sharp.



A - head
B - neck
C - angle
D - body
E - facet for articulation with vertebral transverse process
F - articular surface of head
G - tubercle

1. The first rib is the broadest, mot curved and usually the shorted of the ribs. The head has only one articular facet. If you place the rib flat on the table if the head is angled downward and touching the surface of the table the superior surface is facing upward.
2. The second rib is longer than the first, strongly curved but since it is also forming the upper curve of the barrel lies flatter to the table than the ribs below.
3. The two floating ribs #11 and #12 have fan shaped heads and taper at the stern end.
4. Sort the remaing ribs into pairs, the sharper edge and costal groove lie on the inferior or caudal surface. The head is posterior.
5. Start with Rib #1 and then sort the remains from top to bottom (one side only). The shape of the head changes gradually from long and narrow to fan shaped. The necks gradually shorten and the curvature changes. While the ventral surface of the upper ribs faces towards the table, it faces away from the table on the lower ribs.
6. Finally you can check the arrangement. The head of rib #7 or #8 is usually highest form the surface and each rib conforms to the curvature of the adjacent ribs

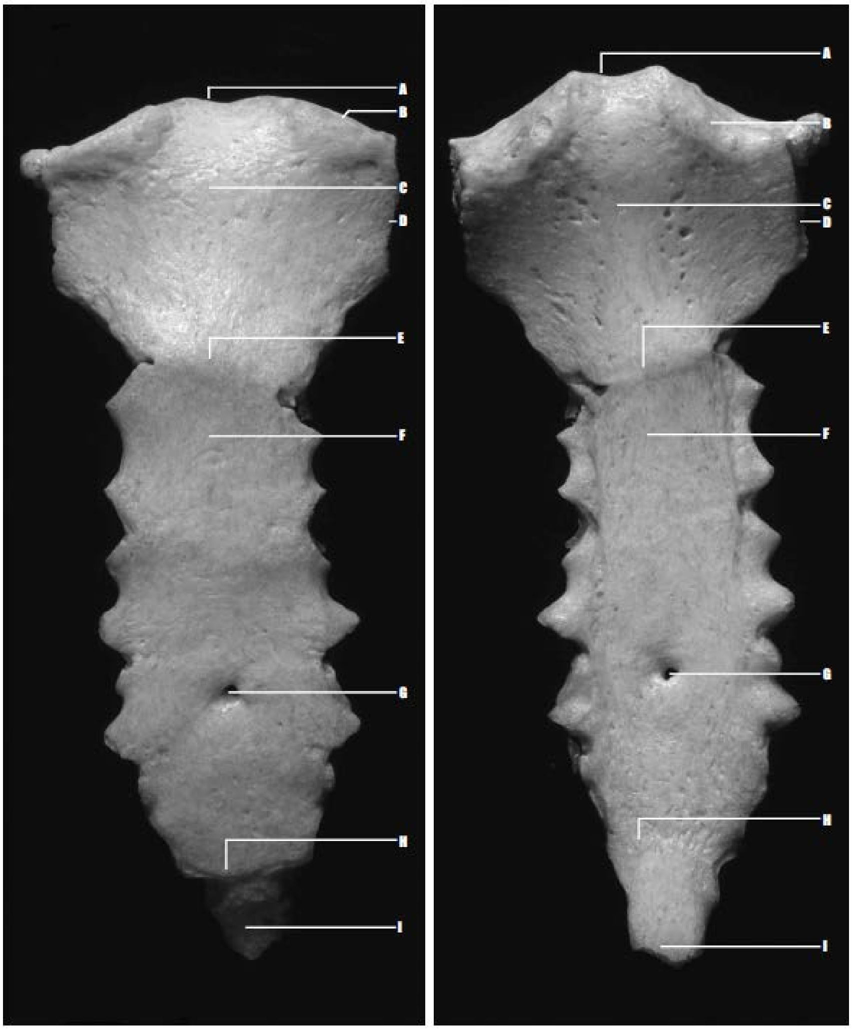


7.

. The rib cage laid out from 1st to 12th ribs, note the size and shape morphology. Occasionally an individual will have only 11 paired ribs or may have an extra pair, this is natural variation. (Image credit: Shutterstock).

THE STERNUM

The sternum or breast bone is located in the ventral wall of the thorax. It has been compared to a broad sword and is a flat bone (often not perfectly symmetrically). It has three main parts:
The manubrium (the upper segment) which has the facets for the sternal end of the clavical and which fuses to the body (not in everyone).
The corpus sternii or body. On either side of this bone are the costal notches where the ribs articulate.
The Xiphoid process or tip – whch is thin and least developed. It is cartilage only in early life, partly ossifying in adults. By old age it tends to become completely ossified and fuses with the body.
The ateernum is slightly concave on the dorsal surface.
In young people the sternum has six segments: the manubrium, the 2nd to 5th segments fuse to form the body and the 6th segment is the xiphoid process.



Anterior and posterior views of sternum

A - suprasternal (jugular) notch; **B** - clavicular notch; **C** - manubrium; **D** - first costal notch; **E** - manubriosternal joint; **F** - body (gladiolus); **G** - sternal foramen (inconstant); **H** - xiphisternal junction; **I** - xiphoid process.

AGE DETERMINATION USING THE RIBS

Rib morphology changes with age. At the sternal ends of the ribs where they are connected by cartilage to the sternum the stresses of movement mean that the bone responds through remodeling and further ossifying the cartilage. This pattern of change has been found by Iscan et al. (1985) to be fairly predictable although the stages do tend to vary with sex. There are casts made by France Casting that assist with applying this method. The method is specific to Ribs 3 or 4 and should be applied with caution to the other ribs only if these ribs are not available. The following images below come from Ramey Burns (1999;37)

CHILD (YOUNGER THAN MID-TEENS)

The rib end begins as a fairly flat surface. The edges are smoothly rounded and the surface is only slightly undulating (Stage 0).


stage 0

TEENAGER+ (MID-TEENS TO EARLY TWENTIES)

The edges are sharper and have a scalloped appearance. The inner surface is beginning to look V-shaped (Stage 1–2).


stage 1


stage 2

YOUNG ADULT (MID-TWENTIES TO EARLY THIRTIES)

The edges are less regular and the centers project further than the superior and inferior edges. The V is deepening (Stage 3–4).


stage 3


stage 4

OLDER ADULT (AGE MID-THIRTIES TO MID-FIFTIES)

The superior and inferior edges have grown to the length of the centers. The V has expanded into a cup-shaped center (Stage 5–6).


stage 5


stage 6

ELDERLY ADULT (OLDER THAN MID-FIFTIES)

The edges are elongated, ragged, and sometimes have a crab-claw appearance. The center is porous and irregular (Stage 7–8).


stage 7


stage 8

Note these age ranges are very loose and imprecise. Given difficulties with the method it does seem appropriate to use these wider age margins.

There are the photographs from Iscan and Loth 1989.

LAB EXERCISES

1. Work in groups and lay out these ribs in order noting as you go the differences in size and shape. Take notes as you go so that you can remember how to esily sort out these elements.

2. We have laid out a cast of a fourth rib end that you can use to determine the phase and consequently the age of this individual. Make sure you describe the sternal end of the rib before you try and decide upon an age. Look for those characteristic features – what is the shape of the surface. What are the shape of the edges. See how much agreement there is between you on these age estimations.

3. We have also laid out a clavicle and scapula – work out which side they come from and identify all the articular surfaces of each. Make a list of those articular surfaces and make sure you can find them all.

WEEK FOUR: THE VERTEBRAE

a. classifying vertebrae
b. identifying individual vertebrae
c. vertebral development
d. vertebral pathology

Aim: By the end of this class you should be able to sort out the vertebrae, identify pathological specimens.

A AND B. THE VERTEBRAE

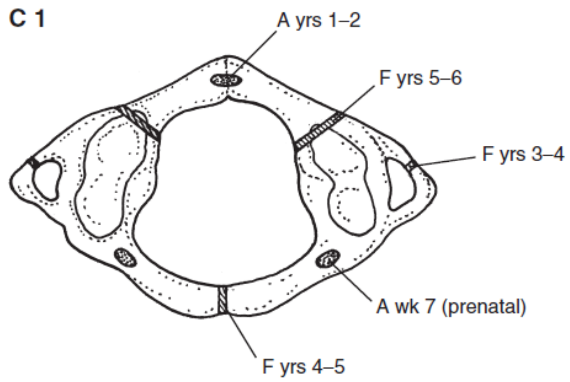
BONE	VIEWS	LANDMARKS
atlas (C-1)	superior	• vertebral foramen • transverse foramina • transverse processes
axis (C-2)	superior	• vertebral foramen • transverse foramina • spinous process • dens
one additional cervical vertebra (C-3, C-4, C-5, C-6 or C-7)	superior	• vertebral foramen • transverse foramina • transverse processes • spinous process • body
one thoracic vertebra (T-1 through T-12)	superior lateral	• vertebral foramen - superior view only • transverse processes • spinous process • body • costal pit(s) - lateral view only
one lumbar vertebra (L-1 through L-5)	superior lateral	• vertebral foramen - superior view only • transverse processes • spinous process • body • inferior articular processes - lateral view only

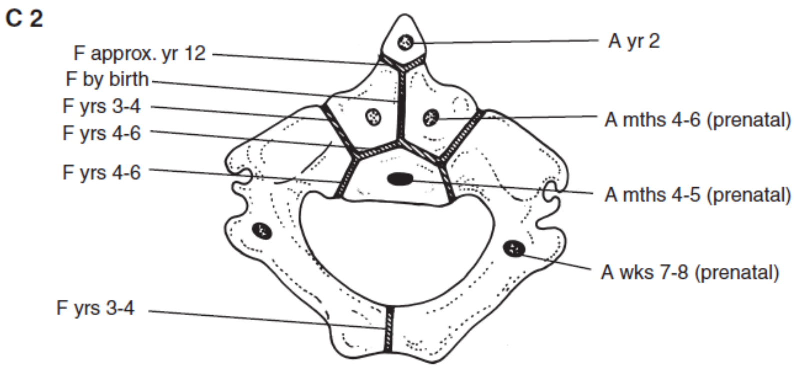
The vertebral column usually has 33 segments (there may be one more or one less vertebra found). The first 24 vertebrae are separate and are movable vertebrae.
All vertebrae are classified to type and function. The first 7 vertebrae are the cervical vertebrae comprising the neck. The next 12 are thoracic vertebrae which carry the ribs. The five lumbar vertebrae of the lower back carry the weight of the upper body and form the lumbar curvature. The sacrum comprises 5 vertebral segments which fuse into the sacrum at adulthood and

articulate with the two os coza of the pelvis. Then there are four small segments, the coccygeal which form the coccyz or tail. (see diagram opposite)

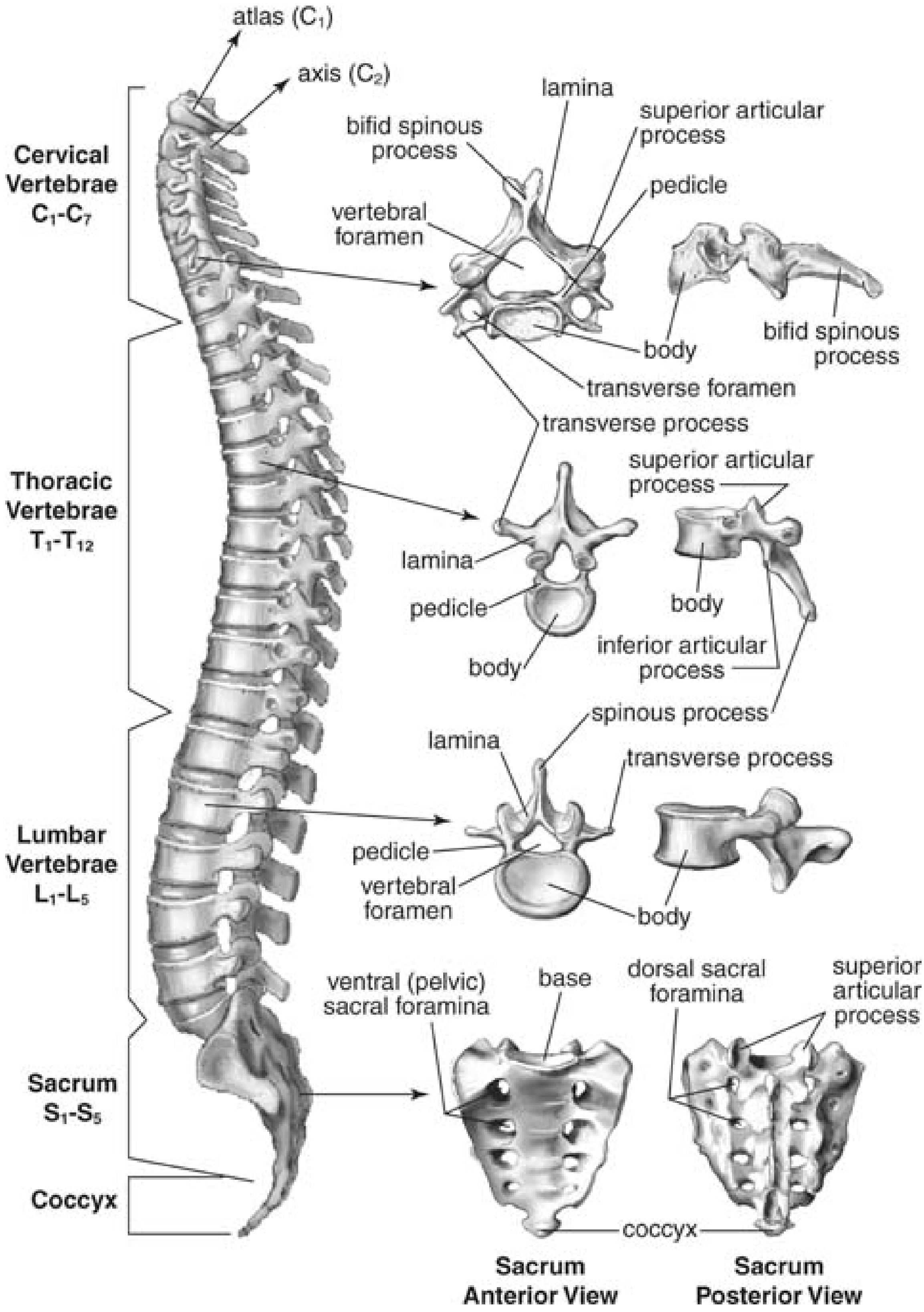
FORMATION OF VERTEBRAE

The vertebrae have three primary centres that appear from 7-20 weeks intra-uterine and five secondary centres that appear around puberty.
At birth each typical vertebrae comprises three separate elements: the centrum (or body) and each half of the neural arch.
Union of the two halves of the arch takes place posteriorly between 1-3 years of age and then the arch fuses to the body between 3-7 years of age. By puberty the vertebrae have reached almost their full size but the epiphyses have not fused. With the exception of the atlas and atlas (C ! and C2) (shown here), all vertebrae have five epiphyses – the lower and upper annual rings (which fuse to the edges of the body), the tips of the spinous process and both transverteverse processes (see opposite). These epiphyses appear around puberty and fused between 17-25 years. (Bass





1986).
The surface of an immature centra (without the rings) have a billowed appearance similar to other unfused epiphyses in the skeleton.


atlas (C1)
axis (C2)
Cervical Vertebrae C1-C7
lamina
superior articular process
bifid spinous process
pedicle
vertebral foramen
body
bifid spinous process
transverse foramen
transverse process
Thoracic Vertebrae T1-T12
superior articular process
lamina
body
pedicle
inferior articular process
body
spinous process
lamina
transverse process
Lumbar Vertebrae L1-L5
pedicle
vertebral foramen
body
ventral (pelvic) sacral foramina
base
dorsal sacral foramina
superior articular process
Sacrum S1-S5
Coccyx
coccyx
Sacrum Anterior View
Sacrum Posterior View

ADULT VERTEBRAE

Cervical Vertebrae (n=7)

The cervical vertebrae articulate the skull (resting on the atlas or C1) to the rest of the body. Therefore these vertebrae have a geat deal of flexibility and are also the smallest vertebrae. All cervical vertebrae have transverse foramina, one on either side of the body.

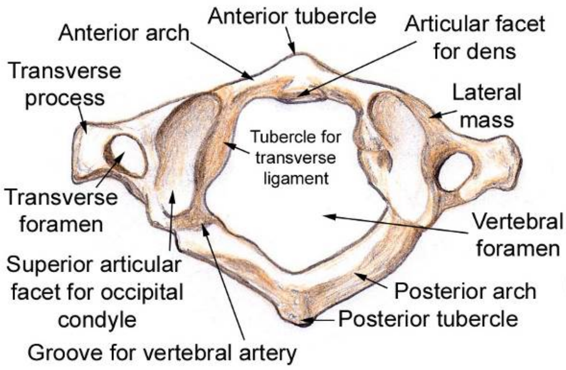
The occipital condyles of the cranium articulate with the atlas which is a ring link bone with no apparent centrum. The atlas rotates in the dens (projection) or odotntoid process of the axis (C2). The dens is actually the body of the atlas. During the foetal period the ossification centre appears as the centrum of the atlas but instead of fusing the C1 neural arches it fuses to the second centrum.

So the atlas is the only true vertebra without a centrum and no spinous sprocess. It is just a large ring.

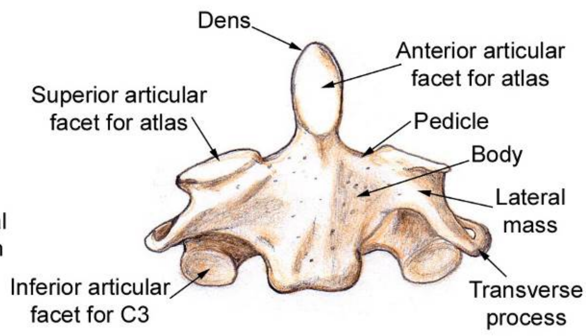
The Axis has the dens projecting cranially and forming a pivot on which the atlas carrying the head rotates. The dens has an articulat facet on its ventral surface for articulation with the atlas.

The rememaining vertebrae have transverse foramine and the body appears lower than at the sides.

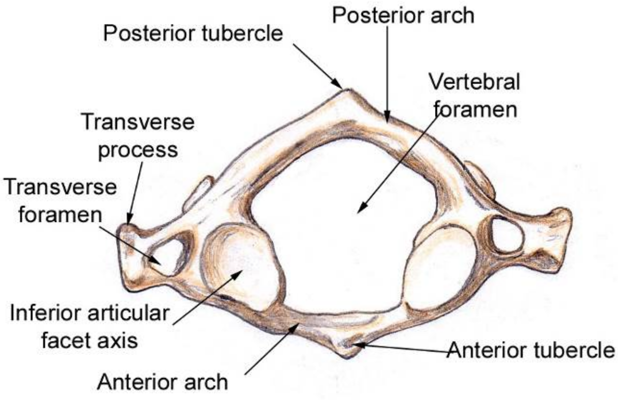
The 7th certebical vertebra is transition between the cervical and the thoracic so while it still has the transverse foramina it has the largest body of the cervical vertebra and the lower edge of the body is straight.



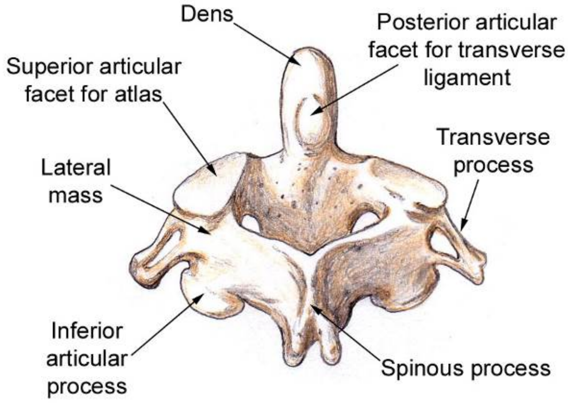
Atlas (C1): superior view



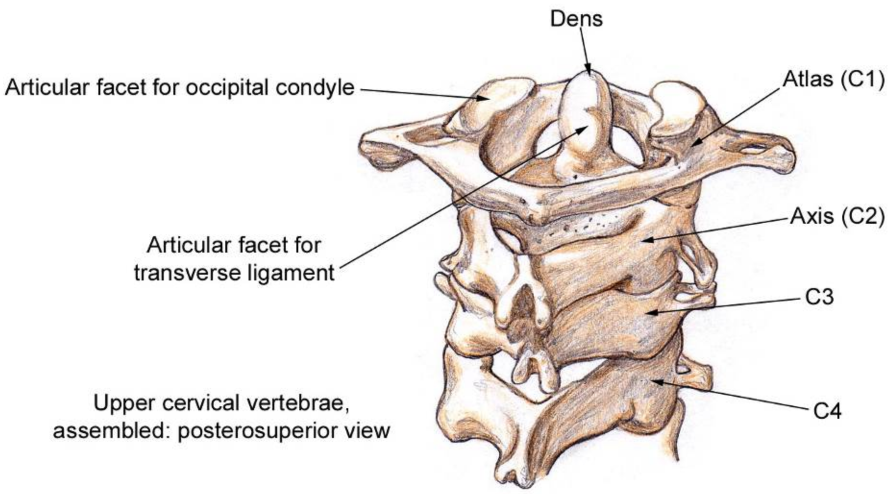
Axis (C2): anterior view



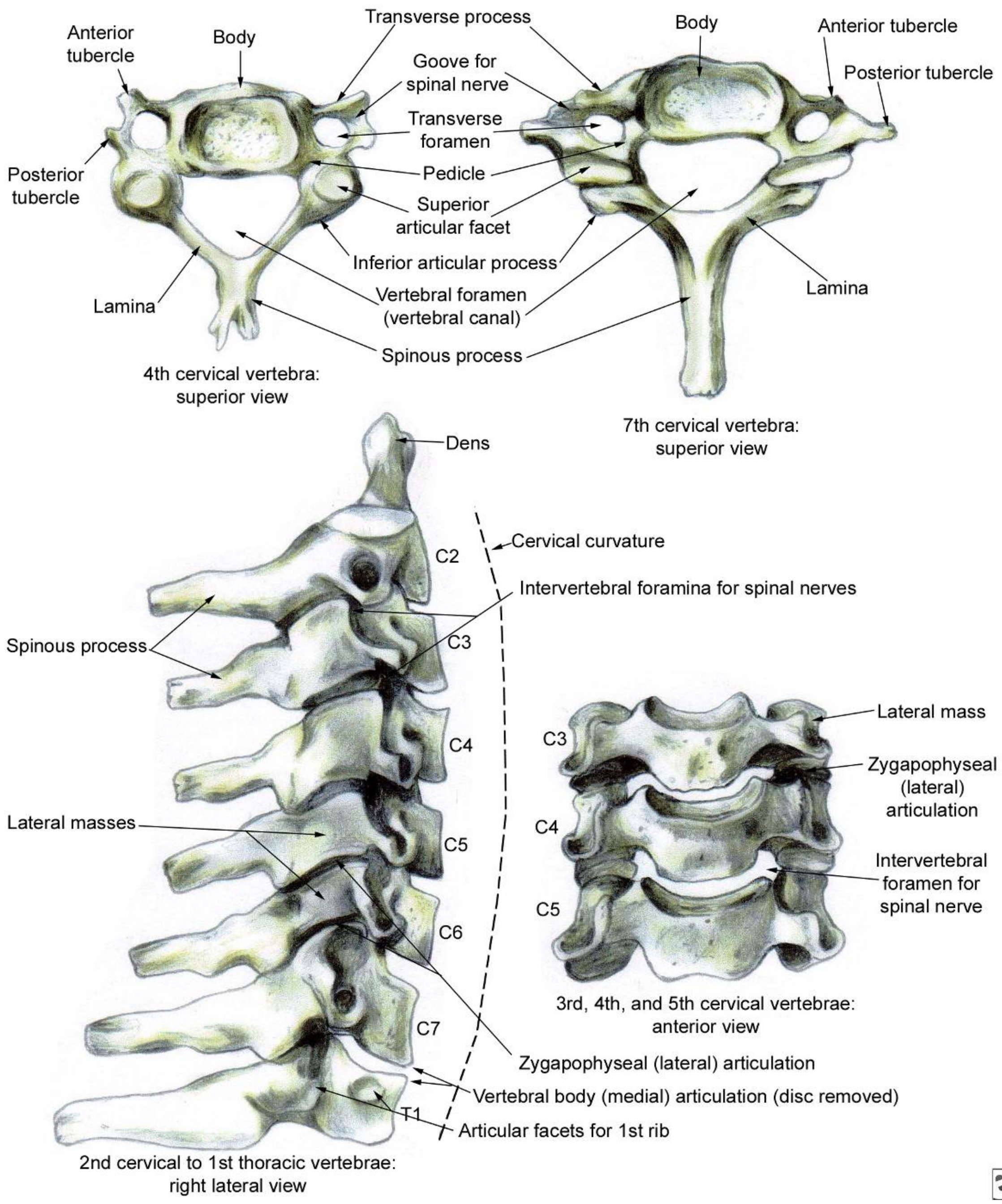
Atlas (C1): inferior view



Axis (C2): posterosuperior view

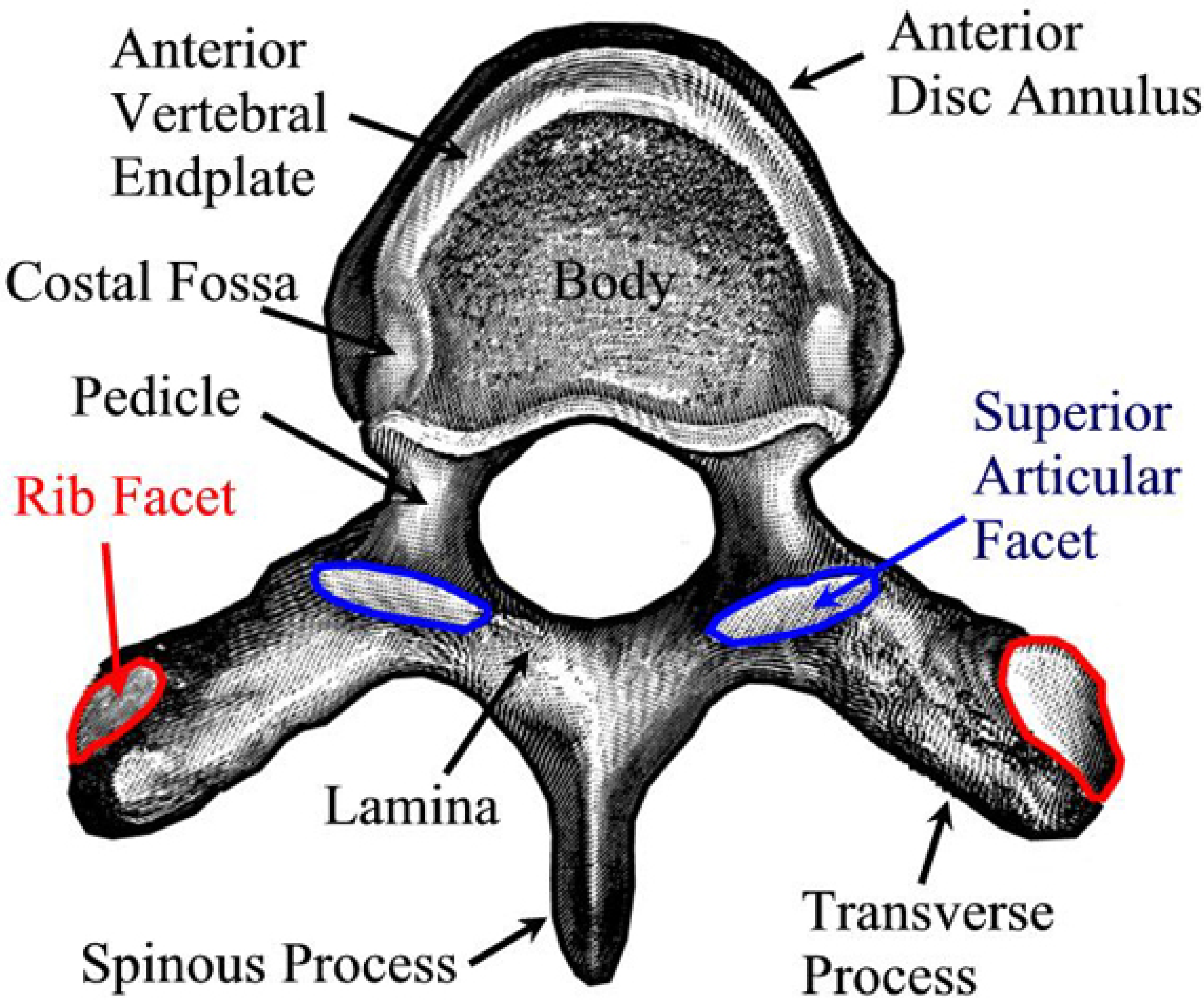


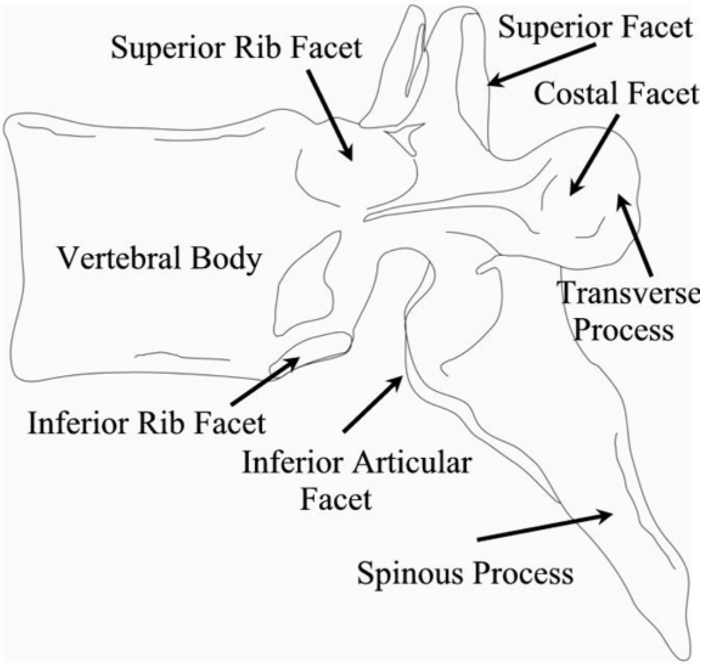
Upper cervical vertebrae, assembled: posterosuperior view

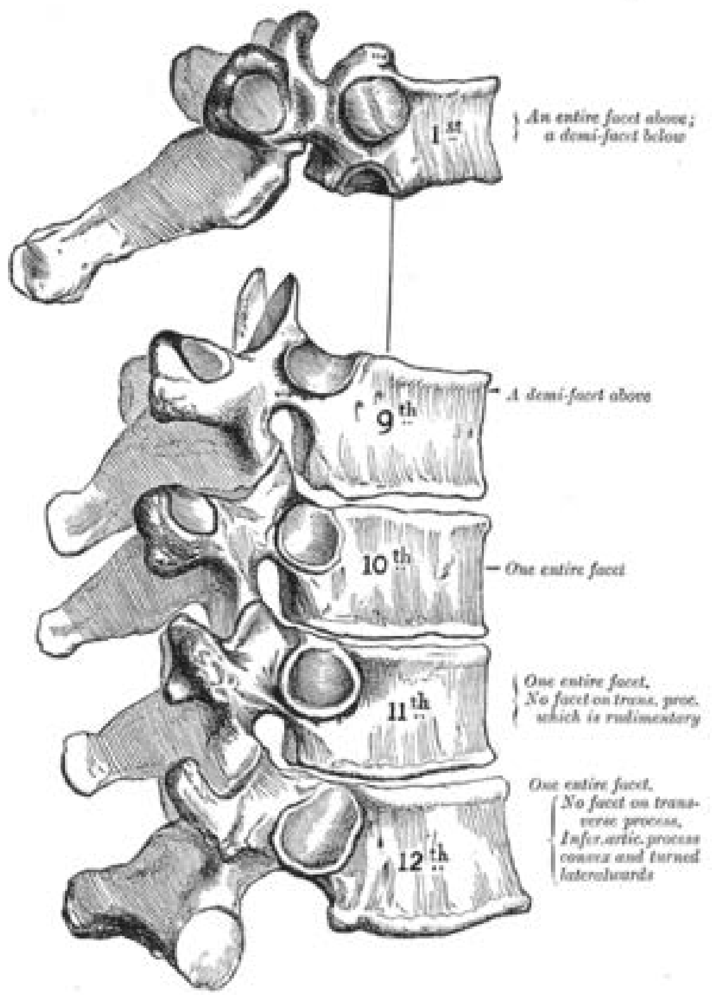

Anterior tubercle
Body
Transverse process
Goove for spinal nerve
Transverse foramen
Pedicle
Superior articular facet
Inferior articular process
Posterior tubercle
Lamina
Vertebral foramen (vertebral canal)
Spinous process
4th cervical vertebra: superior view
Body
Anterior tubercle
Posterior tubercle
Lamina
7th cervical vertebra: superior view
Dens
Cervical curvature
C2
Intervertebral foramina for spinal nerves
Spinous process
C3
C4
Lateral masses
C5
C6
C7
T1
Lateral mass
C3
Zygapophyseal (lateral) articulation
C4
Intervertebral foramen for spinal nerve
C5
3rd, 4th, and 5th cervical vertebrae: anterior view
Zygapophyseal (lateral) articulation
Vertebral body (medial) articulation (disc removed)
Articular facets for 1st rib
2nd cervical to 1st thoracic vertebrae: right lateral view

Thoracic Vertebrae (n=12)

There are 12 thoracic vertebrae which support the 12 ribs. So each thoracic vertebrae is characterised tbe presence of costal pits or fossa on the sides of the body and on most of the transverse processes except T11 and T12. These pits vary down the vertebral colum so:
T1 has a whole and a half costal pit
T2-9 all have half pits, one each on the superior and the inferior body
T10 has a whole pit on the body and on the tranverse process
T11 has a whole pit on the body but none on the transverse process
T12 looks like T11 but the inferior articular surfaces are not parallel and assume the lumbar patter (curving inward).

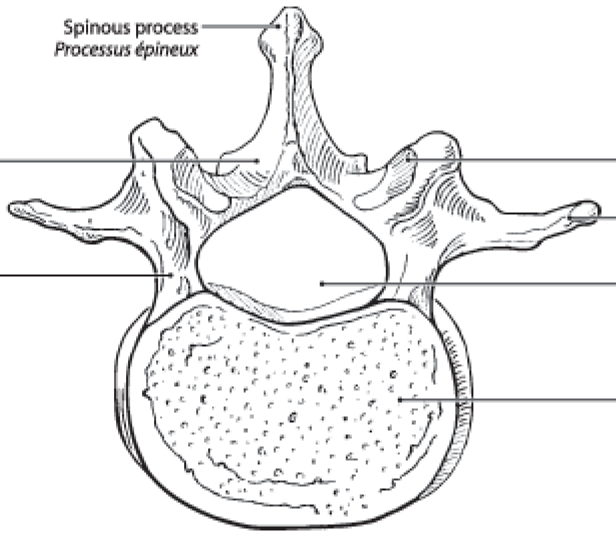



Superior Rib Facet
Superior Facet
Costal Facet
Vertebral Body
Transverse Process
Inferior Rib Facet
Inferior Articular Facet
Spinous Process

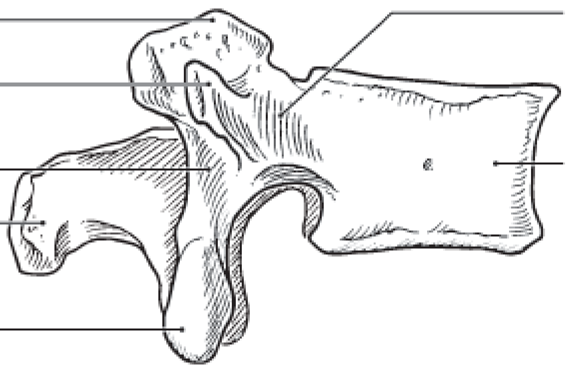

1st
An entire facet above; a demi-facet below
9th
A demi-facet above
10th
One entire facet
11th
One entire facet. No facet on trans. proc. which is rudimentary
12th
One entire facet. No facet on transverse process. Infer. artic. process convex and turned lateralwards

Lumbar Vertebrae (n=5)

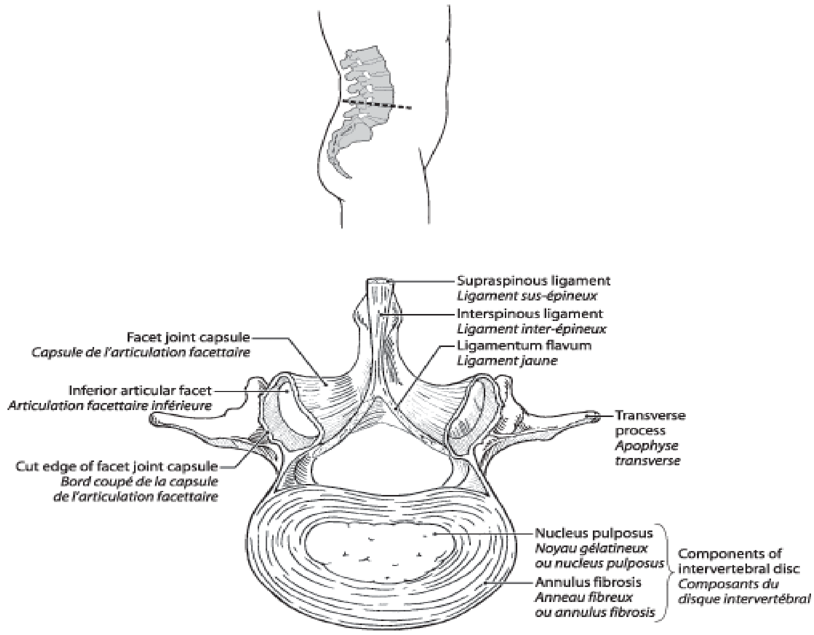
The five lumbar vertebrae support the weight of the body. They have neither transverse foramina nor costal pits. They have transverse spines that slant upward, a large and more horizontal spinous process, and the superior and inferior articular facets are U shapes (compared to the parallel arrangement of the cervical and thoracic vertebrae. This shape serves to limit the range of movement in the lumbar vertebrae.



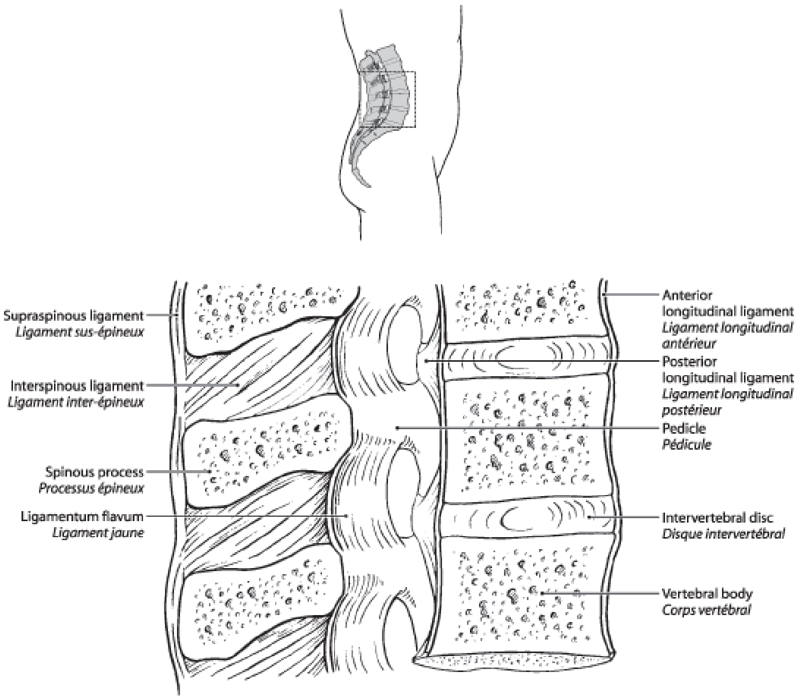
Normal lumbar vertebra, seen from above
Vue supérieure d'une vertèbre lombaire normale



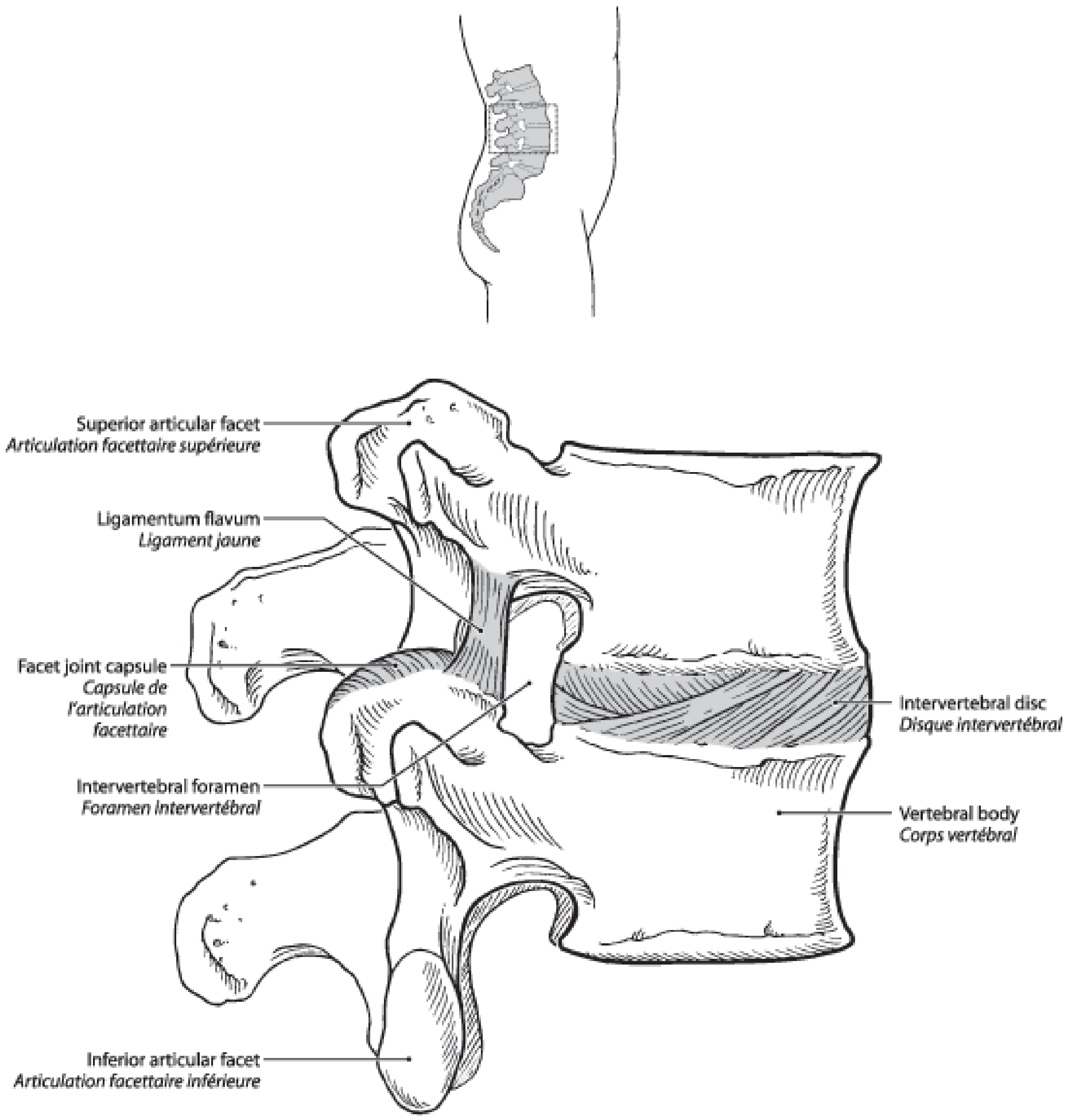
Normal lumbar vertebra, side view
Vue latérale d'une vertèbre lombaire normale



Cross-section through normal intervertebral disc showing various ligaments
Coupe transversale d'un disque intervertébral normal montrant les différents ligaments



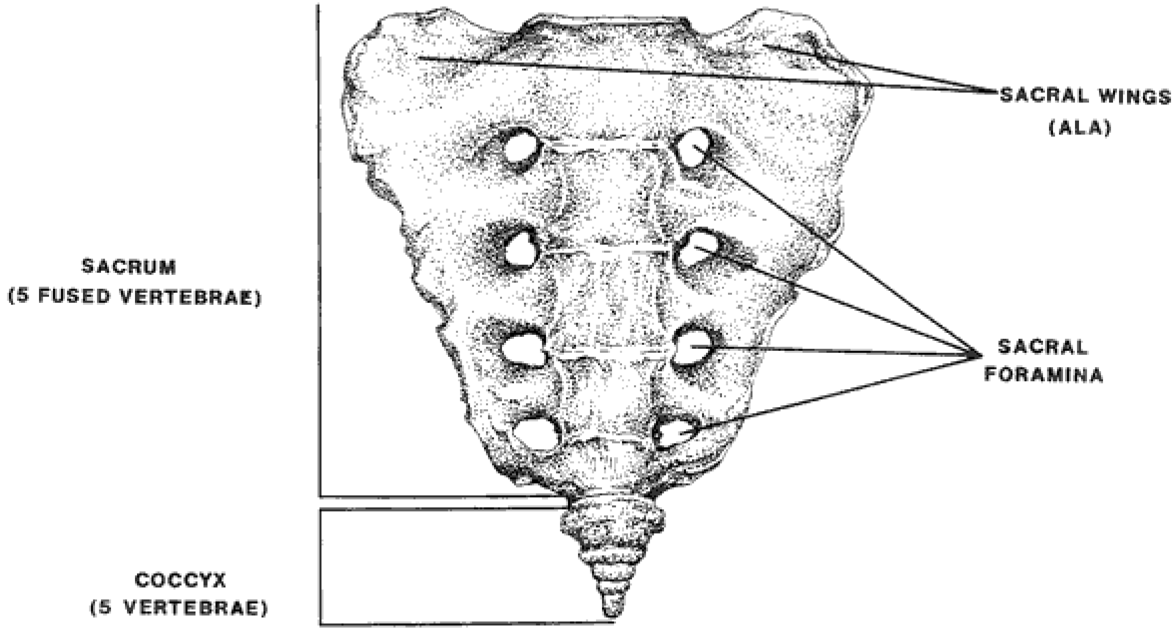
Midline section through the vertebral column and principal ligaments
Coupe médiane à transvers la colonne vertébrale et les principaux ligaments

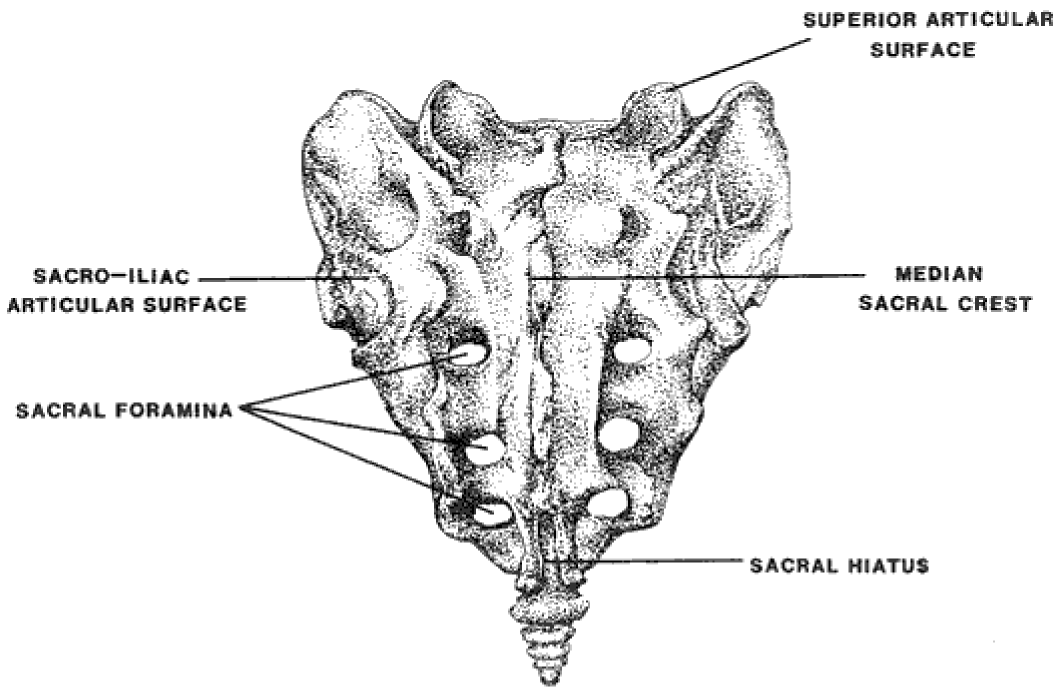


Side view of normal vertebrae showing ligaments and intervertebral disc
Vue latérale d'une vertèbre normale montrant les ligaments et le disque intervertébral

Saccrum (n=5 segments)

The sacral vertebrae are separate segments in a child. Each segment has the typical vertebrae's centra and two neural arches as well as two costal elements (except S4 and S5 – no costal segment). The costal elements begin to fuse around puberty which is the same time epiphyseal rings for the bodies appear. Thee bodies fuse together into a single bone in the 18-25 year age range. Later on the coccyz often fuses to the sacrum.
So the adult sacrum is a wedge shaped bone that firmly connects to the two os coxe at the sacro-iliac joint formed by the sides of the three first segments.

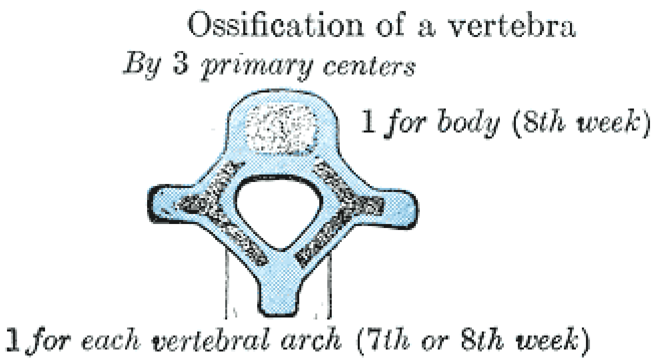




C

Coccygeal vertebrae (coccyx n=4)
The first segment is distinctive but the other segments are very small and highly variable. It is common for these four segments to fuse with the sacrum

C. DEVELOPMENT OF VERTEBRAE



Order of fusion

Neural arch to Neural arch

Neural arch to centrum

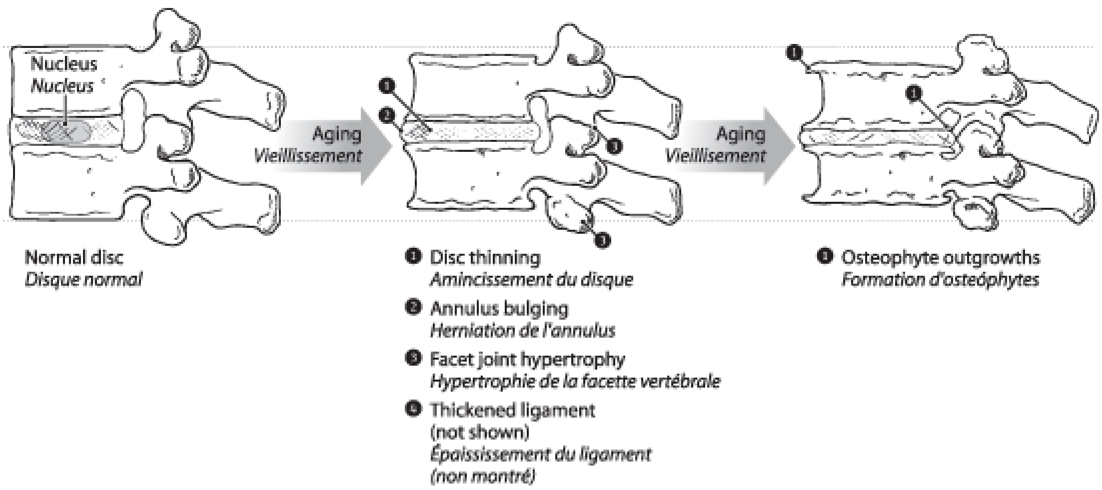
Epiphyseal rings to centrum

D. AGING CHANGES IN THE LUMBAR SPINE

http://www.wsiat.on.ca/english/resources/medical/mlo/back_screen.htm

Any discussion of back pain is often dominated by the term "Degenerative Disc Disease". This is an inappropriate phrase because what is being described is usually not a disease but normal aging change. A better description would be "age related" change. This normal process produces typical x-ray and CT or MR changes which are commonly misinterpreted by physicians as being evidence of something abnormal. In turn this may lead to unnecessary investigation and, sometimes, surgery.

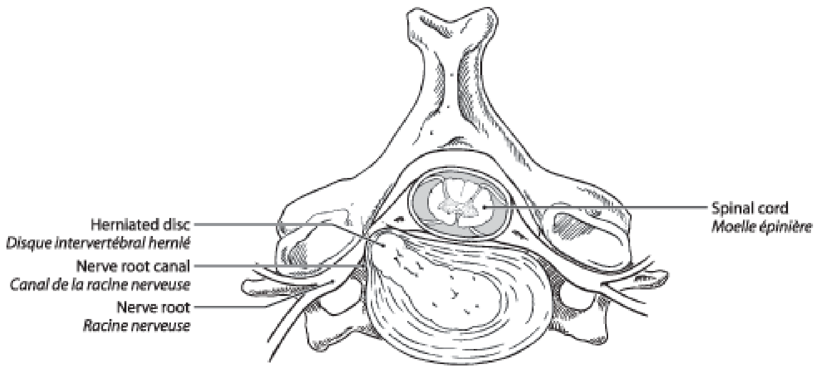
With gradual aging, there is loss of water from the nucleus pulposus with resulting thinning of the disc space between the adjacent vertebrae and this can be seen on plain x- rays. The narrowing of the disc space causes the annulus fibrosis to "bulge" and this can be seen on CT or MR scans. It does not usually cause symptoms but if the bulging is excessive one or more nerve roots may be compressed with resultant symptoms. The bulge is centrally located and as there is usually plenty of room in the spinal canal nerve roots are rarely compressed. A lateral bulge, if very large, may sometimes compress a nerve root. This process of bulging is not the result of trauma. Aging is often associated with the formation of a bony out growth (spur, osteophyte, exostosis) at the periphery of the vertebral body. Another result of the height loss is that the facet joints are distorted. This can cause wear and tear changes in them (described as "facet arthritis"). Sometimes the disc narrowing is accompanied by backward ("retrospondylolisthesis") or forward (degenerative or pseudo spondylolisthesis) displacement of the upper vertebra on the lower. These tongue twisters simply mean slipping of a vertebra (spondylos=vertebra, listhesis=slip, retro=backwards). (True as opposed to pseudo spondylolisthesis is the result of a bony defect in the structure of the vertebra and will be discussed later). The incidence of these aging changes is affected by heredity and race. Some families are predisposed to develop marked changes at an early age. There is no convincing evidence that these changes which are so obvious on the x- ray or scans cause pain. In most people who have back pain in the presence of aging change, the pain is the result of ligament or muscle strain and not because of the age change seen in the x- ray.



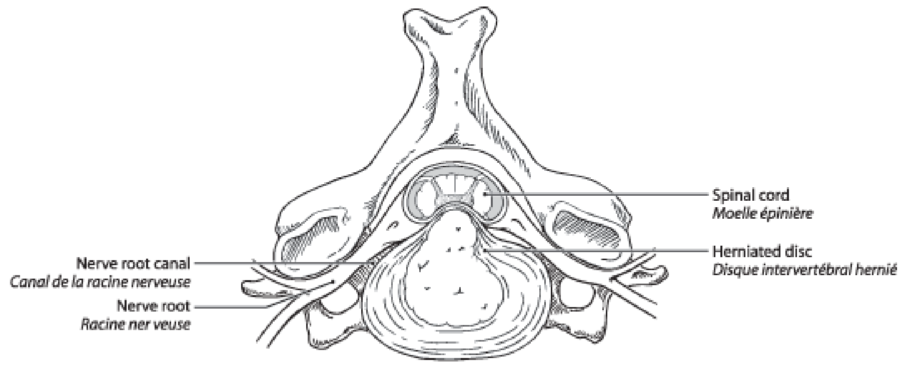
Progressive changes in the normally aging spine
Changements progressifs observés dans le vieillissement de la colonne vertébrale

There are three conditions in which aging may cause symptoms: 1) a disc problem (herniated, sequestrated, ruptured disc); 2) spinal stenosis (narrowing of the spinal canal); and 3) facet arthritis.

Cross-sections of the cervical spine at the level of a herniated disc
Coupes de la colonne cervicale au niveau d'un disque intervertébral hernié

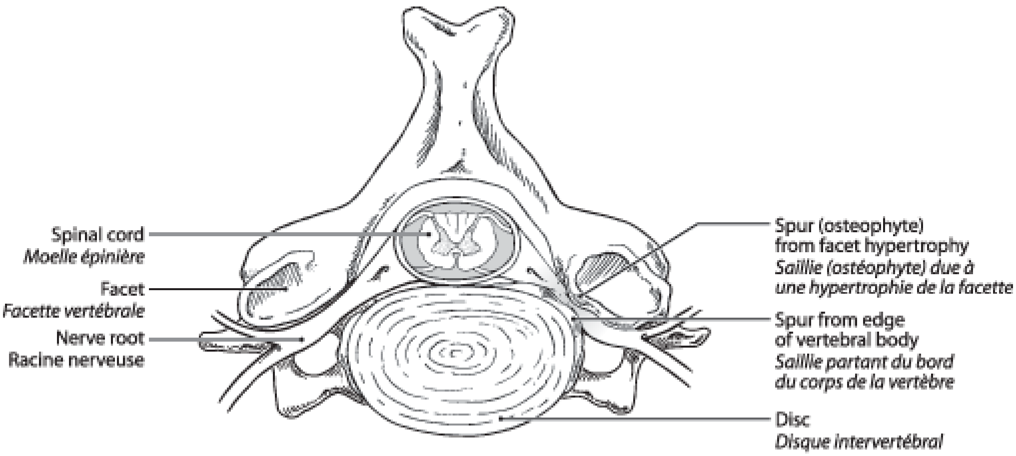


A laterally located ruptured nucleus pulposus compressing the nerve root in its canal.
Le noyau gélatineaux (nucleus pulposus) dont la hernie lateral comprime la racine nerveuse dans son canal.



A midline ruptured nucleus pulposus pressing on the spinal cord, but sparing the nerve root.
Le noyau gélatineaux (nucleus pulposus) dont la hernie médiane comprime la moelle épinière mais n'affecte pas la racine nerveuse.

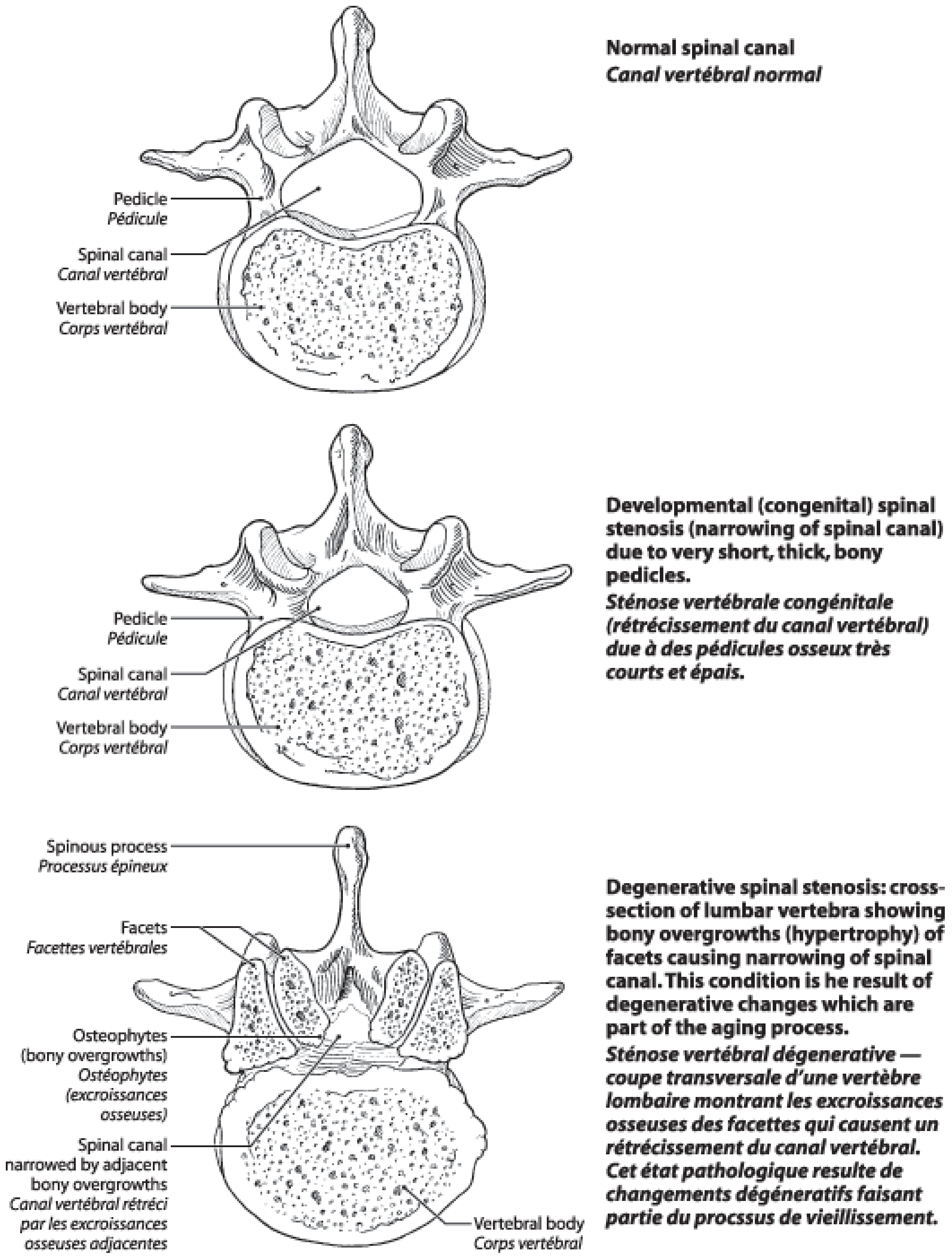
Sometimes some fibres of the annulus fibrosis may give way or tear, either spontaneously or from an injury, resulting in back pain. This usually heals in a few weeks with resolution of the pain. However a tear may allow some of the nucleus pulposus to protrude into or even completely through the annulus (called "herniation" or "sequestration"). This may or may not irritate or compress one or more nerve roots (Figs. 9,10). Even so, the great majority of patients with such a protrusion or rupture get better in a few weeks with healing of the tissues and resolution of the pain. A few such patients fail to get better and may require surgery. A few others may get better but are vulnerable to recurrent pain in the future.



Cross-section of the cervical spine showing compression of the nerve root due to the narrowing of the nerve root canal by osteophyte outgrowths
Coupe de la moele épinière montrant une compression de la racine nerveuse due au rétrécissement du canal de la racine nerveuse par des ostéophytes

In spinal stenosis, the gradual formation of bony outgrowths narrows the spinal canal and the openings through which the spinal nerves emerge. This condition is not caused by trauma. In people who have a small diameter spinal canal to begin with, the nerve roots are more vulnerable to compression. This narrowing of the spinal canal produces numbness and weakness ("my legs feel rubbery") in the legs, typically brought on by walking and disappearing slowly with rest. If the symptoms are severe and disabling, surgery to decompress the affected nerve roots may be required.

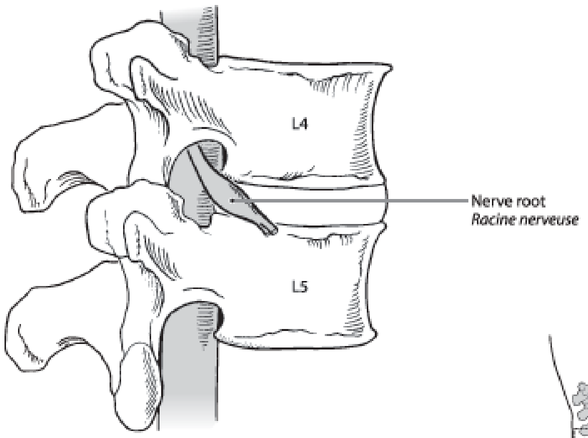
The above pre-existing conditions, can become symptomatic following trauma. In the case of a herniated disc, presumably the nucleus pulposus had worked its way partially through the annulus fibrosis but not far enough to produce symptoms. Then an injury, sometimes relatively trivial, permits the nucleus to escape completely. In the case of spinal stenosis, the canal is already narrowed but not sufficiently to cause symptoms. Then if an injury causes a disc to bulge or herniate, further narrowing the spinal canal, symptoms are produced. Facet arthritis is the result of loss of disc height distorting the facet joints. It can be the cause of chronic intermittent back ache. When seen soon after an injury it is a pre-existing condition as it takes years for the x- ray changes of facet arthritis to occur. Whether or not it is aggravated by trauma is a moot question. For this to be true, the injury would probably have to be severe rather than a simple lifting strain.



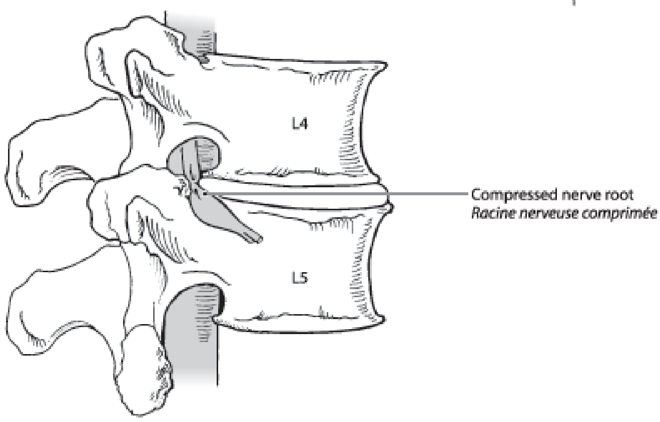
Other Abnormalities of the Lumbar Spine

1) Spondylolysis and Spondylolisthesis

In spondylolysis (Fig. 8) the pars interarticularis instead of being made of bone is made of gristle. As the gristle is not calcified, it appears as a defect in the x- ray. This is spondylolysis. While the gristle is very strong it is not as strong as bone. Over time it may stretch permitting the upper vertebra to slip forward on the lower one. This is spondylolisthesis. Both spondylolysis and spondylolisthesis occur most commonly in the 4th and 5th lumbar vertebrae.

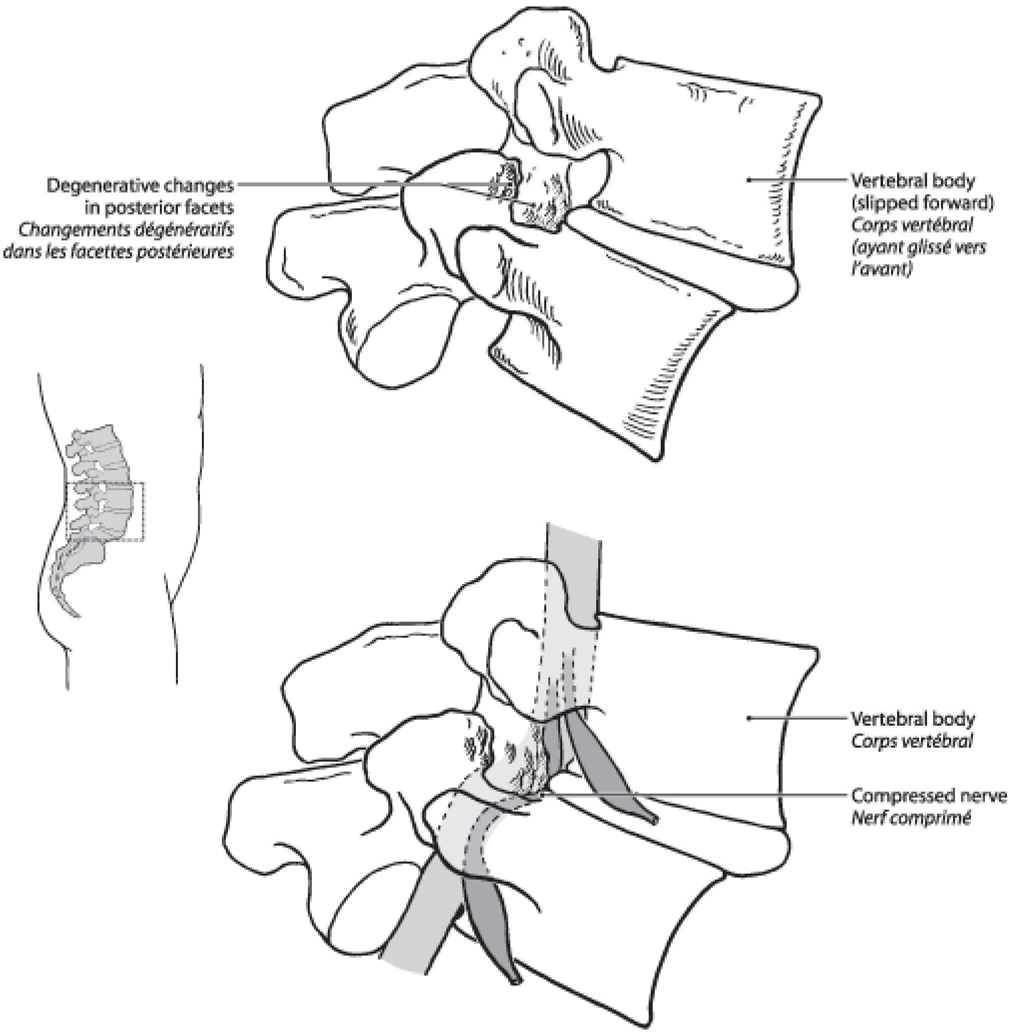


Normal relationship of vertebrae with normal nerve root foramen
Relation normale des vertèbres avec le foramen: la racine nerveuse n'est pas pincée



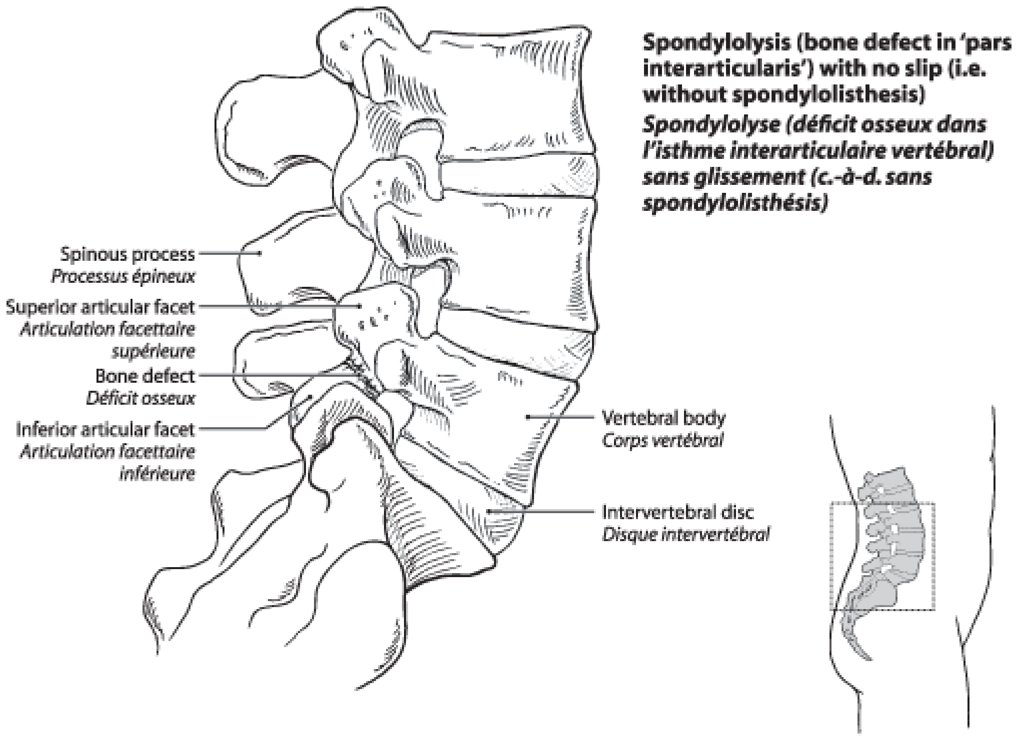
Backward slip (retrospondylolisthesis) of L4 upon L5 caused by degenerative weakening of ligaments and facet joints
Glissement vers l'arrière (rétrolisthésis) de L4 par rapport à L5 causé par un affaiblissement de type dégénératif des ligaments et des articulations facettaires

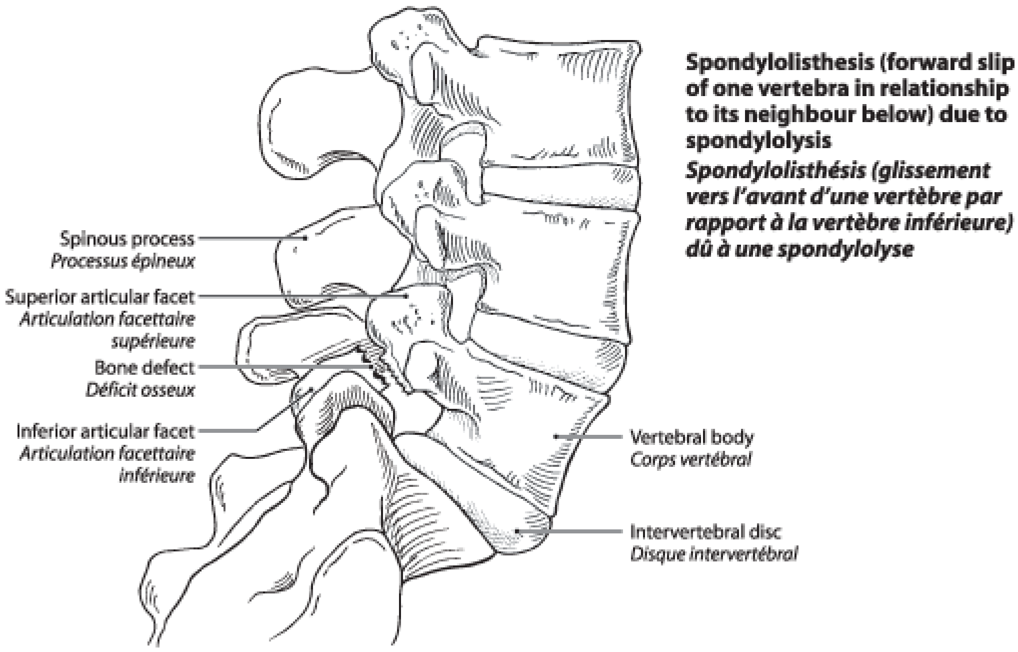
The exact cause of spondylolytic spondylolisthesis is unknown. It occurs in 5% of Caucasians and in almost 20% of Inuit. There is no clear evidence that it is caused by trauma. It is commoner in ballet dancers and acrobats who arch their backs a lot. The majority of people with it have no symptoms. But symptoms (back ache) can occur in a person with pre-existing and painless spondylolisthesis as the result of a strain or repetitive lifting. Once symptoms commence, they tend to recur.



Degenerative spondylolisthesis — forward slip of L4 upon L5 vertebra due to degenerative changes in ligaments and facet joints. Lower picture shows how nerve root may be compressed.

Spondylolisthésis dégénératif — glissement vers l'avant de L4 sur L5 dû à des changements dégénératifs dans les ligaments et les facettes articulaires. Le deuxiéme croquis montre comment la racine nerveuse peut-être comprimée





2) Sacralisation of the 5th lumbar vertebra

In this congenital condition, the lowest (5th) lumbar vertebra is fused to the sacrum, reducing the number of joints in the lumbar spine from 5 to 4. It does not cause symptoms. There may be more than usual wear and tear of the next disc up (between L4 and L5) causing premature aging change in some patients. Often the transverse process of the 5th lumbar vertebra is connected to the pelvis by means of a false joint (pseudoarthrosis) but this does not cause pain.

3) Lumbarisation of the 1st sacral segment

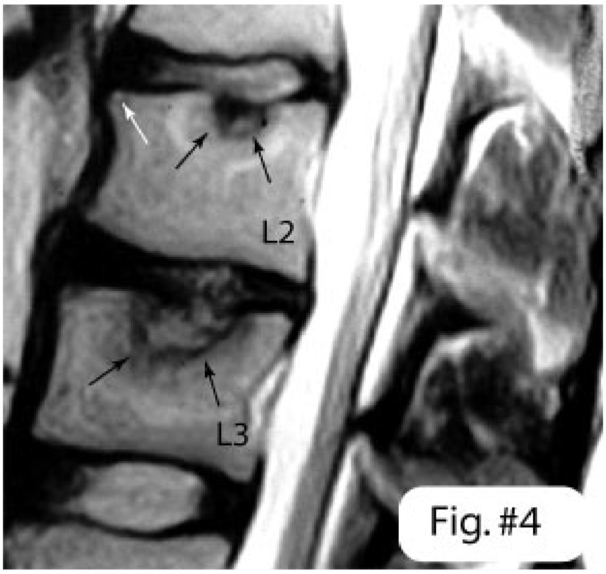
In this congenital condition the first sacral segment is separated from the second by a true intervertebral joint, increasing the number of joints in the lumbar spine from 5 to 6. It does not cause symptoms.

4) Ankylosing Spondylitis (Marie Strumpell disease, Bechterew's disease)

This is an inflammatory arthritis that affects the spinal column, sacro-iliac joints and sometimes the hips. It occurs almost exclusively in young males. Its cause is unknown. It produces fusion of the spinal column, sometimes in a flexed position so that victims of it have trouble seeing where they are going. It is characterised by intermittent flare ups of back pain often with leg radiation so that it can mimic a herniated disc. Eventually the process "burns out" leaving the patient with a stiff but painless spine. Although some authorities believe that trauma plays a role in its onset, the evidence is that it is not caused by trauma.

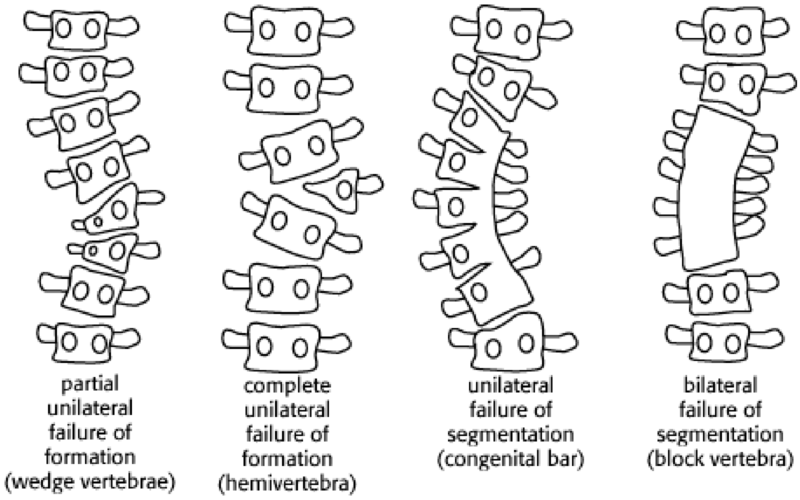
6 Schmorl's Nodules.

These are indentations of the nucleus pulposus into the body of the vertebra above. They are normal and are never a source of pain.



Schmorl's Nodes *(SNs): On this lateral T2-weighted MRI image, we have and example of two SNs, which are one of the most common type of end-plate disruptions. These typically occur in around 50% of the population, usually in the thoracolumbar junction (T12, T11, & L1) (34). Often, SNs are rather small in size but if they get big (as depicted in fig.#4), not only can they cause back pain, but they may also trigger the DDD process via a fatal loss of hydrostatic nuclear pressure (see more on this below). Note the disc below the L3 vertebra is white, healthy, and non-degenerated. The L3 disc (between L2 and L3) has been prematurely degenerated (black appearance) as the result of a huge traumatically induced Schmorl's Node (white arrows) which occurred as the result of a ski* *jumping accident. The L2 upper front corner of the vertebra has suffered an old compression fracture (white arrow) and another good sized SN is noted in the upper vertebral end-plate. The disc, although not as arid, has collapsed by about 50% (as has the L2/3 disc) which is classic of DDD.*

DEVELOPMENTAL DEFECTS



Vertebral Osteophytosis

Vertebral osteophytes were visually assessed according to a method devised by Stewart (1958) and Nathan (1962) (Figure 1). Osteophytic variation was scored from 0 to 4 depending on the severity of the projections. A score of 0 was given if there was no indication of osteophytosis (Stewart, 1958; Steinbock, 1976). Score 1 was assigned if only single points of osteophyte development were visible on the body, with slight lipping being present on the superior and inferior margins (Nathan, 1962; Steinbock, 1976). A score of 2 was given if more developed lipping was visible on the margins. These bony protrusions project almost horizontally from the vertebral body (Nathan, 1962). Score 3 indicated advanced lipping (Steinbock, 1976). These osteophytes assumed a very characteristic shape of a bird's beak, with the free end curving in the direction of the closest intervertebral space. Often in this phase, free ends of spurs on adjacent vertebrae come into close contact with each other (Nathan, 1962). A score of 4 was assigned to osteophytes of two or more adjacent vertebrae that fused together (Nathan, 1962; Steinbock, 1976).
But there are differences in the types of bony outgrowth that occur and these different forms have different names and are associated with different disease processes. It is important to recognise these differences.

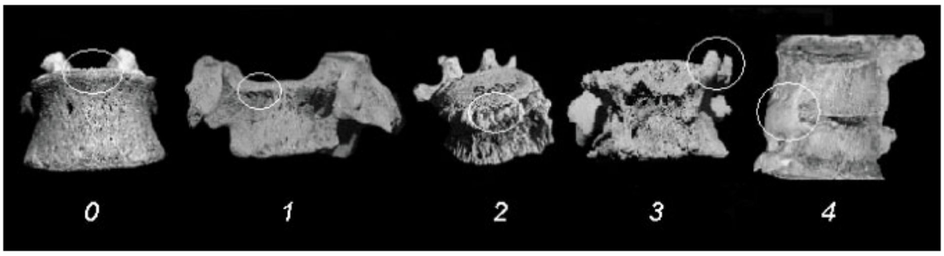


Figure 1. Successive stages of osteophyte development indicated by the circles: 0: No signs of lipping present on the margins of the bodies. 1: Slight osteophytosis starting to develop. 2: Osteophytes start to project horizontally from the vertebral body. 3: Body protrusions curving up or down. 4: Vertebrae fused together.

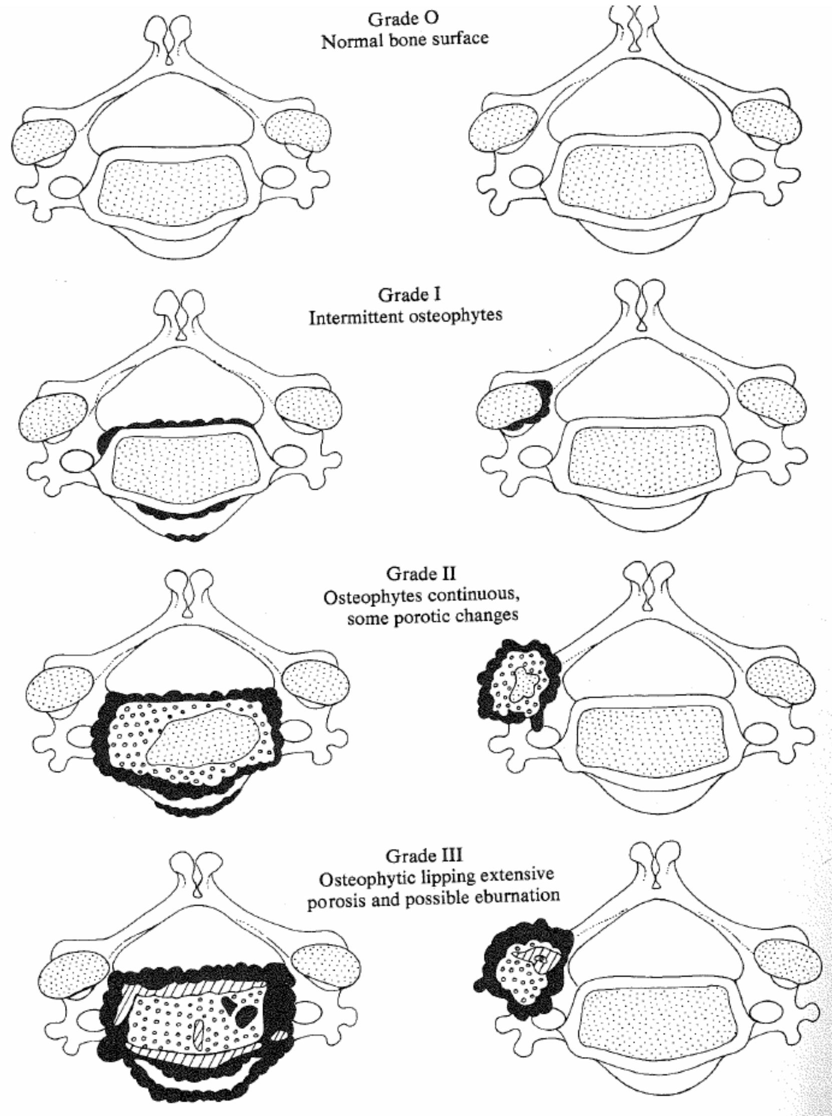
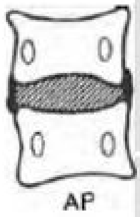


Figure 6.9 *Left, schematic drawings of the macroscopic bone changes seen on the discal surface of cervical bodies in progressive grades of degeneration. Right, joint surface diagrams of cervical vertebrae with progressive grades of lateral spondylarthrosis (after Sager, 1969). See Figure 6.7 for key.*

SYNDESMOPHYTES

Ossification of the annulus fibrosus. Thin, vertical and symmetrical. When extreme results in the 'bamboo spine'.

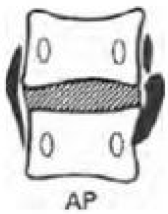
1. **Ankylosing spondylitis*.**
2. **Alkaptonuria.**



PARAVERTEBRAL OSSIFICATION

Ossification of paravertebral connective tissue which is separated from the edge of the vertebral body and disc. Large, coarse and asymmetrical.

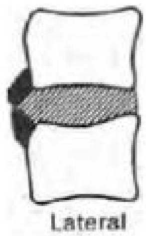
1. **Reiter's syndrome*.**
2. **Psoriatic arthropathy*.**



CLAW OSTEOPHYTES

Arising from the vertebral margin with no gap and having an obvious claw appearance.

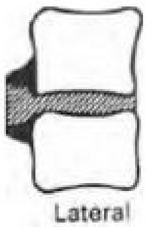
1. **Stress response** — but in the absence of disc-space narrowing does not indicate disc degeneration.



TRACTION SPURS

Osteophytes with a gap between the end-plate and the base of the osteophyte and with the tip not protruding beyond the horizontal plane of the vertebral end-plate.

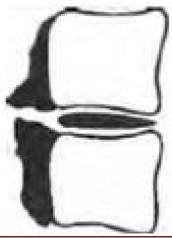
1. **Shear stresses across the disc** — more likely to be associated with a degenerative disc.



UNDULATING ANTERIOR OSSIFICATION

Undulating ossification of the anterior longitudinal ligament, intervertebral disc and paravertebral connective tissue.

1. **Diffuse idiopathic skeletal hyperostosis (DISH).**



LAB EXERCISES

1. Working in groups reassemble thev ertebral colm in the correct order. You can do this by:
   a. sorting the vertebrae by sction into three rows (cervical, thoracic, lumbar)
   B. place each vertebra on the table with the dorsal spine pointed away
   C. Turn each so that the superior surface is up
   d. Beginning at the top fit the atlas and axis together.
   e. Then fit the cervical vertebrae successively.
   f. continue matching

2. Mystery vertebrae: having done that (and without reference to it) then work out what the mystery vertebra is.

3. We have laid out casts showing you degeneration of the spine. Given that some of these conditions involve osteophytes and other forms of ossification have a look at the differences and see if you can see the differences depicted in the information above.

WEEK FIVE: THE ARM AND HAND

Goal:
a. identify the bones of the arm and hand
b. Identify the different types of bones in the hand
c. Stature estimation using the humerus

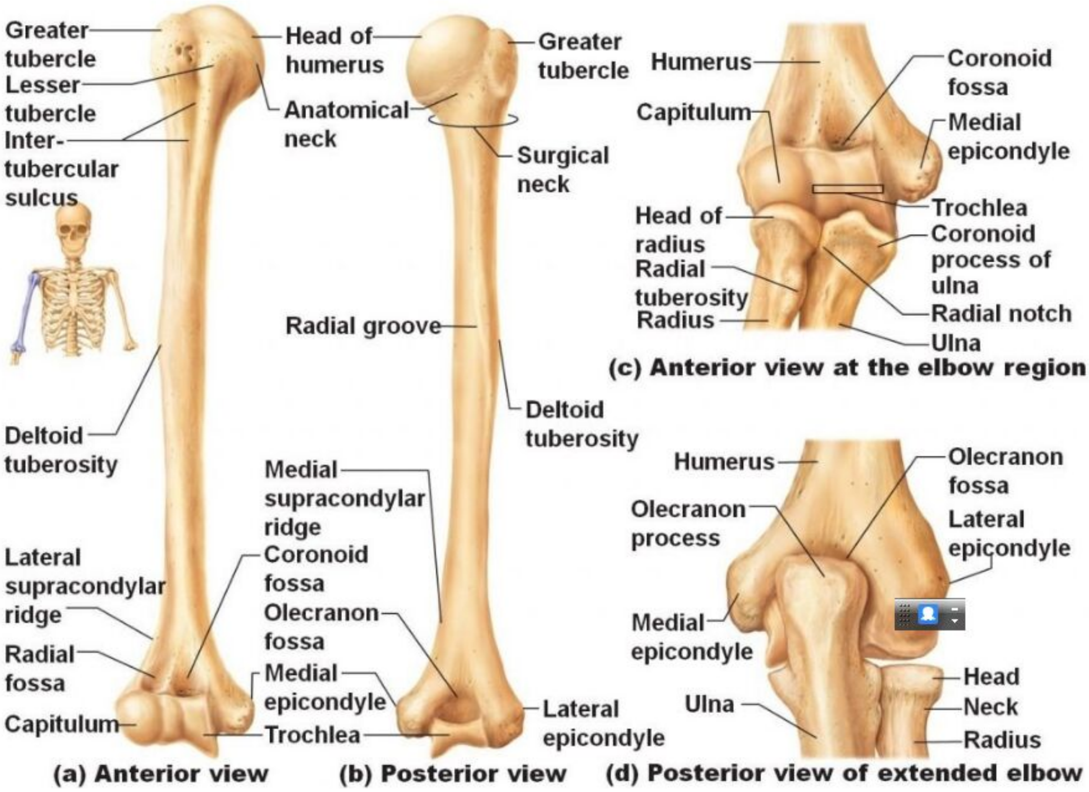
Aim: by the end of this class you should be able to identify and side the bones of the arm, divide the bones of the hand into the appropriate sections, and undertake stature estimation.

THE HUMERUS

The humerus articulates at the shoulder with the glenoid fossa of the scapula. At the distal end it radius and ulna at the elbow. The joint surface is condylar in form (like a cotton reel). The proximal ulna articulates with the trochlea (the cotton reel side) with the projecting end of the ulna resting in the olecranon fossa on the posterior surface of the distal humerus. This is a hinge joint while the radial head articulates with the capitulum the rounded end on the lateral end of the joint allowing a pivotal movement.

To assist in siding and orienting the humerus, the nutrient foramen enters the humeral shaft toward the elbow useful for orienting incomplete shafts. The deltoid tuberosity is a large muscle insertion on the lateral side of the upper shaft. This muscular area is one where it can be particularly obvious how bone responds to muscular activity. In some individuals there is a distinct difference between the size of the tuberosity on the left and right arms.

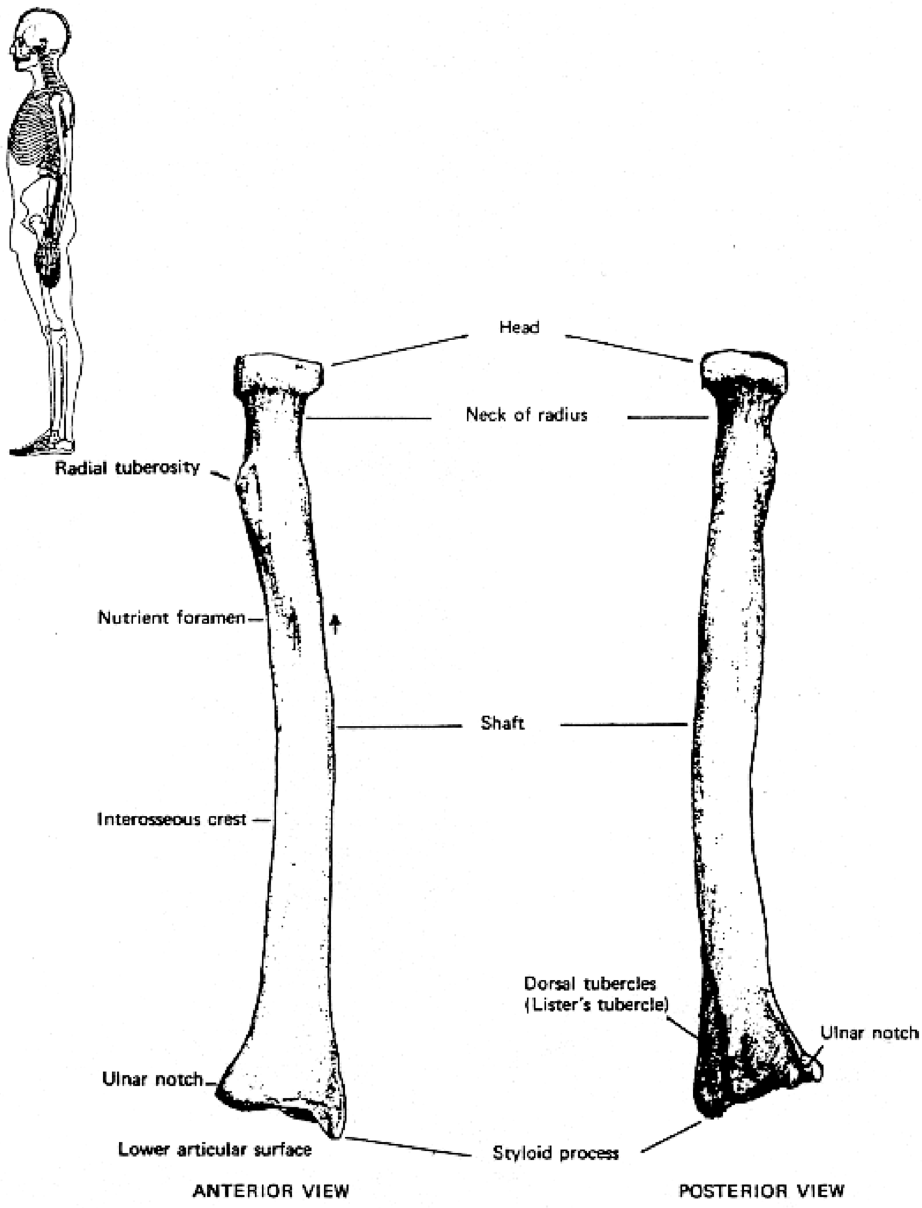
The humerus has four centres of ossification: the shaft, the head, and the medial epicondyle and the distal epiphysis. The distal end fuses first around 14-15 years of age approximately while the head fuses later (c19.5-20.5 years in males).



https://www.anatomynote.com/wp-content/uploads/2017/09/Humerus-anatomy.jpg

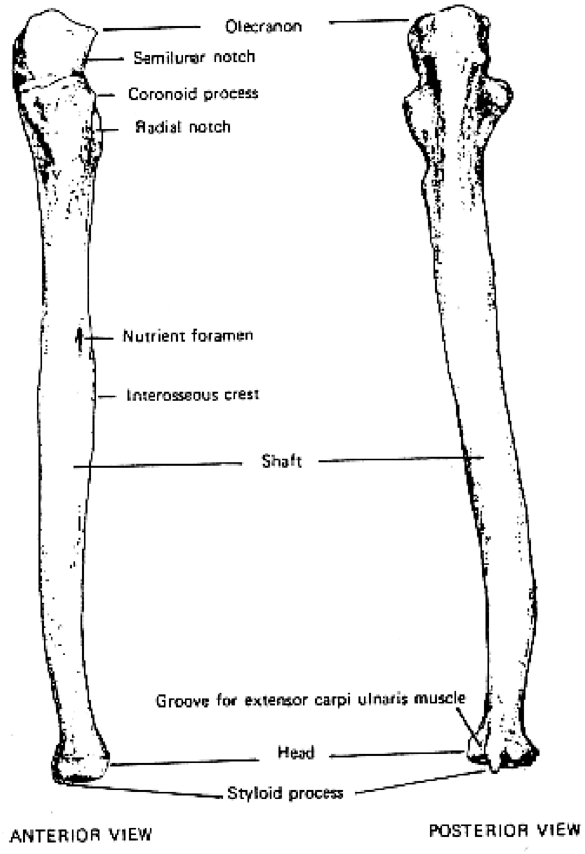
THE RADIUS AND ULNA

The radius and ulna lie parallel to each other articulating at the proximal end at the elbow and at the distal end with the wrist. While the ulna acts as a lever, the radius pronates over the ulna at the wrist moving the palm anteriorly and posteriorly.
The **radius** is lateral to the ulna, on the same side of the forearm as the thumb. The head of the radius is proximal, rotating on the capitulum of the distal elbow. The distal end is slightly flattened articulating the scaphoid (one of the carpal bones). The styloid processes at the distal end indicates the direction of the thumb.



LEFT RADIUS

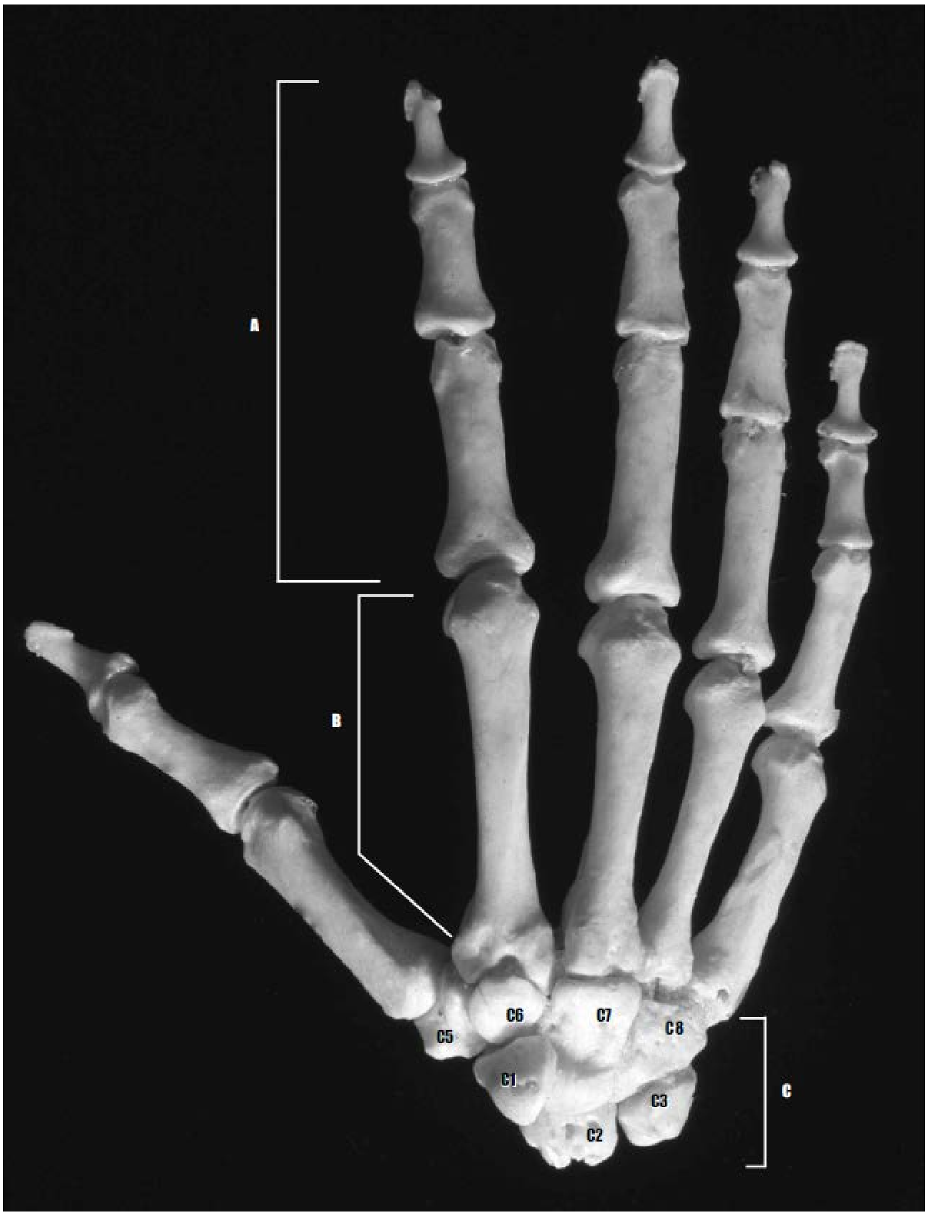
The **ulna** is medial to the radius. The proximal end of the ulna is the projecting olecranon process. The articular surface faces anteriorly, wrapping around the trochlea of the humerus. On the lateral surface there is a radial notch (a semicircular depression) where the radial head articulates. At the distal end of the ulna is a head (a circular projection which articulates with the lunate carpal bone. The styloid process of the ulna indicates the direction of the fifth finger.



LEFT ULNA

THE HANDS

Each hand is built of 27 bones. There are 8 carpal bones (of the wrist), 5 metacarpal bones (the palm) and 14 phalanges (finger bones). Each carpal and metacarpal is unique and can be recognized by side and name. The phalanges are more difficult. Right and left can be confused and the second and fourth fingers can be interchanged because of their size similarity. In standard anatomical position is palm forward and thumbs out. The back of the hand is dorsal, the palm is palmar, the thumb is lateral and the little finger medial.



Hand – dorsal view
Phalanges
metacarpals (I-V)

c1: scaphoid, C2 lunate, c3 triquetal, c4 pisiform (not visible)
c5 trapezium c6 trapezoid c7 capitate c8 hamate
(Seven little tough punks have come to town)

Right Hand – palmar view

The bones of the hand take time and patience to recongise but in this course we expect you to be able to distinguish a carpal from a tarsal (shape and size), metacarpals from metatarsals, and the phalanges of the foot from those of the hand as well as distinguishing phalanges by rank ie. Terminal phalanges versus medial phalanges and proximal phalanges.

Looking at the metacarpals:

#1 is short and wide. From the dorsal side the base points toward #2.

#2 is one of the two larger metacarpals It is the only metacarpal with two major processes at the base. From the dorsal side the long of the processes points toward #3.

#3 is the other large metacarpal. It has only one major process at the base. From the dorsal side this process points back to #2.

#4 is one fo the two smaller metacarpals with no processes on the base and facets on both sides of the base. The simpler facets is on the side of #5.

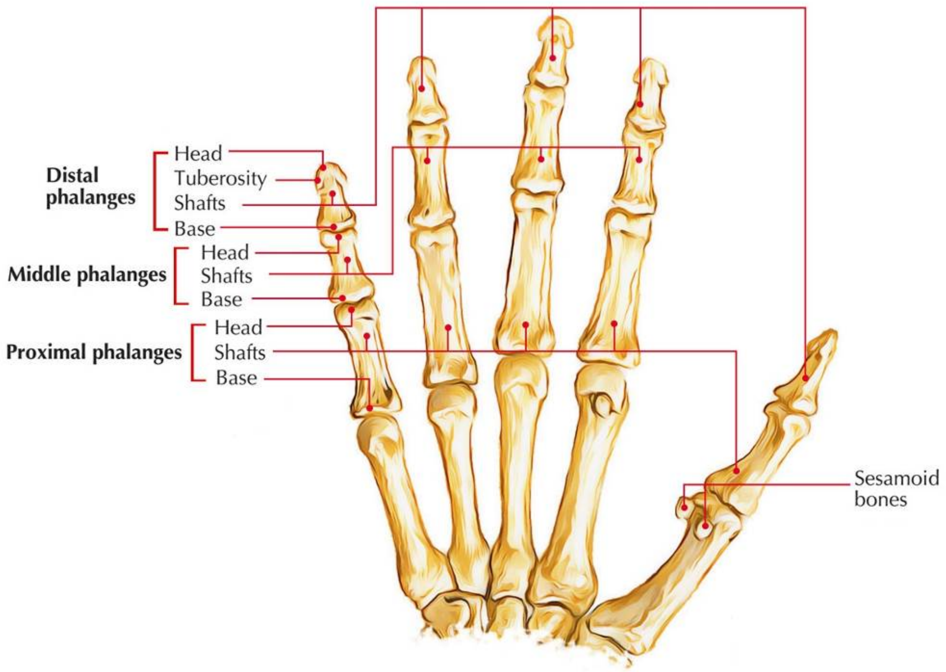
#5 is the other small metacarpal but with no processes and only one facet which of course faces #4.

Each finger comprises three phalanges except for the thumb which has only two phalanges. In order to sort them out:

First identify all the terminal phalanges-the distal end of these is flat and roughened on the palmar side while the distal end has no facet for articulating with another bone instead it is shaped to hold a fingernail, attach tendons and provide support for a fingertip.

Second, examine the proximal ends of the other phalanges. The medial phalanx had a double faceted proximal end with a scalloped appearance. This double facet fits the indented surface of the distal end of thep roximal phalanx. The proximal phalange has a single cupshaped proximal end that fits against the rounded head of the metacarpal.

Phalanges of the hand are distinguished from those of the toes by having marked ridges on the borders of the palmar surface. Metacarpals are distinguished from metatarsals by having rounder shafts and distal heads which are rounded rather than having a marked groove as on a metatarsal.



MEASURING THE HUMERUS

Measurements of the long bones are used for stature estimation (see below) and for other purposes such as sexing or assessing sexual dimorphism or robusticity. Below are a series of measruements for the humerus as an example although the one you will need to use is the maximum length of the humerus.

40. Humerus: Maximum Length: direct distance from the most superior point on the head of the humerus to the most inferior point on the

trochlea. Humerus shaft should be positioned parallel to the long axis of the osteometric board. Instrument osteometric board (Figure).

41. Humerus: Epicondylar Breadth: distance of the most laterally protruding point on the lateral epicondyle from the corresponding projection of the medial epicondyle. Instrument: osteometric board. Comment: Place the bone with its posterior surface resting on the osteometric board. Put the medial epicondyle against the vertical endboard and apply the movable upright to the lateral epicondyle.

42. Humerus: Vertical Diameter of Head: direct distance between the most superior and inferior points on the border of the articular surface. Instrument: sliding caliper.

43. Humerus: Maximum Diameter at Midshaft: maximum diameter at midshaft. Instrument: sliding caliper. Comment: determine the midpoint of the diaphysis on the osteometric board and mark with a pencil. Record maximum diameter wherever it occurs.

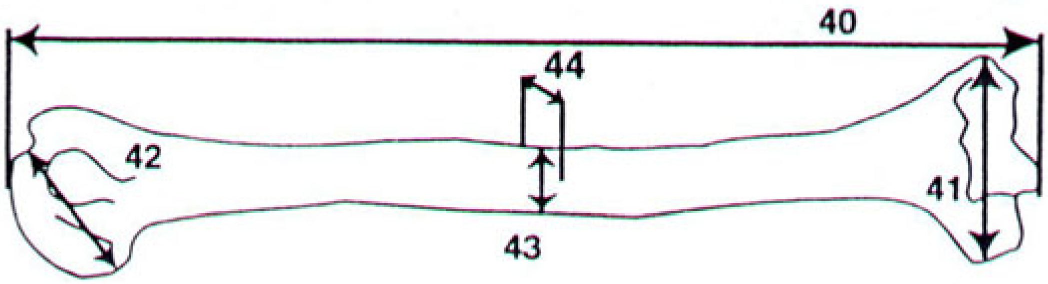


Figure: Measurements of the left humerus, anterior view.

44. Humerus: Minimum Diameter at Midshaft: minimum diameter of midshaft. Instrument: sliding caliper. Comment: determine the midpoint of the diaphysis on the osteometric board and mark with a pencil. Record minimum diameter wherever it occurs

STATURE ESTIMATION

The stature or height of an individual is useful information for making forensic identifications. Before estimating stature, one must determine the race, sex, and age of the individual as stature varies with the variables. Stature estimates are estimates. They are not exact and should always be expressed with a range of error.

Stature estimates are usually calculated in centimeters. An individual who is 5 feet tall is about 152.4 cm tall (5 ft x 12 in/ft x 2.54 cm/in = 152.40 cm).

Stature is estimated by comparing the lengths of certain bones to tables of published data or by plugging lengths into published regression formulas, such as ForDisc 2.0. The most commonly used bones for stature estimation of incomplete remains are the long bones (femur, tibia, fibula, humerus, ulna, radius), but short bones of the hands and feet may also be used. The use of two or more bones to estimate the stature of an individual improves the accuracy. The primary source for measurement points of the long bones listed in the chart given below for this class are taken from Bass (1994) and Moore-Jansen et al. (1994).

Potential stature refers to the stature of an individual who has not undergone skeletal changes associated with the aging process. Most people who are less than 30 years old at the time of death have not undergone these changes.

Living stature refers to the stature of an individual who has undergone degenerative changes associated with the aging process which results in a decrease in stature. Most people who are 30 years old or older at the time of death have undergone some of these changes.

Thus, to account for the loss of height associated with aging, one must subtract from the stature estimates of older individuals. This stature estimate is dependant upon the estimate of age of the individual. That estimated age is plugged into the following equation, the answer of which is subtracted from the stature estimate: 0.06 * (age - 30) cm. So, an individual who is 50 years old will likely have lost 1.20 cm of height (0.06 * 50-30 cm) due to the aging process.

Table 1: Bone length and stature tables; published regression formulas for stature estimation (Bass 1994).

BONE	RACE	MALE EQUATION	FEMALE EQUATION
Femur	Caucasoid	2.32 * femur + 65.53 ± 3.94 cm	2.47 * femur + 54.10 ± 3.72 cm
Femur	Negroid	2.10 * femur + 72.22 ± 3.91 cm	2.28 * femur + 59.76 ± 3.41 cm
Femur	Mongoloid	2.15 * femur + 72.57 ± 3.80 cm	
Tibia	Caucasoid	2.42 * tibia + 81.93 ± 4.00 cm	2.90 * tibia + 61.53 ± 3.66 cm
Tibia	Negroid	2.19 * tibia + 85.36 ± 3.96 cm	2.45 * tibia + 72.56 ± 3.70 cm
Tibia	Mongoloid	2.39 * tibia + 81.45 ± 3.24 cm	
Fibula	Caucasoid	2.60 * fibula + 75.50 ± 3.86 cm	2.93 * fibula + 59.61 ± 3.57 cm
Fibula	Negroid	2.34 * fibula + 80.07 ± 4.02 cm	2.49 * fibula + 70.90 ± 3.80 cm
Fibula	Mongoloid	2.40 * fibula + 80.56 ± 3.24 cm	
Humerus	Caucasoid	2.89 * humerus + 78.10 ± 4.57 cm	3.36 * humerus + 57.97 ± 4.45 cm
Humerus	Negroid	2.88 * humerus + 75.48 ± 4.23 cm	3.08 * humerus + 64.67 ± 4.25 cm
Humerus	Mongoloid	2.68 * humerus + 83.19 ± 4.16 cm	
Ulna	Caucasoid	3.76 * ulna + 75.55 ± 4.72 cm	4.27 * ulna + 57.76 ± 4.30 cm
Ulna	Negroid	3.20 * ulna + 82.77 ± 4.74 cm	3.31 * ulna + 75.38 ± 4.83 cm
Ulna	Mongoloid	3.48 * ulna + 77.45 ± 4.66 cm	
Radius	Caucasoid	3.79 * radius + 79.42 ± 4.66 cm	4.74 * radius + 54.93 ± 4.24 cm
Radius	Negroid	3.32 * radius + 85.43 ± 4.57 cm	3.67 * radius + 71.79 ± 4.59 cm
Radius	Mongoloid	3.54 * radius + 82.00 ± 4.60 cm	

LAB EXERCISES

1. Work in groups or pairs and sort out the bones of the shoulder girdle on the table identifying each element and determining which side they came from. Use this as a chance to get familiar with the shape of the bones and how to side them. Compare the bones with the articulated skeletons to assist your determinations. Make drawings of the elements to increase your familiarity.

2. We have also placed out the bones of hands to give you a chance to become familiar with the major components – carpals, metacarpals, phalanges. Make sure you can distinguish between the different types of phalanges plus have a look at how the metacarpals are articulate with each other.

3. Take the maximum length of the humerus and use that to calculate the estimated stature of this individual assuming that it is a European male around 50 years of age at the time of death.

WEEK 6: BONES OF THE SKULL

a. the bones of the human skull including the mandible
b. sexing the skull
c. population ancestry..

Aim: By the end of the class you should be able to identify the bones of the human skull, recongise the characters used for sexing and have a sense of the common characters used for population population ancestry.

A. SKULL MORPHOLOGY

SKULL VIEW	BONES	LANDMARKS
Lateral View	• frontal • parietal • temporal • occipital • sphenoid • zygomatic • maxilla • mandible • nasal • lacrimal • ethmoid	• coronal suture • squamosal suture • lambdoidal suture • temporal line • zygomatic process • zygomatic arch • external auditory meatus • mastoid process • supraorbital ridge • mental foramen • infra-orbital foramen
Superior View	• frontal • parietals • occipital	• coronal suture • sagittal suture • temporal line
Inferior View (without the mandible)	• occipital • sphenoid • temporals • zygomatics • frontal • maxillas • palates • vomer	• foramen magnum • occipital condyles • mastoid processes • external occipital protuberance • styloid processes • basilar suture • zygomatic arches • nuchal ridge
Anterior (Frontal) View	• frontal • parietals • temporals • zygomatics • maxillas • mandible • nasals • lacrimals • ethmoids	• sagittal suture • coronal suture • squamosal suture • temporal lines • supraorbital ridges • nasal cavity • infra-orbital foramina • zygomatic arches • mental foramina

	• sphenoid	• gonial angle
Posterior View	• parietals • occipital • temporals • maxillas • mandible	• sagittal suture • lambdoidal suture • external occipital protuberance • nuchal ridge • mastoid processes
Other	• hyoid bone • an incisor tooth • a canine tooth • a premolar tooth • a molar tooth	• body of hyoid • greater horns of hyoid • lesser horns of hyoid

The skull comprises 20 bones some of which are paired. These bones meet along suture lines many of which fused and become obliterated as the individual ages. In children of course there are many more bones since some bones have multiple ossification centres. For example, while the parietals each have only one ossification centre, the occipital comprises 4 primary ossification centres. These centres often fuse during childhood.

The cessation of growth of the skull is marked around the age of 18-20 by fusion of the basilar suture at the base of the skull. At this point of fusion there is no further growth in cranial length.

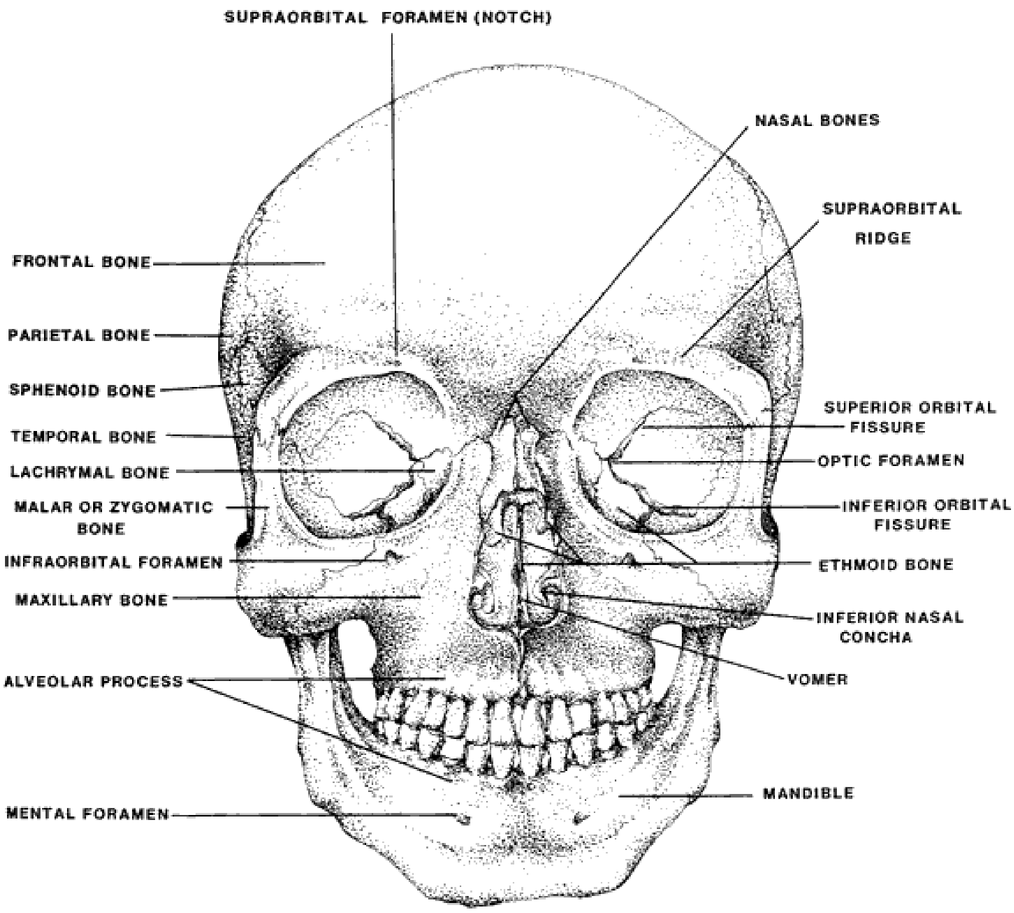
In order to identify the bones of the skull it is necessary to handle it, draw the individual bones, try to reassemble the cast in the lab and in general just handle the remains over and over again.

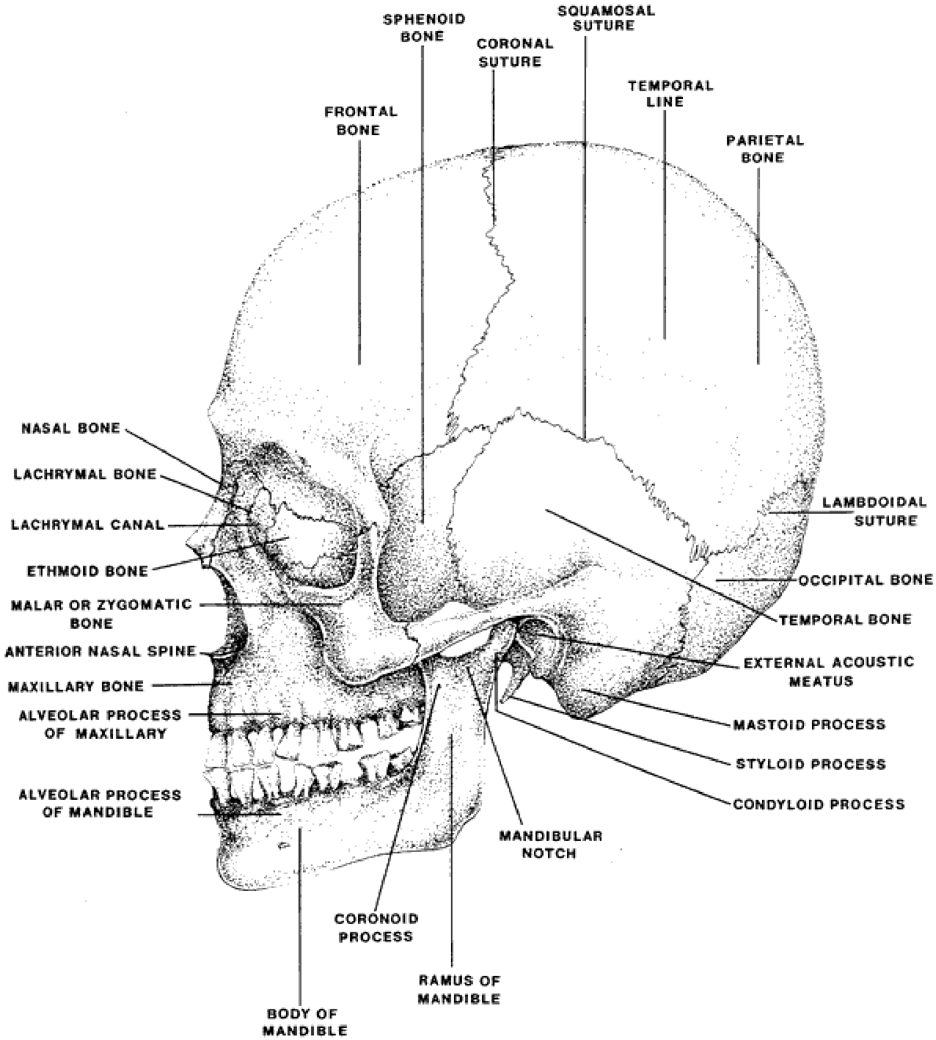
When faced with a disarticulated skull then try to work out the individual bone, then which side, then the landmarks within it.

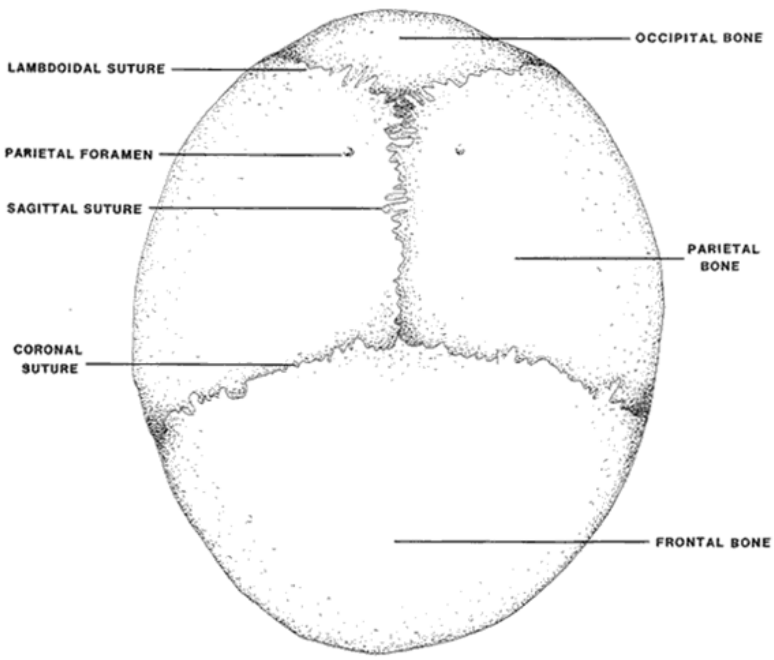
The bones you need to know and recognise are: the frontal, the parietals, the temporals, the occipital, the malars (or zygomatcs), the maxilla and the mandible.

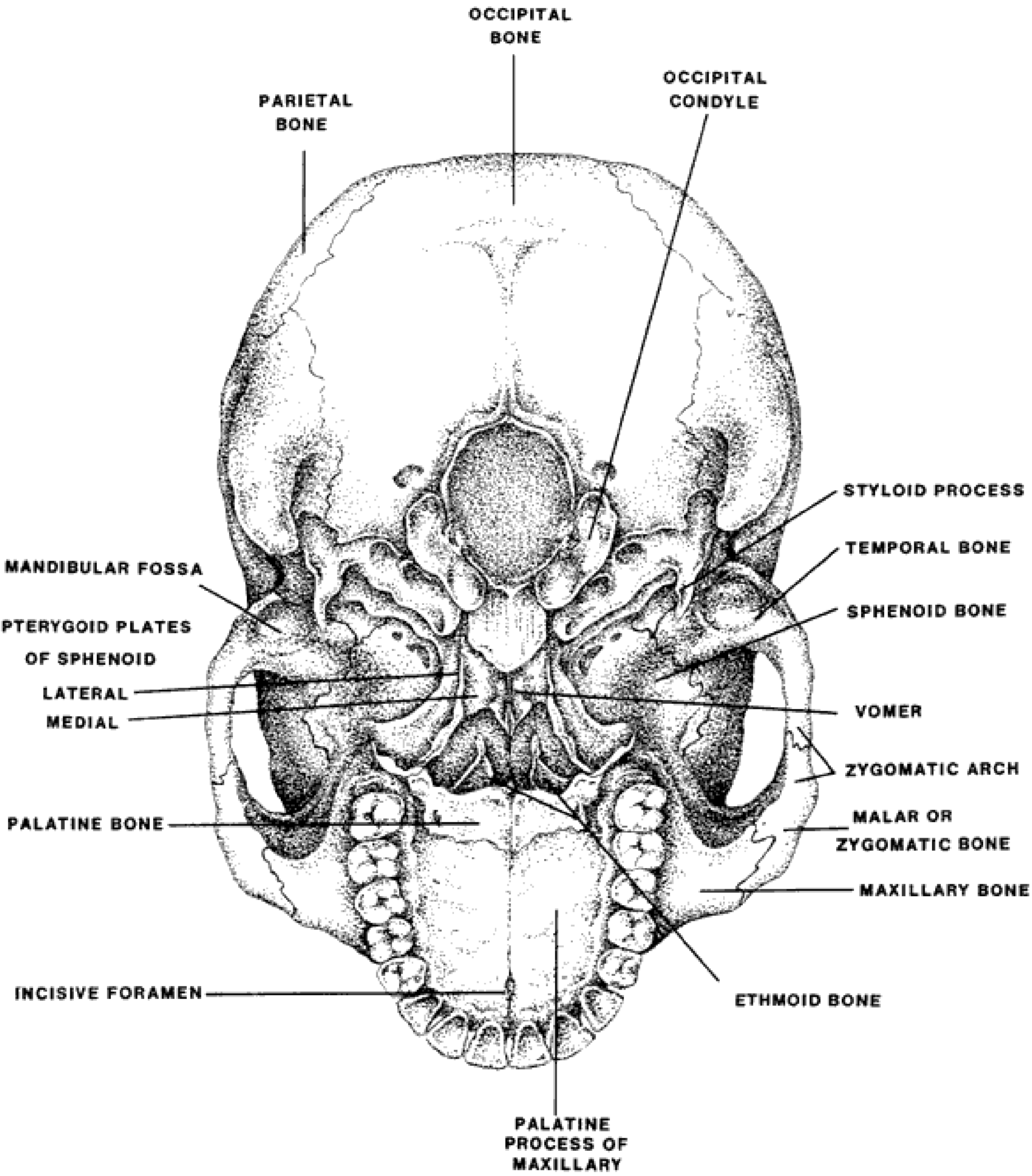
The other bones which are often not preserved are: the lacrimal, the ethmoid, the nasal bones, the sphenoids, and the three bones of the inner ear – the anvil, stapes, and incus.

For the mandible make sure that you can recognise from the crown a molar, a premolar, a canine and incisors.


SUPRAORBITAL FORAMEN (NOTCH)
NASAL BONES
SUPRAORBITAL RIDGE
FRONTAL BONE
PARIETAL BONE
SPHENOID BONE
TEMPORAL BONE
LACHRYMAL BONE
MALAR OR ZYGOMATIC BONE
INFRAORBITAL FORAMEN
MAXILLARY BONE
ALVEOLAR PROCESS
MENTAL FORAMEN
SUPERIOR ORBITAL FISSURE
OPTIC FORAMEN
INFERIOR ORBITAL FISSURE
ETHMOID BONE
INFERIOR NASAL CONCHA
VOMER
MANDIBLE


SPHENOID BONE
SQUAMOSAL SUTURE
CORONAL SUTURE
TEMPORAL LINE
FRONTAL BONE
PARIETAL BONE
NASAL BONE
LACHRYMAL BONE
LACHRYMAL CANAL
ETHMOID BONE
MALAR OR ZYGOMATIC BONE
ANTERIOR NASAL SPINE
MAXILLARY BONE
ALVEOLAR PROCESS OF MAXILLARY
ALVEOLAR PROCESS OF MANDIBLE
LAMBDOIDAL SUTURE
OCCIPITAL BONE
TEMPORAL BONE
EXTERNAL ACOUSTIC MEATUS
MASTOID PROCESS
STYLOID PROCESS
CONDYLOID PROCESS
MANDIBULAR NOTCH
CORONOID PROCESS
RAMUS OF MANDIBLE
BODY OF MANDIBLE


OCCIPITAL BONE
LAMBDOIDAL SUTURE
PARIETAL FORAMEN
SAGITTAL SUTURE
PARIETAL BONE
CORONAL SUTURE
FRONTAL BONE


OCCIPITAL BONE
PARIETAL BONE
OCCIPITAL CONDYLE
STYLOID PROCESS
TEMPORAL BONE
MANDIBULAR FOSSA
SPHENOID BONE
PTERYGOID PLATES OF SPHENOID
LATERAL
MEDIAL
VOMER
ZYGOMATIC ARCH
PALATINE BONE
MALAR OR ZYGOMATIC BONE
MAXILLARY BONE
INCISIVE FORAMEN
ETHMOID BONE
PALATINE PROCESS OF MAXILLARY

A - frontal bone
B - nasal bone
C - palatine process of maxilla
D- middle nasal concha
E - inferior nasal concha
F - sella turcica
G - basiocciput
H - petrous part of temporal bone
I - internal auditory meatus
J - parietal bone
K - occipital bone
L - external occipital protuberance

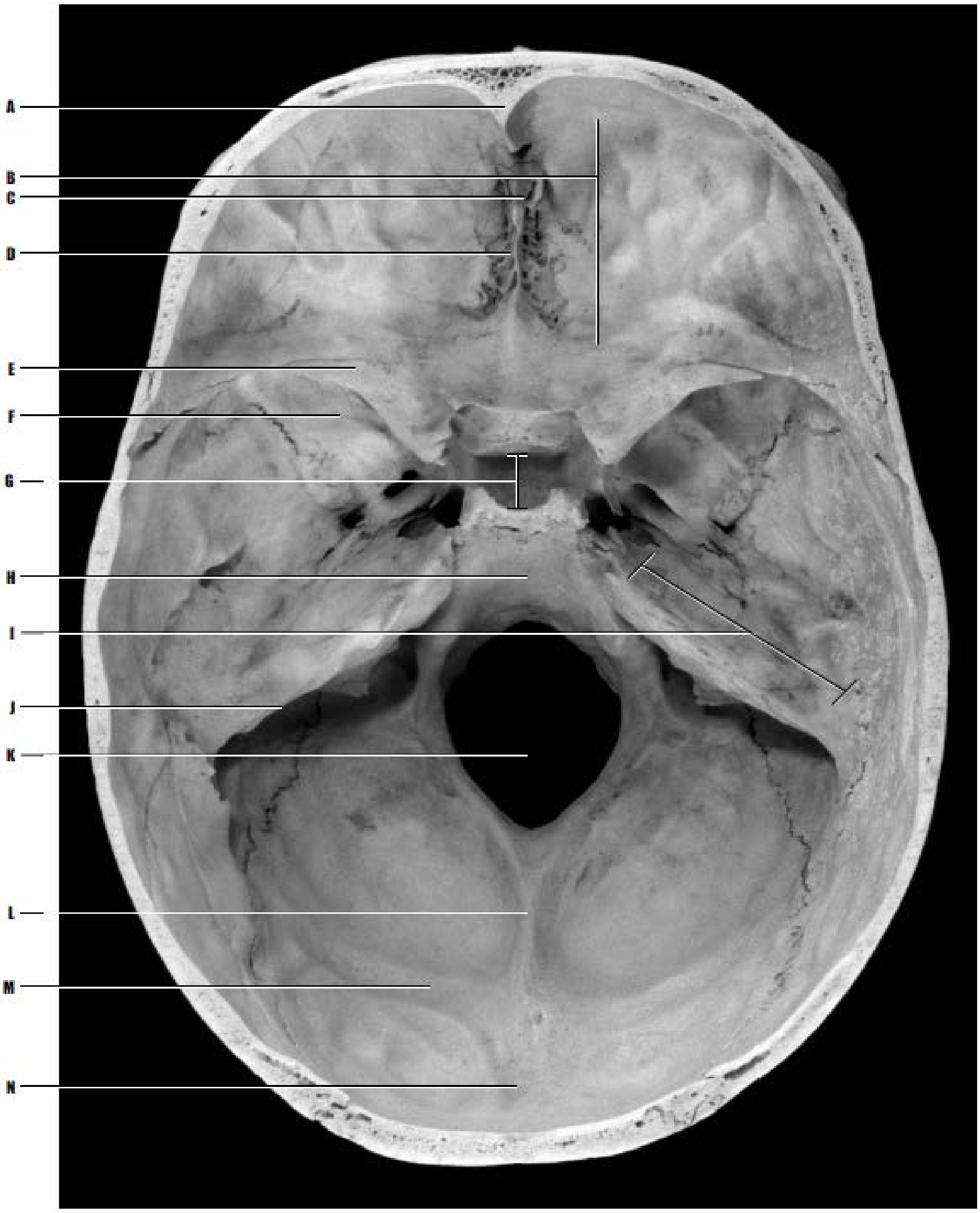
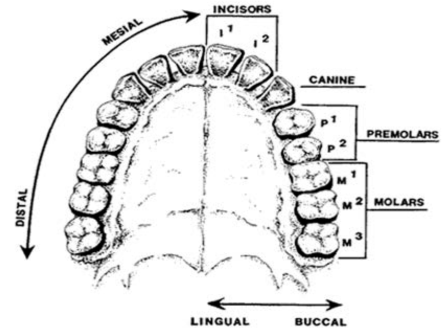
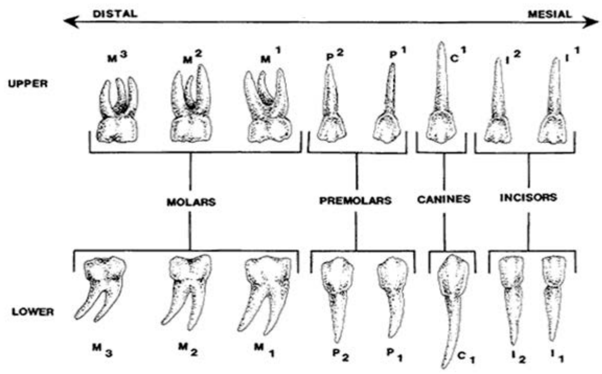
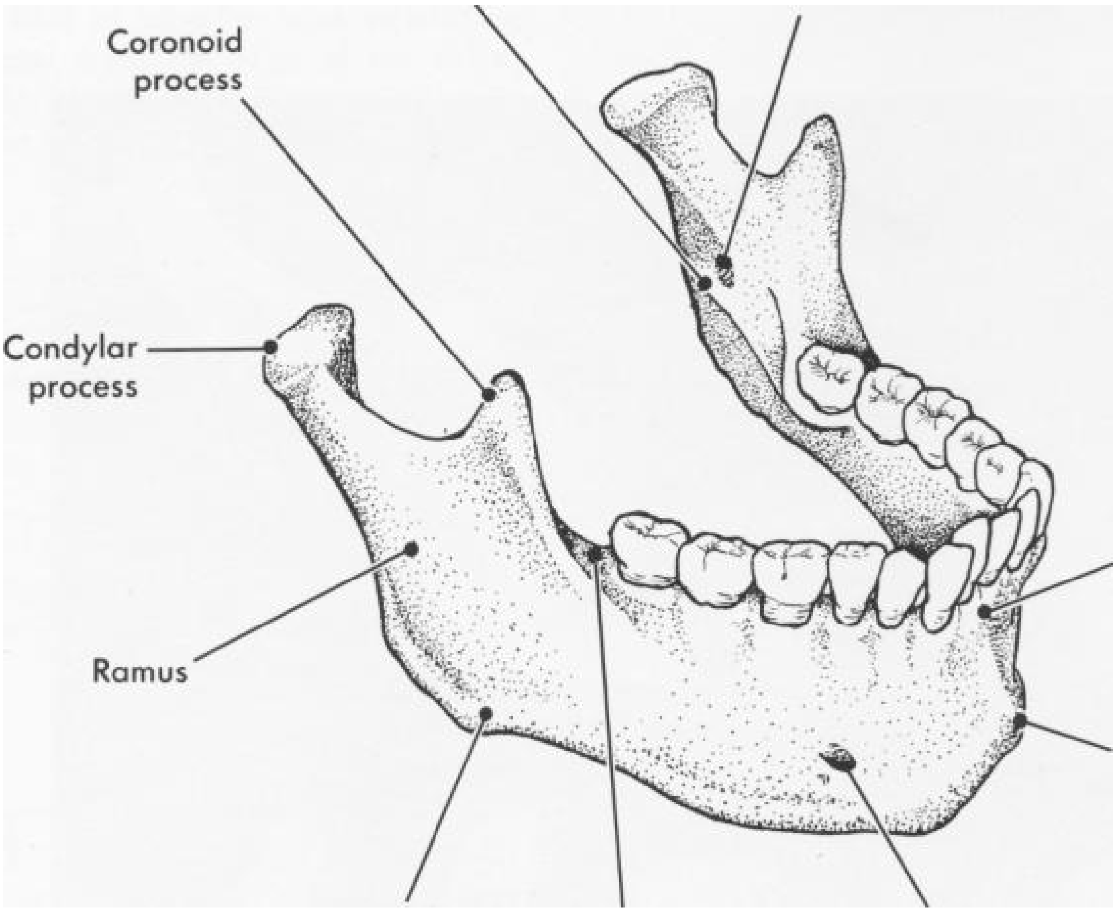


Image 2.35
Skull, intracranial view of skull base.

A Frontal Crest	B Orbital shelf	C crista galli
D cribriform plate	E lesser wing of sphenoid	F greater wing
B. Pituitary fossa	H Clivus	I Petrous portion
J. Petrous ridge	k. foramen magnum	L internal occipital crest
M Groove for transverse sinus	N. Groove for sagittal sinus	


INCISORS
I 1
I 2
CANINE
P 1
P 2
PREMOLARS
M 1
M 2
M 3
MOLARS
MESIAL
DISTAL
LINGUAL
BUCCAL


DISTAL
MESIAL
UPPER
M 3
M 2
M 1
P 2
P 1
C 1
I 2
I 1
MOLARS
PREMOLARS
CANINES
INCISORS
LOWER
M 3
M 2
M 1
P 2
P 1
C 1
I 2
I 1


Coronoid process
Condylar process
Ramus

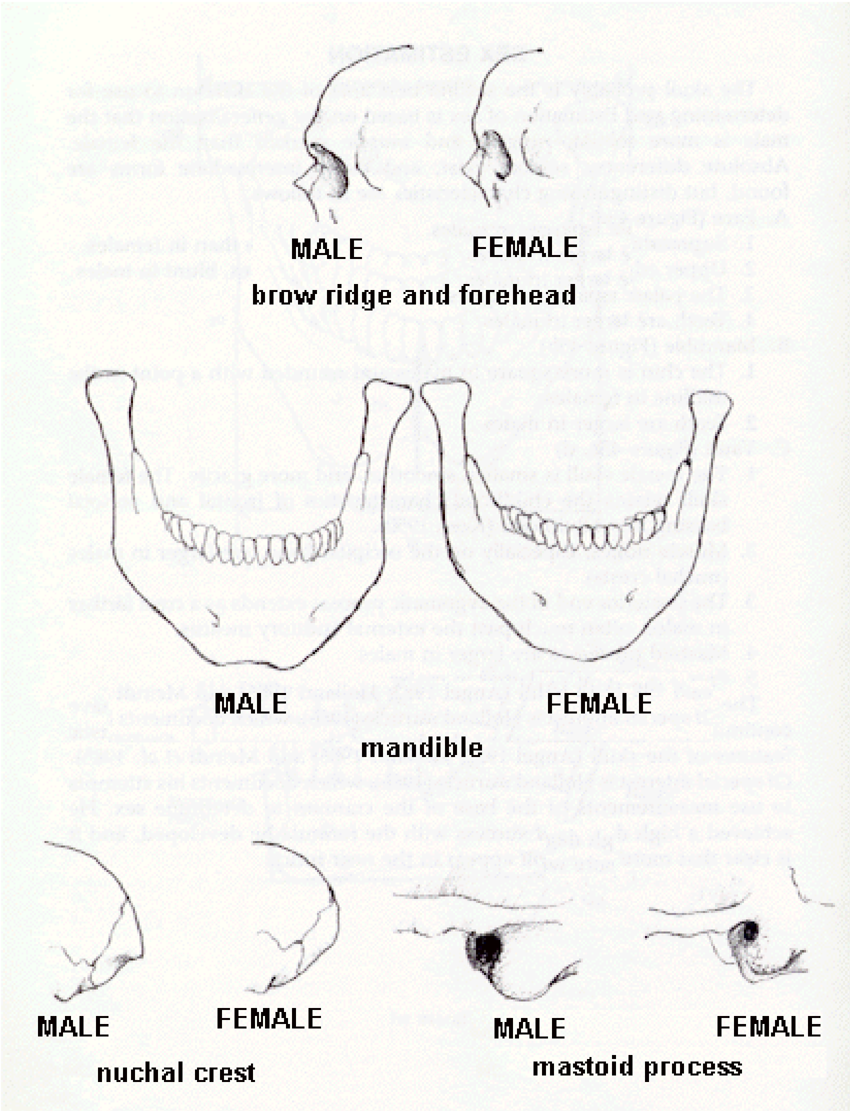
E. SEXING THE SKULL

After the pelvis, the skull is the bone commonly used to estimate sex. (Of course, the accuracy of sex estimation is greater if both bones are used.) We are examining a number of skull features that are indicators of sex. Many of these features are relative, meaning that the male:female differences are most easily observed when looking at one skull relative to another. This is why one's ability to sex a skeleton improves with experience.
Skull features that are used to distinguish males and females are listed below.

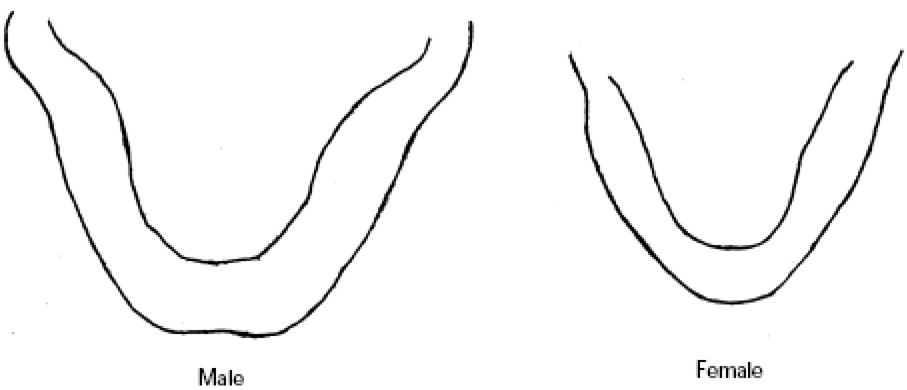
SUMMARY OF SKULL TRAITS RELATED TO SEXING

Trait	**Female**	**Male**
supraorbital ridge/torus	less prominent	more prominent
upper edge eye orbit	blunt	Sharp
eye orbit shape	rounded	Square
palate	smaller	Larger
teeth	smaller	Larger
chin	rounded with midline point, V-shaped	square, U-shaped
cranial vault	smaller, smoother	larger, rougher
frontal bossing*	present	Absent
parietal bossing*	present	Absent
muscle ridges (nuchal)	robust	Gracile
zygomatic process	not expressed beyond zygomatic arch	expressed beyond zygomatic arch and beyond external auditory meatus as crest
mastoid process	smaller, short	larger, broad
frontal sinus	smaller	Larger
occipital condyles	smaller	Larger

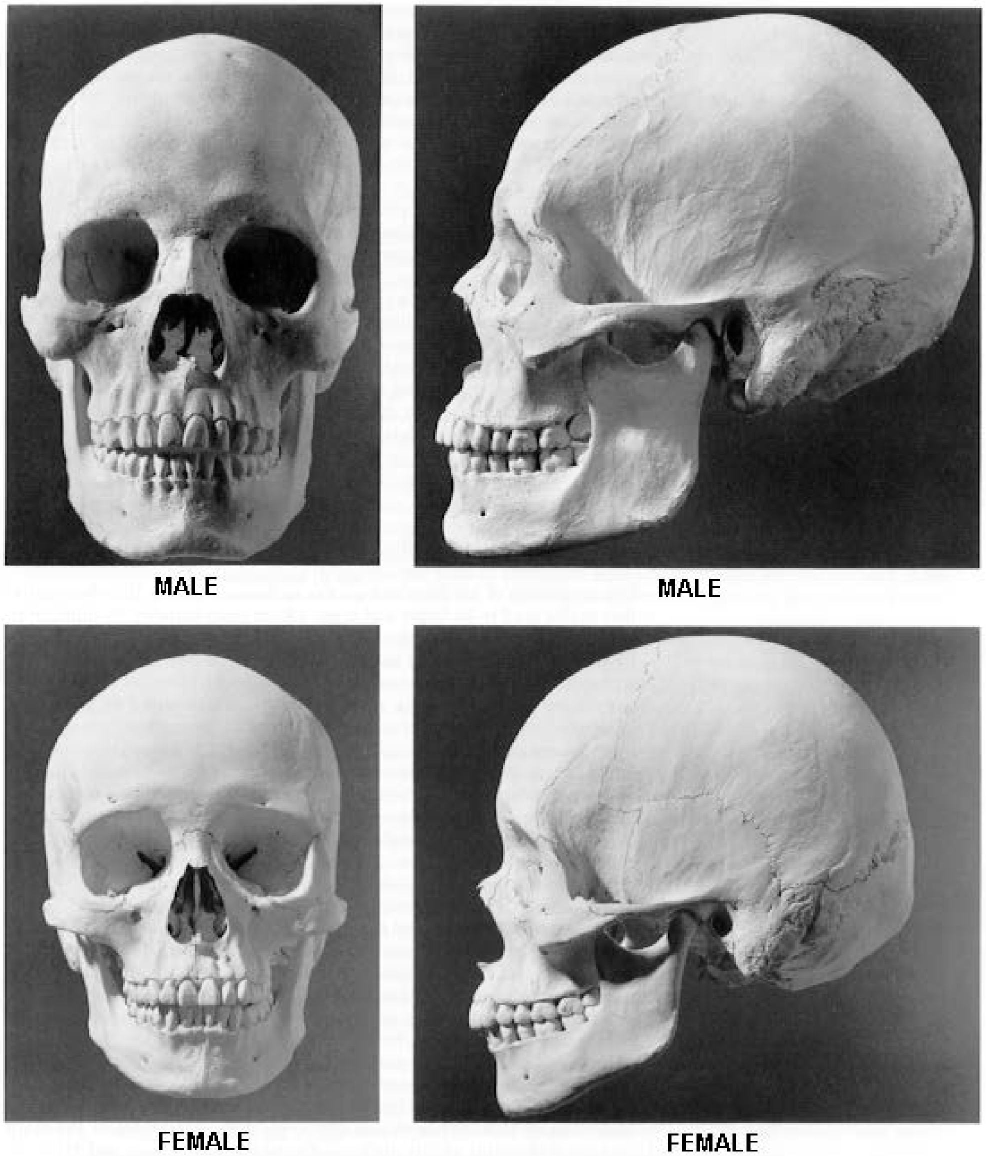
(from Bass 1987:81, White 1991:322, Pickering and Bachman 1997:86)
* a boss is a "smooth, round, broad eminence" or bony projection
that is not as prominent as a process (White 1991:33); look at
White pages 57 and 61-62 for photos of bossing
Some of these sex-related skull features are illustrated in the following figures.



skull traits useful in sexing
(scanned from Bass 1987:82)



Mandible



male and female skulls
(scanned from White 1991:321)

C. POPULATION ANCESTRY OR GEOGRAPHIC AFFINITY

Geographic variation of the skeleton is used to identify the race or ancestry of an individual. Most information is available on differentiating between Asian, African and European groups but in this part of the world it is also necessary to be aware of the distinguishing features of Pacific peoples and Australian Aborigines. Unfortunately information for these two groups is not so readily available. I have included diagrams where available but as you go through see how many features you can identify reliably on the casts we have.
Compared to sex, age, and stature estimation, race determination is "more difficult, less precise, and less reliable" because "no human skeletal markers ... correspond perfectly to geographic origin" (White 1991:328-329). In addition, many skeletal indicators used to estimate race are nonmetric traits, whose documentation can be somewhat subjective, varying for researcher to researcher. However, population estimation is an important endeavour in forensic identification as sex, age, and stature estimation are greatly influenced the population of the individual.
Skeletal indicators of ancestry focus primarily on skull and dental traits, as summarized in the table below. Indicators on the skull are both nonmetric and metric traits and include robusticity, lengths and widths of skull features, shapes of skull features, and unique population-specific dental features.
However, while it is important to recognise these traits it is also important to recognise the following features:
how rarely they occur as a package;
The lack of any necessary link between populaton ancestry and the social identity of an individual;
How gene flow predominates in contemporary populations, and
How population variation operates not with fixed boundaries but large overlaps.
So in identifying or getting used to looking for population characteristics, you also need to learn how to identify these with the appropriate level of explanation and uncertainty.

Skull Trait	Mongoloid	Caucasoid	Negroid
Facial features	smooth	sharp, angular	smooth
Brain case	brachycephalic	brachycephalic	platycephalic
Skull length	long	short	long
Skull breadth	broad	broad	narrow
Skull height	middle	high	low
Sagittal contour	arched	arched	flat
Face breadth	very wide	wide	narrow
Face height	high	high	low
Orbital opening	rounded, circular	rounded	rectangular
Nasal cavity / nasal opening/ nasal aperture	narrow, ovoid shape	narrow to moderately wide, tear shape	wide, broad
Nasal index*	0.5 to 1.0	0.5	1.0
Nasal bones	wide, flat narrow concave	narrow, arched large, prominent	narrow
Lower nasal margin	sharp	sharp	troughed
Nasal sill or dam	in between	present	absent
Nasal spine	downturned	angled, prominent	pointed
Sinuses	four-fold	inverted Y	Inverted U
Facial profile	straight	straight	downward slant
Prognathism	flat face	less flat face	more prognathic, esp. alveolar
Palate shape	moderately wide broad U-shape	moderately wide V-shape	wide U-shape
Zygomatic arches	pronounced, downturned	retreating, receding	pronounced, straight
Shovel-shaped incisors	90%–	<5%	<5%
Mandible	rounded, straight ascending ramus, prognathic chin in profile, slightly concave chin anterior, flaring	angular, incurvate ascending ramus, very prognathic chin in profile, concave chin anterior, flaring	rounded, tapering ascending ramus, chin in line with maxilla in profile, convex chin anterior, nonflaring
Occlusion	edge-to-edge	overbite	overbite
Skull sutures	very convoluted	irregular	irregular
Supraorbital suture	absent	present	absent
Nuchal suture	present	absent	absent
Nuchal crest	rounded	pronounced	pointed
General form	large, smooth	rounded large, rounded, moderately rugged	smooth, elongated
Other		long narrow face	wide interorbital distance

(Pickering & Bachman, p. 80; Rhine Figure 4.7, pp. 96-97; Sciulli; White 1991, Bass 1986)

Note that nasal index is calculated by dividing the width of the nasal cavity by the height of the nasal cavity. Use the sliding caliper to make these measurements.

Note the following instructions for assessing the **nasal sill/dam**: "Carefully observe the base of the nasal aperture [nasal cavity or opening]. With your pencil or ballpoint pen resting against the bone of the maxilla just below the nasal opening, try to run the pencil or pen gently into the nasal opening. In Caucasoids there is usually a dam (nasal sill) that will stop the pen or pencil. In Negroid skulls there is no dam or nasal sill, and the pen easily will glide into the nasal aperture. Mongoloid skulls will range between these two extremes" (Bass 1986:83). Be extremely careful when inserting a pen or pencil into the nasal cavity to avoid bone damage.

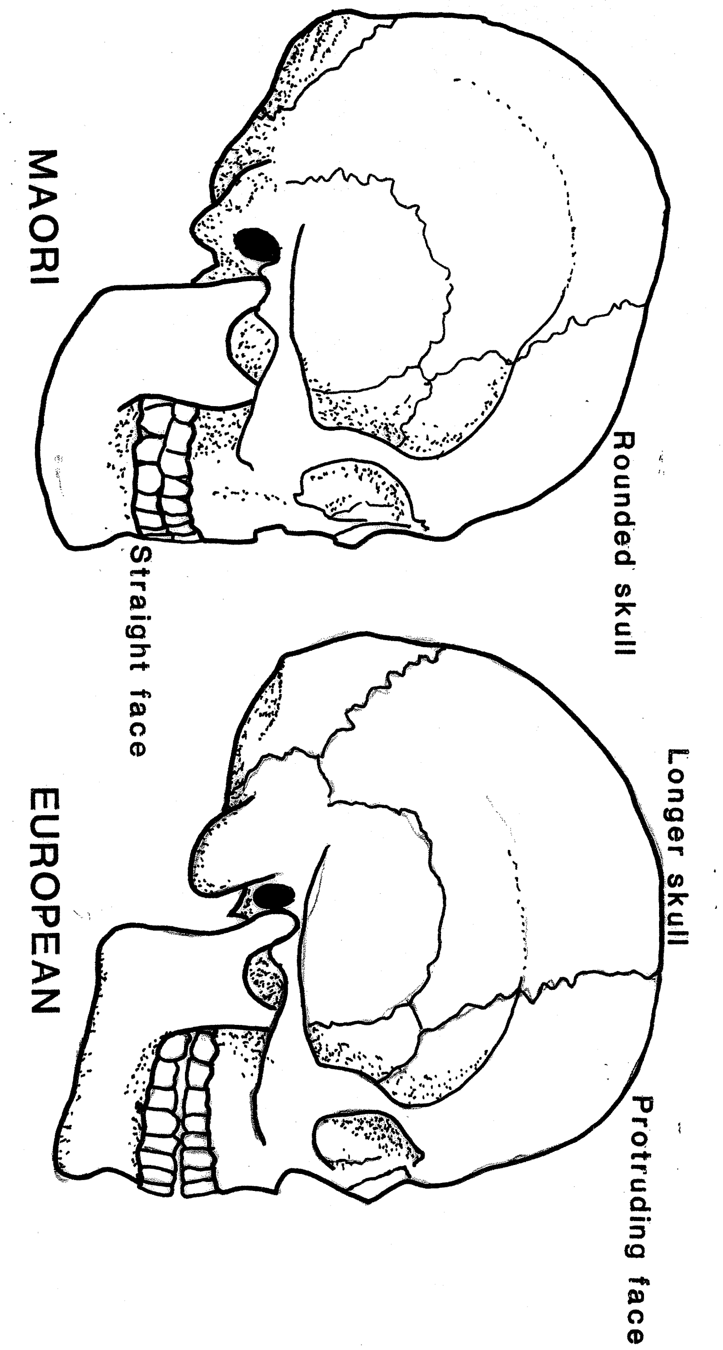
Note the following instructions for assessing the **zygomatic arches**: "Hold the skull with the occipital region in your hand and the facial area up. Place a pencil across the nasal aperture [nasal cavity or opening]. Now try to insert your index finger between the cheek (zygomatic) bones and the pencil. Caucasoids have a face that comes to a point along the midline and cheek bones that do not extend forward. This will allow you to insert your finger between the cheek bones and the pencil without knocking the pencil off. Mongoloids have a much flatter face (the cheek bones extending much further forward), and it is difficult to insert your finger between the pencil and the cheek bones on a Mongoloid skull without knocking the pencil off" (Bass 1986:83).

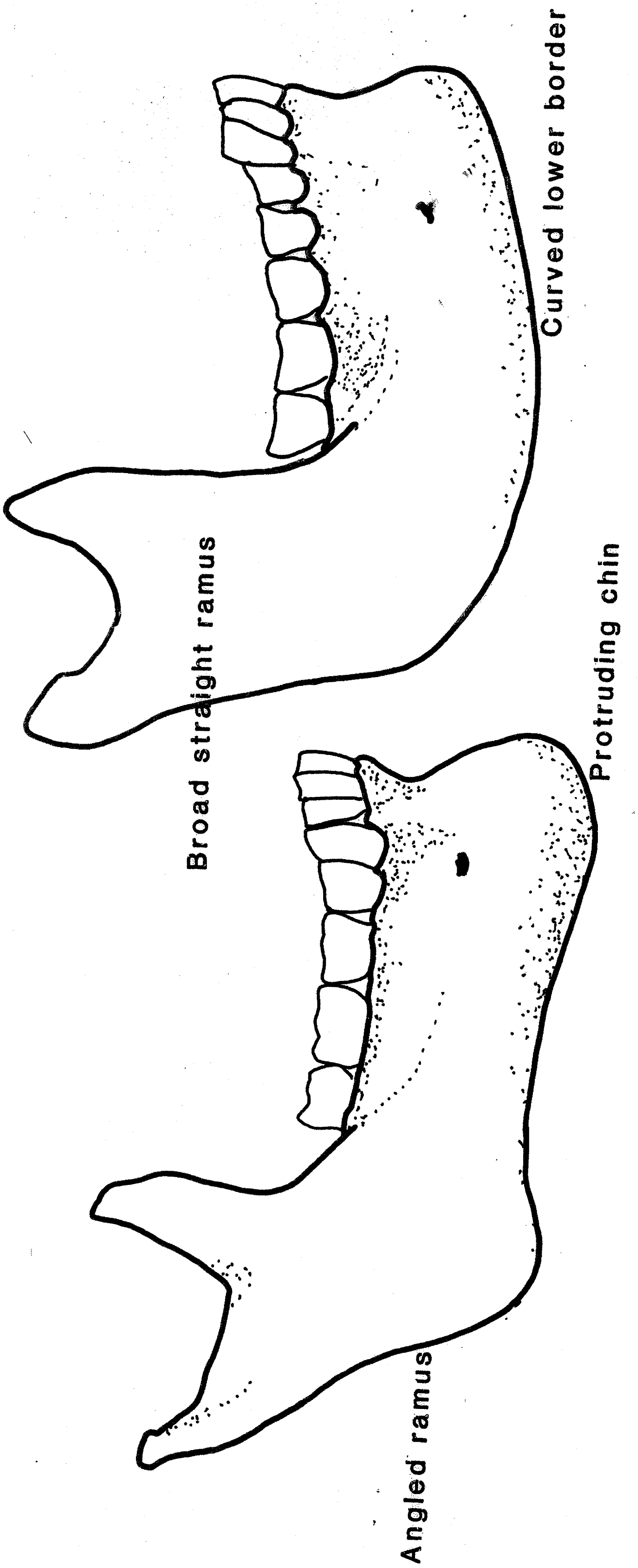
Note the following instructions for assessing **prognathism**: "Place one end of your pencil on or near the anterior nasal spine (on the midline of the skull) at the base of the nasal aperture [nasal cavity or opening]. Lower the pencil toward the face so that the pencil will touch the chin. Caucasoids have a 'flat' (orthognathous) face in the dental area along the midline. This is the opposite of the Negroid face, which exhibits protrusion of the mouth region, known as prognathism. ... Negroids are noted for alveolar prognathism, or an anterior protrusion, of the mouth region. A pencil or ballpoint pen placed with one end on the nasal spine (midline at base of nasal aperture) will not touch the chin (the teeth protrude too far forward)" (Bass 1986:87).

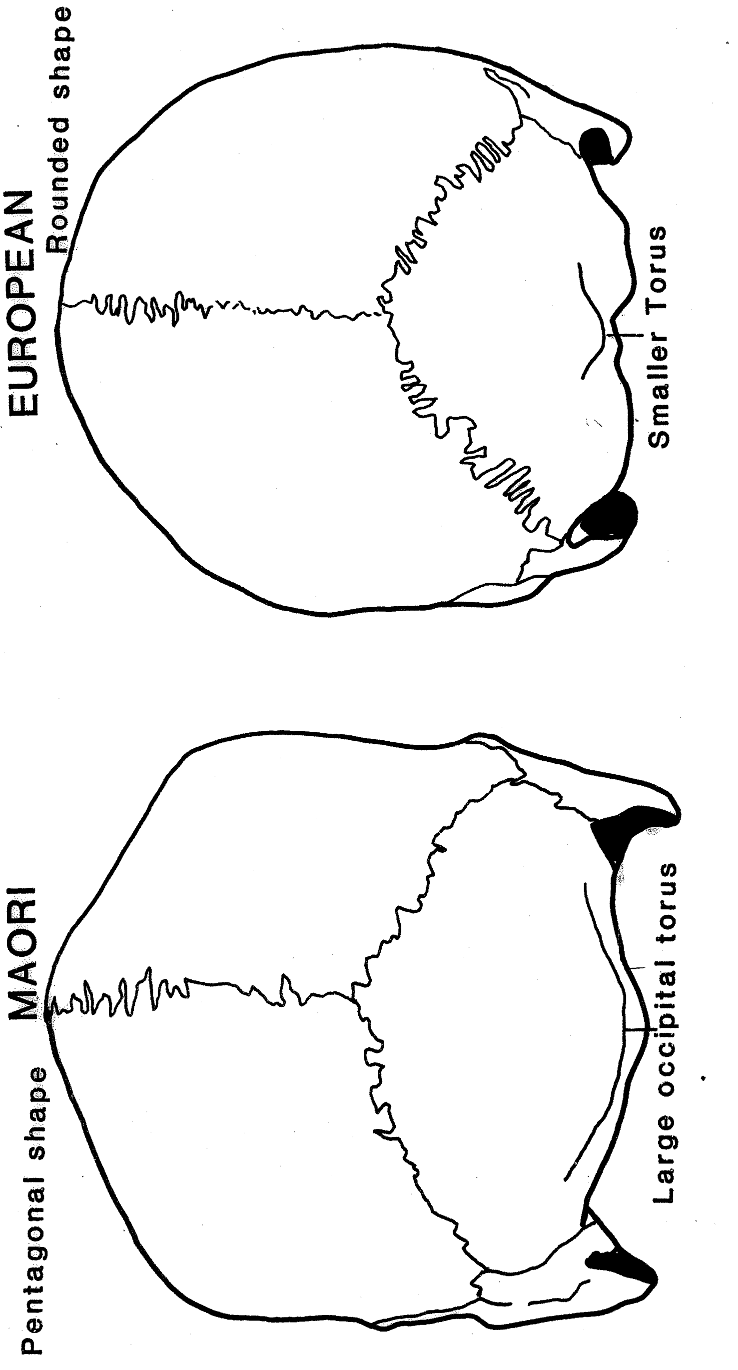
The following drawings illustrate some of the cranial differences among the major groups (Bass 1986:84-86; Houghton 1998; Thorne and Ross 1987).

Assessment of Ancestry

Characteristic	Polynesian	West European
Back of skull	Pentagonal	Rounded
Cranial form	High rounded, angular	Medium
Cranial base	Flat	Angled
Malar form	Visible from superior view	Not visible from superior view
Temporals	Straight	Rounded
Cheekform	Malars turn back at right-angles to face	Rounded, reduced
Orbital form	Rhomboid	Rhomboid
Nasal Breadth	Medium	Narrow
Nasal sill	Dull/absent to rounded	Sharp
Nasal profile	Concave/concavo/convex	Straight
Face protrusion	Flat	Moderate
Palate form	Hyperbolic	Parabolic
Mandibular angle	Square	Oblique-square
Rocker jaw	Rocker, robust	Medium
Mandibular body	Long continuous curve (rocker form), robust	Non-"rocker", medium
Coronoid process	Tall, broad	Reduced
Chin	Median projection, Submental arch	Bilateral form, prominent projection
Mandibular condyle	Oriented upwards or forwards	Oriented backwards
Incisors	Blade, some shoveling (c75%)	Blade, shoveling rare
Femoral torsion	>25 degrees	<c15 degrees
Tibia	Squatting facets	No squatting facets*
Fovea	Oval	Circular
Humerus	Development of deltoid tuberosity	Reduced
Tibia	Horizontal tibial platform	Angled
Shafts of long bones	Bowed	Straight
Clavicle	Costoclavic lig. Insertion marked	uncommon


MAORI
Rounded skull
Straight face
EUROPEAN
Longer skull
Protruding face


Curved lower border
Broad straight ramus
Protruding chin
Angled ramus


EUROPEAN
Rounded shape
Smaller Torus
MAORI
Pentagonal shape
Large occipital torus

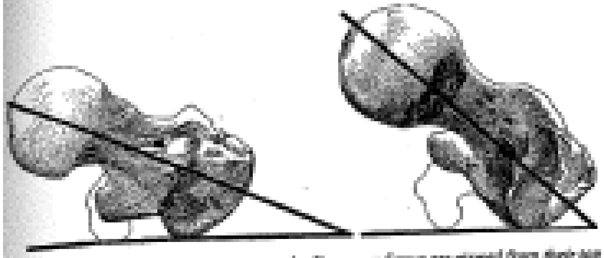


Fig. 3.7: A Polynesian and a European femur are viewed from their top ends when placed on a flat surface. The neck of the Polynesian femur makes a greater angle with the horizontal – that is, points more forward in the body.

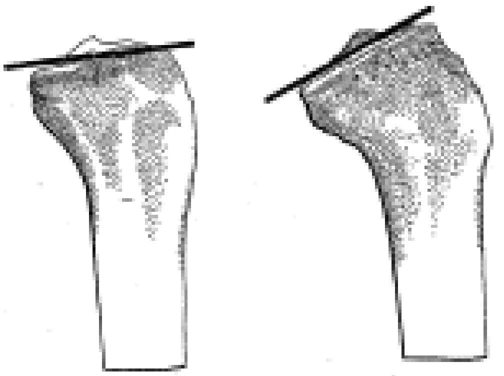


Fig. 3.8: The tilt of the tibial plateau, where it enters the knee, is much inclined to the horizontal, compared with a European tibia on the left.

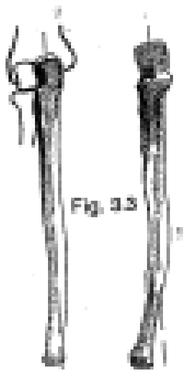


Fig. 3.3

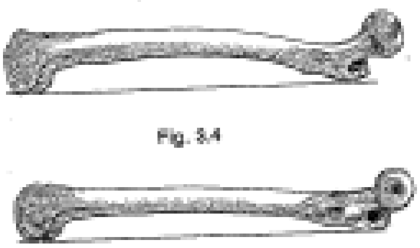


Fig. 3.4

Fig. 3.3: The Polynesian ulna on the right is more robust and more bowed than the European ulna on the left.

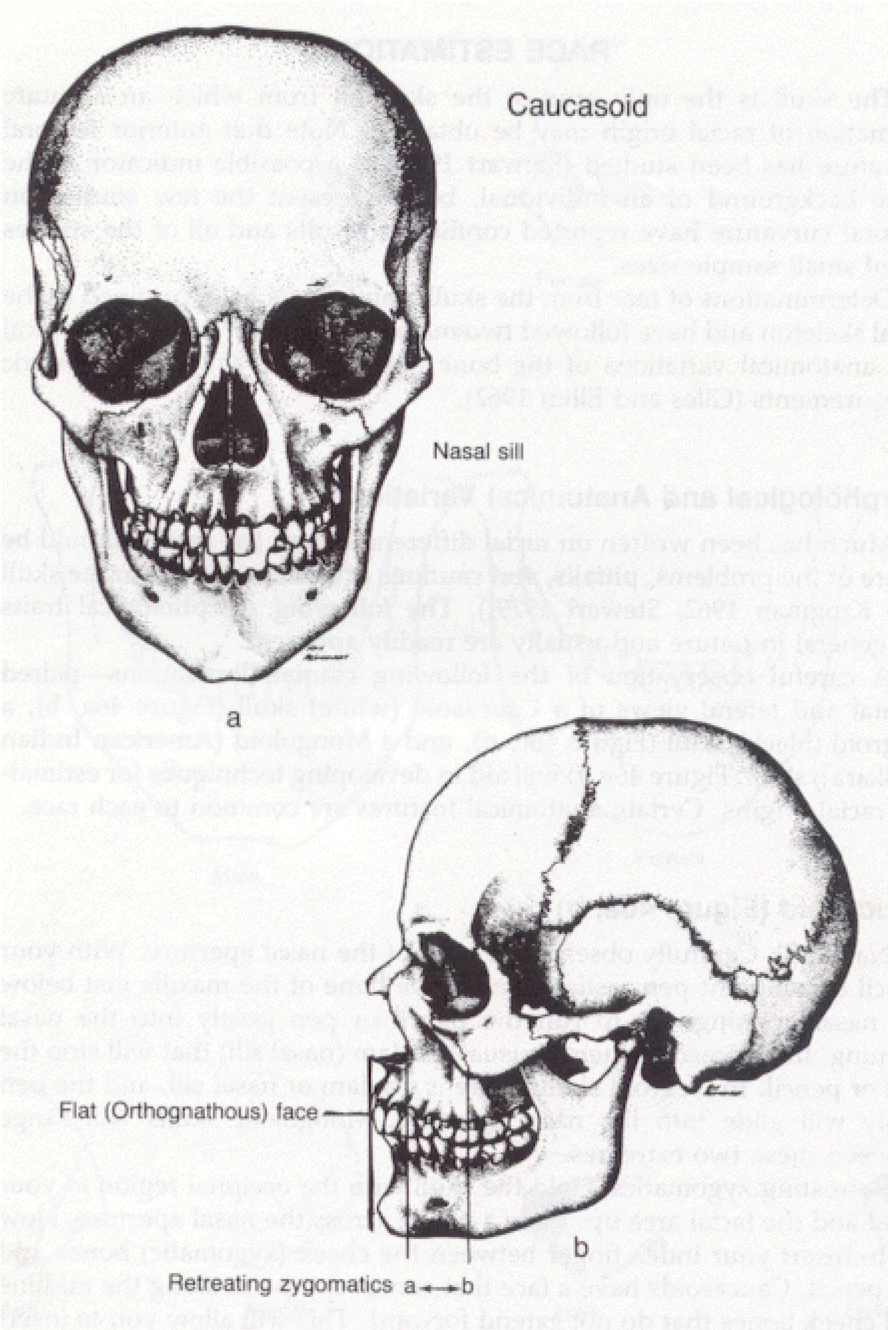
Fig. 3.4: The Polynesian femur (above) is more bowed in the shaft than the European femur below.

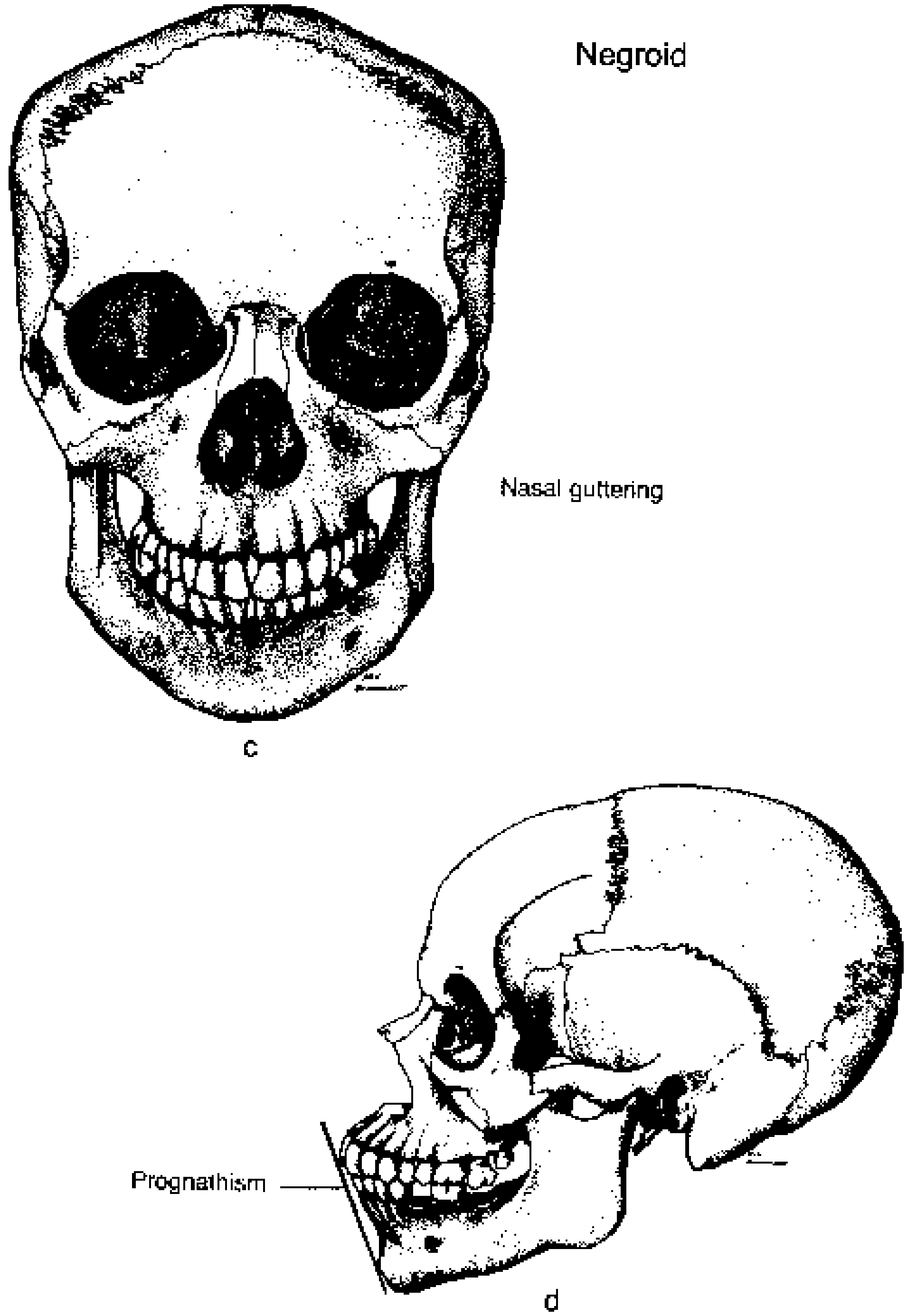
Fig. 3.5

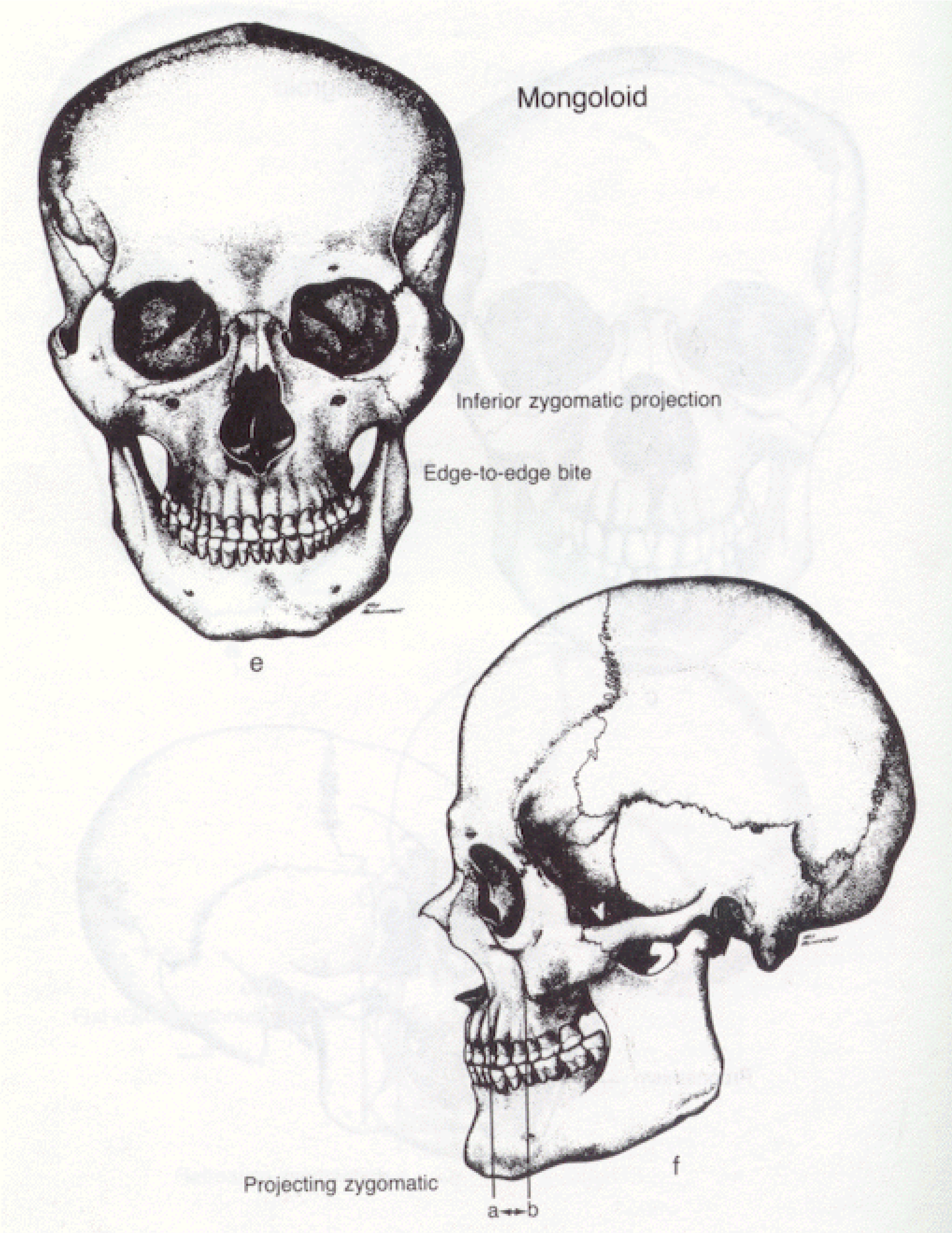
Fig. 3.6

Fig. 3.5: The upper part of the Polynesian femur (thigh bone) is oval in cross-section, compared with the European femur on the left.

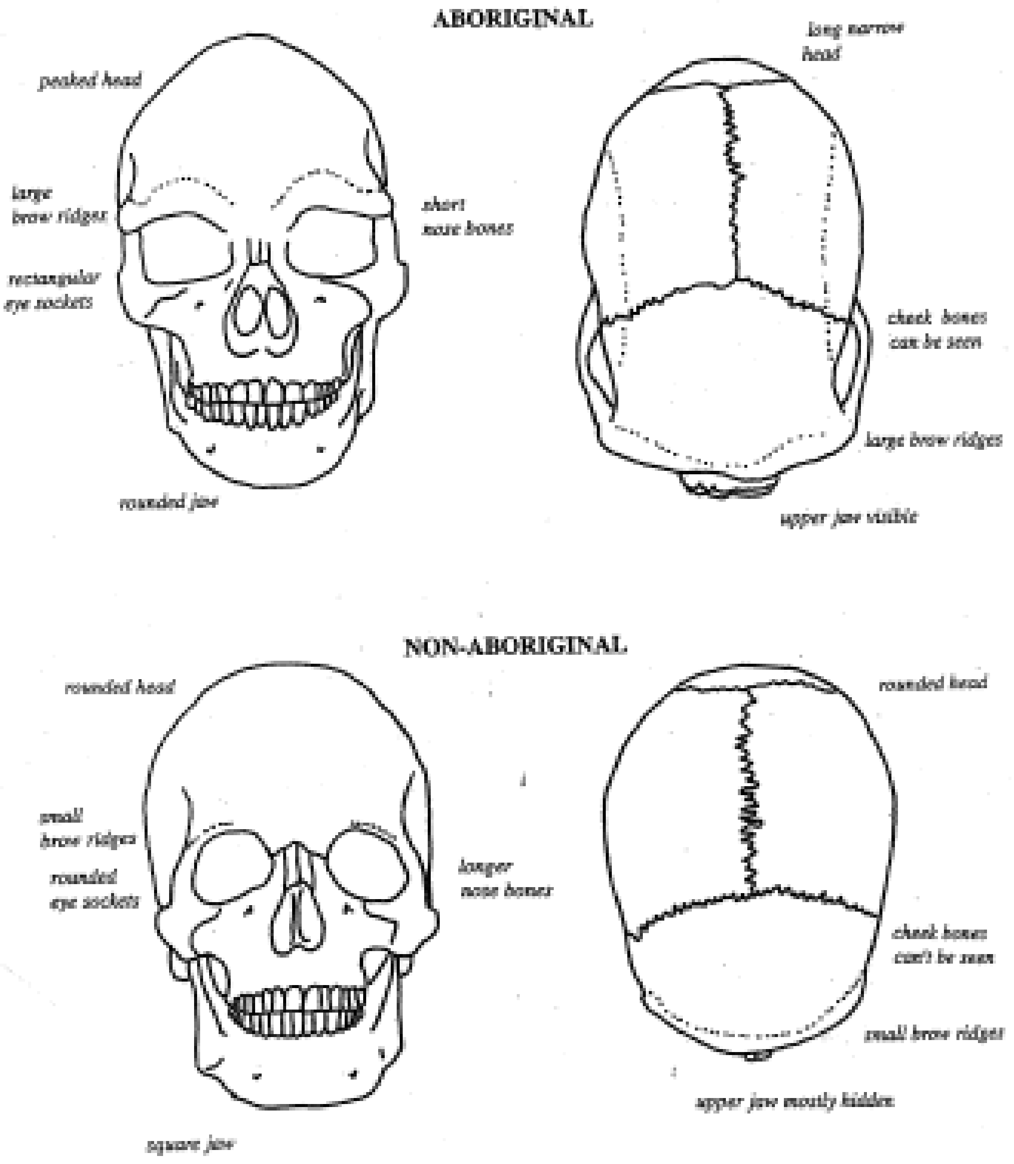
Fig. 3.6: The oval fovea on the head of the Polynesian femur contrasts with the usual round fovea of most of mankind.


Caucasoid
Nasal sill
a
Flat (Orthognathous) face
b
Retreating zygomatics a↔b


Negroid
Nasal guttering
c
Prognathism
d



Postcranial skeletal elements used in race estimation include the femur, tibia, coxa, scapula, sternal rib, and calcaneus.


ABORIGINAL
peaked head
long narrow head
large brow ridges
short nose bones
rectangular eye sockets
cheek bones can be seen
large brow ridges
rounded jaw
upper jaw visible
NON-ABORIGINAL
rounded head
rounded head
small brow ridges
longer nose bones
rounded eye sockets
cheek bones can't be seen
small brow ridges
upper jaw mostly hidden
square jaw

LAB EXERCISES

1. The skull is really complicated so what we are doing this week is really giving you a chance to look and draw and to identify from the individual elements laid out, the elements as they appear in a complete skull. So have a look at the isolated elements and then at the skull you are working with and draw the features you are uncertain of.

2. We have laid out a male and female cast for comparison. Identify the features used for sexing and then work out for each of those characters the probability of your individual being male or female. It is best to do this as a table:

Features	Female	Female?	Indet.	Male?	Male

3. Look at the casts showing different patterns of ancestry. Pay particular attention to features that are relatively easy to see such as the rocker jaw (Polynesian), shovel shaped incisors, the nasal sill, prognathism and the overall shape of the skull.

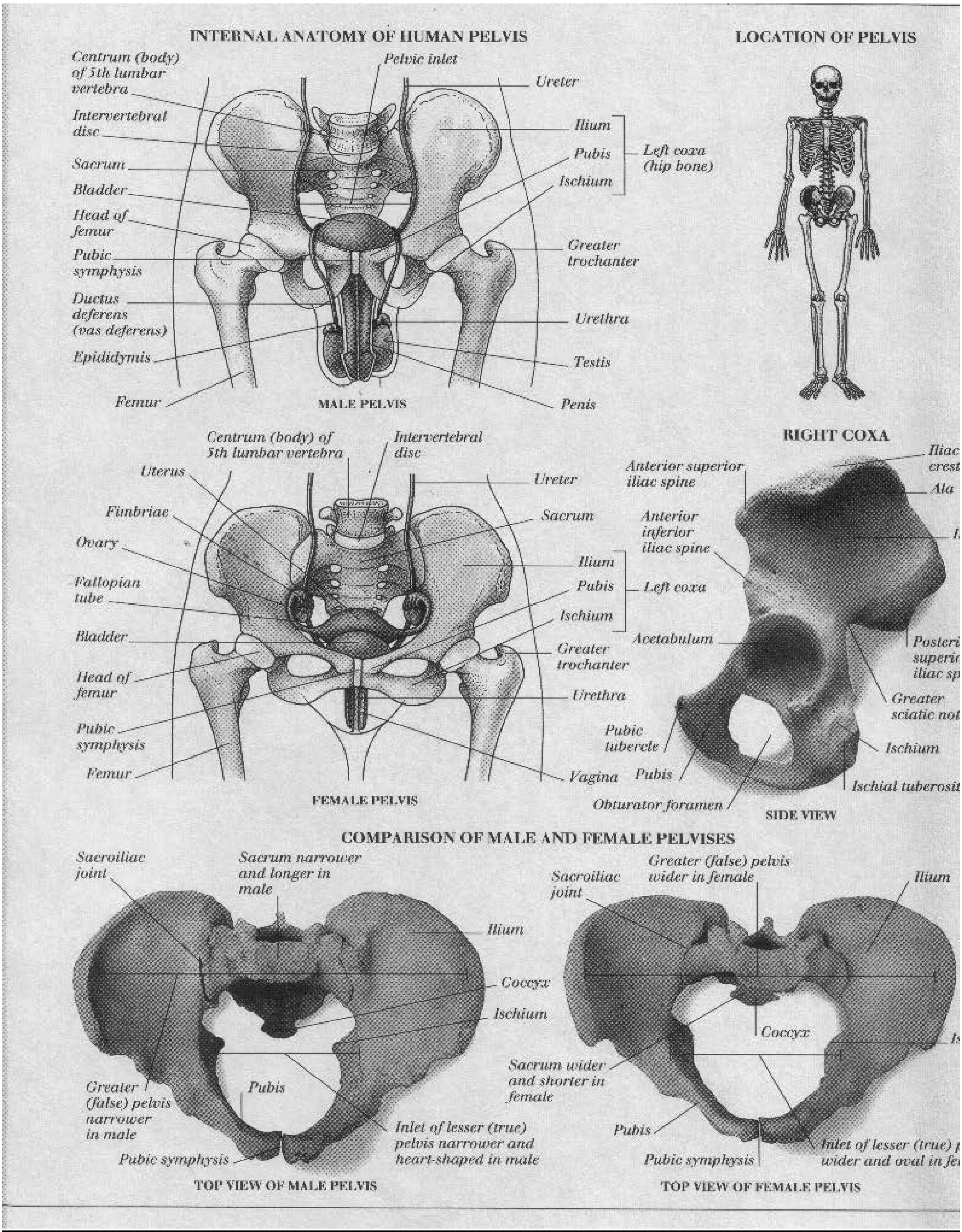
WEEK 8. THE INNOMINATES

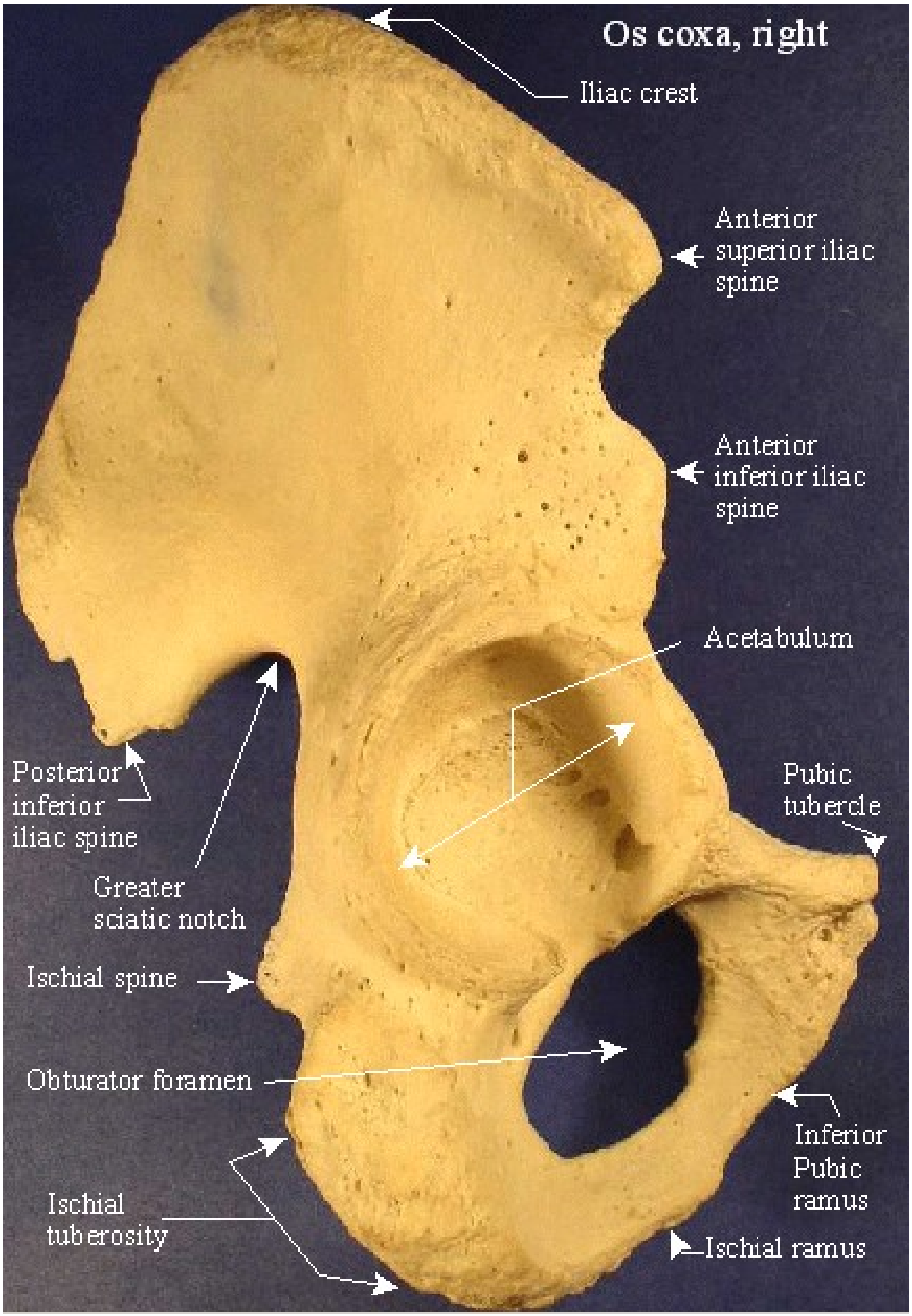
Goal:
a. the three bones
b. hip development
c. the principles of sexing non-metrically and metrically
d. Ageing using pelvic indicators

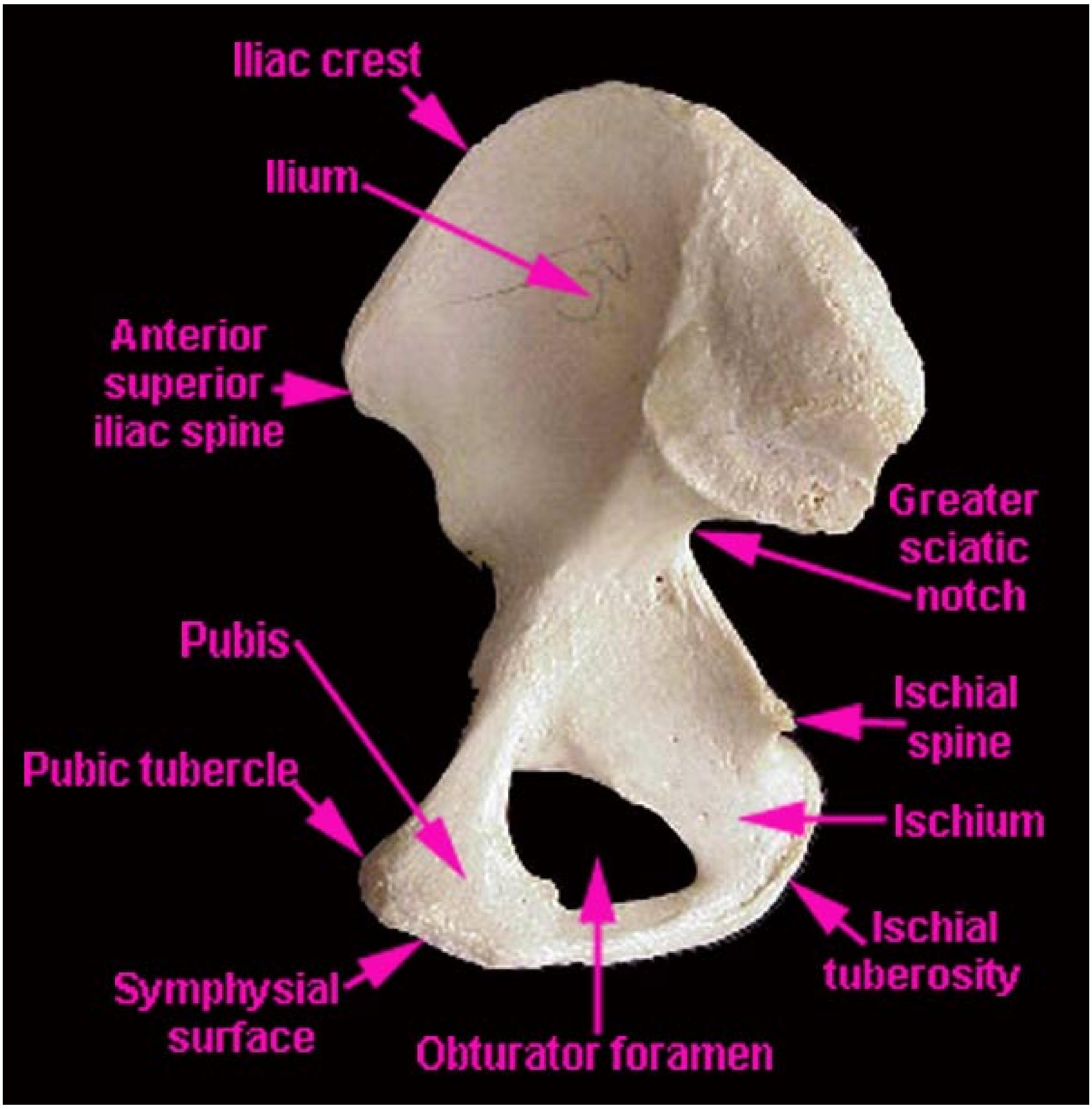
<u>Aim:</u> By the end of this class you should be able to sex and age your innominate. We will also get you to do an unknown.

A. PELVIC GIRDLE

BONE	VIEWS	FEATURES	BONES
sacrum	anterior posterior	promontory (both views) sacral foramina(both views) alae (both views) transverse lines (anterior only) spine (posterior only) articular facets (posterior only)	(not applicable)
coccyx	anterior	cornua	(not applicable
os coxa (innominate)	lateral medial **	obturator foramen (both views) greater sciatic notch (both views) blade (both views) aricular surface (medial only) iliac crest (medial only) pubic symphysis (medial only) acetabulum (lateral only) ischial tuberosity (lateral only) ** use one color for labeling the features	ilium (both views) ischium (both views) pubis (both views) ** use a second color for labeling the bones

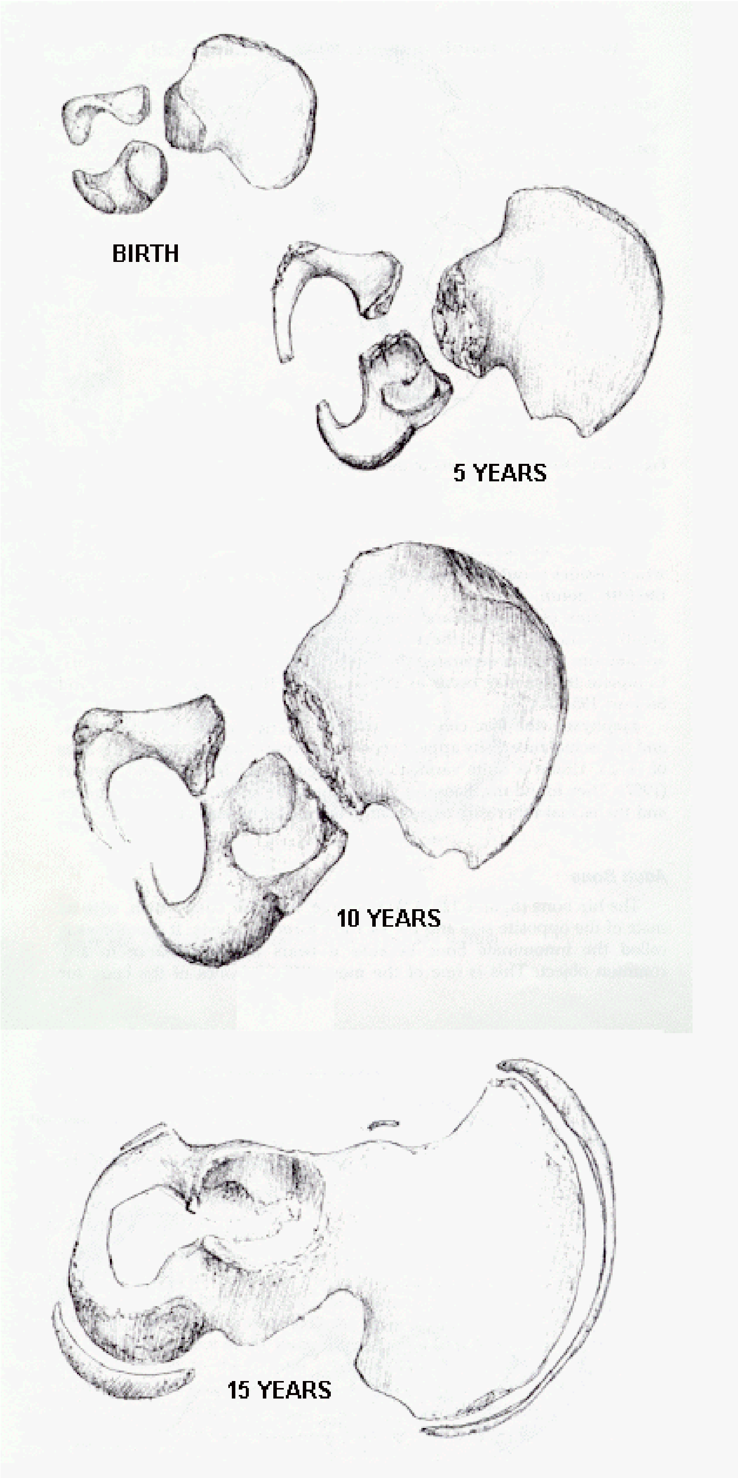

INTERNAL ANATOMY OF HUMAN PELVIS
Centrum (body) of 5th lumbar vertebra
Pelvic inlet
Ureter
Intervertebral disc
Ilium
Pubis
Ischium
Left coxa (hip bone)
Sacrum
Bladder
Head of femur
Pubic symphysis
Greater trochanter
Ductus deferens (vas deferens)
Urethra
Epididymis
Testis
Femur
MALE PELVIS
Penis
LOCATION OF PELVIS
Centrum (body) of 5th lumbar vertebra
Intervertebral disc
Uterus
Ureter
Fimbriae
Sacrum
Ovary
Ilium
Fallopian tube
Pubis
Left coxa
Ischium
Bladder
Greater trochanter
Head of femur
Urethra
Pubic symphysis
Femur
Vagina
FEMALE PELVIS
RIGHT COXA
Iliac
Anterior superior iliac spine
Ala
Anterior inferior iliac spine
Acetabulum
Greater
Pubic tubercle
Ischium
Pubis
Obturator foramen
SIDE VIEW
COMPARISON OF MALE AND FEMALE PELVISES
Sacroiliac joint
Sacrum narrower and longer in male
Ilium
Coccyx
Ischium
Greater (false) pelvis narrower in male
Pubis
Inlet of lesser (true) pelvis narrower and heart-shaped in male
Pubic symphysis
TOP VIEW OF MALE PELVIS
Greater (false) pelvis wider in female
Sacroiliac joint
Ilium
Coccyx
Sacrum wider and shorter in female
Pubis
Pubic symphysis
TOP VIEW OF FEMALE PELVIS


Os coxa, right
Iliac crest
Anterior superior iliac spine
Anterior inferior iliac spine
Acetabulum
Posterior inferior iliac spine
Greater sciatic notch
Pubic tubercle
Ischial spine
Obturator foramen
Inferior Pubic ramus
Ischial tuberosity
Ischial ramus


Iliac crest
Ilium
Anterior superior iliac spine
Greater sciatic notch
Pubis
Ischial spine
Pubic tubercle
Ischium
Ischial tuberosity
Symphysial surface
Obturator foramen

B. OSSIFICATION OF THE INNOMINATE.

There are three primary centres of ossification in the innominate or os coxa:: the ilium, ischium and pubis
Two secondary centres: the ischial tuberosity, the iliac crest fused by adulthood.



pelvis development
(scanned from Bass 1987:188-189)

C. SEX ESTIMATION

The sex of an individual is determined, when soft tissue is not present, by a number of skeletal indicators. Of course, the more indicators used to determine sex, the more accurate the results. However, a forensic anthropologist is analytically limited by the bones present and their condition.
We will look at several features of the pelvis, skull, and limb bones used to estimate sex. What we are doing in lab for sex estimation does not cover all skeletal indicators of sex, but it will give you a good idea of how a forensic anthropologist estimates the sex of an individual using the bones.

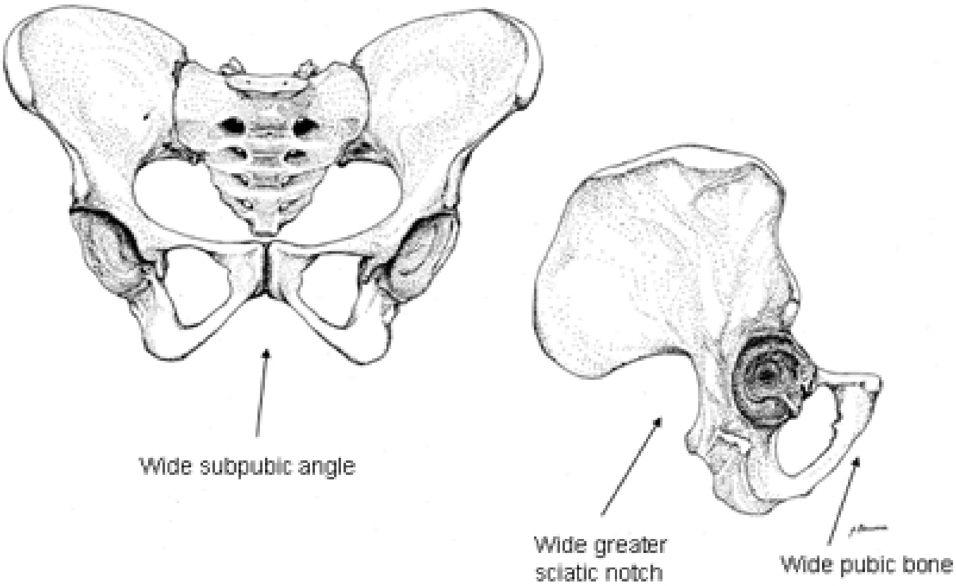
Pelvis
The pelvis is often cited as the best bone with which to estimate sex. We are using the pubis bone and the overall shape of the pelvic girdle to estimate sex. The table below summarises these traits followed by an image that shows these traits in a female.

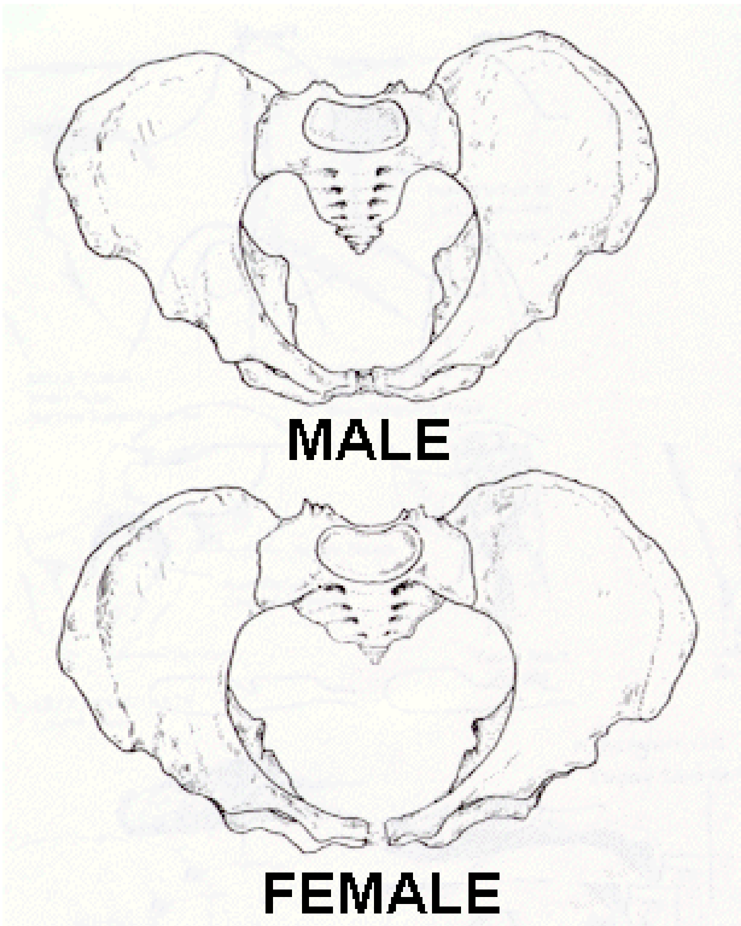
Postcranial Sex Traits: The Innominate.

SUMMARY OF OSSA COXAE TRAITS RELATED TO SEXING

Trait	Female	Male
obturator foramen	small and triangular	large and ovoid
greater sciatic notch	wide, >90 degrees	narrow, deep, <90 degrees
auricular surface	high relief, with pre-auricular sulcus	low relief , lacking pre-auricular sulcus
acetabulum	Small	Large
Ventral arc	Present	Absent
Pubis body width	40 mm	25-30 mm
Subpubic angle	>90 with concavity	<90

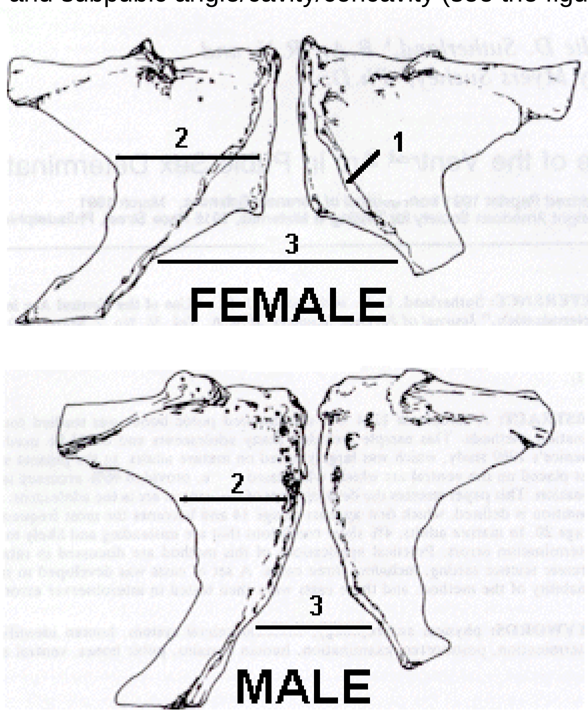
(Adapted from Bass 1987, 1995; White 1991, 2000; Pickering and Bachman 1997)





superior view of pelvis
(scanned from Bass 1987:206)

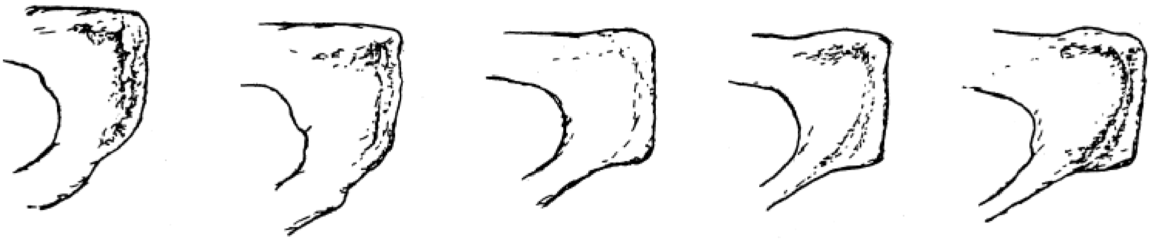
The pubis bone is the most medio-anterior bone of the coxa, on the medial side of the obturator foramen. The pubis bones of both coxae articulate dorsally at the pubic symphysis. Several features of the pubis bone are used in sex estimation; we are examining the ventral arc, pubis body width, and subpubic angle/cavity/concavity (see the figure below).



PUBIS BONE: 1 = ventral arc
2 = pubic body width
3 = subpubic angle

(scanned from Sutherland and Suchey 1991:502)

The **ventral arc** is a roughened projection of bone visible on the anterior surface of the pubis bone. This is a nonmetric trait; it is only present in females and is absent in males.
The **pubis body** width is measured from the middle of the pubic symphysis to the obturator foramen. The width is greater in females, usually about 40 mm, and smaller in males, ranging around 25-30 mm.
The **subpubic angle** (also called the subpubic cavity or subpubic concavity) is angle made by the inferior borders of the articulated pubis bone. In females the angle is wide and greater than 90°. In males the angle is narrow and less than 90° (France, 1996:91).

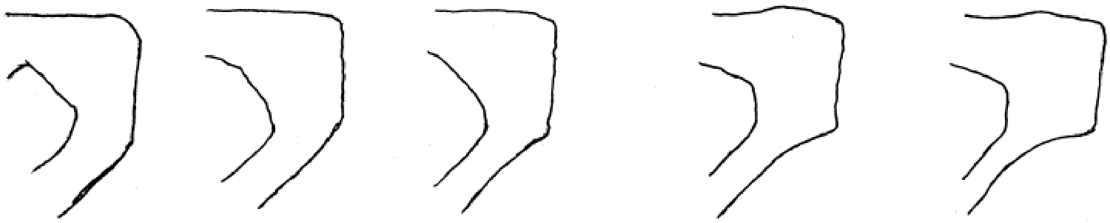


Typical male
5

Typical female
1

Some of the variation observable in the pubic region, from typical male morphology (5) to typical female morphology (1).

Variations include: An increase in 'length' of the pubic bone relative to overall robusticity.
On the ventral surface a shift from a ventral arc to a ridge running parallel to the pubic symphysis.
A 'thinning' of the inferior pubic ramus from typical male to typical female specimens.



Typical male
5

Typical female
1

Changes in the inferior ramus from typical male to typical female, with resulting changes in the profile of the sub-pubic area.

Figure 9a Sexual dimorphism in male and female innominates (pubic region).

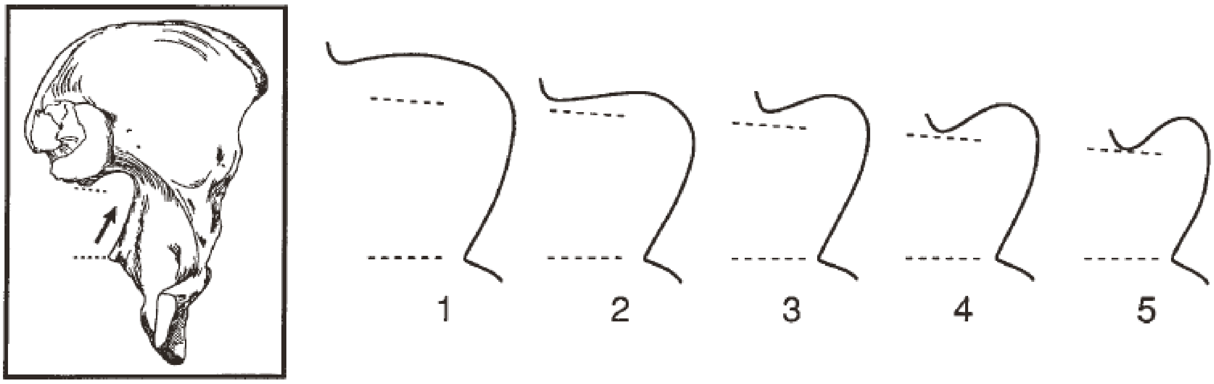


Fig. 1. Standard for scoring sex differences in greater sciatic notch (indicated by arrow at left; after Buikstra and Ubelaker, 994).

D. AGEING USING THE PELVIS

Two aspects of the pelvis are used in ageing: the auricular surface between the os coxa and the sacrum, and the pubic symphysis. The changes are due to metamorphosis in the surface over time. This is the same idea as the rib end changes but both methods have been more extensively tested. In this lab we will just us the pubic symphysis as an introduction.

Pubic Symphysis Morphology

Morphological changes of the articular surfaces of the innominate provides an excellent postcranial age indicators for adult remains. Variation in the face of the pubic symphysis, the anterior-most point of articulation between the two innominates in the pelvic girdle, is a common region analyzed for age determination. Todd (1920) outlined a 10-stage method for assessing this surface, based on a large sample of male innominates. Changes in the symphyseal surface over time proceed in a predictable pattern from a heavily contoured face, to one delimited by a rim in the mid 30s, to a surface marked by increasing porosity after 40 years. Analysis by Meindl and coworkers (1985) has shown the Todd method to be the most accurate of the pubic symphyseal methods available. It should be noted however, that a tendency to over-age individuals has been found after age 40 by some (BROOKS, 1955), while others claim under-aging of the 45+ year old individuals is problematic (Aiello and Molleson, 1993).

SUCHEY/BROOKS METHOD:

Phase 1: Symphyseal face has a billowing surface composed of ridges and furrow which includes the pubic tubercle. The horizontal ridges are well-marked. Ventral bevelling may be commencing. Although ossific nodules may occur on the upper extremity, a key feature of this phase is the lack f delimitation for either extremity (upper or lower). F=15-20 y; M=15-20Y

Phase 2: Symphyseal face may still show ridge development. Lower and upper extremities show early stages of delimitation, with or without ossific nodules. Ventral rampart may begin formation as extension from either or both extremities. F=20-30 y; M=20-30 Y

Phase 3: Symphyseal face shows lower extremity and ventral rampart in process of completion. Fusing ossific nodules may form upper extremity and extend along ventral border. Symphyseal face may either be smooth or retain distinct ridges. Dorsal plateau is complete. No lipping of symphyseal dorsal margin or bony ligamentous outgrowths. F= 25-35 y; M=25-35

Phase 4: Symphyseal face is generally fine-grained, although remnants of ridge and furrow system may remain. Oval outline usually complete at this stage, though a hiatus may occur in upper aspect of ventral circumference. Pubic tubercle is fully separated from the symphyseal face through definintion of upper extremity. Symphyseal face may have a distinct rim. Ventrally, bony ligamentous outgrowths may occur in inferior portion of pubic bone adjacent to symphyseal face. Slight lipping may appear on dorsal border. F= 35-45 Y ; M=30-40Y

Phase 5: Slight depression of the face relative to a completed rim. Moderate lipping is usually found on the dorsal border with prominent ligamentious outgrowths on the ventral border. Little or no rim erosion, though breakdown possible on superior aspect of ventral border. F= 45-55 Y; M=40-55

Phase 6: Symphyseal face shows ongoing depression as rim erodes. Ventral ligamentous attachments are marked. Pubic tubercle may appear as a separate bony knob. Face may be pitted or porous, giving an appearance of disfigurement as the ongoing proecss of erratic ossificaiton procededs. Crenelations may occur, with the shape of the face often irregular. F=55Y+; M=55Y +

	Female (*n = 273*)			Male (*n = 739*)		
Phase	Mean	Standard Dev.	95% Range	Mean	Standard Dev.	95% Range
1	19.4	2.6	15-24	18.5	2.1	15-23
2	25.0	4.9	19-40	23.4	3.6	19-34
3	30.7	8.1	21-53	28.7	6.5	21-46
4	38.2	10.9	26-70	35.2	9.4	23-57
5	48.1	14.6	25-83	46.6	10.4	27-66
6	60.0	12.4	42-87	61.2	12.2	34-86

Note the mean age and standard deviation which increases over time. Generally using a standard deviation as a +- range gives you a useful range.

https://allthingsaafs.files.wordpress.com/2014/01/pubic-symphasis-6stages-stats.png

LAB EXERCSIES

1. **Working in groups we have laid out for you an os coxa. Make sure you can identify the features and landmarks you need to sexing and aging.**

2. **Fill out the following table to identify sex – remember not all features will be congruent with one sex or the other.**

Feature	**F**	**F?**	**?**	**M?**	**M**
ESTD Sex					

3. **Examine the pubic symphysis, use the charts and the casts as comparison but before you decide on an age stage undertake the following:**

   Look at the surface is it billowed, flat, macroporsity?

   Is there a rim to the surface – is it complete or incomplete.

   Is there vetral beveling or is the rampart complete or is it broken down?

   Then identify the stages which it cannot be?

   Which stage do you think it conforms to?

   What age range is that?

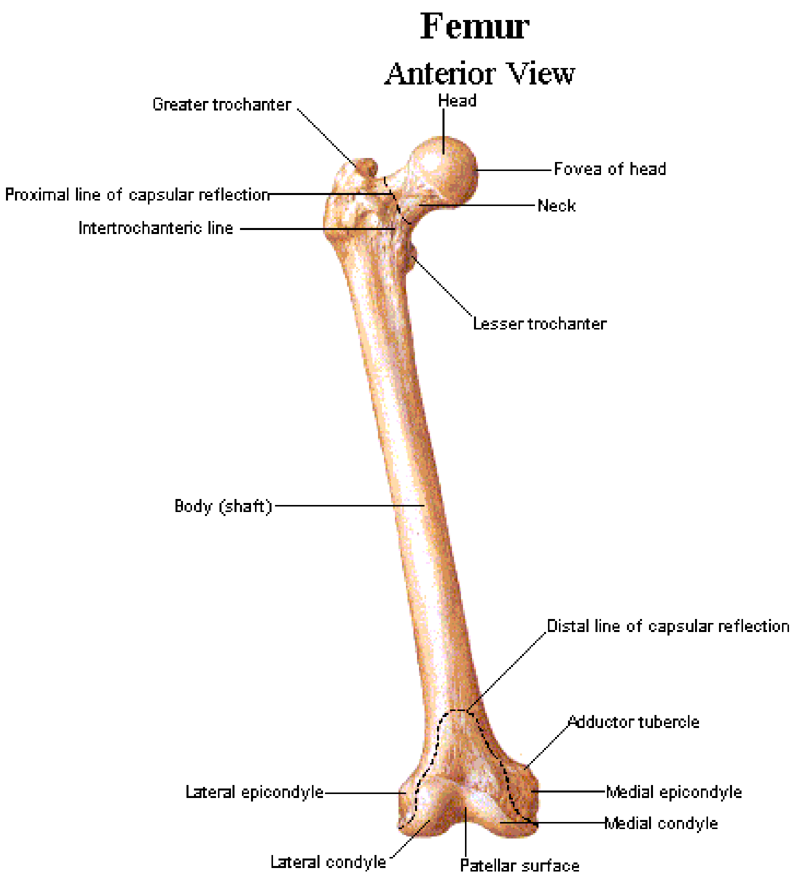
WEEK 9. THE LEGS AND FEET

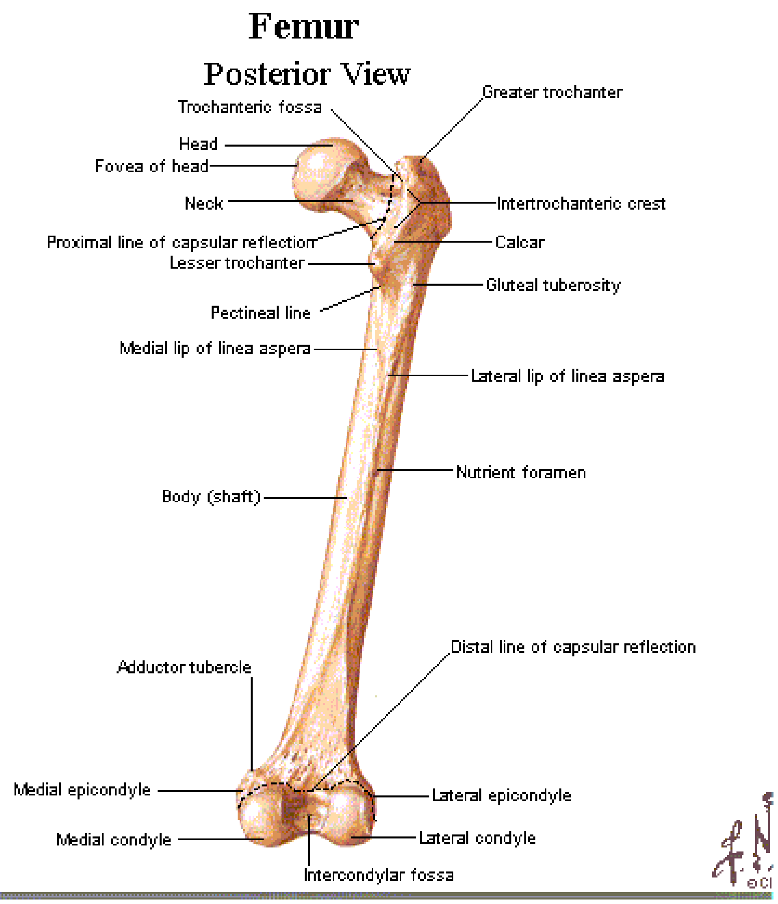
a. The bones of the leg
b. Distinguishing hands from feet
b. Epiphyseal closure
c. Metric indicators of sex

Aim: you should be able to identify and side these four bones, measurement them, estimate sex metrically plus identify unfused versus fused epiphyses.

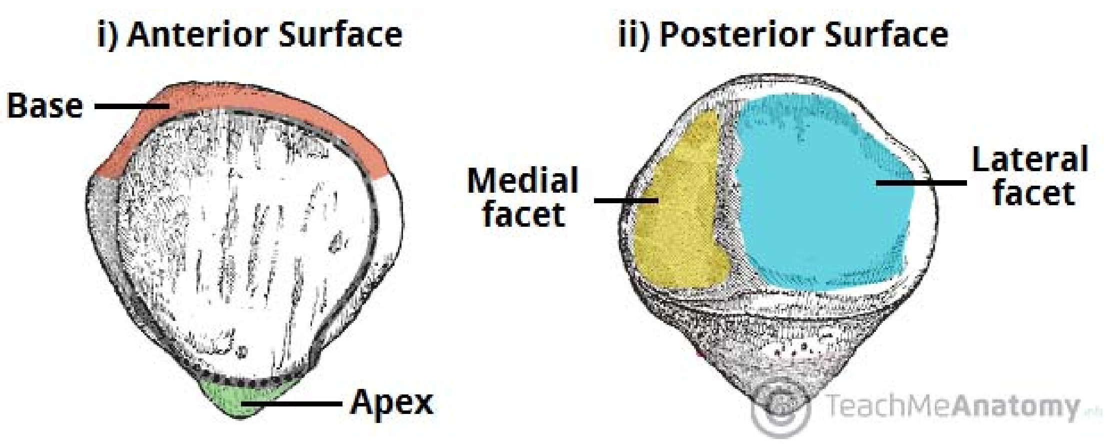
BONES OF THE LEG

The leg comprises four bones: the femur, patella (a sesamoid bone), the tibia and fibula. The foot is articulated at the talus .
The femur is commonly called the thigh bone and is the heaviest, longest and strongest bone of the body. It has a slight anterior curvature but this degree of anterior bowing varies between individuals. In its normal anatomical position the bone is angled from the hip to the knee.
Note the head of the femur is distinguishable from the head of the femur by being both more separately rounded (like a half sphere and by having a fovea (a small circular or ovoid depression where the attachment to the acetabulum inserts.



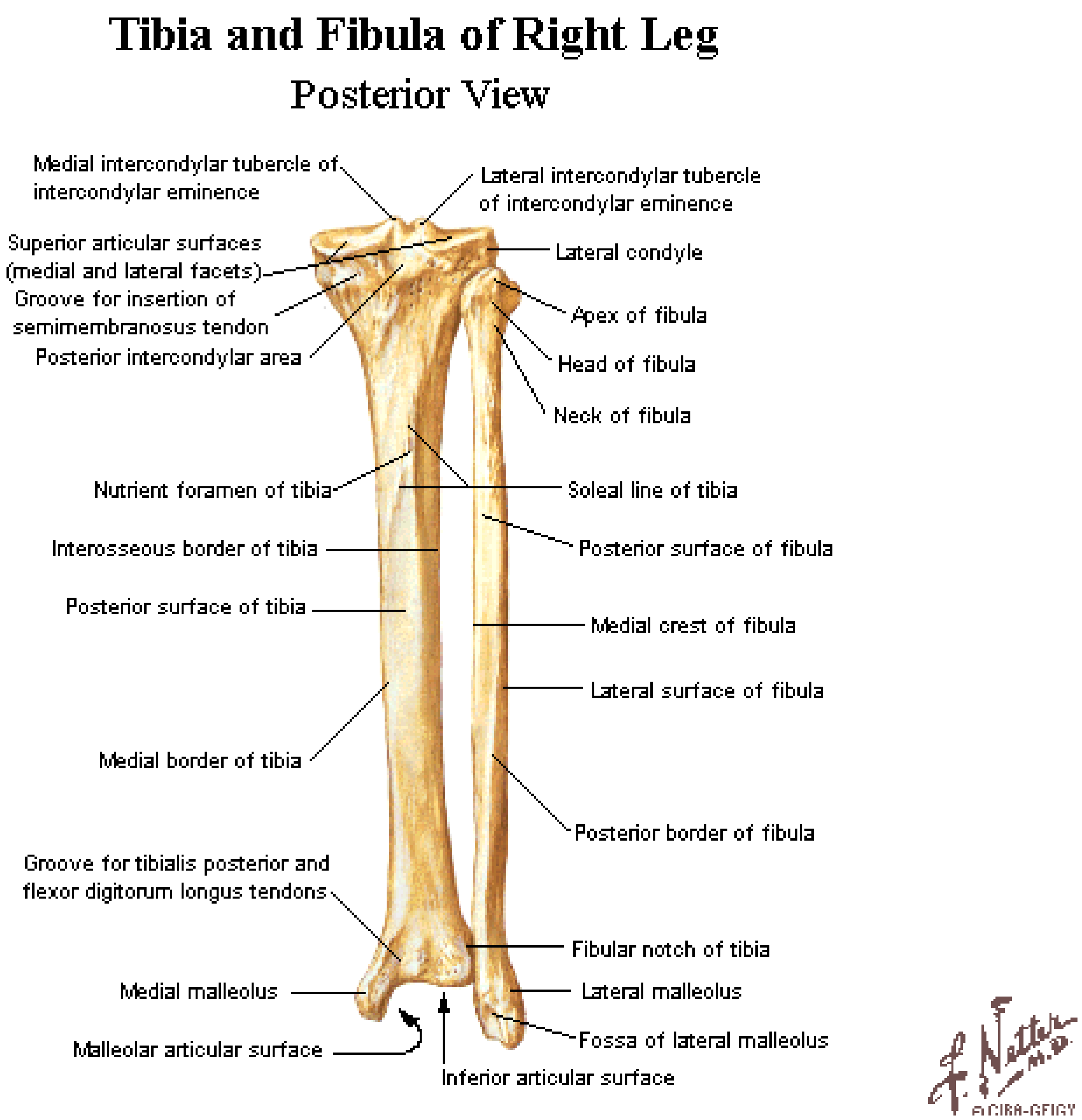


THE PATELLA
The patella, commonly known as the knee cap is the flat rounded bone which articulates with the anterior surface of the distal femur. If you place a patella anterior surface down on the table with the angled point toward you then the larger articular surface on the posterior view is the side that the bone is from.



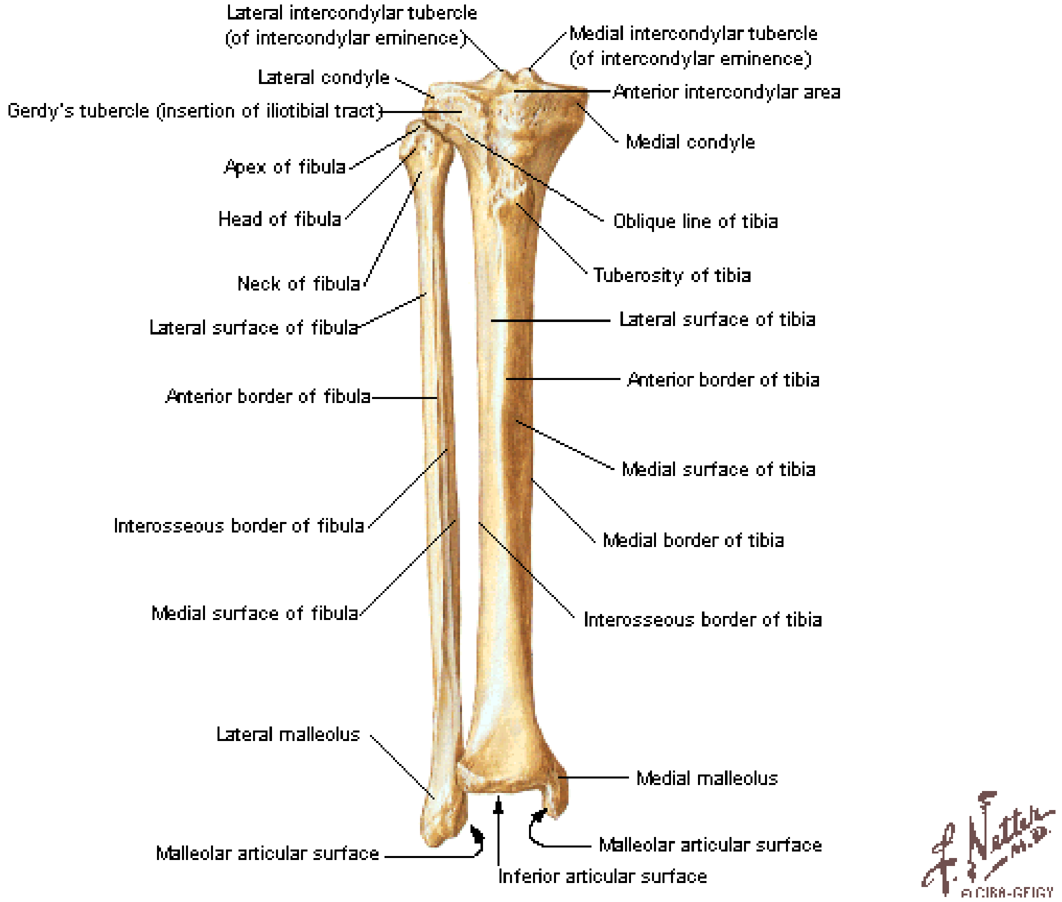
THE TIBIA

The tibia is the second largest long bone. It is straighter than the femur. The tibial shaft is more triangle with the sharpest edge anterior – this is the anterior crest which is subject to trauma. There is a thin ridge on the lateral side of the tibia – the interosseous crest – which is the attachment site for the membrane between the tibia and fibula. (the same feature exists in the radius and ulna).
The distal tibial has the project of the medial malleolus (the bone you can feel when you put your ankles together).
The fibula is a much thinner long bone. The head of the fibula does not form part of the knee bot articulates with the lateral tibia. The lateral malleolus of the fibula points toward to the posterior. You need to handle the fibula and work out a series of rules that help you identify which side it comes from.



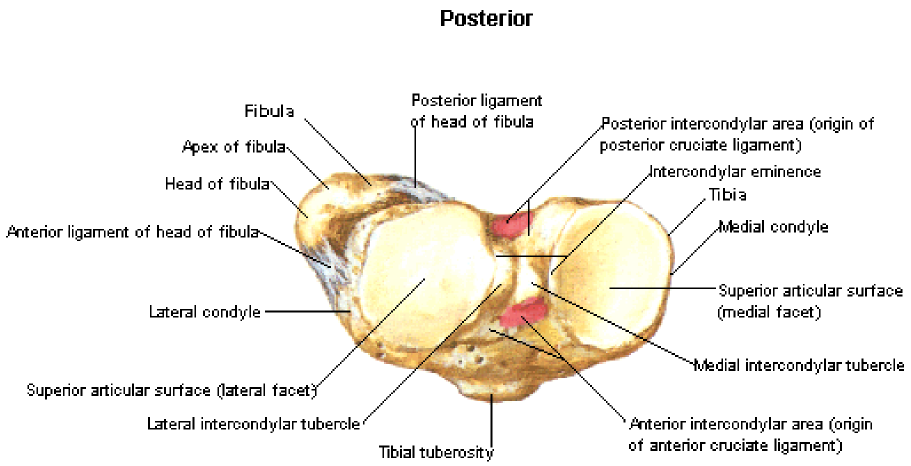
Tibia and Fibula of Right Leg

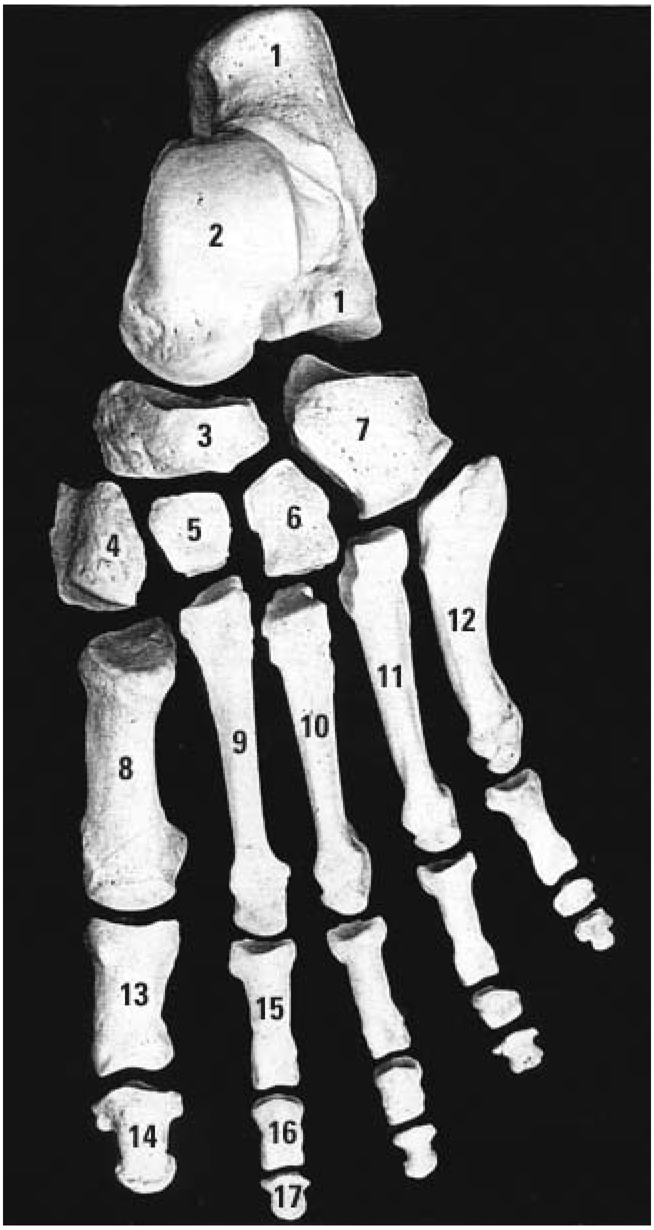
Anterior View



Tibia and Fibula of Right Leg

Superior View





The disarticulated bones of the left foot (picture/photo from above)
(The talus and calcaneus remain articulated) There are 26 bones in each foot, not including the 2 sesamoid bones located underneath the first metatarsal head. **1** Calcaneus **2** Talus **3** Navicular **4** Medial cuneiform **5** Intermediate cuneiform **6** Lateral cuneiform **7** Cuboid **8** First metatarsal **9** Second metatarsal **10** Third metatarsal **11** Fourth metatarsal **12** Fifth Metatarsal **13** Proximal phalanx of great toe **14** Distal phalanx of great toe **15** Proximal phalanx of second toe **16** Middle phalanx of second toe **17** Distal phalanx of second toe

THE FOOT

There are seven tarsals. In this class we will just get you to side the talus and calcaneus but become familiar with the size of the tarsals particularly relative to the carpals as well as the differences between the metatarsals and metacarpals and the phalanges of the hands and feet.
The talus when it is laid with the head away from you, superior surface up, the lateral

process points to the correct side. The calcenus when the heal points toward you with the talar facet up, the distal articulation is on the correct side.

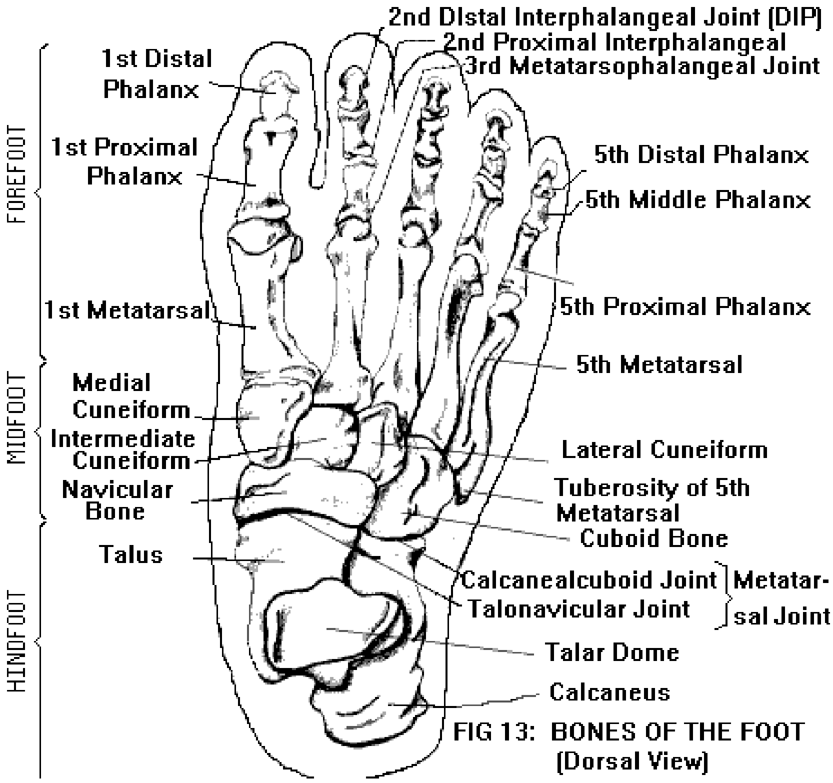
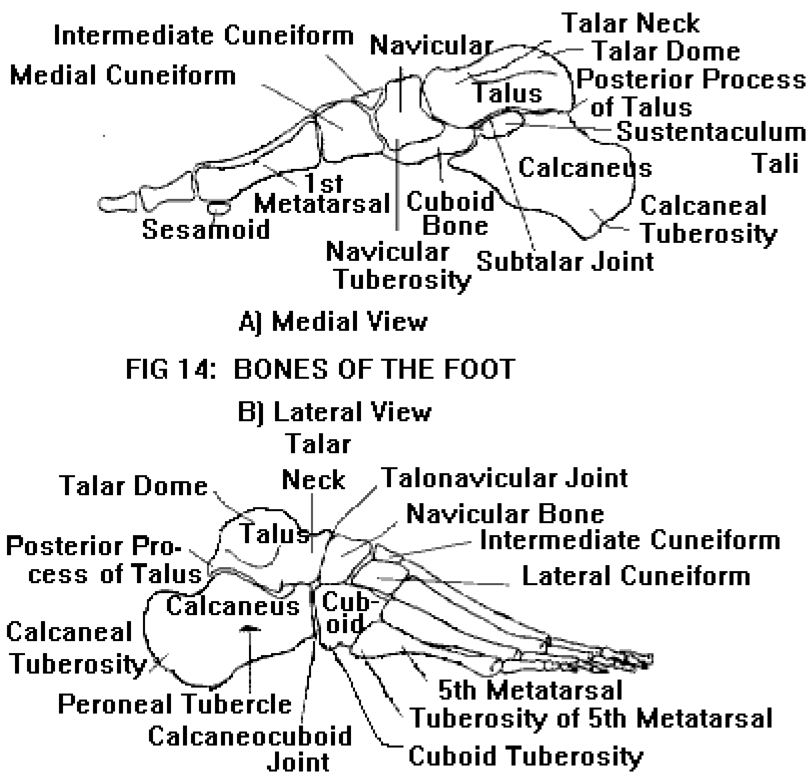


FIG 13: BONES OF THE FOOT (Dorsal View)



A) Medial View

FIG 14: BONES OF THE FOOT

B) Lateral View

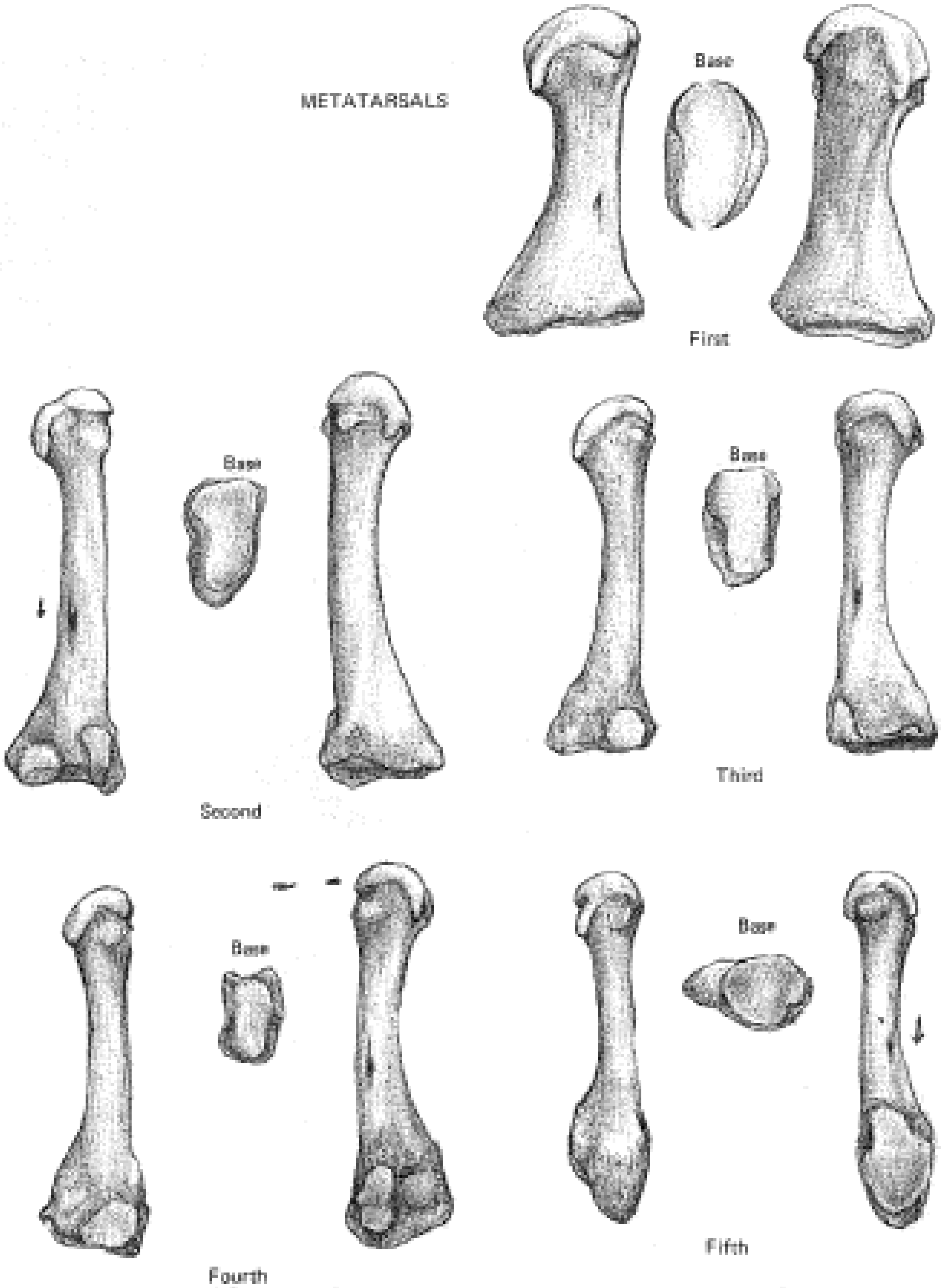


Fig. 133. Metatarsals (all are left bones with fibular, base, and tibia views)

Metatarsals: Paired—Short Bones (Fig. 133).

The metatarsals consist of five cylindrical bones in each foot. They articulate with the tarsus proximally and with the first or proximal row of phalanges distally. As with the metacarpals in the hand, they have been well described as long bones in miniature. As they extend from the tarsus they diverge slightly from each other. They are numbered from the medial (big toe) to the lateral side (small toe).

As with long bones, the metatarsals present a shaft and two extremities. The base or tarsal extremity articulates with the tarsus proximally, and on the side of the basilar end with the adjacent metatarsal bones.

The shaft tapers gradually from the base to the distal end (head) and is curved so as to be convex on the dorsal side (top of foot) and concave on the plantar side (bottom of foot). The shaft is somewhat triangular in cross section.

The head or distal extremity articulates with the proximal (first) phalange. Note that the heads all present large rounded articular surfaces. Although the nutrient foramina are difficult to find in many metatarsals, it should be noted that they are inclined toward the distal end of the first, but toward the proximal end of the second through the fifth (the same pattern as in the metacarpals).

First (big toe)—shortest, thickest and most massive of the metatarsals. The base has a saddle-shaped articular facet for the first cuneiform bone. The head is marked on the plantar surface by two deep grooves, separated by a ridge. These grooves are associated with two sesamoid bones.

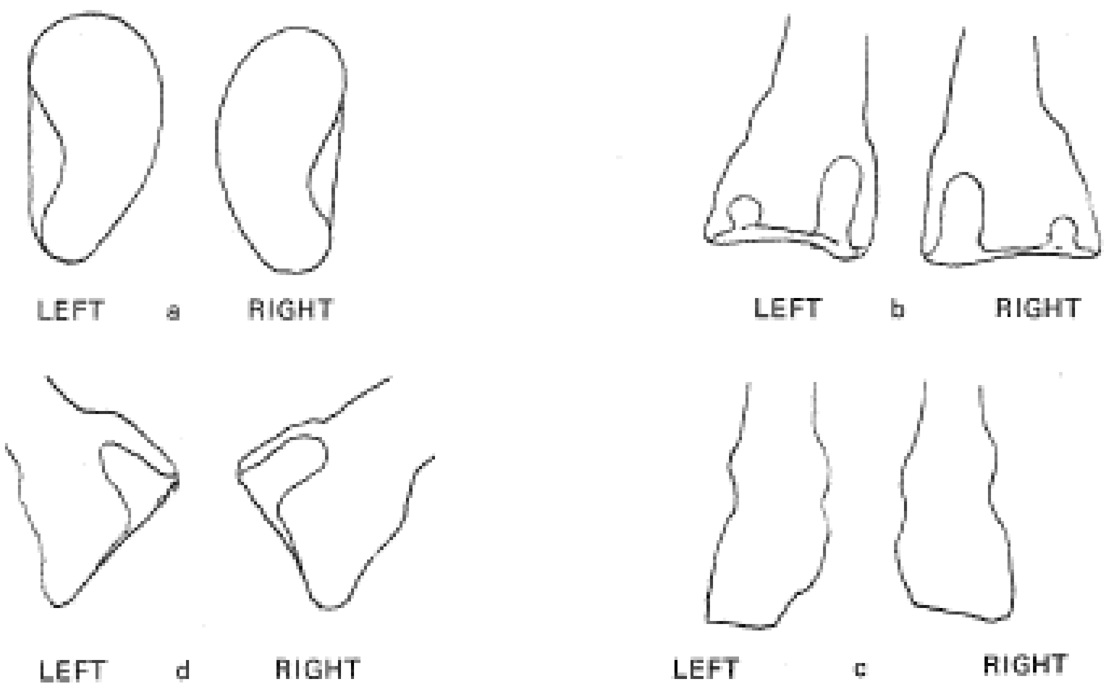
Second—longest metatarsal.

Third, fourth and fifth successively decrease in length.

Side identification:

Anatomical position for all metatarsals will be the same when held with the proximal end (base) toward you.

First—the saddle-shaped articular surface will be slightly inclined toward the opposite side the bone comes from (Fig. 134a).



B. DISTINGUISHING HANDS FROM FEET

Differences between phalanges:

2. Except for the two phalanges of the big toe (which are the largest phalanges) the remaining 12 phalanges of the foot are smaller.

3. The phalanges of the fingers are flat on the volar surface and rounded on the dorsal.

4. 3. The shalft is narrow and comparessed in the phalanges of the toes and the bones are usually not as long in the fingers.

Differences between the metatarsals and metacarpals:

1. The metatarsals are longer and the shafts (except for the first) are a little thinner than the metacarpals.

2. The articular surfaces in the heads of the metatarsals are restricted laterally and are well marked anteriorly-posteriorly. This gives the appearance of having a groove causing a double expansion of the head.

3. the grooves between the articular facets on the proximal end of the metatarsals are much more pronounced.

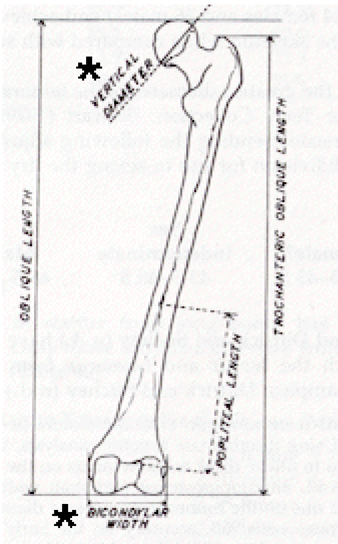
C. SEXING USING METRICS

Limbs

Ordinarily, the limb bones alone are not used for sexing unless absolutely necessary. But characteristics of the limb bones can be used (alone or in conjunction with examination of the pelvis and skull) for sex estimation.

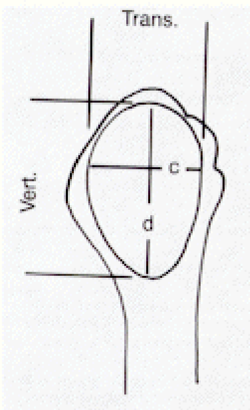
While forensic anthropologists and osteologists have examined most postcranial bones for evidence of metric and nonmetric differences between the sexes, in this lab we are going to look only at two limb bones, the femur and humerus.

Two metric traits of the femur used to estimate sex are maximum diameter of the head (vertical diameter) and bicondylar width. The figure below shows how to measure these traits.



note measurement of femur head diameter
note measurement of bicondylar width
(scanned from Bass 1987:219)

Three metric traits of the humerus used to estimate sex are maximum diameter of the head (transverse and vertical), epicondylar width, and maximum length. The figure below shows how to measure these traits.



c = transverse diameter of humerus head
d = vertical diameter of humerus head
(scanned from Bass 1987:156)

These metric traits vary between males and females in the following ways. All measurements are in mm.

RANGES OF METRIC LIMB TRAITS RELATED TO SEXING (all measurements in mm)

Trait	Female	Probably Female	Indeterminate	Probably Male	Male
femur head maximum diameter (Negroid)	<41.5	41.5-43.5	43.5-44.5	44.5-45.5	>45.5
femur head maximum diameter (Caucasoid)	<42.5	42.5-43.5	43.5-46.5	46.5-47.5	>47.5
bicondylar width (Negroid)	<72	72-74	74-76	76-78	>78
humerus head max diameter vertical (race?)	<43	-	44-46	-	>47

(from Bass 1987:21, 150-151, 156, 219-221)

AVERAGES OF METRIC LIMB TRAITS RELATED TO SEXING (all measurements in mm)

Trait	Female	Male
femur head max diameter (Caucasoid)	43.8	49.7
femur head max diameter (Negroid)	41.5	47.2
humerus head max diameter vertical (race?)	42.7	48.8
humerus head max diameter transverse (race?)	37.0	44.7
humerus head max diameter transverse (Native American)	38-39	43-44
humerus maximum length (Negroid)	305.9	339.0
humerus epicondylar width (Negroid)	56.8	63.9

(from Bass 1987:21, 150-151, 156, 219-221)

D. B. EPIPHYSEAL UNION

At birth a human has about 450 bones, over twice that of a human adult. A single bone in an adult, for example the coxa, is usually a series of several bones in a subadult (see the figure below). During ontogenetic development the multiple bones fuse together into single bones, so that adults have 206 bones. This process is often referred to **epiphyseal union**.

The fusion of bone **epiphyses** to **metaphyses** occurs at regular intervals during the course of development. Because of this regularity, epiphyseal union is a useful trait in aging individuals, especially subadults. While there is some sexual variation, with female epiphysis fusion occurring earlier than in males, the ages of epiphyseal union are regular (see Figure 4.4 on page 85 in Rhine).

The fusion of a particular bone is usually classified into stages: nonunion, one-quarter united, one-half united, three-fourths united, and fully fused or full union (White 1991:313).

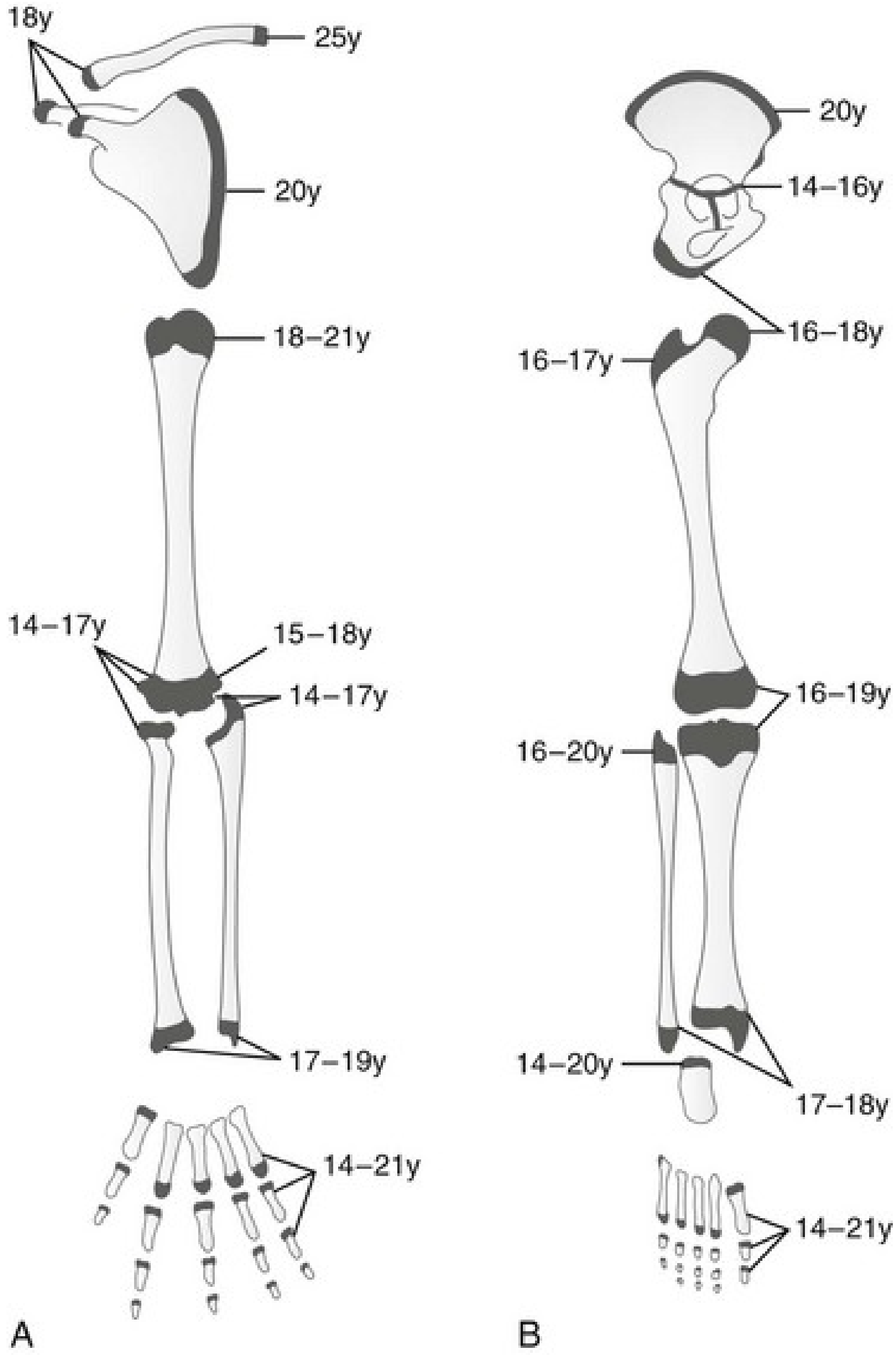
We will examine epiphyseal union of the he tibia, and the femur.

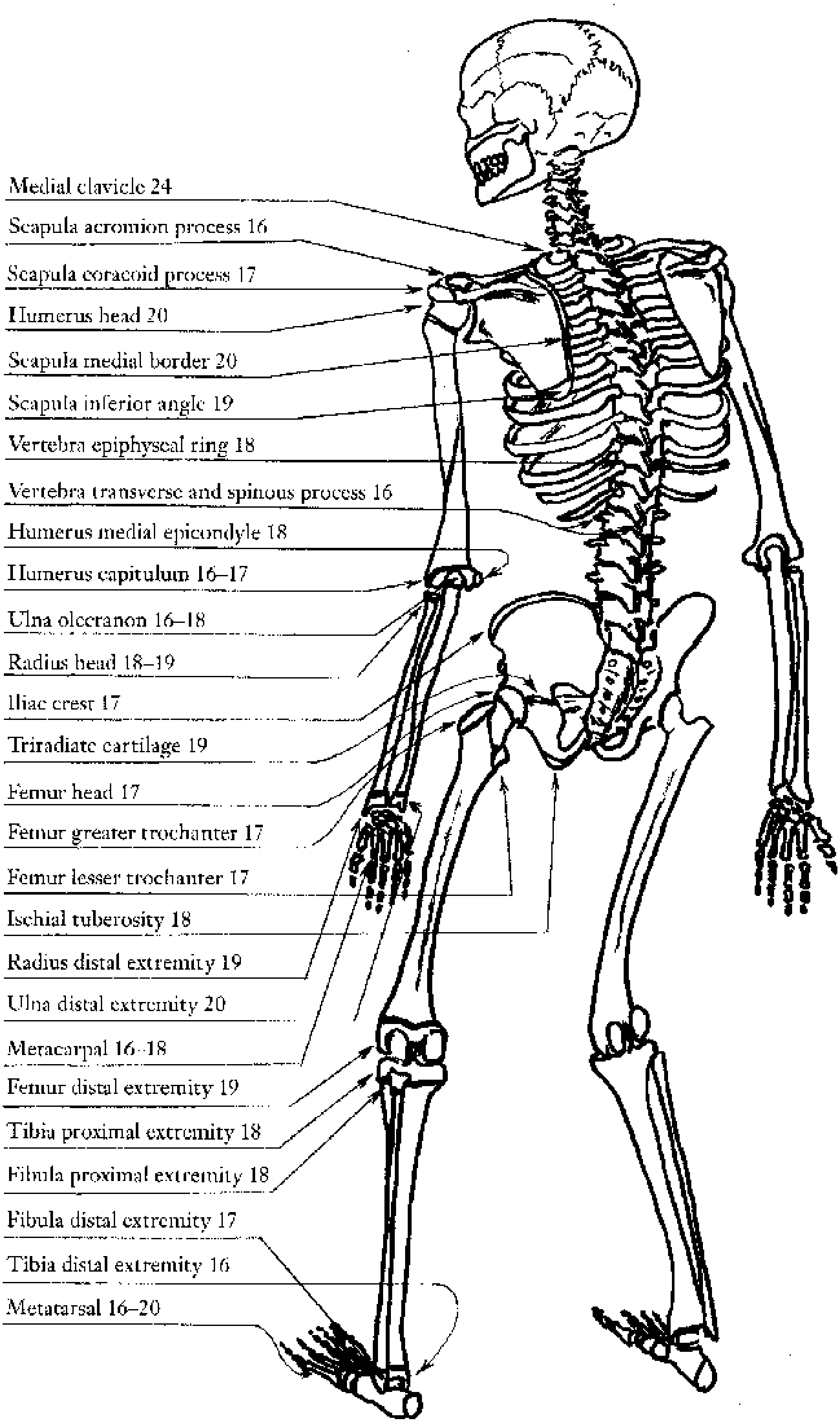
Long Bone Epiphyseal Union

See Figure on next page. Note the ages of epiphyseal union of the proximal and distal tibia and femur for males. As the figure illustrates, fusion of many other bones of the body can be used to determine age for subadults, but we will look at the tibia and femur in this lab.

	Estimated age of fusion	
Bone	Proximal/Medial end	Distal/Lateral end
Humerus (upper arm)	10 – 15 years	9 – 15 years
Radius (lower arm)	14 – 19 years	16 – 22 years
Femur (upper leg)	15.5 – 19.5 years	14.5 – 22 years
Tibia (lower leg)	15.5 – 22 years	14.5 – 19.5 years
Clavicle (collarbone)	19 – 30 years	19 – 20 years

Note the different ranges from different sources. Use Scheur and Black Juvenile Osteology as your primary source.


18y
25y
20y
18–21y
14–17y
15–18y
14–17y
17–19y
14–21y
A
20y
14–16y
16–18y
16–17y
16–19y
16–20y
14–20y
17–18y
14–21y
B



scanned from Rhine (1998:86)

LAB EXERCISES

1. Working in groups, identify and side the bones in front of you. Make sure you make some sketches so you know how to determine the side of the fibula.

2. We have given you disarticulated bones of the foot – sort out the tarsals, metatarsals and phalanges. Separate out eh bones that belong to the hand not the foot. Side the talus and calcaneus.

3. Using the femoral head diameter and the calipers determine the sex of this individual.

4. We have laid out examples of epiphyseal fusion so that you can identify the difference between unfused, fusing, fused, and obliterated epiphyses.

WEEK 10: PATHOLOGY AND TRAUMA

Goal: this week is largely show and tell. To give you an idea of the difference beween normal and nonnormal bone and to help you get used to looking for the features you need to identify when describing pathology. In working with pathology diagnosis is the very last step.

SKELETAL TRAUMAS

A variety of skeletal **traumas**, or damage to bones as a result of the application of force via accident or an instrument or weapon, may be manifested in forensic cases. Skeletal traumas include **bone fractures**, **blunt-force traumas**, **sharp-force traumas**, **gunshot traumas**, **burning**, **amputation**, and **dislocation**. Each of these skeletal traumas was discussed and illustrated in class. In this lab we'll examine and assess bone fractures and sharp-force traumas.

Bone fractures include a variety of breaks to bones that result from the application of unusual forces to bone. Depending on the type and magnitude of force and the skeletal effects, bone fractures are divided into at least eight types (Sciulli 1991).

- **Complete fractures** are angular, separated bone breaks that result from significant angular or oblique forces.
- **Incomplete or green-stick fractures** are angular bone breaks that do not separate. They result from less significant angular or oblique forces.
- **Comminuted or splinter fractures** involve bone fragmentation resulting from the application of perpendicular forces to the bone.
- **Compound fractures** are bone breaks in which the fractured bone or fragments pierce the skin, potentially resulting in infection. They result from angular or perpendicular forces.
- **Pseudo-arthrothis or false joints** are bone breaks in which the bones are separated but too far apart to rejoin during the healing process.
- **Colles fractures** are usually incomplete fractures of the distal ulna, distal radius, or clavicle. They result from trying to catch oneself with one's hands when falling.
- **Parry fractures** are complete or incomplete fractures of the ulna and radius diaphyses that result from self defense.
- **Depressed fractures** are circular fractures of the skull (or other flat bones) that result from armed attached with blunt objects.

When a bone is fractured, broken blood vessels flood the wound and blood clots form. Old bone at the site of the break is broken down and new woven bone is laid down to repair the break. The new woven bone is replaced and a **bone callus** forms over the fracture. Over time the callus resorbs, leaving little evidence of the break if the bones were realigned properly prior to healing (Rhine 1998, Sciulli 1991).

The image below shows a healed bone fracture that was likely a complete fracture.

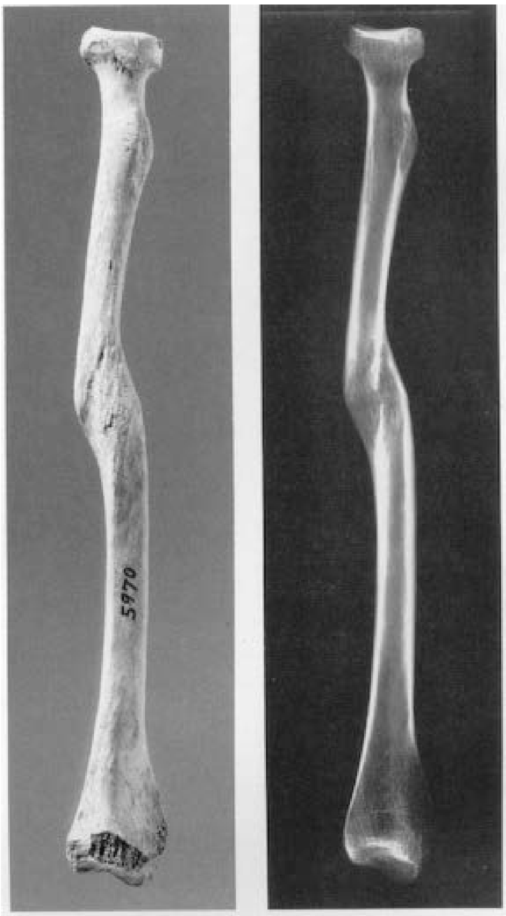


Figure 17.4 Healed fracture. This left radius has a healed midshaft fracture. The radiograph shows that the fracture offset is about equal to the width of the bone. The proximal part of the bone is offset posteriorly. Prehistoric, California. One-half natural size. (White 1991:337)

Sharp-force traumas are incised and stab wounds resulting from attacks or accidents with knives, swords, axes, and other sharp implements. Such injuries cause bone cracks, incisions, scratches, gouges, piercing, and fragmentation of bone. The size and shape of sharp-force traumas provide clues to the instrument that caused the damage, the direction of the attack or accident, and the nature of the events leading to an individual's death (Rhine 1998, Sciulli 1991).

Sharp-force traumas resulting from attacks with metal objects and stone objects must be distinguished from skeletal modifications from postmortem taphonomic processes like rodent gnawing, carnivore gnawing, and trampling. Metal and stone objects leave single incisions that have straight parallel edges. Such traumas could be antemortem, perimortem, or postmortem. **Rodent gnawing** leaves two parallel incisions on bones (Sciulli 1991).

The images below illustrate incisions resulting from sharp-force trauma with a stone instrument and rodent gnawing that resembles sharp-force incision traumas.

Figure 18.3 Cutmarks on the cranial vault. The edge of a stone implement (flake or knife) contacted the bone surface as it was drawn across this area, presumably to slice the scalp prior to its removal. Two times natural size. (White 1991:363)

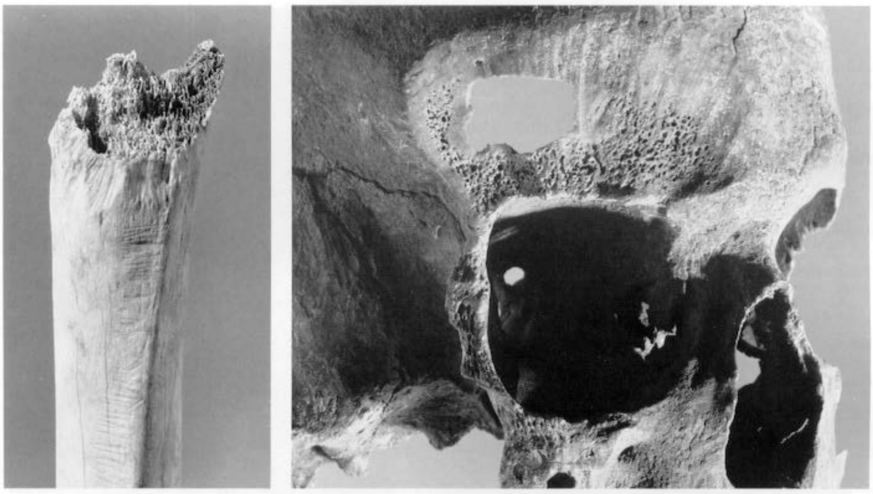


Figure 18.5 Highly patterned rodent gnawing marks on human skeletal elements. The tibia (*left*), from prehistoric California, shows gnawing by a very small rodent. The cranium (*right*), from a prehistoric African site, shows heavy gnawing, with broader gouges left by the incisors of an African porcupine. Natural size. (White 1991:365)

DETERMINING WHEN TRAUMAS OCCURRED

It is important to assess when skeletal traumas occurred - before death, at the time of death, or after death. Skeletal traumas occurring before death may be useful in identifying an individual's identity if those traumas were documented in writing or, better yet, x-rays by physicians or if they required medical hardware to repair. Skeletal traumas incurred at the time of death may be potential causes of death or may be used to reconstruct the events of the crime. Skeletal traumas incurred after death are usually the result of taphonomic processes or improper retrieval and transport of skeletal remains (Rhine 1998, Pickering and Bachman 1997).

Skeletal traumas that were incurred before death are called **antemortem** traumas. They are distinguished by nondifferential weathering and more-or-less even discoloration of the trauma site as well as evidence of healing in the form of calluses or bone remodeling (Rhine 1998).

Perimortem traumas are those incurred at the time of death. The effected bones will show no evidence of healing and will be nondifferentially weathered and discolored (Rhine 1998). Skeletal traumas incurred after death are called **postmortem** traumas. The effected bones will show no evidence of healing and will be differentially weathered and discolored. The trauma edges will be fresher and sharper than those resulting from perimortem traumas (Rhine 1998).

SKELETAL PATHOLOGIES

The following is suggested as a step by step procedure in description. It should be noted that comparison of abnormal with normal elements is a pre-requisite to recognising the abnormal, and access to a comparative skeleton is considered essential for this work (and a good knowledge of the normal appearance of the bone or tooth). Only definite abnormalities should be recorded so as not to over-inflate prevalence rates fordisease (ie avoid recording normal variation as disease):

i Which bone/tooth is affected (including side).

ii What part of the bone/tooth (eg proximal shaft),and aspect (eg medial) is involved, using anatomical terms (also see Lovell 2000, table 8.2 for terms).

iii What is the nature of the lesion itself (see Lovell 2000, table 8.1 for terms)? Is it a forming, destroying or mixed lesion?

iv If bone has been formed, is it woven (porous, disorganised and indicating active disease at the time of death) or lamellar (smooth and organised), indicating a healed and chronic lesion, or is it in the process of healing? See Figures 12 and 13.

v If bone has been destroyed, is there any sign of healing eg rounding of the edges of the lesion (see Figure 14).

vi What is the distribution pattern of the lesions if more than one bone/tooth is involved? Different disease processes have different patterning (for example, leprosy affects the facial, hand and foot bones).

vii Can the abnormality be measured and compared with the normal opposite side?

viii Consider all potential diagnoses for the abnormalities recorded (differential diagnosis).

It is absolutely essential that any description thus given should allow for independent review by another observer who can, based on an objective description, agree or disagree with the preferred diagnosis. This should also help ensure comparability across samples and between populations.

Photographs of abnormal or rare lesions are recommended, especially if they are unusual and a diagnosis made is rather tenuous; this will h elp other researchers when the abnormalities are being reconsidered.

Photographs should also be taken if the severities of lesions are being described. Scales should be used and preferably a normal bone or tooth as a comparison (opposite if appropriate and present). Black backgrounds are often an effective contrast for displaying bones and their lesions. Filling most of the frame with the bone often provides a more informative illustration (Cover, upper left Figure). When X-radiography is used, descriptions should include the relationship of the lesion to the underlying cortex, any endosteal changes and/or changes in the medullary cavity

TYPES OF PATHOLOGIES

Skeletal **pathologies** are diseases that affect the growth of bone due to microbial infection, metabolic or nutrient deficiencies, hematological disorders, repetitive activity, injuries, or congenital conditions.
Pathologies resulting from infections include **periostitis** (periosteal reaction), **osteomyletis** (osteitis), **treponemal diseases** like syphilis, tuberculosis, and leprosy. Scurvy, rickets, and gout are metabolic or nutrient deficiencies that affect bone. **Hematological diseases** that affect bone include iron deficiency anemia and sickle cell anemia. **Osteoarthritis** (degenerative joint disease), **vertebral osteophytosis**, and **rheumatoid arthritis** are forms of arthritic diseases that affect bone. **Dental pathologies** include **caries** (cavities), **abscesses** and **hypoplasias** (Sciulli 1991, White 1991). In today's lab we'll examine periostitis, arthritis and dental pathologies.
Periostitis is an infection of the periosteum caused by mircoorganisms such as staff (Scuilli 1991). In the early stages the outer surface of the bone is resorbed in a wormy or dendritic pattern (see the figure below). As the disease progresses, the periosteum separates from the bone, immature bone is deposited to fill the gap, and the bone begins to bulge (Scuilli 1991).

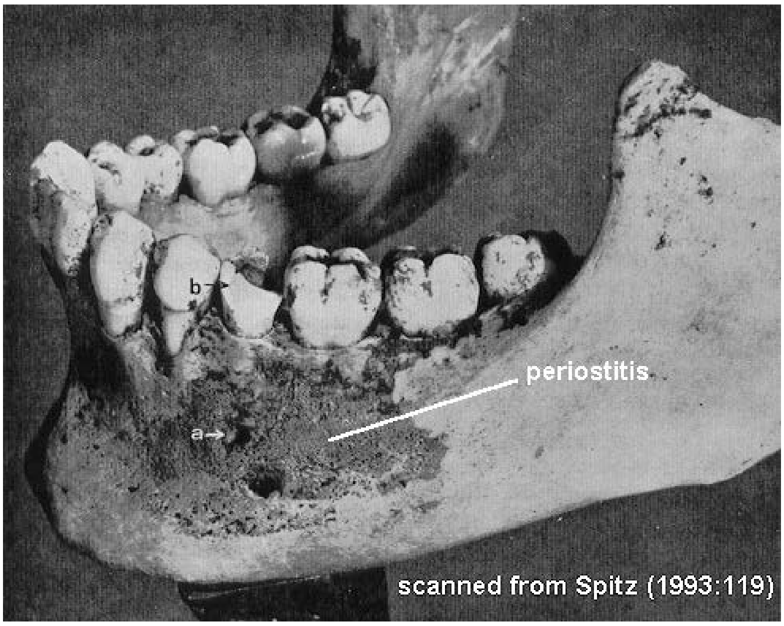


Figure 12 Woven new bone formation (arrowed) on visceral surfaces of ribs

Figure 13 Lamellar new bone formation (arrowed) on long bone shaft

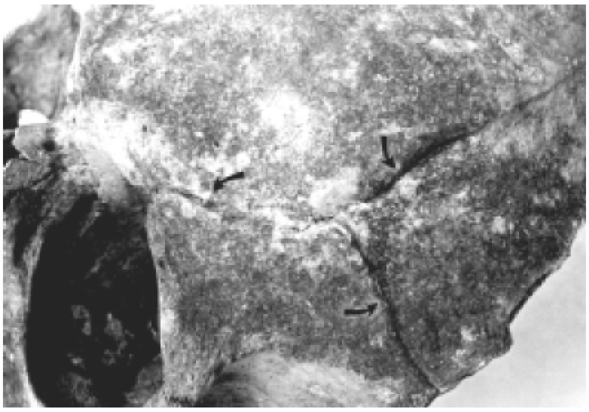
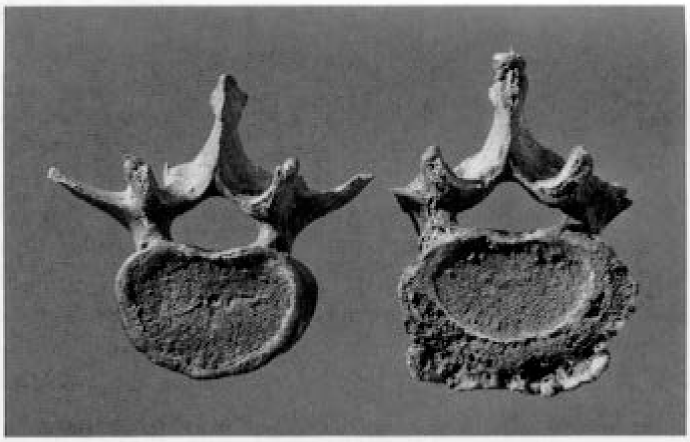


Figure 14 Healed injury to left frontal vault; arrows show healed fracture lines

Osteoarthritis or degenerative joint disease is caused by traumas or wear-and-tear on synovial joints like knees, wrists, and fingers. As cartilage wears down at these joints and the lubricating synovial fluid is lost, bones rub together and cause a smoothing and polishing of the articular surfaces of the bones at the joint. Epiphyseal lipping is another effect of osteoarthritis. Traumatic osteoarthritis is randomly distributed through an individual's body, whereas wear-and-tear osteoarthritis is patterned, based on the repetitive activity in which the individual engaged (Sciulli 1991). The three images below illustrate the effects of osteoarthritis.



(White 1991:350)

Figure 17.14 Osteoarthritis. The normal lumbar vertebra (*left*) lacks the osteophyte development seen on the anterior and lateral edges of the vertebra with degenerative arthritis (*right*). Prehistoric, California. One-half natural size.

Figure 17.15 Osteoarthritis. Eburnation and marginal lipping are evident on this left knee joint, seen here in posterolateral view and lit from the lower right to show detail. The eburnation is the ivory-like, shiny patch on the medial femoral and tibial condyles. Prehistoric, California. One-half natural size. (White 1991:351)

Figure 17.16 Osteoarthritis. Trauma to this left femur produced secondary osteoarthritic changes to the joint, seen here in the form of a bony extension and deformation of the femoral head and a buildup of osteophytes around the perimeter of the acetabulum of the os coxae. Prehistoric, California. One-third natural size. (White 1991:351)

Rheumatoid arthritis is an inherited disease or may a side effect of Lyme disease. It affects more joints than osteoarthritis and affects the body symmetrically, causing epiphyseal lipping. It can also result in ankylosing spondylitis, or fusion of the vertebral column into one structure (Sciulli 1991).
Dental caries or cavities are "the progressive decalcification of enamel or dentine" or lesions left in teeth due to dental deterioration from bacteria (White 1991:353). If caries become infected, **abscesses** may form in the alveolar bone of the maxilla and/or mandible. An abscess is a "localized collection of pus in a cavity formed by tissue disintegration" (White 1991:354). Dental caries and abcesses are illustated in the image below. **Dental hypoplasias** are irregularities in the tooth enamel. These take the form of horizontal lines in the enamel and/or pits that do not completely penetrate the enamel. Dental hypoplasias are the result of interruptions in enamel formation and may develop due to nutritional stress during growth and development (White 1991).

Figure 17.18 Caries. Bilateral carious lesions of the first molars are evident on this individual. A related abscess around the distal first molar root is seen posterosuperior to the right mental foramen. Prehistoric, California. Natural size.
(White 1991:353)

LAB EXERCISES

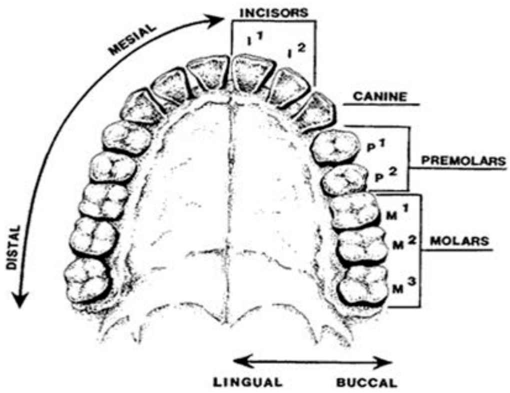
Work your way around the lab have a go with each case at identifying what the change is – is it a change in shape, is there new bone, is there evidence of healing etc. Write down what you can about each one – trying your hand at description. When you are done ask one of us for the description but don't spoil it for the others in the class by blurting out what you know.

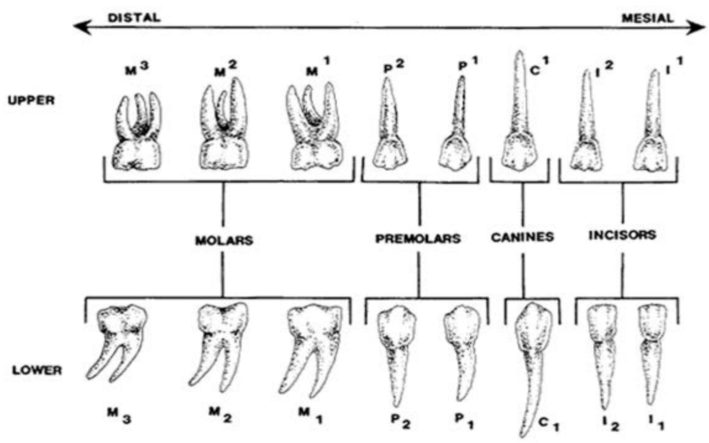
EXTRA INFORMATION: MANDIBLE AND TEETH

a. The different types of teeth
b. dental attrition
c. dental pathology
d. primary vs secondary dentition

A IDENTIFYING DENTAL ANATOMY

Stage 1: Determine type of tooth
Stage 2: Is the tooth upper or lower?
Stage 3: Locate the tooth within its own group?
Stage 4: Is the tooth right or left?



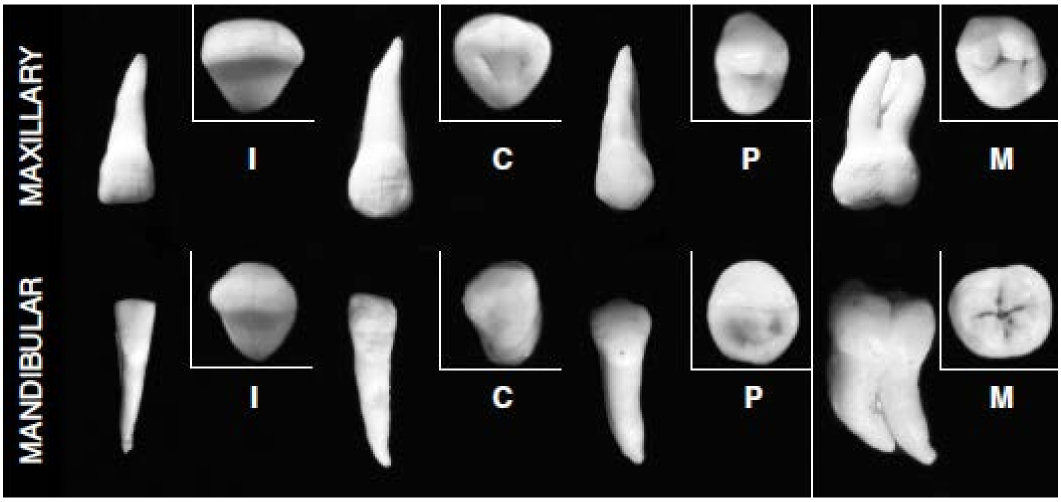


• the typical adult skull has thirty-two teeth which are equally divided between the upper and lower jaws
• each jaw can be divided into right and left halves, each of which contains eight teeth:
- there are **two** incisors, **one** canine, **two** premolars and **three** molars in each quadrant, a relationship that can be conveniently represented with the formula 2.1.2.3 / 2.1.2.3
- the numerator represents onehalf of the maxilla, while the denominator represents one half of the mandible - to aid in the recall of tooth order, students often remember the convenient acronym **ICPM**
• since each tooth has a different morphology which can be categorized into one of the above four types, humans are referred to as being *heterodonts*
• this is in contrast to species like sharks, whose teeth are of only one configuration – they are therefore classified as *homodonts*
Let's consider a few basic, yet important points about teeth:

• *Incisors* are so named because their chisel-like crowns have sharp cutting edges. They are therefore biting teeth. They have a single root.
• *Canines*, or *eyeteeth*, are longer than incisors and their conical crowns may be quite pointed when they first erupt.However, with continued wear, their tips become flattened. They have a single root which is much longer and thicker than that of the incisor.
• *Premolars* are smaller and shorter than canines. They bear two pyramidal cusps on their crowns, an outer buccal (toward the cheek) cusp and an inner lingual (toward the tongue) cusp. It is for this reason that we refer to premolars as being bicuspid. The root of the premolar is flattened and deeply grooved with a tendency to be bifurcated.
• *Molars* are the largest teeth and have broad crowns adapted for the grinding of food. The upper molars have three roots whereas the lowers have only two. Both upper and lower third molars, the *wisdom teeth*, are the smallest molars and frequently erupt late or not at all. Non-eruption may represent complete agenesis of this particular tooth.

Landmarks

• crown
• root
• occlusal surface
• lingual surface
• buccal surface



Examples of adult dentition, one of each of the left maxillary and mandibular central incisors (I), canines (C), second premolars (P) and second molars
(M). *Please note that the images are not printed to scale.*

Incisors

How to distinguish between maxillary and mandibular incisors

- compared to maxillary incisors, mandibular incisors:
  - are thicker than they are wide (i.e. wider buccolingually than mesiodistally)
    - this is in comparison to maxillary incisors which are much wider than they are thick (i.e., wider mesiodistally than buccolingually)
  - have a more symmetrical crown with incisal angles that are more square
  - have smooth lingual surfaces with less prominent anatomy
- it can be difficult to distinguish between maxillary and mandibular lateral incisors
  - note that the crowns of mandibular lateral incisors are thinner/sharper toward the incisal surface
  - this differs from the thicker and somewhat rounded crowns of the maxillary lateral incisors

How to distinguish maxillary central from lateral incisors

- maxillary central incisor crowns are longer than they are wide
- the crowns of the lateral incisors are narrower, and they are less symmetrical
- the roots of the lateral incisors are longer, and they curve distally

How to distinguish between maxillary left and right incisors

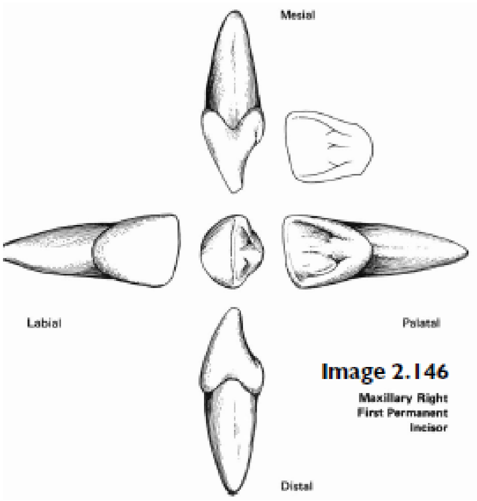
- hold the tooth with the lingual surface toward you with the incisal edge downwards, and the root upwards – the roots will curve slightly toward the same side to which the tooth belongs

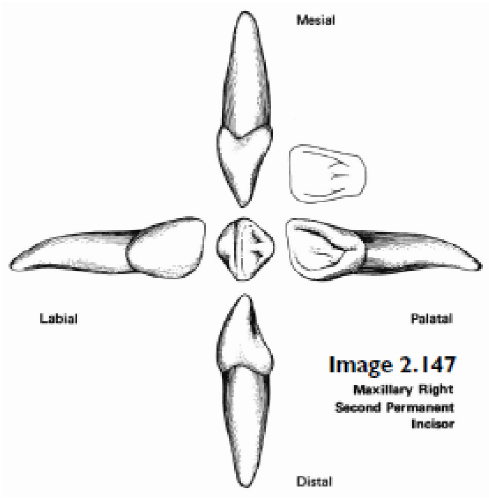
How to distinguish mandibular central from lateral incisors

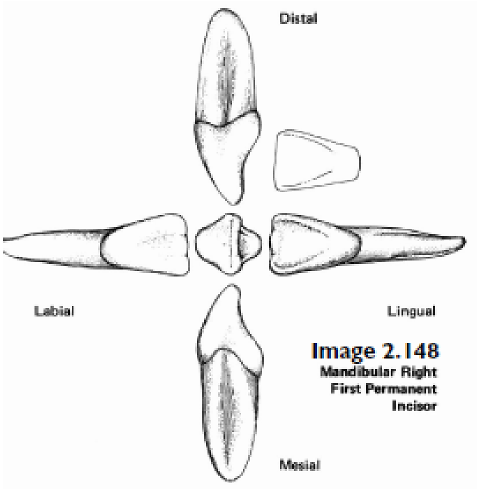
- the central incisors are more symmetrical
- if you compare central and lateral mandibular incisors from the same mouth, the central incisors will be smaller (narrower)

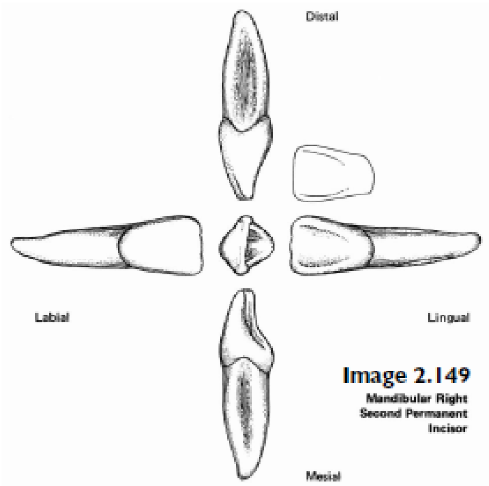
How to distinguish between mandibular left and right incisors

- for all mandibular incisors, hold the tooth with the crown directed upwards, the root downwards, and the buccal surface toward you – with this orientation, the root will point toward the same side as that to which the tooth belongs
- the roots of mandibular central incisors may only be curved minimally – careful examination may be necessary









Canines

How to distinguish between maxillary and mandibular canines

- maxillary canines are sharper, and their crowns are wider
- often, the mandibular root is shorter than the maxillary, but the mandibular crown is longer (i.e., crown:root ratio differs between the two dental arcades)

How to distinguish between maxillary left and right canines

- hold the tooth so that the lingual surface is toward you, the crown is downward, and the root is up – the root tip will bend slightly toward the same side as that to which the tooth belongs

How to distinguish between mandibular left and right canines

- hold the tooth so that the lingual surface is toward you, the crown is upwards, and the root is down– the root tip will bend slightly toward the same side as that to which the tooth belongs

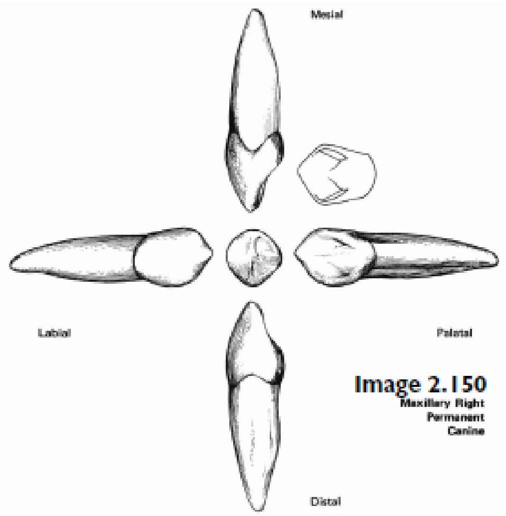


Image 2.150
Maxillary Right
Permanent
Canine

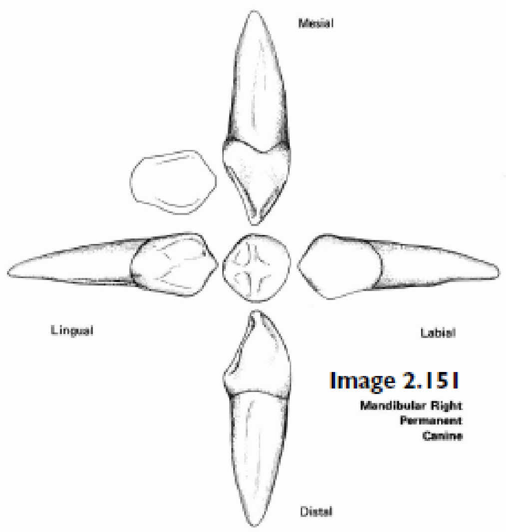


Image 2.151
Mandibular Right
Permanent
Canine

Premolars

How to distinguish between maxillary and mandibular premolars

- crowns of maxillary PM are wider (buccolingually) than they are thick (mesiodistally); mandibular PM are roughly as wide as they are deep
- maxillary PM have two cusps of relatively equal size; mandibular PM typically have two cusps of differing size (the lingual cusp is less prominent)
- a buccal ridge is more prominent on maxillary PM

How to distinguish between maxillary first and second premolars

- first PM crown is larger than the second
- only the first PM may have two root branches (the second premolar usually has a single root)
- buccal and lingual cusps of the second PM are equal in height; first PM have shorter lingual cusps
- the first PM usually has a *mesial concavity*, that is, a linear groove/depression on the mesial side of the tooth, which encroaches upon the crown – there is no such concavity on the second PM

How to distinguish between mandibular first and second premolars

- first PM is smaller than the second
- first PM resembles the mandibular canine in that it has a nonfunctional (small) lingual cusp – that is much like the canine's cingulum
- second PM resembles a molar because it has a functional lingual cusp
- first mandibular PM may have two prominent pits (adjacent a central ridge that runs between the buccal and lingual cusps)
- second mandibular PM typically have a single linear groove running along the midline occlusal surface

How to distinguish between maxillary left and right premolars

- hold the tooth so that the lingual surface is toward you, the crown is downwards, and the root is up – the root tip will bend toward the same side as that to which the tooth belongs

How to distinguish between mandibular left and right premolars

- hold the tooth so that the lingual surface is toward you, the crown is upwards, and the root is down – the root tip will bend slightly toward the same side as that to which the tooth belongs

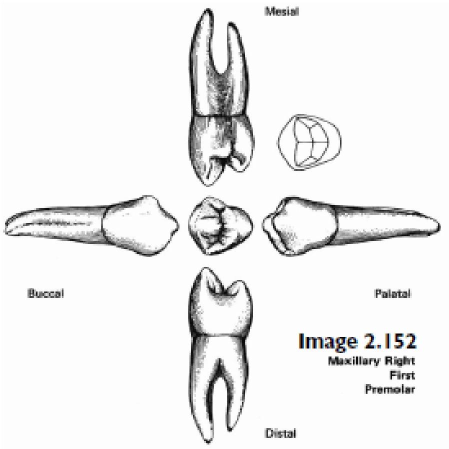


Image 2.152 Maxillary Right First Premolar

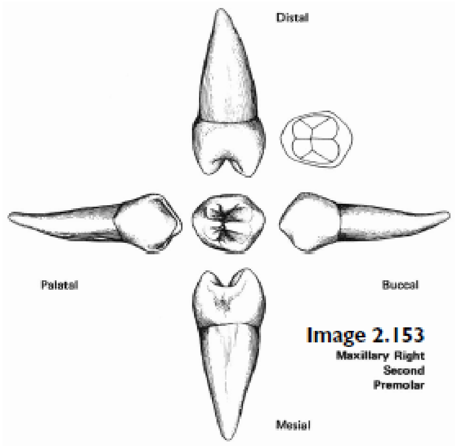


Image 2.153 Maxillary Right Second Premolar

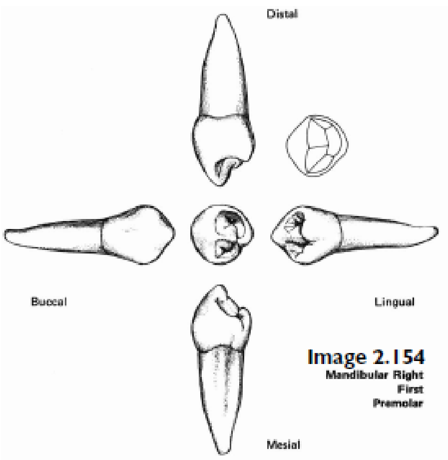


Image 2.154 Mandibular Right First Premolar

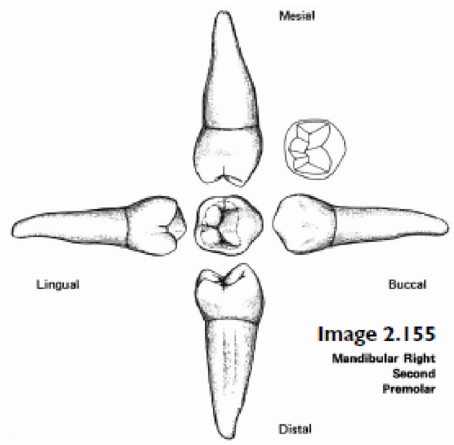


Image 2.155 Mandibular Right Second Premolar

Molars

Occlusal Anatomy & How to distinguish between maxillary and mandibular molars

- maxillary molars (first and second) have an oblique ridge running distobuccally to mesiolingually, and a transverse ridge running mesiobuccally to mesiolingually
- mandibular molars do not have these ridges, instead, they have a central fossa which runs mesiodistally, a lingual groove, and a buccal groove
  - the first molar has two buccal grooves, and the second molar has one
- the two lingual cusps on maxillary molars are of different size (mesial cusp is usually larger than the distal cusp)
- the two lingual cusps on the mandibular molars are the same size

How to distinguish between maxillary first and second molars

- the first molar has roots that are more 'spread out' than those on the second molar
- the buccal cusps on the first molar are nearly the same size, while the mesiobuccal cusp on the second molar is quite a bit larger than the distobuccal
- the distolingual cusp on the first molar is smaller than the mesiolingual cusp
  - on the second molar, the distolingual cusp is much smaller or absent

How to distinguish between mandibular first and second molars

- the first molars (five cusps) have larger crowns than the second molars (four cusps)
- there are three buccal cusps and two buccal grooves on the first molars, while there are two buccal cusps and only one buccal groove on the second molars
- the buccal and lingual grooves of the first molars are not in line with each other; this differs from the second molars where the buccal and lingual grooves align and intersect at the central groove
- the central groove of the first molars *zigzags* mesiodistally, while the central groove of the second molars is relatively more straight

How to distinguish between maxillary left and right molars

- using the above anatomical features, hold the molar so that the root is upwards, the crown is down, and the distal surface is toward you (the roots will be flaring toward you)
  - the root tips should be pointing toward the same side as that to which the tooth belongs

How to distinguish between mandibular left and right molars

- using the above anatomical features, hold the molar so that the root is downwards, the crown is up, and the distal surface is toward you (the roots will be flaring toward you)
  - the root tips should be pointing toward the same side as that to which the tooth belongs

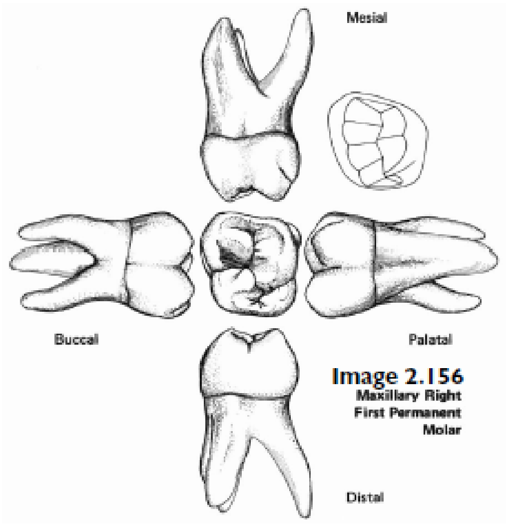


Image 2.156
Maxillary Right
First Permanent
Molar

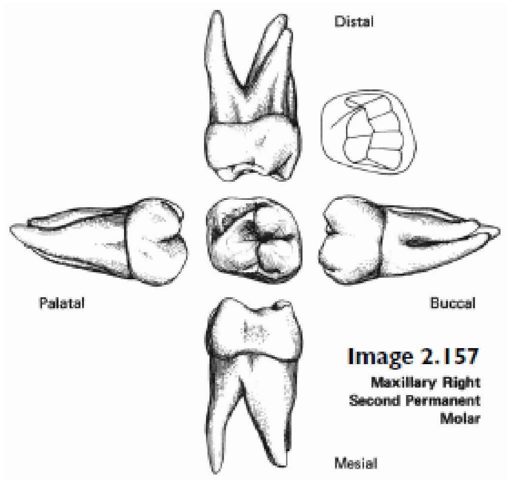


Image 2.157
Maxillary Right
Second Permanent
Molar

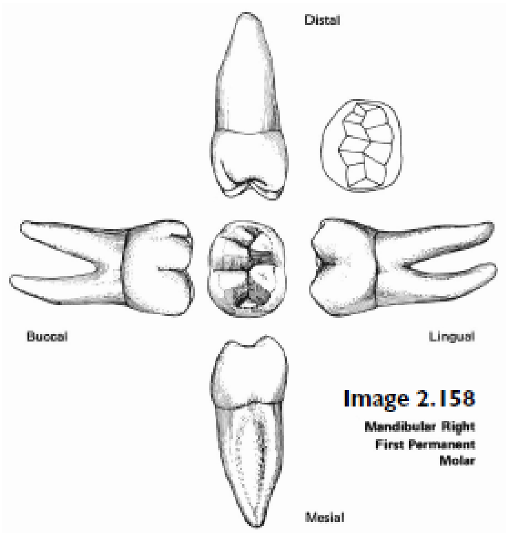


Image 2.158
Mandibular Right
First Permanent
Molar

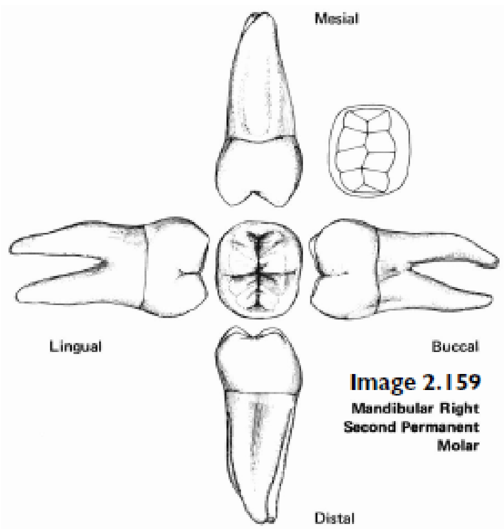


Image 2.159
Mandibular Right
Second Permanent
Molar

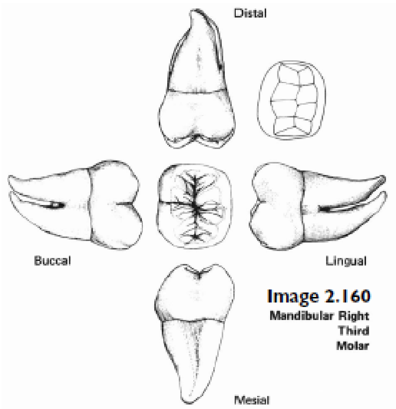
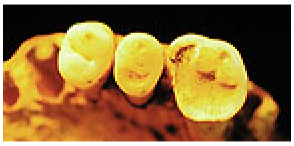


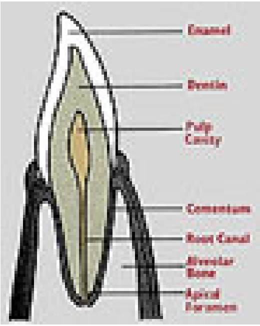
Image 2.160
Mandibular Right
Third
Molar

- the morphology of the third molar is quite variable
- they tend to be the smallest molars in the mouth
- the distolingual cusp is often small or absent
- they are often wider buccolingually than mesiodistally
- the appearance of the roots is variable

B. DENTAL ATTRITION



Introduction: The degree of tooth wear (attrition), when seriated within a population, is a useful indicator of an individual's age at death. Dental attrition varies with types of food consumed, thus it is important to compare teeth within the group of interest, and understand their mode of subsistence. Numerous methods have been developed to determine age using wear patterns, several are listed below:

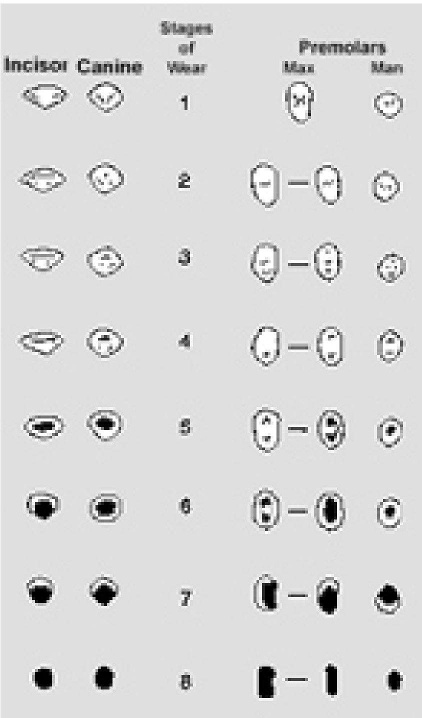


Inventory: Before embarking on a survey of tooth wear, it is important to have an inventory of the teeth present and their general degree of preservation. The following scoring procedure is presented in Buikstra et. al. (1994) and the diagram to the left displaying a cross section thru a tooth adapted from White (1999):

Categories for Recording the Dentition

1. Present, but not in occlusion
2. Present, development completed, in occlusion
3. Missing, w/no associated alveolar bone
4. Missing, w/alveolus resorbing or fully resorbed: premortem loss
5. Missing, w/no alveolar resorption: postmortem loss
6. Missing, congenital absence
7. Present, damage renders measurement impossible, other observations are recorded
8. Present, but unobservable (e.g. deciduous or permanent tooth in crypt)

Dental Attrition Scoring Methods: Wear patterns for these teeth, given their differential functions, are scored accordingly as seen in the methods outlined below.



Smith System for Age Determination Using Dental Attrition -- B. Holly Smith's (1984) method for age determination using dental attrition was based on studies of numerous populations with markedly different subsitence patterns.

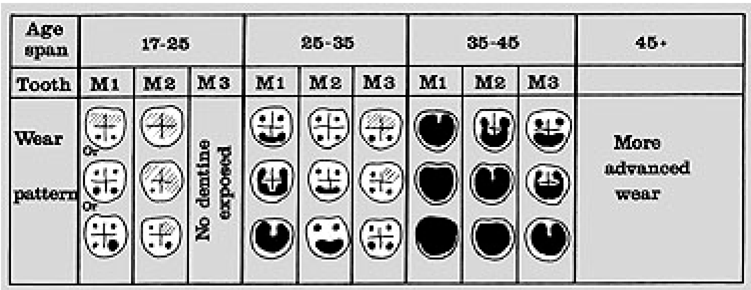
Incisors and Canines:

1. Unworn to polished or small facets (no dentin exposure)
2. Point or hairline of dentin exposure
3. Dentin line of distinct thickness
4. Moderate dentin exposure no longer resembling a line
5. Large dentin area w/enamel ring complete
6. Large dentin area w/enamel ring lost on one side or very thin enamel only
7. Enamel rim lost on two sides or small remnants

of enamel remain
8. Complete loss of crown, no enamel remaining; crown surface takes on shape of roots

Premolars:
1. Unworn to polished or small facets (no dentin exposure)
2. Moderate cusp removal (blunting)
3. Full cusp removal and/or moderate dentin patches
4. At least one large dentin exposure on one cusp
5. Two large dentin areas (may be slight coalescence)
6. Dentinal areas coalesced, enamel rim still complete
7. Full dentin exposure, loss of rim on at least one side
8. Severe loss of crown height; crown surface takes on shape of roots

Brothwell System for Scoring Surface Wear in Molars: Brothwell's method is demonstrated diagramatically, and is useful for scoring wear on the molars (Brothwell, 1981).



Scott (1979) System for Scoring Surface Wear in Molars:

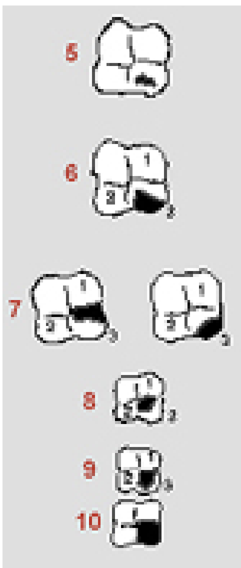
Score 0: No information available (tooth not occluding, unerupted, antemortem or postmortem loss, etc.)

Score 1: Wear facets invisible or very small

Score 2: Wear facets large, but large cusps still present and surface features (crenulations, noncarious pits) very evident. It is possible to have pinprick size dentine exposures or dots which should be ignored. This is a quadrant with much enamel.

Score 3: Any cusp in this quadrant is rounded rather than being clearly defined as in 2. The cusp is becoming obliterated but is not yet worn flat.

Score 4: Quadrant area is worn flat (horizontal) but there is no dentine exposure other than a possible pinprick sized dot.



*Score 5:*Quadrant is flat, with dentine exposure one-fourth of qudrant or less. (Be careful not to confuse noncarious pits with dentine exposure.)

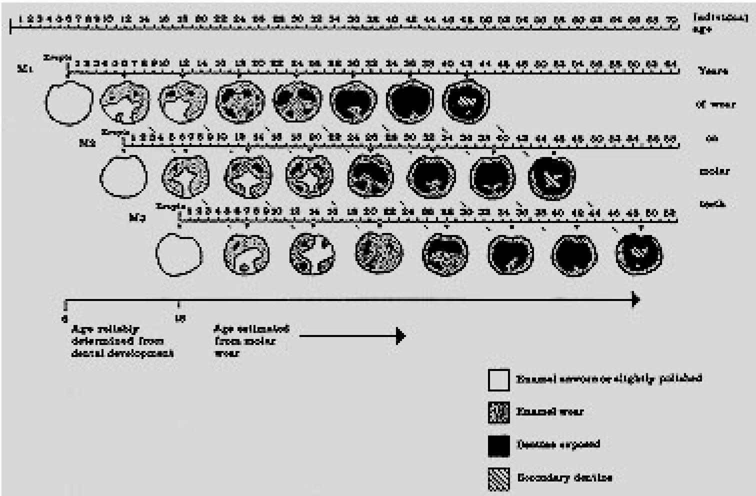
*Score 6:*Dentine exposure greater: more than one-fourth of quadrant area is involved, but there is still much enamel present. If the quadrant is visualized as having three sides, the dentine patch is still surrounded on all three sides by a ring of enamel.

*Score 7:*Enamel is found on only two sides of the quadrant.

*Score 8:*Enamel on only one side(usually outer rim) but the enamel is thick to medium on this edge.

*Score 9:*Enamel on only one side as in 8, but the enamel is very thin—just a strip. Part of the edge may be worn through at one or more places.

*Score 10:*No enamel on any part of the quadrant—dentine exposure complete. Wear is extended below the cervicoenamel junction into the root.



Miles Method for Assessing Dental Attrition:

The method developed by Miles permits within group assessment of age based on dental attrition. It requires a subadult sample as baseline.

The upper and lower scales show ages in years from birth, with different scales for each of the molars (representing separate functional ages of the teeth). The first molars are marked at 6 year intervals, the second at 6.5 and the third at 7 year intervals.

C. DENTAL PATHOLOGY

11.7.7 Dental disease

Dental disease is probably the condition that has most often been well recorded in British contexts, including the provision of absolute prevalence rates. Lesions/defects should be recorded at the individual tooth level (for caries, calculus, enamel hypoplasia) or tooth position (for alveolar resorption, periodontal disease, periapical lesions). Information on the numerical coding of each tooth during recording is provided in Section 3. Dental anomalies should be recorded following Hillson (1996).

11.7.7.1 Caries

For carious destruction of teeth the scheme of Lukacs (1989) should be used with the severity of grades of Hillson (2000; 2001). The position should be based on whether the lesion is on the crown (coronal) or on the root surface. Coronal caries should be described as occlusal, lingual, buccal/labial or on interproximal surfaces (mesial or distal), or the cervical (neck) area at the cemento-enamel junction. In advanced caries with gross destruction of the crown, the site of origin cannot be identified. Be careful not to record caries in occlusal surfaces of molar teeth which may be discoloration in the fissures due to soil. Exposure of the pulp cavity can be mistaken for caries, but may be a complication of caries.

11.7.7.2 Calculus

The amount of calculus deposit can be recorded following Brothwell (1981) or Dobney and Brothwell (1987), the latter being more detailed (and the former rather subjective but easy to use). Calculus deposits should also be recorded as supra or sub-gingival.

11.7.7.3 Alveolar disease

The severity of alveolar resorption is as follows (anything up to 2mm between the cemento-enamel junction and the alveolar margin can be healthy):

1 = 2–3mm

2 = 3–5mm

3 = majority of tooth root exposed.

The severity of periodontal disease could be recorded using Brothwell (1981), which is a rather subjective method but relatively easy to use. However, as the distance between the cemento-enamel junction and the alveolar bone increases with age, an additional method of recording periodontal disease would be to observe and record concavity and porosity of the inter-dental septa.

11.7.7.4 Enamel hypoplasia

(hypoplastic lines, pits and grooves). Recommendations for recording:

• Type of defect: linear horizontal grooves, linear vertical grooves, linear horizontal pits, non-linear array of pits, single pits (from Buikstra and Ubelaker 1994)

• Position: 1 = cusp, 2 = middle section of crown, 3 = neck (crown of tooth divided into three sections by eye), and

• Severity: 1 = just discernible line, 2 = clear groove, 3 = gross defects

• Hypocalcifications may be recorded as yellow, cream/white, orange or brown and where they are located; post mortem discolouration due to burial in the ground may confuse recording and interpretation

To record timing of defect use Reid and Dean (2000), but be aware of the problems of recording and interpretation of these data.

11.7.7.5 Periapical lesions

The location of the drainage sinus should be described (external, internal or maxillary sinus) and whether or not the lesion is associated with a carious lesion or from pulp cavity exposure due to heavy tooth wear.

EXTRA INFORMATION: AGEING

a. dental development

c.

A. AGE ESTIMATION

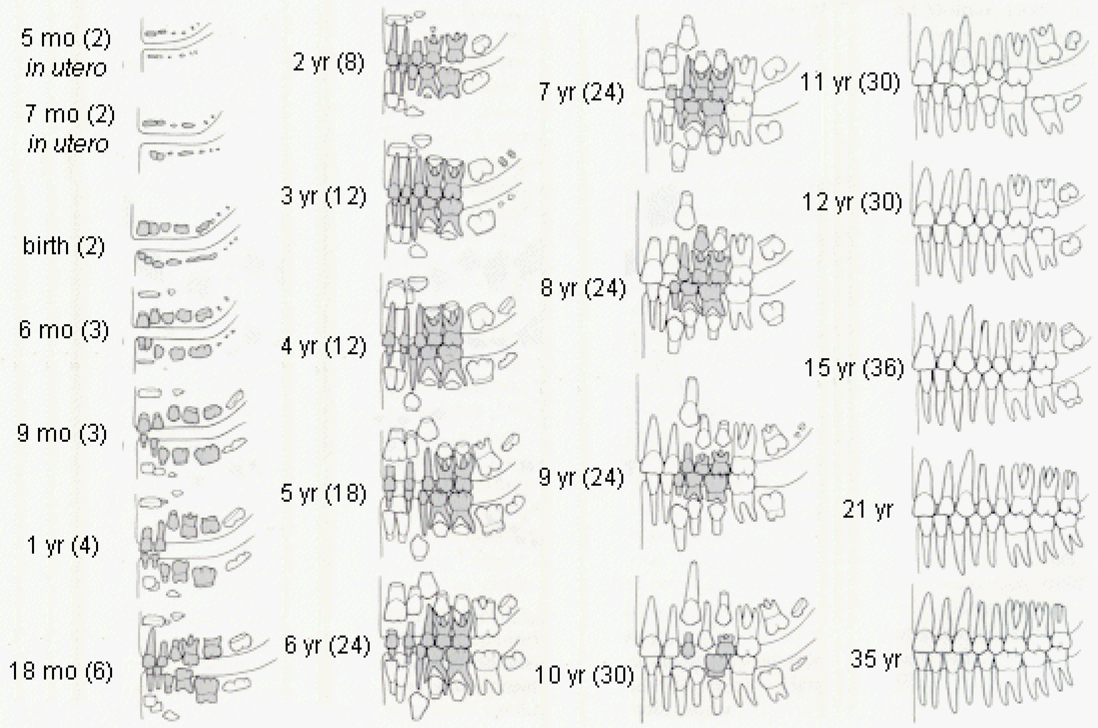
The methods used to estimate age depend on the relative age of the individual. **Developmental traits** used to estimate the age of subadults include **tooth eruption** and **epiphyseal union**. In addition to fusion of the medial clavicle epiphysis, adult ages are estimated using **degenerative traits** like changes in the morphology of the pubic symphysis and auricular surface of the ilium, cranial suture morphology, **dental wear**, **bone resorption**, osteon counting, and joint degeneration. Because developmental traits occur more regularly and consistently than degenerative traits, age estimates for subadults tend to be more accurate and within a smaller range of error than age estimates for adults and the elderly.

As with sex estimation, the more indicators used to determine age, the more accurate the results. However, a forensic anthropologist is analytically limited by the bones present and their condition. Age estimates are usually given as a range, such as 23-32 years, or with a range of error, such as 12 ± 2.5 years.

We will look at dental development, dental degeneration, and epiphyseal union in this lab. Again, what we are doing in lab for age estimation does not cover all skeletal indicators of age, but it will give you a good idea of how a forensic anthropologist estimates the age of an individual using the bones. The pubic symphysis is a useful indicator of age in adults, but we will not have time to look at this trait; interested students may look at casts of changes in the pubic symphysis on their own (ask the instructor).

Dental Traits

Eruption of **deciduous (baby or milk) teeth** and **permanent (adult) teeth** occurs at fairly regular intervals during the subadult years of development (see the figure below, deciduous teeth are shaded). Therefore, dental eruption is a useful skeletal trait for estimating the age of subadults.



dental development
standard deviation given in months in parantheses
(scanned from White 1997:309)

While tooth wear and permanent tooth loss can occur in subadults, these degenerative changes are usually associated with adults. Loss of permanent teeth and accompanying **bone resorption** of the maxilla and/or mandible are often associated with old age. Tooth wear or **dental attrition** most often occurs in adults, but the age of onset depends on diet and other environmental factors. This process leads to loss of outer white tooth **enamel** and exposure of the yellowish **dentine** underneath. The older an individual is, the more dentine is exposed due to tooth wear.

F. RECORDING FORM

Skeleton and Number ________________ Observer ________________

Assessment of Age:

Pubic Symphysis (Suchey-Brooks 1-6) ______________________

Auricular Surface (Phase 1-8) _____________________________

Iliac Crest Fusion (0-3) ___________________________________

Medial Clavicular Epiphysis (0-3) _________________________

Cranial Suture Closure (Meindl & Lovejoy 1985)

(0 open, 1 minimal closure, 2 signifanct closure, 3 obliteration)

Vault	Score	Lateral-Anterior	Score
Midlambdoid		Pterion	
Lambda		Midcoronal	
Obelion		Sphenofrontal	
Anterior sagital		Inf. Sphenotemporal	
Bregma		Superior Sphenotemporal	
Composite Vault Score		Composite AL score	

Estimate Age overall:

Comments (Other observations: dental wear, DJD, ossification of ligaments):