

Study Guide
& Additional Resources
for
Forensic Anthropology,
2013 Edition



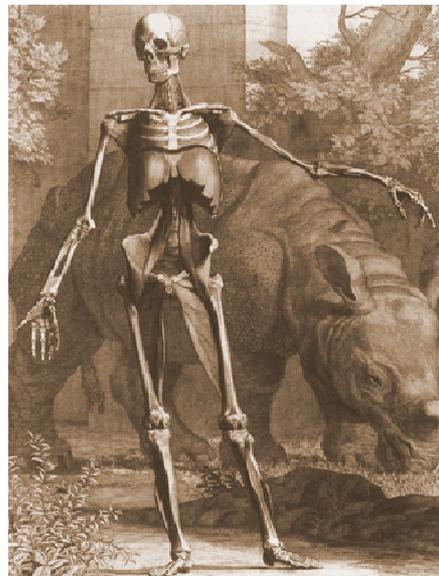
ANT 2524
Indian River State College

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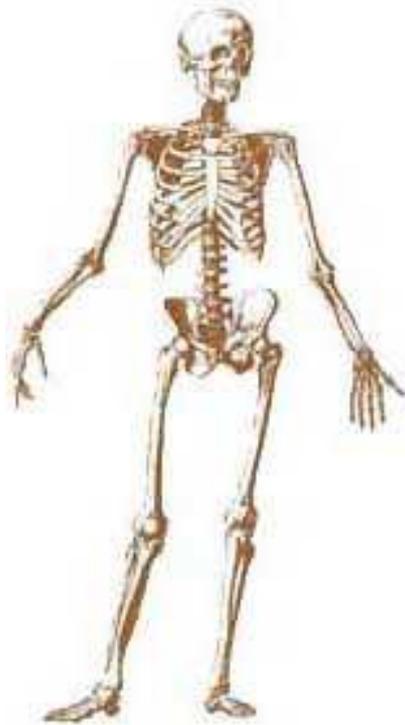
Study Guide and Additional Resources for Forensic Anthropology

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UNIT I

**THE PROFESSION OF
FORENSIC ANTHROPOLOGY**



Chapter 1

The Field of Forensic Anthropology

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 1 & 12 of *Forensic Anthropology Training Manual* and Chapters 1 & 2 of *Dead Men Do Tell Tales*), the film that accompanies this topic (i.e., *Forensic Anthropology at the Body Farm*), and/or the following websites:

American Board of Forensic Anthropology

(the URL for the ABFA is <http://www.theabfa.org/index.html>)

C.A. Pound Human Identification Laboratory

(the URL for the Pound Lab is <http://www.anthro.ufl.edu/capoundlab.shtml>)

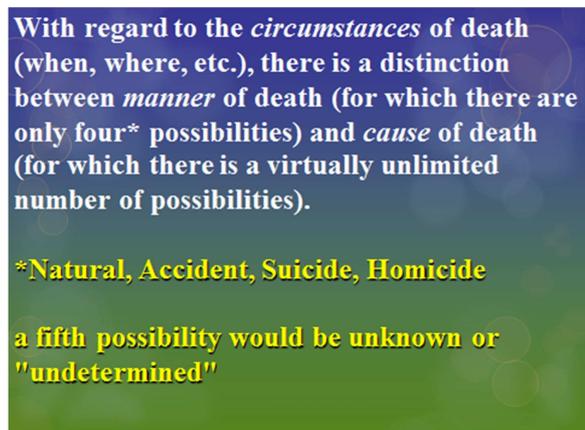
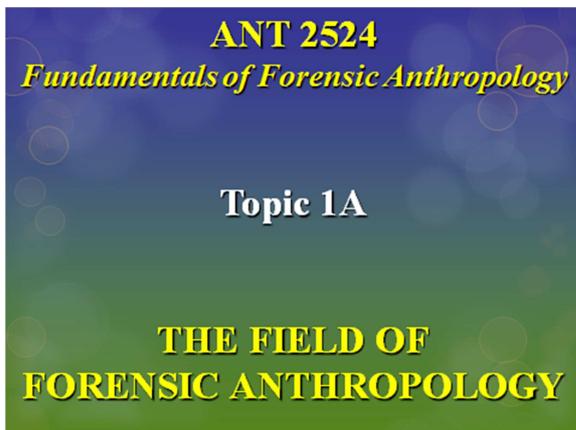
American Academy of Forensic Sciences

(the URL for the AAFS is <http://www.aafs.org/>)

Forensic Anthropology Center at the University of Tennessee

(the URL for the Forensic Anthropology Center at UT is <http://web.utk.edu/~fac/>)

Classroom Presentation (PowerPoint Slides)



The following questions are *basic* to the *personal identification* of human remains in forensic anthropology: (Pp. 6-7)

Are the remains human?

How many individuals are represented?

What did the person look like—what was the person's sex, age, ancestry, height, physique, and handedness?

Who was it—did the person have unique or anomalous skeletal traits that would indicate his or her identity?

Individual Characteristics (Distinctive Dental Ornamentation)



Individual Characteristics (Tooth Loss, Dental Restorations)



Individual Characteristics (Cranial Anomaly—2nd Mastoid Process)



Individual Characteristics (Persistent Metopic Suture)



Individual Characteristics (Inca Bone)



Individual Characteristics (Craniotomy & Benign Osteoma)



Individual Characteristics (Antemortem Trauma & Orthopedic Surgery)



Individual Characteristics (Archaeological Mandible—*not Forensic*)



Individual Characteristics (Facial Reconstruction using Skull Cast)



Forensic anthropologists differ from medical doctors, such as forensic pathologists, in a couple of ways (pp. 5-6)

Typically, forensic anthropologists examine skeletons, while medical doctors typically examine fleshed bodies.

Forensic anthropologists tend to focus on information derived from hard tissues, while forensic pathologists (medical doctors) focus on information from soft tissues.

Since decomposition is a continuous process, these specialties tend to overlap. Forensic anthropologists are useful when decomposition is advanced or when bone trauma is a major element in the death.

In a court of law, there is a distinction between *verbal evidence* and *physical evidence* (p. 181)

Verbal evidence is oral testimony from a witness about his or her own observations—usually an eye witness or a character witness.

Physical evidence is material that can be collected, analyzed, and interpreted by scientific method.

Proper handling of physical evidence involves paying close attention to *documentation, collection, chain of custody, preservation & storage, analysis, interpretation, and reporting.* (Pp. 182-184)

documentation: begins at moment of discovery (evidence should be recorded photographically and in written record before it is disturbed) and continues at each subsequent stage.

collection: make every effort to collect without alteration or contamination...think before touching...label the packaging, prevent tampering by signing on tape and ending on packaging.

chain of custody: make a record of every person who handles the evidence...unbroken record of chain of custody.

preservation & storage: "cool, dry, and away from sunlight" are good general guidelines.

analysis: method must be appropriate for the material and the resources, and generally accepted within the scientific discipline...use multiple methods whenever possible.

interpretation: must take into account the limits of the analytical method(s) being used.

reporting: reporting of results should be as simple and direct as possible.

Recovery of Human Remains (Crime Scene)



Recovery of Human Remains (Bosnian Mass Grave, 1995)



Death investigation specialists include *ballistic specialists, crime scene investigators, criminalists, drug analysts, fingerprint specialists, forensic anthropologists, forensic pathologists, forensic psychiatrists, questioned doc. examiners, serologists, & toxicologists* (Pp. 184-186)

ballistic specialists: weapons and projectiles

crime scene investigators: usually police officers, first on the scene; typically knowledgeable about fingerprints, foot prints, hair, fibers, blood spatter dynamics, weapons

criminalists: jack of all trades, includes many specialties... usually focus on physical evidence at crime scene other than the body...use such techniques as microscopy, chromatography, spectrophotometry, etc.

drug analysts: usually excellent chemists with knowledge of pharmaceuticals

fingerprint specialists: collect, classify, and compare, usually involving computerized analysis

forensic anthropologists: utilize techniques in archaeology and biological anthropology

forensic pathologists: medical examiners responsible for autopsies

forensic psychiatrists: analyze competence, motives, and responsibility of perpetrators

questioned document examiners: writing of all types, including handwriting

serologists & geneticists: chemists who extract essential information from body fluids...includes analysis of blood type and DNA

toxicologists: chemists who extract essential information about drugs and poisons from body tissues and fluids

The C. A. Pound Human Identification Laboratory of the Florida Museum of Natural History at the Univ. of Florida



Film Summary

Forensic Anthropology at the Body Farm

Here's how the producers describe this film:

At the Body Farm, the dead speak. This clinical program travels to the world's first open-air crime lab with founder Bill Bass, of the University of Tennessee, for a close-up look at how cadavers decay. As proxies for murder victims, these decomposing bodies are studied in the name of science and the cause of justice. Factors and biological markers that help pinpoint time since death, including wind and weather, insects and carnivores, fire damage, mold, and bacteria, are addressed. Three homicide cases that hinged on data and expertise gained at the Farm are presented, and Ph.D. students are filmed doing field work and body processing.



A decomposing body at the University of Tennessee's "Body Farm"

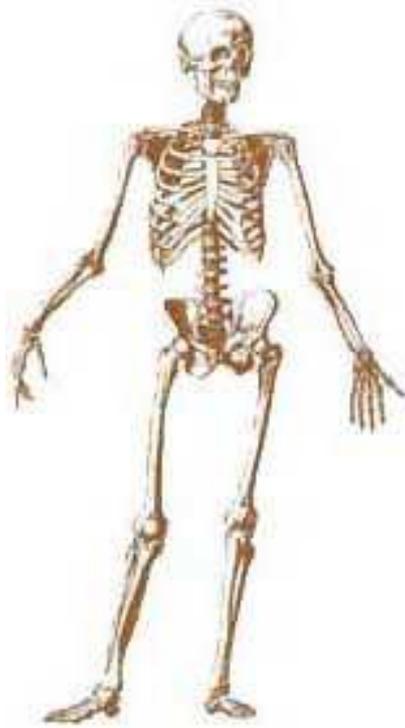
Forensic anthropologist William Bass founded the research facility nicknamed the “body farm” at the University of Tennessee in Knoxville in the 1970’s. He developed the facility after realizing that very little scientific research had been done on the rates of human decomposition. Determining the postmortem interval is often critically important in death investigations, so Bass knew that forensic anthropology could make an important contribution to scientific knowledge that would be relevant in legal contexts. For example, forensic anthropologists can estimate when the body was first deposited by examining the developmental stages of insects that feed on decomposing flesh. Flies arrive at a dead body within minutes, and immediately lay their eggs—with 24 to 36 hours, as Dr. Murray Marks explains in the film, the maggots hatch and begin feeding.

In the film, Bill Bass observes that archaeological excavations and crime scene investigations have something in common: in both cases, you must destroy the thing you're studying in order to study it. As reported in the film, some 65% of all forensic anthropologists in the United States have studied at the University of Tennessee and/or with Bill Bass. One of Bass's longtime collaborators is the bestselling crime novelist Patricia Cornwell. She wrote a book entitled *The Body Farm*, which gave the anthropological research facility at the University of Tennessee its nickname.

Over the years, Bill Bass and his colleagues and students have been involved in a large number of death investigations, including the analysis of the remains of Vicky Bertram, a 16-year-old girl whose body was found at the base of a cliff. At the time of her death, law enforcement officials were unable to determine the manner of her death (she could have fallen from the top of the cliff accidentally, been pushed by a murderer, or committed suicide by jumping off). Years later, her younger brother, who had since become a police officer, initiated an investigation into his late sister's death. At the request of the family, her remains were exhumed and turned over to researchers at the University of Tennessee for analysis. Although the original autopsy report had indicated that the girl had no broken bones, the forensic anthropologists discovered several unhealed breaks throughout the skeleton, all of which would have been consistent with a fall from a height. The evidence, however, was not sufficient to determine whether Vicky Bertram's death had been natural, accidental, suicide, or homicide.

In another case depicted in the film, forensic anthropologists investigated the death of Ted Barnett, an attorney who was murdered in his home. His body was lying on the floor of the bathroom for several days before it was discovered. Forensic anthropologists were able to determine the time since death by analyzing the extent of the mold that had grown on the surface of the body (knowing the temperature and degree of humidity in the house where the body was found allowed researchers to compare known rates of mold growth).

The film also shows forensic anthropologists from the University of Tennessee conducting studies of the effect that fire has on bone. Using pig bones as a close substitute for human bones, they placed both fresh, moist bone and old, dry bone in an abandoned house that firefighters were burning down in a training exercise. The research confirmed that the drier the bone is before it is burned, the fewer fractures it will have as a result of the burning, and those fractures will tend to be straight rather than curved; if the bone is fresh and moist with soft tissue still attached when it is exposed to fire, it will have many more fractures, and those fractures will tend to be curved.



Quiz Questions for Topical Quiz # 1A

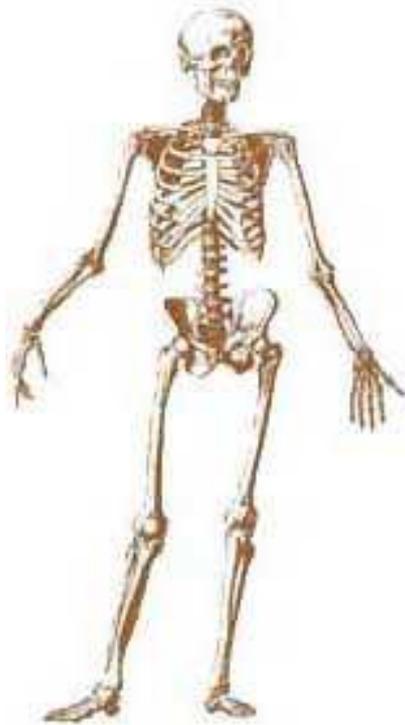
1. What do forensic anthropologists mean by the *manner* of death? Give examples.
2. What do forensic anthropologists mean by the *cause* of death? Give examples.
3. For the forensic anthropologist, which of the following questions are BASIC to the personal identification of human remains: What is the person's age? What is the person's handedness (i.e., right-handed or left-handed)? What is the person's "race" or ancestry? What is the person's religion? What is the person's sex?
4. For the forensic anthropologist, which of the following questions are BASIC to the personal identification of human remains: Are the remains human? Did the person have anomalous skeletal traits? What was the person's height? What was the person's income? What was the person's physique?
5. In contrast to forensic anthropologists, medical doctors tend to focus on information derived from _____.
6. In contrast to medical doctors, forensic anthropologists tend to focus on information derived from _____.
7. Oral testimony from a witness (usually an eyewitness or a character witness) about his or her own observations is called _____.
8. Material that can be collected, analyzed, and interpreted by scientific method is called _____.
9. In the proper handling of physical evidence, before the evidence *in situ* is disturbed, photographic and written records should be made as part of the process of _____.
10. In the proper handling of physical evidence, the admonition to "think before touching," which is intended to ensure that the evidence is neither altered nor contaminated, is especially relevant as part of the process of _____.
11. In the proper handling of physical evidence, the limits of the analytical methods being used must be taken into account, which means that the size of the sample, origin of the sample, and the composition of the sample population must all be taken into account as part of the process of _____.
12. In the proper handling of physical evidence, the creation of an unbroken record of each and every person who handles the evidence, which makes it possible to trace any alteration in the evidence and to address accusations of evidence tampering, is the central element in the process of _____.

13. In the proper handling of physical evidence, the guidelines “cool, dry, and away from sunlight” are especially relevant to the process of _____.
14. In the proper handling of physical evidence, it is especially important that the methods be appropriate for the material and the resources, and that they be consistent with generally accepted methods within particular scientific disciplines, in the process of _____.
15. A death investigation specialist who studies the mind of the criminal as well as the crime itself and the crime scene in an attempt to profile the type of person capable of a particular crime is called a(n) _____.
16. A death investigation specialist who relies upon expertise in chemistry to extract essential information such as DNA comparisons from body fluids such as blood, sperm, saliva, and other biological fluids is called a(n) _____.
17. A death investigation specialist who is usually a police officer with the ability to recognize, photo-graph, organize, and collect evidence, and who is ideally the first responder to a crime, is called a(n) _____.
18. A death investigation specialist who relies upon expertise in firearms to recognize and analyze weapons and projectiles is called a(n) _____.
19. A death investigation specialist who utilizes expert knowledge of ink, paper, pens, pencils, typewriters, printers, and copy machines to analyze and compare writing of all types is called a(n) _____.
20. A death investigation specialist who typically focuses on the physical evidence from the crime scene other than the body itself and who analyzes materials with the help of microscopy, chromatography, spectrophotometry, mass spectrometry, neutron activation analysis, x-ray diffraction, and other scientific methods is called a(n) _____.
21. A death investigation specialist who is generally employed as a medical examiner and who is responsible for autopsies, trauma analysis, and courtroom testimony is called a(n) _____.
22. A death investigation specialist who relies upon expertise in chemistry to extract drugs and poisons from body tissues and fluids for the purpose of identifying the presence of foreign substances such as alcohol or drugs, carbon monoxide poisoning, or lead or arsenic poisoning is called a(n) _____.
23. Give additional examples of what forensic anthropologists mean by the *cause* of death.
24. Give additional examples of what forensic anthropologists mean by the *manner* of death.

25. As described in the film *Forensic Anthropology at the Body Farm*, the research facility that is nicknamed “the body farm” is located at the University of _____.
26. As described in the film *Forensic Anthropology at the Body Farm*, the research facility that is nicknamed “the body farm” was founded in the 1970’s by the forensic anthropologist _____.
27. As described in the film *Forensic Anthropology at the Body Farm*, the postmortem investigation conducted at the Body Farm on the exhumed remains of 16-year-old Vicky Bertram revealed that the body _____ [did or did not] have extensive fractures, which _____ [was or was not] consistent with the original autopsy report.
28. As described in the film *Forensic Anthropology at the Body Farm*, the postmortem investigation conducted at the Body Farm on the exhumed remains of 16-year-old Vicky Bertram revealed that the evidence of perimortem trauma _____ [was or was not] consistent with a fall from a height, and that evidence _____ [did or did not] allow investigators to determine the manner of death.
29. As described in the film *Forensic Anthropology at the Body Farm*, what are the differences between bone that was dry when it was burned and bone that was still moist with soft tissue attached when it was burned?
30. As described in the film *Forensic Anthropology at the Body Farm*, how were investigators from the Body Farm able to determine the time since death for the remains of Ted Barnett (the murder victim whose body was deposited in the bathroom of his house)?
31. As described in the film *Forensic Anthropology at the Body Farm*, what percentage of American anthropologists have studied at the University of Tennessee in Knoxville?
32. As Bill Bass observes in the film *Forensic Anthropology at the Body Farm*, archaeological excavations and crime scene investigations have one crucial thing in common, namely _____.
33. As described in the film *Forensic Anthropology at the Body Farm*, the person who gave the nickname “the body farm” to the anthropological research facility at the University of Tennessee was _____.
34. In the film *Forensic Anthropology at the Body Farm*, Dr. Murray Marks explains that after flies lay their eggs on a dead body, the maggots hatch and begin to feed within _____ hours.
35. Diplomates of the American Board of Forensic Anthropology must apply for recertification every _____ years.

36. To date, the American Board of Forensic Anthropology has awarded Diplomate status to a total of _____ individuals.
37. Approximately how many total members are there at present in the Physical Anthropology Section of the American Academy of Forensic Sciences?
38. What are the objectives of the American Academy of Forensic Sciences?
39. The Director of the the C.A. Pound Human Identification Laboratory from 1991 to 1997 was _____.
40. The current Program Director of the C.A. Pound Human Identification Laboratory is _____.
41. The forensic anthropology laboratory that William Maples built, and where he spent most of his career as a forensic anthropology, is located at _____
[*what institution?*].
42. The forensic anthropology laboratory that William Maples built, which is today one of the foremost forensic anthropology labs in the country, is called the _____.
43. List the several famous people whose skeletal remains William Maples examined during his career as a forensic anthropologist.
44. As a boy growing up in Texas, William Maples was impressed by the autopsy photographs he was shown of the famous outlaws _____.
45. During the time that he was an undergraduate student in Texas, William Maples acquired early experience with dead bodies while engaged in what activity?
46. When he first became an anthropologist, William Maples lived for a few years in _____ [what country?], helping to capture wild _____ [what animals?].
47. When William Maples was a graduate student, he and his mentor Tom McKern examined a skull found in a Texas lake that had a fishing line tied around its zygomatic arch, attaching it to a large rock. They concluded that the skull was that of a _____.
48. One of William Maples' earliest forensic cases involved a skullcap which a medical examiner had declared to be useless as evidence but which Maples was able to identify as _____.

49. Like most forensic anthropologists, William Maples' professional training resulted in his earning _____ [what degree with what specialization?]
50. Like most forensic anthropologists, William Maples spent the majority of his career employed primarily as a(n) _____.



Chapter 2

Recovery & Laboratory Procedures

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 13 & 15 of *Forensic Anthropology Training Manual* and Chapter 3 of *Dead Men Do Tell Tales*) and the film that accompanies this topic (i.e., *Iceman*).

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 1B

**RECOVERY
&
LABORATORY PROCEDURES**

As Burns explains, the objective of skeletal analysis is to gather the maximum amount of information possible, and she describes five categories of information that might be obtained if the analysis is handled correctly. (p.190)

- 1) describe and/or identify deceased
- 2) provide insight into activities of deceased
- 3) describe circumstances surrounding death
- 4) the postmortem interval (time since death)
- 5) the fate of the remains during that interval [taphonomy]

The factors that the forensic anthropologist should consider when preparing for fieldwork involving the collection and analysis of human remains that typically begins with excavation are described on pages 240-243:

Is the job legally, financially, physically, and technically possible—i.e., legal permission, funding, insurance, security & storage

There are the various ways in which burials are classified. (Notice that some of these categories overlap—for example, a burial could be *both* an "above ground interment" *and* a "commingled burial"—and at the same time it could also be a "primary burial" and a "disturbed burial") Pp. 247-248

surface burial
a "non-interment"—body left on surface to decompose

below surface burial
standard interment, with or without clothing, shroud, coffin, casket, or vault

above ground interment
in areas where water table is high...body protected by a vault of stone or concrete

individual burial
single person in a single location, above or below the surface

commingled burial
more than one person in the same location, buried either at the same time or different times

isolated burial
shares no walls with other graves

adjacent burials
share at least one wall with another grave

primary burial
initial resting place of the remains

secondary burial
any subsequent reburial

undisturbed burial
unchanged (except by natural processes) since the time of primary burial

disturbed burial
altered sometime after the time of burial...“disturbances caused by burrowing animals, grave diggers in the process of digging other graves, looters, or any number of other incidents”...all secondary burials are disturbed burials

The C. A. Pound lab has several security features that are very important in a forensic lab:

Burglar alarms & motion detectors, lab doors have special locks that cannot be duplicated w/out Maples' signature, no one outside the staff has a key (including college administrators & campus police)...as potential evidence in court cases, the chain of evidence must not be broken.

There are two fundamental chemical/biological processes that are involved in decomposition?:

Autolysis (aw-TOL-ih-sis)
digestive juices begin to digest the gastrointestinal tract

Putrefaction (PYOO-truh-fac-shun)
bacterial action throughout the body (a much greater component of the decomposition process than autolysis)
...body swells, becomes distended with methane gas

Fingernails and hair do *not* continue to grow after death (although the skin may retract around them, making the hair and nails appear more prominent).

Film Summary

Iceman Murder Mystery

In 1991, hikers in the Alps on the border between Italy and Austria made one of the most dramatic archaeological discoveries of the 20th century: the frozen, perfectly preserved body of a man who lived more than 5,000 years ago, during the transition from the Neolithic to the Bronze Age in Europe. This NOVA episode presents the latest results of the ongoing research program focused on this remarkable body.



The Iceman lying in the glacier where he was found



The Iceman in the museum in Bolzano, Italy

Transcript of *Iceman Murder Mystery*

NARRATOR: Frozen for more than 5,000 years, on a remote mountain pass, and now, preserved for the ages in a refrigerated tomb; he is the Iceman, a frozen relic from the Stone Age, the oldest intact human body ever found. He's a messenger from the past, bearing secrets of how humans lived nearly a thousand years before the pyramids.

He is also a homicide, waiting to be solved.

Who was he? And who shot an arrow into his back?

PATRICK HUNT (Alpine Archaeologist): Whoever shot him went up and pulled the arrow shaft out of his back.

Why would you do that? Why would you take the arrow away?

NARRATOR: Was it warfare? Or murder?

Now, a rare and dangerous procedure leads to some startlingly fresh clues. A piece of bone, a copper ax and a last meal surprise the experts, as they come closer to understanding our ancient past and to solving the Iceman Murder Mystery, right now on this NOVA-National Geographic Special.

On a remote mountainside, high in the European Alps, a man makes his way through the thin mountain air. It is a desolate place, but he is not alone. On this day, 3,000 years before the birth of Christ, this man's life will end in a violent death. But his body will remain on the mountain for over 5,000 years.

September, 1991: Two hikers climbing in the Italian Alps wander off the trail...and stumble across a gruesome sight: the head and shoulders of a man, emerging from the ice.

At first, the pathologist responding to the scene assumes it's simply the remains of an unfortunate hiker, one of many lost to the Alps over the years. But this body looks different. It shows almost no signs of decomposition. Its skin and flesh appear to have been freeze-dried. Hands, feet, even eyeballs are still intact. The mountain air and ice had transformed this corpse into a mummy.

As the recovery continues, some unusual items begin popping up: bits of leather and hand-made rope and a knife with a flint blade. This was no ordinary hiker.

Initial analysis of his gear suggests he was thousands of years old. The find causes a world-wide sensation. The press dubs him the “Iceman,” or “Ötzi,” after the Ötztal Mountains where he died.

Eventually, carbon dating confirms that Ötzi died 5,300 years ago. His were the oldest intact human remains ever recovered.

What can they tell us about our own history? And about how this man died up on that mountain?

PATRICK HUNT: For some reason, Ötzi makes a fateful journey up this ridge, along this valley all the way up. He goes from essentially about 1,000 feet to almost 11,000 feet. Why?

NARRATOR: At first, they suspect he was lost in a storm, but mounting evidence begins to suggest something else happened to the Iceman, something more violent.

Exactly what that was will likely be uncovered here, in Bolzano, Italy, just 30 miles from the spot where he died. A multi-million dollar museum celebrates what could be the world's oldest open case of homicide. Ötzi's mummified body is on display, carefully frozen in a custom-made crypt; temperature: 20.3 degrees Fahrenheit, relative humidity: 98 percent.

Now, doctors in charge of the body are hoping to force a break in the ancient case by conducting a rare and dangerous procedure. They are letting the Iceman's body defrost.

Scientists flock to Bolzano to get their hands and instruments on the 5,000-year-old corpse. They will be following fresh leads about the Iceman's death, but also his life, at a key turning point in human civilization. They will have just nine hours to complete their investigations before the Iceman must be refrozen.

Pathologist Eduard Egarter Vigl is leading an operation that could be risky.

DR. EDUARD EGARTER VIGL (Head of Conservation for the Iceman) (Translation):

One risk is that scientists who enter the room bring their bacteria and germs with them. Another risk is that we have no way of knowing if there are still living organisms in the mummy itself, and if these would be activated in the defrosting.

NARRATOR: If the body is harmed by the defrosting, the loss would be profound. Scholars depend on this one corpse to shed light on a crucial time in human history.

NEWS FOOTAGE (Translation): Ötzi is unique. He's from the very end of the Stone Age, a time when humans still used stone tools, but before they had mastered the art of smelting metal.

NEWS FOOTAGE (Translation): Struck down in mid-stride, he provides a glimpse of what life was like in those times, with some surprising twists.

PATRICK HUNT: One find—the man in the ice—opened up a whole new window on the ancient world that was never there before.

NARRATOR: Five thousand years ago, on the European continent, is a time before countries, before kings, even before the introduction of the wheel. In these alpine valleys, some people are living in small settlements, just beginning to grow crops like wheat and barley, and to raise goat, sheep and cattle. But others are nomadic hunters, still depending on wild game for survival.

Population is increasing, and so is competition between those hunters and early farmers.

PATRICK HUNT: We now know that with increasing population, there are more people contesting boundaries. This is the first time we're actually farming. So people can now fight over a plot of land and over the resources on it.

NARRATOR: This is 1,000 years before writing comes to this area, so Ötzi's gear, well-preserved by the icy glacier, provides a critical insight into prehistoric culture.

PATRICK HUNT: Everything was placed in that refrigerator, and the door was sealed. And we can open up that window in time, 5,300 years later, and everything was almost just as he left it.

NARRATOR: In fact, when they found the Iceman, he was still wearing one of his shoes. The artifacts are now in the Bolzano museum, where Patrick Hunt is joined by Annalisa Pedrotti, of nearby Trento University, to carefully examine each item, searching for clues, not only about Ötzi's culture, but about his last day alive.

Why would he have been carrying these things with him at the time of his death? The shoe is one of the earliest examples of its kind and surprisingly complex.

PATRICK HUNT: You can just see here, at least three different kinds of material. You see grass, you see skin, and you see cord.

NARRATOR: It's unlikely a man from the Stone Age would wear shoes all the time, but if he knew he was going to cross the rocky slopes and glaciers of the Alps, shoes like this would be important to pack along.

The artifacts not only provide personal details about the man who carried them, they prove that Stone Age designs could be surprisingly sophisticated.

His backpack, with its wooden frame, seems almost modern. A leather pouch was possibly tied around his waist like a fanny pack. Chunks of tree fungus, thought to have medicinal powers, served as first aid kit. Maple leaves were used to carry hot embers for starting fires.

PATRICK HUNT: Ötzi's culture knew the use of every possible plant...

ANNALUISA PEDROTTI (Trento University): Yes.

PATRICK HUNT: ...and stone and wood.

ANNALUISA PEDROTTI: Yes, they use the optimal material.

NARRATOR: But venturing into the mountains beyond his settlement could be dangerous. Wolves, wild boar and bears were common. Clashes between settlements and hunters were also possible, so Ötzi carried weapons.

Along with his knife, he had a bow and arrows. His quiver, the oldest ever found, contained carefully crafted wooden arrows, with flint arrowheads, chipped to a razor's edge and glued on with pitch made from the sap of a birch tree. The feathers on the shafts are also carefully attached—to stabilize the arrow in flight. But for some mysterious reason, the bow and arrows were not ready to use.

PATRICK HUNT: If you count the number of arrows here, easily over a dozen, most of the arrows are completely un-useable at this time. Why do we have so many arrows unfinished?

ANNALUISA PEDROTTI (Translation): This is a huge mystery. He was found with equipment that was not fully prepared.

NARRATOR: It's as if he were walking in the wilderness with an unloaded gun.

PATRICK HUNT: I would say that Ötzi is going to be in trouble. This is a serious flaw in his plan for survival.

NARRATOR: But he wasn't completely unarmed. He was carrying a weapon far advanced for his time, an ax made of copper.

PATRICK HUNT: The one object that continues to draw our attention, like a magnet, is that copper ax. It's so intriguing, because the technology required to make it is far beyond anything we've seen before.

NARRATOR: The Iceman's copper ax surprises archaeologists and forces a revision in the timeline of history. Before Ötzi, scholars didn't think alpine cultures had learned to smelt copper until about 2,000 B.C. But carbon-dating shows that the Iceman's ax is far older than that. This means his people already knew how to heat copper-rich rock up to 2,000 degrees Fahrenheit, hot enough to extract the metal from the ore.

The discovery of the ax meant they were stepping out of the age of stone tools a thousand years before experts thought possible.

PATRICK HUNT: To be that far ahead so far back, this is simply incredible. This is one find that changes forever what we think about the past. The mind that can create that copper ax is practically, and for all purposes, the same mind that can create a computer, a circuit board. In other words, Ötzi is us.

NARRATOR: For years after the Iceman was discovered in 1991, scholars believed he had frozen to death in an alpine storm. But how could someone so in tune with his environment get caught out in a storm? Experts searched for other clues to explain his death. The body was CT-scanned and X-rayed, but all they saw was some broken bones, nothing fatal.

Then one day, 10 years after the Iceman's discovery, Dr. Paul Gostner, a Bolzano radiologist, was studying images from the Iceman, when he saw something that struck him as strange.

PAUL GOSTNER (Radiologist) (Translation): It's this little white spot here. But you could also confuse it for a rib. It's hard to see right away, isn't it?

NARRATOR: As Gostner began to look again at the original X-rays, he saw something that didn't add up.

So he had a CT scan image taken, and this time, there could be no doubt. There it was, lodged in the Iceman's back: an arrowhead, made of stone.

PAUL GOSTNER (Translation): That was a great surprise since, up until that time, we didn't know that he was shot.

NARRATOR: But did the arrow kill the Iceman?

PATRICK HUNT: We know he was shot in the back from slightly down below, with an arrow that penetrated his scapula, his shoulder blade.

NARRATOR: The CT scans revealed that the arrowhead had, in fact, hit its mark.

PATRICK HUNT: The arrowhead penetrated a subclavial artery so that Ötzi bled to death very, very quickly.

NARRATOR: Who killed the Iceman? And why? The desire to solve this ancient homicide drives researchers back to the body one more time.

In the small operating room at the Bolzano museum, an international team of nearly two dozen researchers has gathered for the chance to examine the mummy. One of their first objectives will be to see if they can get a look at the fatal arrowhead.

Over two decades, scientists have learned a great deal about the Iceman. From his skeleton, they know he was five feet, two inches tall. Evidence of muscle development in his legs indicates a grueling routine of mountain hikes. The softness of his hands suggests he was not a farmer working the earth, but perhaps a hunter or a shepherd; while study of his bones reveals that he was in his 40s the day he died. Identifying marks include over 50 tattoos of unknown significance.

Biological anthropologist Albert Zink is head of the Institute for Mummies and the Iceman. Together with Dr. Egarter Vigl, Zink is leading the procedure.

ALBERT ZINK (Director, European Academy of Bozen/Bolzano (EURAC)-Institute for Mummies and the Iceman): We're all a little bit excited and also nervous, because we have a lot to do, and we also have to be sure that the Iceman doesn't have any damage due to this investigation.

NARRATOR: After a night spent outside his freezer, Ötzi is thawing nicely. As the mummy melts, he starts to sag. To prevent the body from completely falling apart, scientists place him in a special box. The box will allow them to move the body without damaging it and without altering the position of the limbs.

EDUARD EGARTER VIGL: You can see the mummy is well defrosted, the tissue is soft, so I think that we can start now with the investigation.

NARRATOR: Body parts that were frozen now move.

With just nine hours to conduct their investigations, each team must stick to a tight schedule.

In order to gain access to his left shoulder and the arrowhead, doctors move quickly to flip Ötzi face down. They hope the arrowhead may provide a clue to help solve one of the key mysteries of Ötzi's death: was he killed in a skirmish with another settlement or some hunters fighting over territory? Or was the arrowhead, still in his back, put there by one of his own—perhaps a jealous rival from his clan?

One clue supporting this idea is his copper ax. That ax was so advanced some believe it marks Ötzi as a man of great importance in his community. Stone carvings found in the valley below where he died prominently feature the exact same kind of ax, suggesting that the weapon had great symbolic power.

PATRICK HUNT: And that makes us wonder more about Ötzi.

Who was he? Why did he have this? What kind of status did he have in the culture?

NARRATOR: Zink and Egarter Vigl wonder whether the arrowhead might be able to provide other clues.

ALBERT ZINK: So we really hoped to get close to the arrowhead, because the arrowhead is still inside the body, and we never really saw the arrowhead. And so we really hoped to get close, to maybe see what is going on there.

NARRATOR: Guided by an endoscope, they are now within half an inch of the actual arrowhead. But their route is blocked by tissue. With minutes ticking by, Egarter Vigl has a key decision to make. So far, they have used pre-existing access routes, created long before the presence of the arrowhead was known. If Egarter Vigl gives the okay to cut the Iceman in a new place, they will surely be able to gain access to the Stone Age arrowhead, but this creates a dilemma. It's Egarter Vigl's mission to learn all he can about the mummy, but it's his duty to keep it from harm.

The Iceman's body has become a kind of protected landscape, an archaeological site older than Stonehenge, with distinct areas marked out for exploration over the years. So the Iceman is not just an extremely cold case; he's considered by the government to be a cultural treasure. That prevents Egarter Vigl from performing a true autopsy: the kind of procedure that might radically alter a human time capsule that has remained intact for nearly 2,000,000 days.

Egarter Vigl and Zink have devoted much of their careers to studying this time traveler from the Stone Age. Now, they visit the remote pass where Ötzi met his fate.

EDUARD EGARTER VIGL: We see now, in front of us, this wall and, uh, the place in which the Iceman was found.

NARRATOR: Ötzi was found just 100 yards from the border between Italy and Austria. Five thousand years ago, he climbed to this ridge and was killed.

EDUARD EGARTER VIGL: Here we are, on the top of the mountain. And if you look down in the valley we see that, the distance is very, very long. There are more than 1,500 meters.

ALBERT ZINK: So we can see here, very well, that here was the glacier, and the glacier tends to move down. And normally a dead body would have been transported with the glacier, down, and destroyed completely.

NARRATOR: Most bodies lost in glaciers get buried in the river of ice and slowly glide down the mountain, along with tons of stone and other debris all grinding together. Alpine glaciers typically move about 100 feet per year. And after a few hundred years, most of the debris that gets caught up in them emerges at the bottom along the melting edge of the ice.

But, while the circumstances of Ötzi's death appear extremely unlucky, in archaeological terms, he couldn't have fallen in a better spot. The sun and wind dried his body out completely. Rocks on either side of him formed a small trench. This eventually filled in with 10 feet of snow and ice, preventing the Iceman's body from being swept into the deadly frozen current that flowed all around it. Fifty feet to the right or left and his body would have been ground to bits and lost forever. The mountain created and then protected the Iceman.

Back in the operating room, Egarter Vigl and Zink have to decide whether they are going to cut into the mummy, risking permanent damage.

Though investigators have known for a decade that Ötzi was killed, no one has ever seen the actual murder weapon. It is the last piece of unexamined evidence remaining. The team going after the arrowhead is tantalizingly close, but there is no way to get through the tissue without doing damage to the mummy.

Egarter Vigl decides to play it safe and move on without making a new incision.

PATRICK HUNT: We want to make sure that Ötzi is kept intact. Archaeologists have a tendency to alter the artifacts in a very destructive way. Once you excavate some sites, you can never go back, and you can't correct your mistakes, you can't do it over again.

NARRATOR: Though the arrowhead is critical, it's not only evidence in the case. The idea that Ötzi was killed in a skirmish with a rival settlement or band of hunters seems to be supported by microscopic signs that he was on the run in the days leading up to his violent death. He's carrying those tiny clues in his intestine.

PATRICK HUNT: Wherever you walk in late spring to early summer, there's going to be a lot of pollen in the air. The pollen is going to also be in his throat and on his food.

NARRATOR: At different elevations, different trees release their pollen. In this region, a tree called hornbeam dominates the lower elevations, while higher up the mountain, conifer forests cover the slopes.

In Ötzi's intestine, scientists find a layer of hornbeam pollen; on top of that, a layer of conifer. It's a clear indication he's moving up the mountain.

PATRICK HUNT: Oddly enough, we believe he came back down again, because there's another layer of hornbeam pollen on top of the conifer pollen, which means he went up for some reason, came back down, and then went back up again, to his death.

What possesses a man to make such a journey, unless, for life-threatening reasons, he has to move?

NARRATOR: And there is more forensic evidence that the Iceman was being pursued in the days leading up to his death. On his right hand: a deep cut slicing across the palm, possibly the result of hand-to-hand combat involving a knife.

PATRICK HUNT: So has he been in a battle? Has he already been fighting for his life? There's some evidence that would lead to that interpretation.

NARRATOR: But this war-like scenario has one hitch, and it has to do with what must have been the Iceman's most prized possession: his ax. Why would the killers leave such a valuable object behind?

PATRICK HUNT: It makes sense if Ötzi is just a victim of a long distance kill-shot where someone would shoot him, leave the arrow, leave the ax and run away.

NARRATOR: But the shaft of the fatal arrow was never found, suggesting the attacker got close enough to pull it from the Iceman's back. Anyone getting that close to the body would have been within reach of Ötzi's copper ax.

PATRICK HUNT: Why was the ax left by his body? A huge mystery; surely people knew its value.

NARRATOR: Perhaps the killer left the ax and took the arrow to avoid being discovered.

PATRICK HUNT: If you took his ax, you'd be identified; if you left your arrow shaft, you could be identified. So, to leave the ax and take the arrow says that someone is exercising great caution. They're thinking this through. Possibly, they don't want to be identified as Ötzi's killer.

NARRATOR: In the search for more clues about Ötzi's killer, it's time for a new group to have their turn with the body. This team will be looking for blood, specifically in Ötzi's brain.

On scans of Ötzi's skull, there are clear signs of fracture. And in pictures of the shrunken but still intact brain, some areas appear darker than others, which could be either blood or rot. If it's blood, it's proof he suffered a blunt force trauma to the head, just before dying.

ALBERT ZINK: If you could really find evidence for a bleeding, this would prove that this was an injury that happened during the process when he was dying. Bleeding just happens if you are still alive or if you are in the process of dying.

NARRATOR: Pincers, threaded through holes drilled in Ötzi's cranium years ago, snip samples of his brain.

When analyzed in the lab, these dark clumps of brain matter test positive for blood, confirming that Ötzi suffered a blow to the head before he died. But how?

Either he was finished off by his killer at close range, or he hit his head on a rock after being struck by the arrow. Ultimately, the forensic evidence is inconclusive, but the blood in the brain confirms that his last moments were traumatic.

All this analysis has taken time, and the body cannot remain defrosted much longer. With so much information about his death still inconclusive, scientists shift their focus to look for more clues about Ötzi's life.

The copper ax suggests he was figure of some importance. But was he a farmer? A hunter? A shepherd? Why was he alone? Was he perhaps on the run? Unfortunately, the one vital organ that could possibly answer all these questions has been missing for 20 years, but recently it has been found, by the same radiologist who discovered the arrowhead.

Over the years, Dr. Paul Gostner has seen thousands of images of the mummy's insides. But one day, while scanning the familiar images, an unexpected shape seemed to emerge.

PAUL GOSTNER (Translation): Here we have the esophagus, heart, lungs. See? And if you go further down, then you see an image that corresponds to that of an organ, a big, hollow organ.

NARRATOR: The “big, hollow organ” was something no one had noticed before: the Iceman's stomach. How was it possible for everyone to miss something so basic as his stomach? The answer? Because it was not where it should have been. The stomach had moved.

When the Iceman was found, his body was draped, face down, over a rock. For 50 centuries the he hugged that rock, pressed under tons of ice. His body, squeezed between the rock below and the ice above, pancaked. While the organs inside his body were preserved intact, some of them were squeezed out of place.

PAUL GOSTNER (Translation): The stomach usually sits in the upper abdomen. When a person stands, then the stomach moves down a bit. When a person lies on his stomach, then the stomach pushes up. When a person lies on his stomach and has a ton of ice on top of him, then the stomach is pushed up even further. You don't see the stomach because it is too far up.

NARRATOR: The team assembled to explore the stomach first tries to reach it the usual way—passing an endoscope in between the Iceman's teeth, through his mouth, and down his throat—but the Iceman's body is too compressed.

TEAM MEMBER: We cannot pass. We cannot pass.

NARRATOR: So the team takes a different route, through an existing incision in the abdomen. And, here, they find the stomach, almost in his chest, just where Dr. Gostner predicted it would be.

ALBERT ZINK: I think this is stomach here.

NARRATOR: The stomach is not only there, it is full of food: grain, fat and meat.

TEAM MEMBER: So much material from the stomach now.

NARRATOR: Initial analysis establishes the grain is a variety of wheat called einkorn. Einkorn was one of the first grains cultivated by human beings. The meat is ibex, a kind of wild goat still roaming the alps.

This last meal confirms the Iceman lived at a turning point in history. He and his people were just beginning to farm, but they still depended on meat from wild game. Ötzi himself may have been a hunter, connected to a small farming community. However he made his living, he was well fed.

After nine hours, Ötzi is resealed, holes plugged, flaps put back in place.

This one day has yielded 149 biological samples, enough material to keep scientists busy for years to come. The most important of all could be the vials that may contain the Iceman's D.N.A. Techniques of salvaging and sequencing D.N.A. have only recently improved enough to make it possible to get useful information from a mummy as old as Ötzi. But it will still be extremely difficult.

ALBERT ZINK: Testing the D.N.A. of the Iceman is difficult, on one hand, because he's a wet mummy, and wet mummies have a lot of humidity. This is very bad for the D.N.A. preservation. On the other hand, he was frozen for more than 5,000 years, and this turned out to be good, because the coldness preserves the D.N.A.

NARRATOR: If fragments of D.N.A. can be reconstructed, scientists have hopes they will be able to learn a great deal about characteristics like his eye color, medical history and genetic mutations. But first they have to get the D.N.A. They will follow a multi-step process, in order to see if it is even possible.

For Angela Graefen, a researcher at Albert Zink's lab, helping to piece together the Iceman's genetic profile is the chance of a lifetime.

ANGELA GRAEFEN (Researcher, Institute for Mummies and the Iceman): I've always been very interested in mummies, and when I got the chance to work on the Iceman, yeah, well, of course I...it's everybody's dream to work on such a, such a well-known sample as that.

NARRATOR: First, Graefen cuts the precious sample of Ötzi's bone into smaller pieces using a diamond-tipped saw. Tiny bone samples are placed into a sterile container with a steel ball. When the container is shaken at a high speed, the ball pulverizes the bone, breaking apart individual cells. Graefen adds various chemicals to make the D.N.A. easier to extract. Days later, what's left is a mixture of clear water and a golden-hued pure D.N.A.

The D.N.A. is sent from Bolzano, Italy, to a lab outside of Boston that specializes in reconstructing D.N.A.

TIMOTHY HARKINS (Director of Research and Development, Life Technologies): Ancient D.N.A. is very different from modern D.N.A. for several reasons. One of the bigger issues with ancient D.N.A. is contamination.

NARRATOR: Contamination occurs when the D.N.A. of an outside source, whether from a microbe or a human being, gets mixed up with the D.N.A. being studied.

Over the years, countless people have touched the mummy, leaving traces of their own D.N.A. behind. So Zink and Egarter Vigl took their samples from deep within Ötzi's bone, counting on the outer bone to provide a natural seal to protect the inner bone from contamination.

Because the procedure was so meticulous, the D.N.A. extracted is remarkably pure; 97 percent is Ötzi's. But there is a mysterious three percent that clearly does not belong to him.

TIM HARKINS: We found an interesting surprise when we looked at this contamination; a significant portion of the contamination was actually attributable to a microbe that causes Lyme disease.

NARRATOR: Lyme disease is caused by a bacteria, spread to humans by ticks. Untreated, its symptoms can include muscle weakness and serious swelling of the joints and arthritis. While Lyme disease is common today, the microbial D.N.A. contained within Ötzi's genes is proof that the disease is at least as old as the Stone Age. It is the oldest trace of Lyme disease ever identified.

And here is where Ötzi's ancient D.N.A. is nearly unique: his D.N.A. has an actual body connected to it.

ANGELA GRAEFEN: This is different, because this is not just a bone we can't tell anything of, but this is a whole mummy. The whole body is preserved. So this is the first time we can actually compare a whole genome with a whole preserved body.

NARRATOR: X-rays reveal that the Iceman's left knee shows signs of swelling, consistent with someone suffering from arthritis or Lyme disease. And there are more revelations to come. After tediously reconstructing 98 percent of Ötzi's fragmented D.N.A., a clearer picture of who he was emerges.

On the chromosomes of the genes that determine eye color, there's a marker showing that Ötzi had brown eyes. Other markers reveal that those with the closest genetic match living today are not from the Alps, but from Sardinia. They also found that Lyme disease is not the only ailment Ötzi shares with 21st century humans.

TIM HARKINS: Another surprising thing that we find, in sequencing Ötzi's whole genome, is that he had a marker for heart disease.

ANGELA GRAEFEN: And of course, one would ask, isn't that a modern disease? Why should he have those? And we know a bit about his lifestyle. He wasn't overweight. He wasn't lazy. He didn't sit on his sofa all day. Um, so, where could he have got those from?

ALBERT ZINK: We still think that many of the diseases are very modern diseases, are civilization diseases that just occur maybe 100, 200 years ago. Now we see that these genetic modifications were already present much, much longer before.

NARRATOR: In fact, Ötzi's predisposition to heart disease is more than just a genetic curiosity. Dr. Paul Gostner's CT images reveal a sight familiar in today's cardiology labs.

PAUL GOSTNER (Translation): These two small clumps of calcium correspond to an atherosclerosis of the blood vessels.

NARRATOR: While cholesterol forms the blockage that people are most familiar with, these calcium deposits in Ötzi's artery are also a common sign of heart disease. Despite a lifetime of exercise and what surely must have been an organic diet, Ötzi's arteries look like those of a typical 40-year-old man in the 21st century. Perhaps that shouldn't be surprising, since, genetically, we are almost unchanged from Ötzi's kind.

EDUARD EGARTER VIGL: We are in a big mistake, because we believe that 5,000 years are a lot of time in the human being development. But 5,000 years are only 250 generations, and so we can't expect changing in our genome in so short time.

NARRATOR: But a few genes do adapt quickly to environmental and cultural factors. There's more D.N.A.evidence suggesting Ötzi lived in a time of great transition. Ötzi's genes indicate he was lactose intolerant; he couldn't digest milk as an adult.

It's a condition many believe to be a result of an ailment or allergy. But they're wrong.

ANGELA GRAEFEN: Many people think lactose intolerance is an illness, but it's, you have to bear in mind, it's not, actually. It's the original state of humans. In the Stone Age, all humans were lactose intolerant.

NARRATOR: In the ancient past, all humans could digest milk as babies, but lost the ability as they grew older. That's exactly what happened to Ötzi. But at the very time and place where Ötzi lived, a certain gene was just beginning to mutate, probably in response to greater availability of domesticated cow's milk. That mutation allows adults to digest milk, an evolutionary process that is still underway. Today, about 40 percent of adults worldwide are able to digest milk. But in the Alps, where Ötzi lived, 85 percent can digest dairy products.

D.N.A.analysis suggests Ötzi lived in a time of significant change, but it gives few clues as to how he died. That leaves some key questions: what was he doing on the mountain and why was he killed?

The key evidence to emerge from the autopsy comes from his stomach. Analysis of the extracted material reveals it is a balanced meal of meat and grain. The most important clue is the amount of food itself. During the autopsy, they removed nearly a quarter pound of food; another quarter pound was left behind.

Food remains in the human stomach for an average of about one hour. Ötzi ate this very large meal shortly before dying. This does not seem to be the behavior of a man on the run, being pursued up and down the Alps by enemies.

ALBERT ZINK: So, I think, now, this completely changes the picture. So, he really felt sure he was not fleeing from somebody, because otherwise, I cannot imagine that somebody is sitting down, having a big meal.

NARRATOR: So what does this tell us about how Ötzi died? Add up the evidence: the missing arrow, the bleeding from his brain, a valuable copper ax left behind, a full stomach. Zink and Egarter Vigl think this final clue tips the balance. They now are convinced the Iceman was killed by someone he knew, perhaps a member of his own community, and he never saw it coming.

With the procedures complete, the samples taken, the visiting scientists gone, Egarter Vigl preps the body to be refrozen.

EDUARD EGARTER VIGL (Translation): During this period, I am alone with the mummy. Naturally, you let your mind wander, and science is no longer the focus, but you think about how this was actually a person who lived 5,000 years ago.

What is his face telling me? What is the position of his body telling me? Then I start thinking about mortality and, well, I feel a real connection with him.

NARRATOR: Now, for a while at least, the Iceman will be left in peace.

Of the estimated one-hundred-billion humans who have been born and passed from this earth, the Iceman has managed to survive the ravages of time, and he continues to help us understand what it means to be human.

Quiz Questions for Topical Quiz # 1B

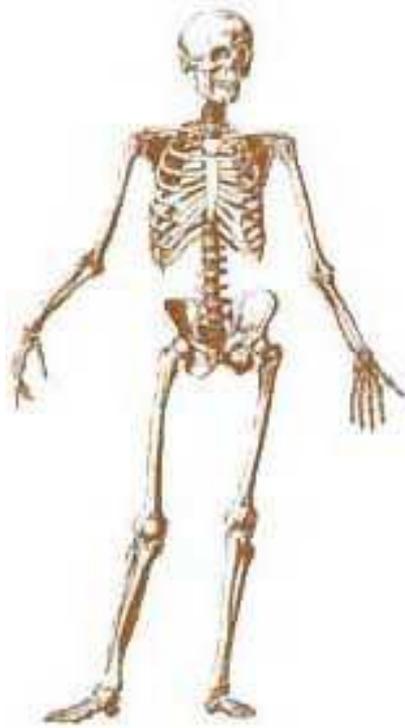
1. The objective of skeletal analysis in forensic anthropology, which is to obtain the maximum amount of information possible, _____ [does or does not] include description of the circumstances surrounding death, and it _____ [does or does not] include description of the fate of the remains during the postmortem interval.
2. The objective of skeletal analysis in forensic anthropology, which is to obtain the maximum amount of information possible, _____ [does or does not] include description and/or identification of the deceased, and it _____ [does or does not] include description of the perpetrator's motive.
3. The objective of skeletal analysis in forensic anthropology, which is to obtain the maximum amount of information possible, _____ [does or does not] include description of the state of mind of the deceased at the time of death, and it _____ [does or does not] include identification of the place of birth of the deceased.
4. The objective of skeletal analysis in forensic anthropology, which is to obtain the maximum amount of information possible, _____ [does or does not] include insight into the activities of the deceased, and it _____ [does or does not] include description of the postmortem interval (i.e., time since death).
5. What are the three basic requirements for a good physical facility to conduct skeletal analysis?
6. Of the three basic requirements for a good physical facility to conduct skeletal analysis, which one is the most important?
7. Standard procedure in managing the evidence collected for laboratory analysis involves assigning a case number. That case number should be assigned at the time of _____, and it should include some reference to _____.
8. Standard procedure in managing the evidence collected for laboratory analysis involves organizing a database. What should be included in that database?
9. What are some of the factors that the forensic anthropologist should necessarily consider when preparing for fieldwork involving the collection and analysis of human remains?
10. What are the rest of the factors that the forensic anthropologist should necessarily consider when preparing for fieldwork involving the collection and analysis of human remains? [Note: the answers to questions # 9 & 10 are discussed on pages 233-235 of *Forensic Anthropology Training Manual*--you will be expected to be able to identify *all* of the factors that the forensic anthropologist should necessarily consider when preparing for fieldwork involving the collection and analysis of human remains.]

11. What changes can occur in the vegetation that exists over a burial?
12. What *antemortem* medical information would be likely to be MOST useful for positive identification of skeletonized human remains?
13. After finding a burial site, what is the first thing a forensic anthropologist would do before beginning excavation?
14. The simplest way to check for differences in soil density when searching for a burial site is to use a(n) _____.
15. A burial that is the initial resting place of the remains is referred to as a(n) _____.
16. If human remains are left to decompose on the surface of the ground (where they are often disturbed or destroyed by carnivores and scavengers), the deposition of the body is referred to as a(n)_____.
17. A burial that shares no walls with other graves is called a(n) _____.
18. A burial that contains the remains of two or more persons in a single location (either above or below the surface of the ground) is referred to as a(n)_____.
19. A burial that is unchanged (except by natural processes) since the time the remains were first buried is referred to as a(n) _____.
20. If the remains have been disinterred and reburied (for any number of subsequent times), the burial is referred to as a(n)_____.
21. Burials that typically involve vaults of stone or concrete in areas close to the coastline where the water table is high and water erosion is common (as, for example, in New Orleans) are called _____.
22. A standard below ground internment, regardless of depth, that may include or not include clothing, shroud, coffin, casket, or vault, is called a(n)_____.
23. A burial _____ [*could be or could not be*] both adjacent and primary, and a burial _____ [*could be or could not be*] both individual and commingled.
24. A burial _____ [*could be or could not be*] both adjacent and secondary, and a burial _____ [*could be or could not be*] both below surface and disturbed.
25. A burial _____ [*could be or could not be*] both undisturbed and isolated, and a burial _____ [*could be or could not be*] both primary and disturbed.

26. A burial _____ [could be or could not be] both undisturbed and adjacent, and a burial _____ [could be or could not be] both primary and secondary.
27. A burial _____ [could be or could not be] both secondary and below surface, and a burial _____ [could be or could not be] both isolated and adjacent.
28. A burial _____ [could be or could not be] both individual and above ground, and a burial _____ [could be or could not be] both disturbed and undisturbed.
29. As described on pages 244-247 of *Forensic Anthropology Training Manual*, what are some of the general guidelines to follow in most excavations with regard to documentation, evidence retrieval, mapping, and digging techniques?
30. As described on pages 244-247 of *Forensic Anthropology Training Manual*, what are some of the general guidelines to follow in most excavations with regard to terminating the excavation, exposing the body, and recording the evidence?
31. As described in the film *Iceman Murder Mystery*, examination of the Iceman's intestines revealed a layer of conifer pollen lying on top of a layer of hornbeam pollen; because conifers grow at _____ [higher or lower?] elevations than hornbeams, it indicated that the Iceman had been moving _____ [up or down?] the mountain just before he died.
32. As described in the film *Iceman Murder Mystery*, when the Iceman's body was compressed by the ice, one of his internal organs was moved far out of place, namely his _____.
33. As described in the film *Iceman Murder Mystery*, radiocarbon dating has established that the Iceman died about _____ years ago.
34. As described in the film *Iceman Murder Mystery*, at the time of his death the Iceman was equipped with arrows whose heads were made of _____ and an ax whose head was made of _____.
35. As described in the film *Iceman Murder Mystery*, DNA evidence indicated that the Iceman _____ [could or could not?] digest milk as an adult, and that he _____ [did or did not?] have a genetic predisposition to heart disease.
36. As described in the film *Iceman Murder Mystery*, forensic examination revealed that the Iceman would have been approximately _____ tall in life, and that he was in his _____ [what decade of life?] when he died.
37. As described in the film *Iceman Murder Mystery*, forensic examination revealed that the Iceman's last meal consisted of _____.

38. As described in the film *Iceman Murder Mystery*, a CAT scan performed ten years after the body was discovered revealed that the Iceman had been shot with an arrow that penetrated his _____ [*which bone in the body?*].
39. As described in the film *Iceman Murder Mystery*, the shaft of the arrow that penetrated the Iceman _____ [*was or was not?*] found with the body, and the Iceman _____ [*did or did not?*] suffer a blow to the head at the time of his death.
40. As described in the film *Iceman Murder Mystery*, the body of the Iceman is stored today in a museum in _____ [*what city & country?*], and it is kept in a specially designed crypt that is maintained _____ [*above or below?*] freezing.
41. As William Maples explains in *Dead Men Do Tell Tales*, most forensic anthropologists and pathologists _____ [*do or do not*] put Mentholatum on their upper lips during an autopsy to block the smells emanating from the cadaver, and fingernails and hair _____ [*do or do not*] continue to grow after death.
42. As William Maples explains in *Dead Men Do Tell Tales*, the minimum time required for skeletonization of human remains under appropriate environmental conditions is about _____.
43. What security features did William Maples put into place at the C. A. Pound Human Identification Laboratory with regard to construction and maintenance of the facility?
44. What security features did William Maples put into place at the C. A. Pound Human Identification Laboratory with regard to access to the facility?
45. The process of decomposition that occurs after death when the stomach acids that serve as digestive juices in life begin to digest the gastrointestinal tract is called _____.
46. The process of decomposition that occurs as a result of bacterial activity throughout the body, and which is the major component of decomposition, is called _____.
47. For their own protection, staff members at the C. A. Pound Human Identification Laboratory at the University of Florida in Gainesville are required to be inoculated against _____.
48. In his experience as a forensic anthropologist, William Maples found that _____ were commonly misidentified as human hands, and that _____ were commonly misidentified as human skullcaps.

49. William Maples examined the skull of the infamous Piltdown Man at one point in his career. Where is the skull currently stored?
50. Why did William Maples prohibit his students from putting hats on the heads or cigarettes in the mouths of the skeletons in the C. A. Pound Human Identification Laboratory?



Chapter 3

Professional Standards & Historic Cases

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapter 16 of *Forensic Anthropology Training Manual* and Chapters 13, 14, & 15 of *Dead Men Do Tell Tales*), the film that accompanies this topic (i.e., *Anastasia Dead or Alive?*), and/or the following website:

Recovering the Romanovs

(The URL for Recovering the Romanovs is <http://www.dnai.org/d/index.html>)

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 1C

**PROFESSIONAL STANDARDS
&
HISTORIC CASES**

There are four fundamental categories of information in the professional record keeping of forensic anthropologists (*Pages 264-265*)

Background Information
Name, title, address, telephone of person responsible for the report

Significant Dates
Initial contact, recovery, entry into records, examination, report

Chain of Custody
who gave the evidence, when & where? Did you sign for it? Did you release it? When and where, and did you obtain a signature?

Notes
Of *all* findings; decide later what goes into final report.

The following kinds of information should be included in the forensic anthropologist's written report (*Pages 265-267*)

Case background, condition of the evidence, inventory (bones, teeth, artifacts), anthropological description (sex, age, ancestry, stature, handedness), other observations (evidence of antemortem disease & injury, perimortem disease & injury, postmortem trauma), conclusions, & recommendations, signatures and dates, appendices of maps & photos

There are three fundamental requirements in the code of ethics followed by forensic anthropologists (*Pages 271-272*)

Respect
sensitivity to highly charged human dimension of the work...dress and speak appropriately in court

Honesty
report findings accurately, never go beyond evidence

Confidentiality
complete silence until the legal process is complete

Francisco Pizarro was a self-made soldier of fortune who conquered the Inca empire with a treacherous capture of Inca King Atahualpa at Cajamarca in 1532...slaughtered the courtiers and raped the concubines...Atahualpa offered to fill a 22' x 17' room with gold to a height of 7'...when the room was not quite full, Pizarro had Atahualpa tried on charges of treason and executed in 1533...later that year the Inca capital at Cuzco fell...Pizarro became governor of Peru, ruled from Lima, which he founded.

Pizarro was buried with his slain half-brother Alcantara behind the cathedral...four years later, 1545, remains moved to a wooden box under the main altar of the cathedral...then in 1551, his daughter donated money for a special chapel for the remains, which were placed in a wooden box...sometime between 1623 and 1629 the remains were moved again, inside the church.

1891 (350th anniversary of his death) attempt to identify mummified remains from the crypt under the altar said to be Pizarro's...American anthropologist W.J. McGee present, who identified it as typical of a criminal...then accidental discovery of wooden boxes with bones in 1977, one with a lead casket with inscription (which appeared in 1661 historical records) identifying Pizarro.

William Maples made two trips to Lima in 1984...skull & skeleton belonged to white male at least 60 years old with clear traces of terrible wounds: four sword thrusts to neck (one mortal wound that pierced the right vertebral artery), one that cut away portions of the vertebrae...other vertebra & ribs cut...defensive wounds on hands and arms, skull wounds including eye orbit...total of at least 11 stab wounds, possibly 14, *most on the right side of the body and neck* (the side a right-handed swordsman would present to his opponents)...trauma to neck agreed with historical accounts.

The mummy in the glass coffin whose remains had been mistakenly identified for years as those of Francisco Pizarro was small in stature, gracile skeleton, no evidence of wounds—most likely a churchman, who lived a quiet life and died a quiet death.

President Zachary Taylor

July 4, 1850, ceremony to lay foundation stone for Washington Monument, ate raw vegetables, fresh cherries, and iced buttermilk, developed gastroenteritis and acute diarrhea, died five days later on July 9.

Natural death caused by intestinal infection by *E. coli* from unwashed vegetables or vegetables washed in contaminated water... medical practice at the time was to withhold fluids from diarrhea patients, prescribing laxatives instead (miniscule traces of arsenic were in the body that would be found in any 19th century person, insufficient to cause death or even illness).

President Zachary Taylor's death *could* have been caused by arsenic poisoning, because the symptoms were consistent—vomiting, abdominal spasms, diarrhea, and progressive weakening.

Arsenic and other metallic poisons are quickly deposited in the skeleton and hair of victims, if they live for a few days after the initial intake of poison...a sudden massive dose could kill within hours, and no trace would be deposited in bones or hair...but if the victim lives for 28 to 30 hours after ingesting arsenic, traces will be deposited.

William Maples knew it was necessary to get permission to exhume the remains of President Zachary Taylor, because human remains belong to the relatives who survive them (not to the cemetery, the courts, or the nation).

Taylor was buried at a national cemetery in Louisville, Kentucky.

When Maples opened the lead box containing the remains of President Zachary Taylor, he found a soldered lead liner inside a rotted wooden casket inside a marble vault: the body had not been embalmed, and butyric acids from decomposition had eaten through the metal in several places (good that he hadn't been embalmed, because 19th century embalming used arsenic)

Totally skeletonized, with abundant hair adhering to skull, bushy eyebrows clinging to supraorbital ridges...no shoes or stockings, but hands in cloth gloves...a few lumps of adipocere (a waxy substance that forms when body fats combine with moisture)

Maples removed all ten fingernails, collected samples of hair from head and body, small portion of bone from the sternum, small piece of adipocere, textile samples from under the body that had soaked up decomposing fluids (arsenic would be in all of these things...everything divided into two identical sets of samples).

Tsar Nicholas II and his family

Ekaterinburg (800 miles from Moscow in the Urals), night of July 16-17, 1918...Eleven (11) victims: tsar Nicholas, Tsarina Alexandra, son Alexei, four daughters Olga, Tatiana, Marie, and Anastasia, family doctor Botkin, cook Kharitonov, footman Trupp, maid Anna Demidova...shot, clubbed, and bayoneted by a Bolshevik death squad led by Commander Jacob Yurovsky... Tsar died instantly, bullets from revolvers bounced off chests of children (18 pounds of diamonds recovered from corsets)

Participant claimed the bodies were originally deposited in an abandoned mineshaft about 12 miles out of town...stripped the bodies (found jewels), funeral pyre of bodies two layers deep, poured gasoline & sulfuric acid, set afire, and burned to ash.

White Russians recaptured Ekaterinburg 8 days after the murders...found some artifacts in and around the mine shaft and a single severed finger, but no bodies (house was destroyed by communists in 1977)...corpses dumped into 8 foot deep mine shaft, grenades tossed in...next night removed the bodies from the mine...three days later decomposing bodies put in a pit 6 feet deep and 8 feet square, sulfuric acid applied for smell.

Location of grave discovered in 1979, announced in 1989, Maples heard about it in 1992.

9 skeletons, 5 female (3 of them young, having just reached maturity), 4 male...all 9 faces badly fractured (done with rifle butts, according to assassins, to make them unrecognizable)...all females had dental work, no males did...enamel of teeth and outer surfaces of cranial vaults eroded away by acid (broken jar that once contained sulfuric acid found among remains)...14 bullets recovered from grave.

17 yr old Anastasia and 14 yr old Alexei not identified...Tsar had rotten teeth

Maples thinks Anastasia's body was burned (along with Alexei), as Yurovsky reported...Maples thinks their calcined remains are still there, and might be recovered by excavation.

DNA tests matched a blood sample from the British royal family with 98.5% degree of certainty...confirmed at Berkeley...all related to Queen Victoria, whose mitochondrial DNA is in Prince Philip.

Imposter Anna Anderson died in 1984, was cremated, so can't be DNA tested (although there are tissue samples from one of her surgeries, not yet tested because of legal difficulties)

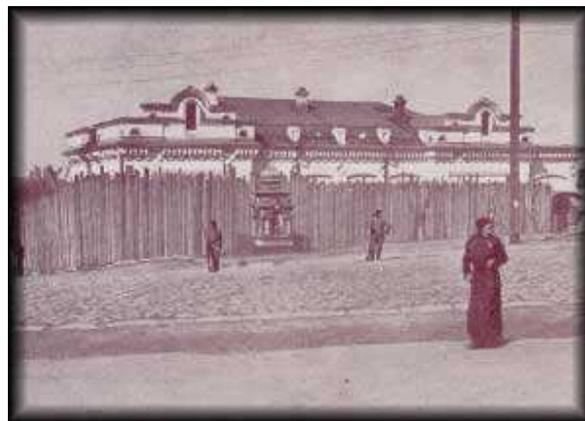
Film Summary

Anastasia Dead or Alive?

During the Bolshevik Revolution of 1917, Czar Nicholas Romanov II was overthrown and exiled to the town of Ekaterinburg. In the middle of the night of July 16, 1918, Bolshevik guards, using the pretense that the Romanovs were in danger, led the Czar and his family into a basement and killed them. Although reports indicated that no one survived, some people believe that one of the Czar's daughters, Princess Anastasia, may have escaped. In 1922 a woman claiming to be Anastasia surfaced in Berlin. Six years later, she visited the United States and registered in a hotel using the name Anna Anderson. Relatives, doctors, and former acquaintances of the Romanovs interviewed and studied her, but until the advent of DNA analysis, no one could prove or disprove her claim with certainty. NOVA investigates this mystery, presenting personal testimonies, evidence from DNA tests, and extensive efforts to determine her true identity.



The Romanov Family



The Ipatiev House where the Romanovs were murdered

The film provides an excellent illustration of the uncritical, credulous perspective that many people employ when they are asked to consider extraordinary claims. It also provides an important lesson in human nature: people who seem sincere and credible, and who have no obvious motivation to lie, may nevertheless be thoroughly duplicitous. Finally, the film shows the crucial difference between conclusions based on evidence derived from sound scientific methodology and conclusions based on techniques that have not been tested and proven.

Various people who knew Anna Anderson (or who knew people who knew her) are interviewed in the film—some of them are confident that she was genuine (i.e., that she was in fact Anastasia), and others are confident that she was a fraud. Anastasia's former tutor, Pierre Gilliard, dismissed Anderson's claim to being Anastasia, while a former playmate of Anastasia's (Gleb Botkin, who was also the son of the murdered royal physician) accepted Anderson's claim. Peter Kurth, who wrote a biography of Anna Anderson, was absolutely convinced that she was Anastasia, but he said he would change his mind if definitive evidence were produced that undermined her claim. When the results of scientific tests were announced proving that Anderson was a fraud, Kurth demonstrated his lack of personal and intellectual integrity by refusing to accept the obviously correct conclusion. When it comes to extraordinary claims, most people believe what they want to believe, not what the evidence shows, and they rationalize the evidence that seemingly contradicts their preferred conclusion.

Various techniques used for personal identification are described in the film, and it's obvious that not all of them are equally valuable. Computerized photo comparisons of the faces of Franziska Schanzkowska (a Polish factory worker long suspected of being Anna Anderson) and Anastasia seemed to indicate that the two women were not the same person, but photographic comparisons of the ears of Anna Anderson and Anastasia seemed to support Anderson's claim. It was DNA testing that eventually proved that Anna Anderson had been lying about her identity for most of her life, and DNA testing is much more certain than photographic comparisons of faces or ears. The DNA evidence wasn't available until after she died in 1984, but a German court had already ruled that she had failed to prove that she was Anastasia. Two decades later, of course (after the film was made), the remains of Anastasia were finally recovered in Russia, and William Maples was posthumously vindicated in his certainty that Anastasia died the same night as the rest of her family, and that her remains would likely be found one day.

Quiz Questions for Topical Quiz # 1C

1. What information should the professional records of the forensic anthropologist include with regard to the anthropologist's identity, time of involvement, and chain of custody?
2. What information should the professional records of the forensic anthropologist include with regard to the anthropologist's associates, the perpetrator's associates, and the anthropologist's equipment?
3. What information should the professional records of the forensic anthropologist include with regard to the perpetrator's motive, the emotional impact on the victim's family, and the anthropologist's emotional response to the brutality of the crime?
4. What information should the professional records of the forensic anthropologist include with regard to the human remains, the other physical evidence, and evidence regarding antemortem, perimortem, and postmortem disease, injury, and trauma?
5. Prior to the legal resolution of the case in question, the ethical rule of confidentiality prohibits the forensic anthropologist from discussing the details of the case with _____.
6. What are the three fundamental requirements upon which the code of ethics followed by forensic anthropologists is based?
7. Under the guidelines of the 1993 *Daubert* decision, what are the five questions that trial judges are likely to consider when deciding whether to accept expert testimony?
8. As described in the film *Anastasia*, the Bolshevik Revolution led by Lenin occurred in the year _____, and the Tsar and his family were killed by the Bolsheviks in the year _____.
9. As described in the film *Anastasia*, nineteen months after the Tsar and his family were killed, a woman who claimed to be Anastasia attempted suicide by jumping into a canal in the city of _____.
10. As described in the film *Anastasia*, Gleb Botkin, son of the murdered royal physician and a former playmate of Anastasia, _____ [did or did not] believe that Anna Anderson was Anastasia, and Pierre Gilliard, Anastasia's former tutor, _____ [did or did not] believe that Anna Anderson was Anastasia.
11. As described in the film *Anastasia*, computerized photo comparisons of the faces of Anna Anderson and Franziska Schanzkowska _____ [did or did not] support the claim that Anna Anderson was Anastasia, and photographic comparisons of the ears of Anna Anderson and Anastasia _____ [did or did not] support the claim that Anna Anderson was Anastasia.

12. As described in the film *Anastasia*, in 1967 a German court ruled that Anna Anderson had _____ [*proven or not proven?*] that she was Anastasia; Anna Anderson (Manahan) died in Virginia in the year _____.
13. As described in the film *Anastasia*, before the DNA testing on Anna Anderson's preserved tissue was completed, Peter Kurth, Anderson's biographer, said he _____ [*would or would not?*] change his mind about Anna Anderson's identity, if necessary, based on the scientific evidence; after the results of the scientific tests were announced, Kurth _____ [*did or did not?*] change his mind about Anderson's identity.
14. As explained in the film *Anastasia* (as well as the website *Recovering the Romanovs*), if the rings have fused to the vertebrae, you can assume the person was at least _____ years of age or older at the time of death, while if the rings have *not* fused to the vertebrae, you can assume the person was at most _____ years of age at the time of death.
15. Who was Francisco Pizarro? (In other words, what are the chronological details of his biography?)
16. Who was Francisco Pizarro? (In other words, what do we know about his character?)
17. From all of the historical and forensic evidence, what do we know about the details of the assassination of Francisco Pizarro?
18. From the historical accounts and the evidence of his skeleton, the *first* sword thrust that felled Francisco Pizarro, rendering him defenseless to his attackers, was a sword thrust to his _____.
19. What happened to the remains of Francisco Pizarro between the time of Pizarro's death and the time Maples examined the remains?
20. When William Maples examined the skeleton of Francisco Pizarro in 1984, Pizarro's entire set of bones had just been recovered from a burial that would be characterized as _____ [i.e., primary? secondary? commingled? individual?].
21. What was William Maples able to determine about Francisco Pizarro with regard to lifestyle and state of health during life?
22. What was William Maples able to determine about Francisco Pizarro with regard to age, stature, handedness, and the circumstances surrounding his death?
23. When William Maples examined the mummy in the glass coffin in the Lima cathedral that had for many years been misidentified as Francisco Pizarro, what was he able to determine about the circumstances of the mummified individual's life and death?

24. The mummy in the glass coffin in the Lima cathedral that had for many years been misidentified as Francisco Pizarro was finally identified as the remains of _____.
25. William Maples was able to determine that the likely *cause* of President Zachary Taylor's death was _____.
26. William Maples was able to determine that the *manner* of President Zachary Taylor's death was _____.
27. As was the case with the body of President Zachary Taylor, according to U.S. law human remains are owned by _____.
28. What did William Maples conclude about the possible causes of the fatal symptoms of gastroenteritis and acute diarrhea that President Zachary Taylor suffered beginning five days before his death (in particular, what roles could poisoning and/or microbial infection have played in producing those symptoms?)
29. What is adipocere, which was found in the lead box that contained President Zachary Taylor's remains?
30. When William Maples examined the remains of President Zachary Taylor, what did he observe with regard to the degree of skeletonization of the body, the presence or absence of soft tissue, the presence or absence of nails on the digits, and the presence or absence of particular articles of clothing?
31. In order to test for arsenic poisoning, did William Maples remove samples of organ tissue, skin, and/or textiles from the lead box containing President Zachary Taylor's remains?
32. In order to test for arsenic poisoning, did William Maples remove samples of adipocere, fingernails, hair, and/or bone from the lead box containing President Zachary Taylor's remains?
33. Traces of arsenic poisoning can be detected in human remains long after death only if _____.
34. What did the tests performed on samples taken from President Zachary Taylor's coffin reveal with regard to the presence or absence of arsenic in the remains and its role in the cause of Taylor's death?
35. When were Tsar Nicholas II and his family executed by the Bolsheviks?
36. Where were Tsar Nicholas II and his family executed?

37. Of the people in the Russian royal entourage that was executed by the Bolsheviks, some were servants; how many were members of the royal family itself?
38. How many people, including servants, were in the Russian royal entourage that was executed by the Bolsheviks?
39. William Maples examined only 82% of the skeletons from the Russian royal entourage that was executed by the Bolsheviks, and concluded that the missing skeletons must have belonged to _____.
40. When William Maples examined them, how many skeletons were missing from the total number of people in the Russian royal entourage that were known to have been executed by the Bolsheviks?
41. What did William Maples conclude about the skeletons he examined from the Russian royal entourage with regard to sexual differences or similarities in terms of dental work and perimortem trauma?
42. Based upon his examination, what did William Maples conclude about the skeletons from the Russian royal entourage with regard to their identities, the presence or absence of perimortem trauma, and the presence or absence of antemortem dental work?
43. The Bolsheviks who executed the Russian royal entourage decided to transfer the bodies from the initial burial in a mine shaft to a secondary burial in a shallow pit because _____.
44. What did the Bolsheviks do to dispose of the bodies of the Russian royal entourage?
45. What did William Maples find to be particularly striking or surprising about the skull of Tsar Nicholas II?
46. The historical and forensic evidence indicates that the women in the Russian royal entourage died more slowly than the men because _____.
47. Because Britain's Prince Philip and Russia's Tsarina Anastasia were both descended from Queen Victoria through the maternal line, they both shared what same characteristic?
48. In addition to the principal bones of the skeletons, the physical evidence recovered from the grave of the Russian royal entourage included _____.
49. What recommendations did William Maples make in his final report about his examination of the skeletons of the Russian royal entourage executed by the Bolsheviks?

50. DNA testing conducted in 1993 indicated that there was a 99% chance that some of the skeletons examined by William Maples were indeed members of the Russian royal family, because a maternal genetic component of those skeletons matched that of _____.

Chapter 4

Disasters, Human Rights, & POW/MIA Recovery

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapter 17 of *Forensic Anthropology Training Manual* and Chapters 6 & 7 of *Dead Men Do Tell Tales*), the film that accompanies this topic (i.e., *Finding Anastasia*), and/or the following website:

Joint POW/MIA Accounting Command

(The URL for JPAC is <http://www.jpac.pacom.mil/>)

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 1D

**DISASTERS, HUMAN RIGHTS
& POW/MIA RECOVERY**

Mass Fatality Incidents (Pages 277-283)

Sudden, extraordinary events with substantial loss of life and/or property...*natural* (hurricanes, floods, earthquakes, volcanoes, tsunamis) or *man-made* (transportation accidents, technological disasters, criminal acts, terrorism, unexpected acts of war, mass suicides—even cemetery floods or misconduct)

Forensic anthropologists work in both field recovery and morgue operations (which include standard laboratory analysis)

“DMORT” stands for Disaster Mortuary Operational Response Team

10 regional teams, each composed of anthropologists, pathologists, radiologists, odontologists, dental assistants, mortuary officers, coroners, medical examiners, fingerprint experts, x-ray technicians, law enforcement personnel, medical records and database experts, and an administrative support staff

they work together to recover, identify, and facilitate the ultimate disposition of the victims’ remains

Physical evidence can be very important in corroborating verbal evidence; it is of even greater value when there is conflict among testimonies from several parties. The most critical need for physical evidence is when no verbal evidence exists. Scientific analysis is required for the evaluation of physical evidence.

Human rights work and standard forensic work are essentially the same, but the perpetrators of the crime are people in authority, and the scale of the work is greater. There’s likely to be a lack of support facilities. In many parts of the world, human rights are not upheld by civil or criminal law.

The field of forensic anthropology in the United States can trace its origins to a celebrated murder case in 1849:

Dr. George Parkman, Boston physician and landlord, killed in 1849 by a Harvard anatomy professor who owed him money, John Webster...when Parkman demanded repayment, Webster murdered him, dismembered his body, and hid pieces among other remains in his anatomy laboratory...concealed rest of corpse in an indoor privy, where it was discovered by a janitor...other bits, including lower jaw, found burned in a furnace...lab specimens found not to have been treated with preserving chemicals, false teeth in furnace were Parkman's...confronted with evidence, Webster confessed, was hanged in 1850.

Another significant early homicide case involved the Chicago sausage maker Adolph Luetgert in 1897:

Luetgert murdered his wife Louisa in 1897...case solved by George A. Dorsey (1868-1931)...wife murdered at home, body taken to sausage factory, placed in huge vat with 375 pounds of potash...stirred mixture all night...acidic potash leached most of calcium out of bones, reducing them to jelly ("grease" found on floor)...ring and four tiny pieces of bone (all could fit on a quarter) found in vat by police... Adolph's defense was that there was no *corpus delicti*... Dorsey able to prove that the bones were human...end of a metacarpal, head of a rib, portion of a phalanx (toe), and a sesamoid bone from the foot...Adolph convicted (factory shut down from bad publicity, even though he hadn't tried to make his wife into sausage)

Details of the famous Ruxton case of 1935:

Single most quoted murder case in modern forensic textbooks... Doctor dismembered bodies at home, charwomen report horrible odors and strange stains...bandage on doctor's finger arouses neighbor's suspicion...killer rents a car to dispose of bodies and collides with bicyclist, who reports to police...found guilty & hanged. Ruxton accused his wife of having an affair with the town clerk...he murdered wife Isabella and personal maid Mary Rogerson (Ruxton said they had gone on holiday to Scotland)...dismembered remains found in Scotland, but mutilated and decomposed...two skulls, two torsos, 17 parts of limbs, 43 portions of soft tissue...all identifying characteristics carefully removed...wife's fingers removed to prevent fingerprinting...squinty eye of maid removed...wife's fat legs tapered, distinguishing bunion hacked off foot...bodies reconstructed, posed at same angles as photographs of living victims, and compared...mutilated skulls superimposed on living photos, agreed in every detail.

Human Rights Cases

1995 Genocide in Rwanda



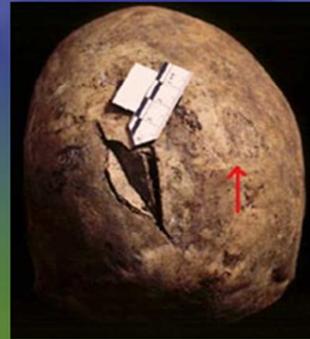
1995 Genocide in Rwanda



1995 Genocide in Rwanda



1995 Genocide in Rwanda



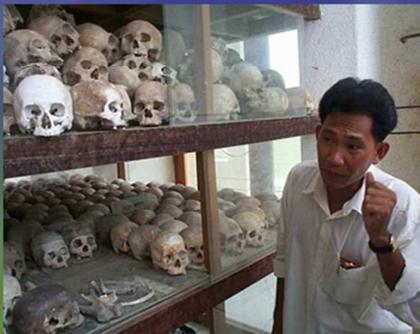
1995 Genocide in Rwanda



**Mass Grave from the Black Death,
Mid-14th Century England**



**Pol Pot Regime, Cambodia, 1970's—8,000
Skulls from "The Killing Fields"**



**1937-38 Massacre of Chinese in Nanjing
by Japanese Soldiers
(estimates as high as 300,000 victims)**

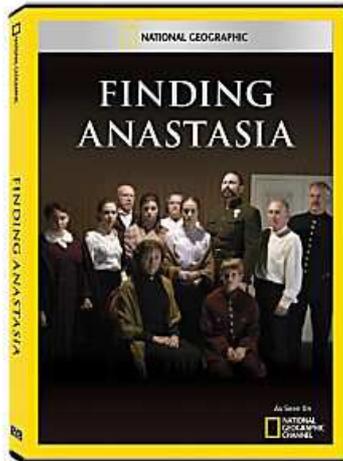


**1937-38 Massacre of Chinese in Nanjing
by Japanese Soldiers
(estimates as high as 300,000 victims)**



Film Summary

Finding Anastasia



Did Romanov Princess Anastasia survive a Bolshevik firing squad that killed her parents and sisters in 1918, or did she and her brother Crown Prince Alexei perish with the other members of their family? This National Geographic Society film explores additional evidence about the fate of the children that became available after the NOVA episode *Anastasia Dead or Alive* was produced.



The Romanov sisters: Marie, Olga, Tatiana, and Anastasia

What really happened to Princess Anastasia was one of the unsolved mysteries of the 20th century, but the early-21st century discovery of a grave containing fragmentary bones promises to provide the final proof. The film documents the scientific analysis of the evidence, and puts to end once and for all any speculation about what happened to the seven members of the Romanov family in 1918.

When the new grave was discovered in 2007, in a remote forest about twelve miles outside the Siberian city of Ekaterinburg, the Russian government called in a team of scientific experts, including American forensic anthropologist Anthony Falsetti. When he visited the site, Falsetti was disappointed to discover that the Russians who had found the grave had not conducted a systematic archaeological excavation, and the documentation they had made of their activities was scant. Falsetti had played a small role in the original investigation of the 1991 grave, so he was familiar with the political obstacles to objective scientific research that he might encounter in Russia. In 1991, for example, when American scientists concluded that the remains of Anastasia were not in the original grave, Russian scientists rejected that conclusion, although not on the basis of persuasive evidence. At the same time, the Russian Orthodox Church refused to accept the DNA identification of the Tsar and his family, claiming that the evidence was tainted (although the Church later accepted the identification of the bodies, and canonized the royal family as martyrs). The influence of ideology and propaganda was long-standing: under the Bolshevik government headed by Lenin, the Russians lied for 8 years after the executions about the death of the Romanovs, claiming that only the Tsar had been killed and that the rest of the family was in seclusion and in good health.

There were forty-four fragments of human bone belonging to two individuals found in the new grave. Falsetti was able to determine from the shape of the sciatic notch on a shattered piece of an innominate that one of the individuals was female, and by examining other indicators he was able to establish that the other individual was male; subsequent DNA analysis confirmed the sex identifications. Ultimately, the DNA evidence was sufficient to prove that the male remains in the 2007 grave belonged to Crown Prince Alexei and that the female remains belonged to either Princess Maria or Princess Anastasia. Whether the remains of Anastasia were in fact in the 1991 grave or the 2007 grave ultimately doesn't matter, however—what is certain is that all seven members of the royal family (and all four of their servants) have been accounted for.

Quiz Questions for Topical Quiz # 1D

1. What are examples of *natural* disasters?
2. What are examples of *man-made* disasters?
3. What are Mass Fatality Incidents?
4. What are examples of disasters that would be classified as Mass Fatality Incidents even if there were no fatalities?
5. “DMORT” stands for _____.
6. What is the essential task or goal of DMORT?
7. What kinds of specialists are included in DMORT teams (particularly with regard to those whose training falls primarily with the natural sciences)?
8. What kinds of specialists are included in DMORT teams (particularly with regard to those whose training falls primarily with the social sciences and/or human services)?
9. Rights that individuals possess simply by virtue of being human, and that are considered to be universal and nonconditional, are called _____ rights, and they _____ [*are* or *are not*?] protected by international law.
10. What rights are included in the 1948 Universal Declaration of Human Rights?
11. How is physical evidence useful in the investigation of human rights violations?
12. In the investigation of human rights violations, forensic anthropology (in contrast to other scientific specialties) can be best utilized in cases that involve or require _____.
13. The first well-publicized use of forensic anthropology in a human rights mission occurred in the year _____, when a group of U.S. scientists were asked to identify victims of the “Dirty War” in the country of _____.
14. For forensic anthropologists, what are the differences between human rights work and standard U.S. forensic work?
15. Of the 78,000 Americans who are unaccounted for from World War II, how many recoverable remains does JPAC estimate that there are?
16. The best-funded and best-equipped human identification laboratory in the world (as well as the one that employs more forensic anthropologists than any other in the United States) is the _____ Laboratory.

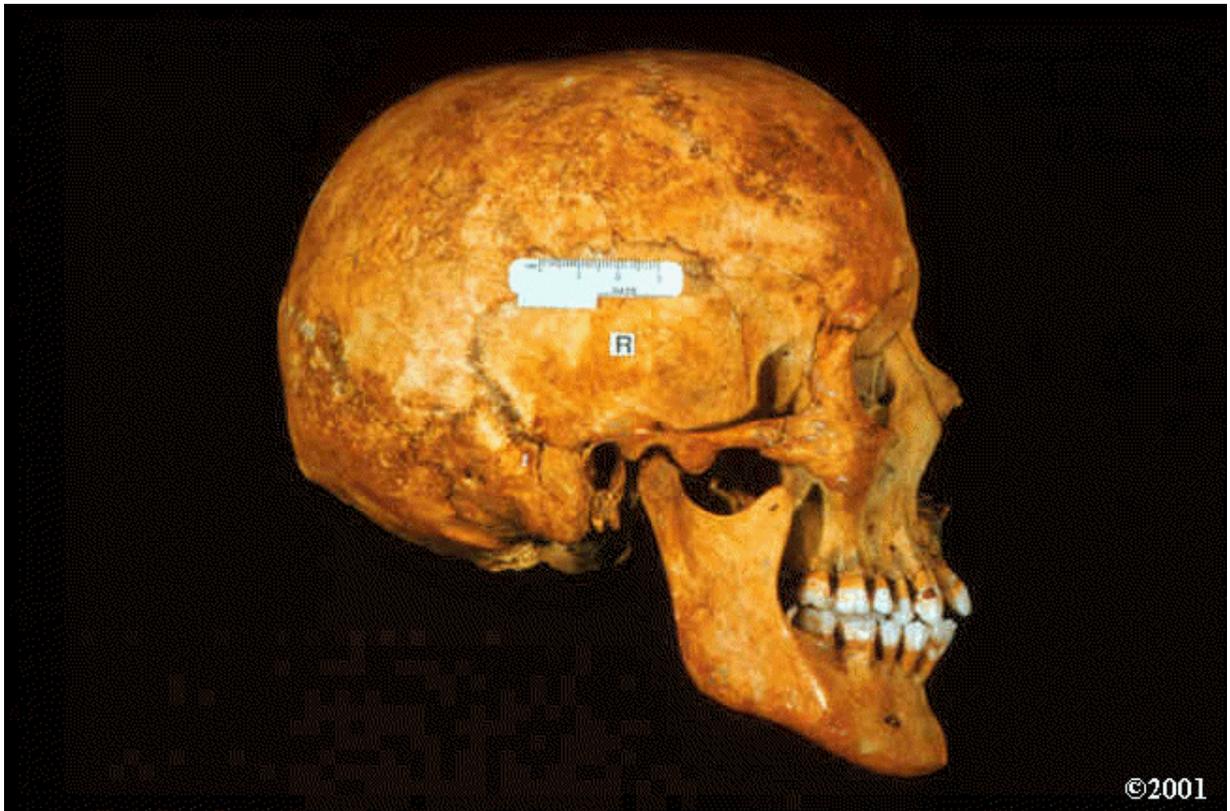
17. The human identification laboratory at JPAC identifies the remains of a total of approximately _____ persons per month.
18. In the sequence of analysis that forensic anthropologists at JPAC follow when constructing a biological profile from skeletal remains, the *first* step is to determine the _____ of the individual.
19. In the sequence of analysis that forensic anthropologists at JPAC follow when constructing a biological profile from skeletal remains, the *second* step is to determine the _____ of the individual.
20. The primary mission of JPAC is to _____.
21. The laboratory portion of JPAC is called the _____.
22. JPAC is located in _____.
23. Forensic anthropologists at JPAC work “in the blind,” which means that _____.
24. “JPAC” stands for _____.
25. As described in the film *Finding Anastasia*, Russian scientists who investigated the original grave in 1991 believed that the remains of Anastasia _____ [were or were not] present in the same grave as her parents, and the Russian Orthodox Church _____ [did or did not] accept the validity of the DNA evidence at the time.
26. As described in the film *Finding Anastasia*, the Russians who found the new grave in 2007 _____ [did or did not] carry out a systematic scientific excavation of the site, and they _____ [did or did not] thoroughly document their procedures and findings.
27. As described in the film *Finding Anastasia*, there were a total of _____ fragments of human bone found at the new grave site in 2007, and forensic anthropologists were able to determine that the bones belonged to two individuals of _____ [the same sex or different sexes].
28. As described in the film *Finding Anastasia*, for eight years following the 1918 execution of the royal family, the Russian government attempted to cover up the true story by claiming that only _____ of the seven Romanovs had been killed, and that the other(s) were alive and well.

29. As described in the film *Finding Anastasia*, DNA evidence _____ [was or was not] sufficient to demonstrate beyond doubt that the remains of 13-year-old Crown Prince Alexei were present in the new grave discovered in 2007, and DNA evidence _____ [was or was not] sufficient to demonstrate beyond doubt that the remains of Princess Anastasia were present in the new grave discovered in 2007.
30. As described in the film *Finding Anastasia*, the American forensic anthropologist who was called in by the Russian government to investigate the new grave found in 2007 was _____.
31. As described in the film *Finding Anastasia*, based on all of the evidence, including the historical evidence as well as the evidence collected from the 1991 grave and the 2007 grave, what does the scientific analysis indicate really happened to Anastasia?
32. As described in the film *Finding Anastasia*, the new grave found in 2007 was located about _____ miles outside the Siberian city of Ekaterinburg, and about _____ yards away from the original grave that contained the remains of five of the seven Romanovs.
33. As described in the film *Finding Anastasia*, forensic anthropologists were able to determine that at least one of the sets of remains found in the new grave site in 2007 belonged to a female, because of the shape of the _____ that could be seen on a fragment of an os coxa.
34. As presented in the film *Finding Anastasia*, when he visits the site of the new grave in Siberia, Dr. Falsetti wears a stocking cap bearing the emblem of his employer at the time, namely _____.
35. Which motivations for suicide does William Maples suggest might be justifiable (or at least understandable) in some circumstances?
36. Which motivations for suicide does William Maples believe would never be justifiable under any circumstances (i.e., which ones does he think are especially wasteful and ill-considered)?
37. What kinds of generalizations does William Maples make about suicides (especially with regard to the persistence that people are liable to display when attempting suicide, the concern they're likely to show for the appearance of their corpse, and the likelihood that their suicide notes will be discovered)?
38. What kinds of generalizations does William Maples make about suicides (especially with regard to the intent and planning that typically goes into a suicide)?
39. What kinds of generalizations does William Maples make about suicides (especially with regard to the techniques and goals of typical suicides)?

40. What are some of the surprising or unusual causes of death that William Maples has encountered as examples of accidental death (when it might have been assumed instead that the cause of death could have been associated with a suicide or even a homicide)?
41. Who was the murderer in the celebrated homicide case in 1849 to which the field of forensic anthropology in the United States can trace its origins (i.e., what was the murderer's name and occupation)?
42. Who was the victim in the celebrated homicide case in 1849 to which the field of forensic anthropology in the United States can trace its origins (i.e., what was the victim's name and occupation)?
43. In the celebrated homicide case in 1849 to which the field of forensic anthropology in the United States can trace its origins, what were the two Harvard anatomists who investigated the case able to determine based upon their review of the evidence?
44. In the celebrated homicide case in 1849 to which the field of forensic anthropology in the United States can trace its origins, how did the murderer dispose of the victim's body?
45. George Dorsey, the forensic anthropologist involved in the 1897 case in which the Chicago sausage maker Adolph Luetgert murdered his wife Louisa, was able to reach several conclusions based upon his investigations. What were those conclusions, and what was Dorsey able to prove in court?
46. What did Chicago sausage maker Adolph Luetgert do with the body of his wife Louisa when he murdered her in 1897?
47. In the famous homicide case from Great Britain in 1935 involving Buck Ruxton, the forensic investigators were able to identify the two victims, despite the murderer's elaborate attempts to disguise their bodies, primarily by using the technique(s) of _____.
48. In the famous homicide case from Great Britain in 1935 involving Buck Ruxton, what did the murderer do to the bodies of his victims in an attempt to disguise their identity?
49. Who was the murderer in the famous homicide case from Great Britain in 1935 involving Buck Ruxton (in particular, what was his occupation, and how did he apply his occupational knowledge when committing his crime)?
50. Who were the victims in the famous homicide case from Great Britain in 1935 involving Buck Ruxton?

UNIT II

FUNDAMENTALS OF HUMAN OSTEOLOGY



Chapter 5

Overview of the Skeleton

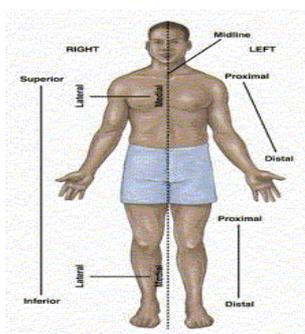
The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapter 2 of *Forensic Anthropology Training Manual*), the film that accompanies this topic (i.e., *Secrets of the Dead: Titanic's Ghosts*), and/or the following website:

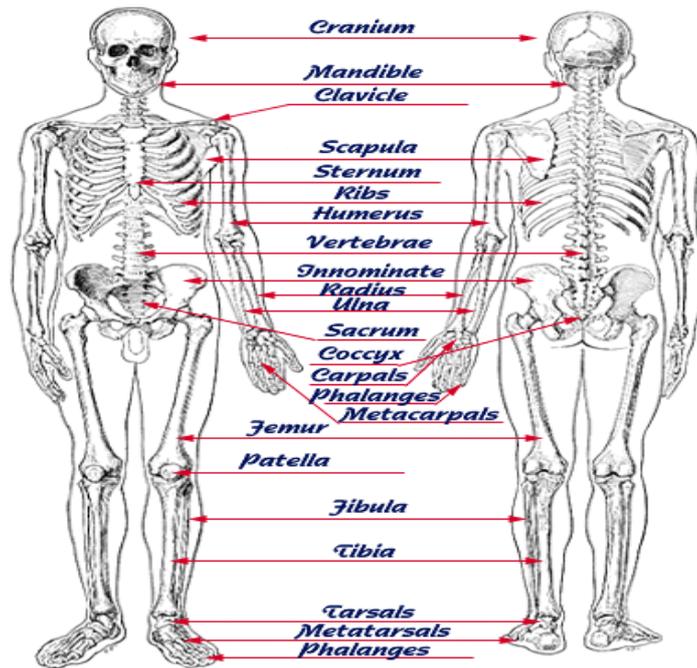
eSkeletons (When you visit the site, begin by clicking on the human skeleton on the left under the “Taxon” tab. The URL for eSkeletons is <http://www.eskeletons.org/>)

Note: Chapter 2 of *Forensic Anthropology Training Manual* contains a good deal of valuable information about the structure and function of the skeletal system that will be useful to you when you take additional courses in human osteology and forensic anthropology. For our purposes, however, we will be primarily concerned with the classification and description of the bones of the human body, as well as the directional terms that are used to describe the body with reference to the Standard Anatomical Position. (All of that information will provide essential background for the more detailed description of the human skeleton that we’ll be exploring in the remaining three topic of this Unit.) Thus for this topic you’ll be expected to be able to list and identify both the scientific and common names of the principal bones of the body, as summarized in the table on the following page.

Finally, the illustration on page 19 of *Forensic Anthropology Training Manual* depicts a skeleton in what is called *standard anatomical position*—the position defined as a body standing, facing forward, with feet pointing forward and the palms of the hand facing forward. In standard anatomical position, none of the long bones are crossed from the viewer’s perspective; in standard anatomical position, the radius is lateral to the ulna, and the fibula is lateral to the tibia. In standard anatomical position, the front of the body is the side facing the viewer (and obviously the head is above and the feet are below).

Standard Anatomical Position





The Bones of the Human Skeleton	
Scientific Name	Common Name
skull	skull
mandible	lower jaw
vertebrae	backbone
clavicle	collar bone
scapula	shoulder blade
sternum	breast bone
ribs	ribs
humerus	upper arm bone
radius	lower arm bone
ulna	lower arm bone
pelvis	hip bones
femur	thigh bone
tibia	shin bone
fibula	lower leg bone
carpals, metacarpals, and phalanges	wrist bones, hand bones, and finger bones
tarsals, metatarsals, and phalanges	ankle bones, foot bones, and toe bones

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 2A

**OVERVIEW
of the
SKELETON**

Axial skeleton
The foundation to which the appendicular skeleton is attached. Some parts are singular, others are paired. Includes:

skull, hyoid, backbone (including sacrum), sternum, ribs

Appendicular skeleton
Attached to the axial skeleton. All parts are paired. Includes:

pectoral girdle (clavicle and scapula), arm (humerus, ulna, and radius), hand (carpals, metacarpals, and phalanges), pelvic girdle (innominates), leg (femur, patella, tibia, fibula) foot (tarsals, metatarsals, and phalanges)

Directional terms for the human body (page 17):

anterior
toward the front of the body; opposite of posterior

posterior
toward the back; opposite of anterior

distal
away from the body (used with limbs); opposite of proximal

proximal
toward the body (used with limbs); opposite of distal

dorsal
toward the back of the body, the back of the hand, or the top of the foot; opposite of ventral or palmar

ventral
toward the abdomen; opposite of dorsal

palmar
toward the palm of the hand; opposite of dorsal

plantar
toward the sole of the foot; opposite of dorsal

inferior
below; opposite of superior

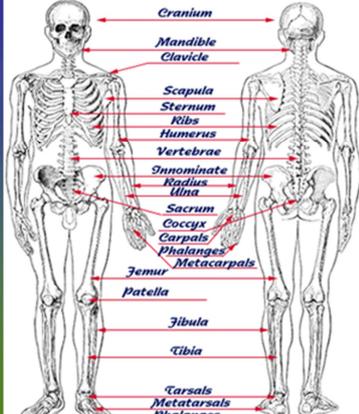
superior
above; opposite of inferior

lateral
toward the side; opposite of medial

medial
toward the midline; opposite of lateral

Principal Bones

The E-Skeletons Project



The diagram shows a human skeleton from both anterior and posterior views. Red arrows point to the following bones: Cranium, Mandible, Clavicle, Scapula, Sternum, Ribs, Humerus, Vertebrae, Innominate, Radius, Ulna, Sacrum, Coccyx, Carpals, Phalanges, Metacarpals, Femur, Patella, Fibula, Tibia, Tarsals, Metatarsals, and Phalanges.

Film Summary

Secrets of the Dead: Titanic's Ghosts

On April 10, 1912, the largest, most elegant luxury liner in the world set sail from Southampton, England. At 46,000 tons, the Titanic was, at the time, the largest moving object ever built.

On the evening of Sunday, April 14, 1912, three passengers on board the Titanic were anticipating their arrival in America. Catherine Wallis was a 35-year-old widow with four children at home in Southampton, England. As a third-class matron, she tended to the needs of the third-class passengers. Two-year-old Gosta Paulson and his three siblings were traveling from Sweden with their mother, Alma, to meet their father, Nils, in Chicago. Two years earlier, Nils was forced to leave the country in the wake of a coal mining strike. He had since been working as a trolley operator and saving enough money to move his family to the United States. Although born and raised in rural England, Charlie Shorney's work as the valet for a wealthy family had enabled him to travel. His worldliness spawned an ambitious plan; with half the family silver in tow, Shorney was on his way to meet his fiancée Marguerite and start one of the first taxi cab companies in New York City. Inspired by the notion of sailing on the world's greatest vessel, Shorney had changed his ticket so that he could ride on the Titanic. It was a fatal decision. Titanic was headed directly into an ice field 80 miles long.



Titanic's monstrous size and extravagance was part of a plan by the Aberdeen White Star Line to create a new breed of massive, lavish ocean liners. The White Star Line sailing clipper fleet had been founded in 1845 to transport prospectors rushing to Australia in search of recently discovered gold. Eventually the company began building steamships, famously operating a high-class passenger service between Britain and North America. In an attempt to compete with the Cunard Line's pair of speedy, quadruple-funneled liners, the Lusitania and Mauritania, White Star hatched a plan in 1907 to build its Olympic-class luxury liners -- three ships larger, heavier, and far more opulent than any the world had seen. Each ship got progressively larger, starting with the 45,000-ton Olympic, launched in 1910. Yet the ambitious Olympic liners were doomed from the start. The Olympic was plagued with mechanical problems, the Britannic sank in the Aegean Sea after colliding with a mine or a torpedo, and as for the Titanic ...

At 11:40 p.m., April 14, lookouts spotted an iceberg in the ship's path, but it was too late. Titanic hit the iceberg and water began to flood into the forward hull. The ship was totally submerged by 2:20 a.m. Catherine, Gosta, and Charlie never made it to America.

More than 1,500 passengers perished when Titanic sank. Two days later, a Canadian salvage ship, the Mackay-Bennett, left port in Halifax, Nova Scotia, sailing 700 nautical miles southeast to the scene of the ocean liner disaster. All in all, the sailors were able to recover over 300 bodies from the water. The sailors numbered each of the bodies, buried some at sea, and brought the rest back to Halifax. Many of the unidentified victims were buried in graves in Halifax's Fairview Lawn cemetery.

Among the unidentified victims recovered by the shipmates of the Mackay-Bennett was a young blond boy described in the coroner's report as being around two years of age. The sailors were so moved by the fate of this unknown child that they arranged a funeral service for the boy and had a headstone placed on his grave, which they dedicated "to the memory of an unknown child." The little boy's grave has come to symbolize all the children who perished on the Titanic.

Ninety years later, Catherine Wallis' granddaughter, Joan Allison, is trying to put her grandmother to rest. Hopeful that her grandmother might have been buried in one of these graves, Allison contacted historian Alan Ruffman. Searching through coroner's reports in the Public Archives of Nova Scotia, Ruffman identified a victim that fit the description of Catherine Wallis and, with the help of DNA expert Dr. Ryan Parr of Lakehead University in Thunder Bay, Ontario, sought to solve Joan Allison's mystery. Inspired by their task, Ruffman and Parr continued working to identify victims of the Titanic. With a little luck, they hoped to pinpoint the resting-places of Gosta Paulson and Charlie Shorney.

Canadian historian Alan Ruffman began the quest to find Catherine Wallis at the Public Archives of Nova Scotia in Halifax. Searching through a back storage room, Ruffman came upon an assortment of documents left over from the recovery efforts of the Mackay-Bennett -- letters, photographs, and coroners reports for all of the bodies found at sea. After carefully sorting through the collection, Ruffman found a description of a victim that sounded like Joan's grandmother:

NO. 281. - FEMALE. - ESTIMATED AGE, 30. - HAIR, BROWN.

CLOTHING - Black coat; blue skirt; red jersey; green blouse; woolen singlet; grey underskirt; black boots and stockings.



Extracting DNA from the lone bone fragment of the "unknown child."

In order to prove that body #281 was that of Catherine Wallis, a DNA comparison was needed between Joan and the remains recovered from the grave. The man in charge of this DNA work was Ryan Parr, a bio-anthropologist at the paleo-DNA lab of Lakehead University in Thunder Bay, Ontario, which specializes in the extraction of DNA from degraded biological material. But before Parr's team of scientists opened the grave of body #281, Ruffman and Parr agreed to take the opportunity to try to identify more victims of the Titanic disaster, including the "unknown child." There were still 44 unidentified bodies left in Fairview cemetery; 44 bodies left to name.

"A lot of the grief focused on this baby," says Parr of the "unknown child." "At the time, people from all over the world sent flowers. The headstone reads 'an' unknown child, not 'the' unknown child. I think that's because you think, 'Here's this child that lost its life, its mother, its whole future, tragically.' And in a sense it represents all the lost, and in particular those with the most life and potential yet to be realized."

According to the records from the archives, the boy was originally thought to be two-year-old Gosta Paulson, whose body was never recovered. In fact, the grave of the “unknown child” -- body #4 -- is located near the grave of Gosta's mother, Alma, whose body was identified by the third class ticket stub still in her coat pocket. Also in the records was a description of body #240:

NO. 240. - MALE. - ESTIMATED AGE, 24. - HAIR, DARK.
CLOTHING - Grey overcoat; blue serge suit; white sweater.

The watch mentioned in the above description bore the name of a shop located in Brighton, England, and thus Ruffman was able to connect this description to a twenty-three-year-old passenger named Charles Shorney.

Ruffman tracked down living relatives of Gosta -- Ola Lindfeldt and Lars Inge in Sweden -- and Charles -- Gillian Wilkinson, and her siblings Imelda and Hillary Sutton in England. But there was a problem. There are two kinds of DNA, nuclear DNA and mitochondrial DNA. In this situation, mitochondrial DNA (mtDNA) is preferred because its molecules are present in hundreds to thousands of copies per cell compared to nuclear DNA, which contains two copies per cell. After ninety years decomposing in the ground, any remnants of the bodies would be scarce, and mtDNA would be much more likely to provide an adequate sample. Mitochondrial DNA is inherited from the mother only, so in order to compare the samples they were hoping to get from the corpse, mtDNA needed to be obtained from maternally related relatives of Catherine, Gosta, and Charles. This was easy in the case of Catherine, since Joan is her maternal granddaughter. But none of the relatives of Gosta or Charles are maternal descendents.



Magda Schleifer stands at the grave of her uncle, Eino Panula, formerly known as the “unknown child.”

For Gosta, Ruffman enlisted the help of Swedish genealogists to locate a distant relative of Ola and Lars, John Heylan, who is a maternal cousin to Gosta. No such relative could be found for Charlie Shorney. Yet hope was not lost. Gillian and her siblings decided to exhume the grave of their great uncle, Austin Shorney Sr., Charlie's father, who could provide nuclear DNA to compare with body #240. Dr. Parr's Canadian forensic team was able to remove Austin Sr.'s right femur for DNA extraction.

The results of Dr. Parr's grave exhumation at Fairview cemetery were mixed. The cemetery is built into the gently sloping side of a hill, and when the scientists began digging, they found that water had seeped into the graves of bodies #281 and #240. They continued their search, but the flooding had amplified the earth's power to decay and eliminated any shred of human remains, greatly reducing the chances that Joan and the English siblings would be able to identify their ancestors.

Perched higher up on the slope, the grave of body #4 escaped the erosive effects of water damage, and scientists found a 6 cm sliver of bone and three teeth in the grave of the “unknown child.” An analysis of these teeth by two separate dental experts showed that they belonged, not to a two-year-old, but to a child less than one year of age. This revelation suggested that Gosta might not be the “unknown child,” and a DNA comparison performed at Lakehead University and at the Kuvim Center for the Study of Infectious and Tropical Diseases at Hebrew University in Jerusalem proved that, indeed, body #4 was not Gosta Paulson. The teeth suggested that whoever filed the original coroner's report, misestimated the age of the child. Furthermore, the age of the teeth also eliminated the possibility that two other potential third-class passengers, two-year-olds Eugene Francis Rice from Ireland and Sidney Leslie Goodwin of England, might be the “unknown child.” Nevertheless, the search continued, focusing on three more third-class passengers: a five-month-old child from Sweden, a seven-month-old child from England, and a thirteen-month-old child from Finland.

Meanwhile, hope was not lost for the English relatives of Charles Shorney. Ruffman had found a photo of corpse #240, which Gillian and her siblings compared to photos of Charlie. Employing techniques developed by the FBI, forensic investigator Gerry Richards performed a photographic analysis of the photos of Charles and the corpse. “[We] take the known photograph of Mr. Shorney,” explains Richards, “and move it right directly side by side in a juxtaposition so that we can very closely examine the ear patterns.” Yet the ears were different. Charlie's ear lobe was attached to his cheekbone, with the picture of the corpse showing a man with unattached ear lobes. Charlie was not body #240.

Finally A Name ...

On November 6, 2002, Alan Ruffman and Dr. Ryan Parr announced that the remains of the “unknown child” had finally been identified through DNA analysis. Blood samples provided by descendents of a child from Finland named Eino Panula matched the DNA extracted from the tiny bone fragment recovered from Fairview Lawn Cemetery.

Eino, who was just over a year old at the time, was traveling as a third-class passenger with his mother and four brothers. Eino's mother, Emilia Maria Ojala, and father, Juho Panula, had married on February 14, 1892 before immigrating to Coal Center, a small community near Pittsburgh, Pennsylvania. Five children were born in Coal Center before the family moved back to a small farm in western Finland in 1904. There, two more children were born, including Eino on March 10, 1911. Shortly thereafter, the Panulas decided to move back to Coal Center, and Juho preceded his family to the U.S. sometime in 1910 or 1911. Maria stayed, finalizing the sale of the family's farm on February 1, 1912 before booking third-class tickets for her family on the Titanic to join her husband in America. None of the family members traveling on the Titanic survived the disaster, and Eino is the first of the Panulas to be identified.

The discovery of the child's identity stands as the first time that an unknown victim of the 1912 Titanic sinking has been named through DNA analysis.

Additional information about the film can be found on the PBS website for the *Secrets of the Dead* series at http://www.pbs.org/wnet/secrets/previous_seasons/case_titanic/clues.html

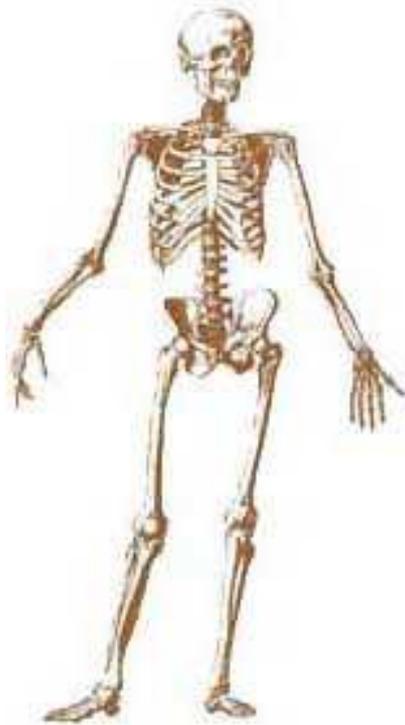
Quiz Questions for Topical Quiz # 2A

1. Which bones are included in the *axial* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
2. Which bones are included in the *axial* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
3. Which bones are included in the *axial* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
4. Which bones are included in the *axial* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
5. Which bones are included in the *appendicular* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
6. Which bones are included in the *appendicular* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
7. Which bones are included in the *appendicular* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
8. Which bones are included in the *appendicular* skeleton? (You can expect to see four versions of this question on the exams, each listing different options among the answer choices—and you'll be expected to be able to identify the bones by both their scientific and common names.)
9. The scientific name for the upper arm bone is _____.
10. The scientific name for the shoulder blade is _____.

11. The scientific name for the breast bone is _____.
12. The scientific name for the shin bone is _____.
13. The directional term for the human body which means “toward the palm of the hand” is _____.
14. The directional term for the human body which means “toward the sole of the foot” is _____.
15. The directional term for the human body which means “toward the body” (when used with limbs) is _____.
16. The directional term for the human body which means “away from the body” (when used with limbs) is _____.
17. The directional term for the human body which means “below” is _____.
18. The directional term for the human body which means “above” is _____.
19. The directional term for the human body which means “toward the back of the body, the back of the hand, or the top of the foot” is _____.
20. The directional term for the human body which means “toward the abdomen” is _____.
21. The directional term for the human body which means “toward the front of the body” is _____.
22. The directional term for the human body which means “toward the back” is _____.
23. The directional term for the human body which means “toward the side” is _____.
24. The directional term for the human body which means “toward the midline” is _____.
25. In relation to the spine, the sternum is _____ [*what direction?*].
26. In relation to the nose, the forehead is _____ [*what direction?*].
27. In relation to the spine, the arm is _____ [*what direction?*].
28. In relation to the foot, the ankle is _____ [*what direction?*].

29. In relation to the elbow, the wrist is _____ [*what direction?*].
30. In relation to the sternum, the spine is _____ [*what direction?*].
31. In relation to the foot, the head is _____ [*what direction?*].
32. In relation to the humerus, the hand is _____ [*what direction?*].
33. “Superior” is the opposite of _____.
34. “Palmar” is the opposite of _____.
35. “Ventral” is the opposite of _____.
36. “Proximal” is the opposite of _____.
37. “Posterior” is the opposite of _____.
38. “Inferior” is the opposite of _____.
39. “Medial” is the opposite of _____.
40. “Anterior” is the opposite of _____.
41. The scientific name for the lower jaw is _____.
42. The scientific name for the collar bone is _____.
43. As described in the film *Titanic’s Ghosts*, the cemetery containing the graves of 150 victims of the Titanic disaster (including the graves of 44 unidentified victims) is located in _____.
44. As described in the film *Titanic’s Ghosts*, the Titanic sank on April 15 in the year _____.
45. As described in the film *Titanic’s Ghosts*, a total of approximately _____ people died in the Titanic disaster, and a total of _____ bodies were recovered at the scene.
46. As described in the film *Titanic’s Ghosts*, the living relatives of Titanic victim Charles Shorney _____ [*did or did not*] think that the postmortem photograph of Body #240 was Shorney, and photo analysis expert Gerald Richards _____ [*did or did not*] conclude that the postmortem photograph of Body #240 was Shorney.

47. As described in the film *Titanic's Ghosts*, the 2001 exhumation of the graves of the unidentified bodies that were suspected to be Charles Shorney and Catherine Wallis (Bodies #240 and #281) revealed that human remains _____ [*were or were not*] found in the grave of #240, and human remains _____ [*were or were not*] found in the grave of #281.
48. As described in the film *Titanic's Ghosts*, the 2001 exhumation of the grave of the unknown child (Body #4) revealed that, in addition to three teeth, the grave contained a single fragment of bone, namely a small piece of the _____ [*which bone, specifically?*]
49. As described in the film *Titanic's Ghosts*, DNA analysis ultimately revealed that the unknown child (Body #4) was a Finnish boy named _____.
50. As described in the film *Titanic's Ghosts*, researchers _____ [*were or were not*] able to extract mitochondrial DNA from the remains of the unknown child (Body #4), and the available evidence _____ [*did or did not*] indicate that the unknown child was Gosta Paulson.



Chapter 6

The Skull & Teeth

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 3 & 11 of *Forensic Anthropology Training Manual*), the film that accompanies this topic (i.e., *The Boldest Hoax*), and/or the following websites:

eSkeletons

(When you visit the site, begin by clicking on the human skeleton on the left under the “Taxon” tab. The URL for eSkeletons is <http://www.eskeletons.org/>)

The Skull Module

(The URL for the Skull Module is <http://www.csuchico.edu/anth/Module/skull.html>)

Note: The objective of this Topical Quiz is to make you familiar with the basic anatomy of the skull and teeth. For the moment, you may ignore the information about determining sex, age, and ancestry from the skull and teeth—we will review that material in detail in Unit # 3. You will not be responsible for any of the information about anthropometry (the measurement of the human body), including the names and locations of the various craniometric points, since those details are beyond the scope of our course. You should understand, however, that anthropometry is crucial to the practice of forensic anthropology, and if you intend to take future courses in the field you will eventually have to become intimately familiar with all the details, procedures, and terminology of anthropometry.

Note as well: As described on page 233 of *Forensic Anthropology Training Manual*, the anatomically correct position for the skull is called the Frankfurt Plane (also known as the Frankfort Horizontal). To place a skull in the Frankfurt Plane, position the skull so that the line connecting the upper margin of the external auditory meatus with the lower margin of the eye orbit is parallel to the ground, or horizontal (the line connecting the two external auditory meatus should also be horizontal). The Frankfurt Plane is used for all skull descriptions—the degree of prognathism, for example, must be described with the skull in the Frankfurt Plane.



One final note: You'll also need to be familiar with the meaning of the terms *skull*, *cranium*, and *calvaria* (also called the *neurocranium*). As it happens, the definitions Burns offers for these three terms on page 26 are not as clear and precise as they might be, and they're not entirely consistent with the way the terms are used in other osteological reference materials. For our purposes, then (which will include being able to answer the questions on the tests), you should use the following definitions for the terms *skull*, *cranium*, and *calvaria*:

Skull: the entire bony structure of the head, including the jaw (mandible).

Cranium: the skull without the mandible.

Calvaria: the skull without the face or mandible (the bones of the face include the *nasal*, *lacrimal*, *ethmoid*, and *vomer* bones, although you will not be responsible for naming or locating these specific facial bones).



Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 2B

THE SKULL & TEETH

Skull
the entire bony structure of the head, including the jaw (mandible)

Cranium
the skull without the mandible

Calvaria
the skull without the face or mandible (the bones of the face include the *nasal, lacrimal, ethmoid, and vomer* bones, although you will not be responsible for naming or locating these specific facial bones)

wormian bones
small extra bones located within skull sutures, such as an *Inca bone* in the back of the skull resulting from an extra suture across the occipital (a.k.a. extrasutural bones)



metopic suture
midline suture diving the frontal bone, usually not persistent into maturity

Bones and features in the skull:

frontal: forehead

occipital: rear of skull

parietal: upper side of skull

temporal: lower side of skull

Lambdoidal suture: between occipital & parietals

coronal suture: between frontal and parietals

sagittal suture: between parietals

squamosal suture: between parietal and temporal

mastoid process: part of temporal bone

palatine: posterior portion of roof of mouth (rest of roof formed by maxilla)

sphenoid: behind eyes, small portion appears on side of skull at temple where frontal, parietal, and temporal bones join

external auditory meatus: ear opening

zygoma (a.k.a. zygomatic): orbital margin, together with part of temporal bone forms zygomatic arch

maxilla: upper jaw, includes inferior and lateral margins of nasal aperture

mandible: lower jaw

ascending ramus: vertical portion of mandible

mandibular condyle: posterior point of mandibular articulation with temporal

mental protuberance: chin

hyoid: U-shaped bone between the mandible and the larynx, with no articulation with any other bone

To place a skull in the **Frankfurt Plane**, position the skull so that the line connecting the upper margin of the external auditory meatus with the lower margin of the eye orbit is parallel to the ground, or horizontal (the line connecting the two external auditory meatus should also be horizontal).



There are four categories of human teeth:

incisors

one of eight anterior single-rooted teeth with straight cutting edges whose function is biting

canines

one of four anterior single-rooted teeth with single cusps whose function is holding and ripping

premolars

one of eight posterior double-and-single-rooted teeth with two cusps (hence synonym "bicuspid") whose function is chewing

molars

one of twelve posterior multi-rooted teeth with more than three cusps whose function is chewing

An adult has 32 teeth: 2-1-2-3

A child has 20 deciduous teeth: 2-1-0-2

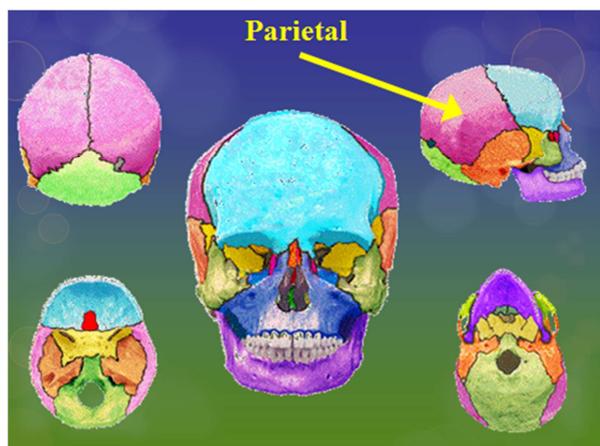
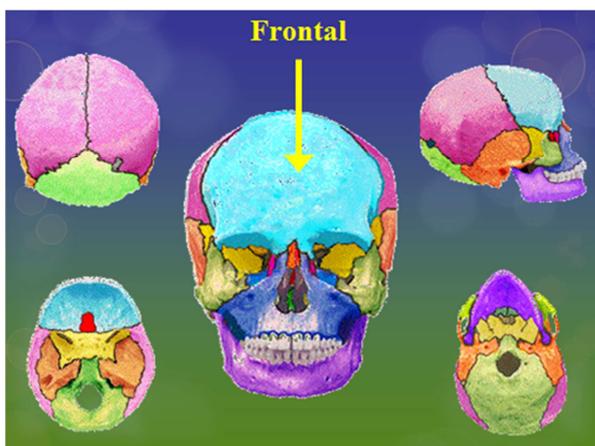
Notice that the directional term *medial* means "toward the midline of the mouth;" *distal* in this context means "away from the midline of the mouth".

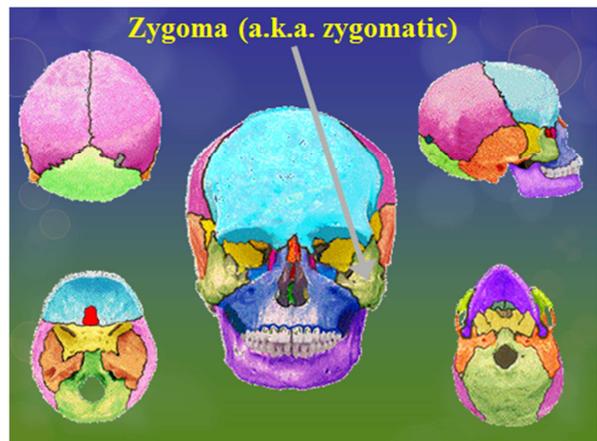
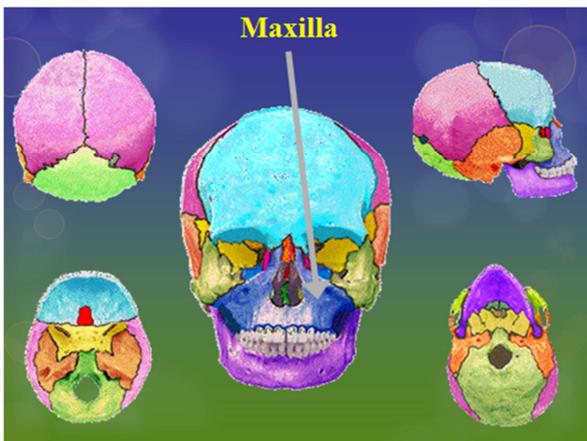
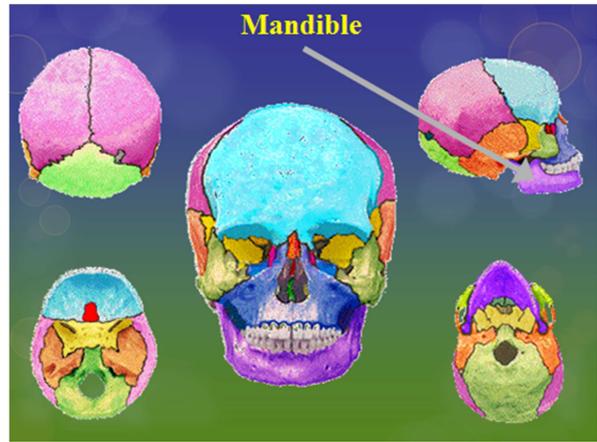
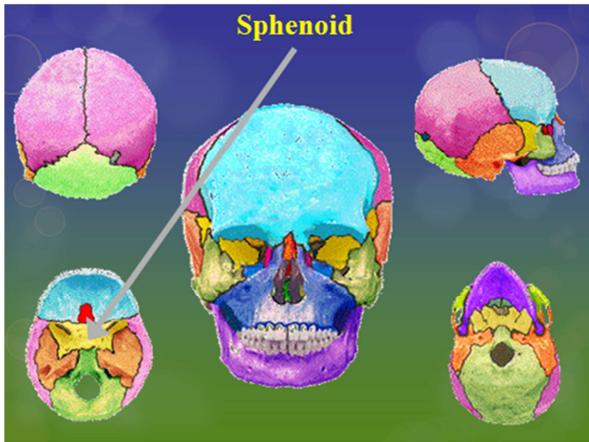
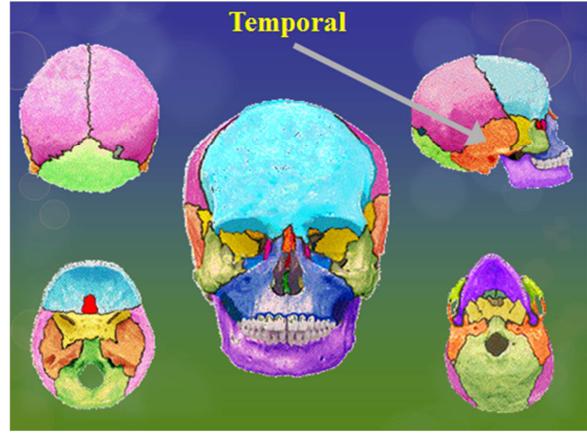
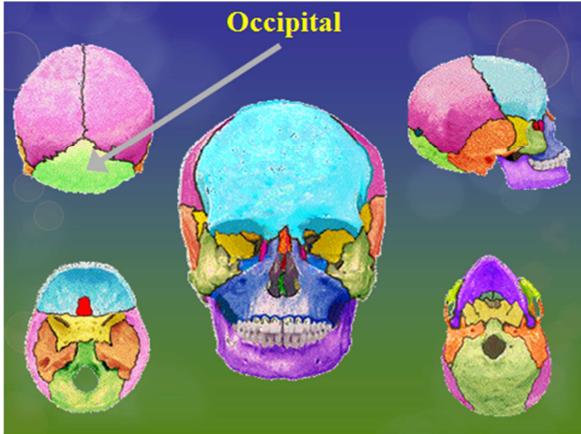
Notice too that the premolars and molars are numbered in ascending order *away from* the midline; thus the premolar that's identified as the "second premolar" is *distal* to the "first premolar".

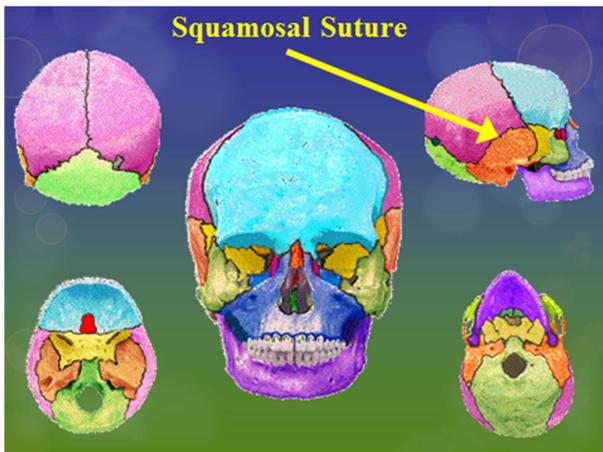
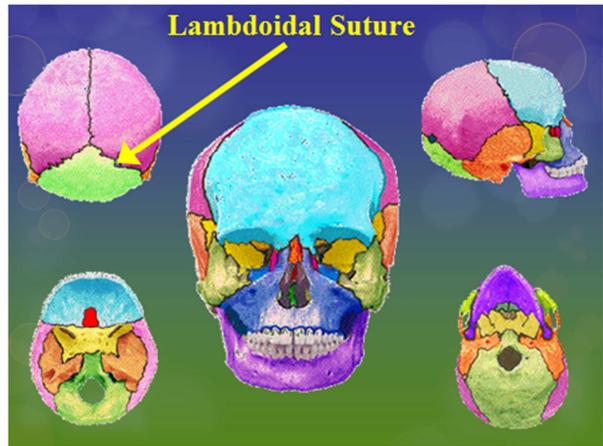
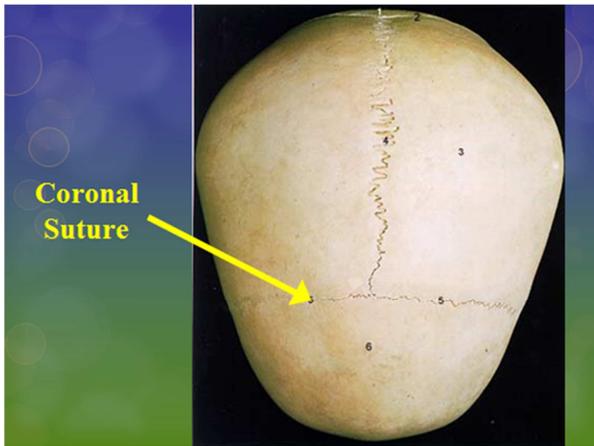
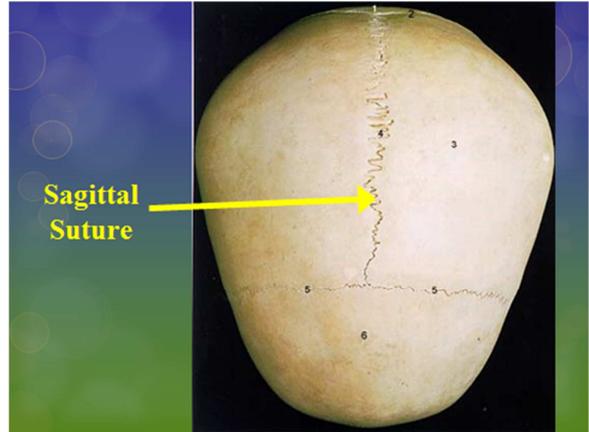
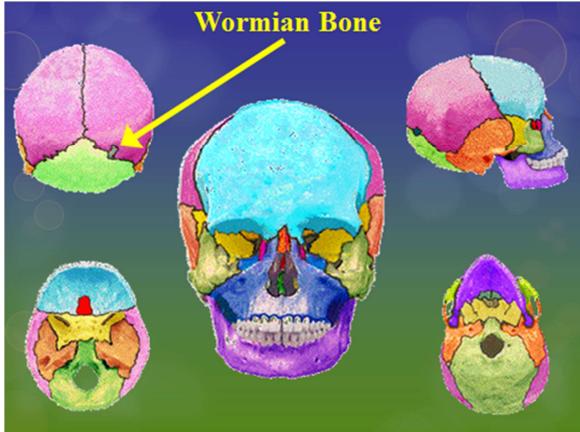
Incisors are distinguished as "central" or "lateral"--the lateral incisor is *distal* to the central incisor.

Universal Numbering System for each tooth position in the mouth of an adult:

- #1 upper (maxillary) right third molar
- #8 upper (maxillary) right central incisor
- #9 upper (maxillary) left central incisor
- #16 upper (maxillary) left third molar
- #17 lower (mandibular) left third molar
- #24 lower (mandibular) left central incisor
- #25 lower (mandibular) right central incisor
- #32 lower (mandibular) right third molar



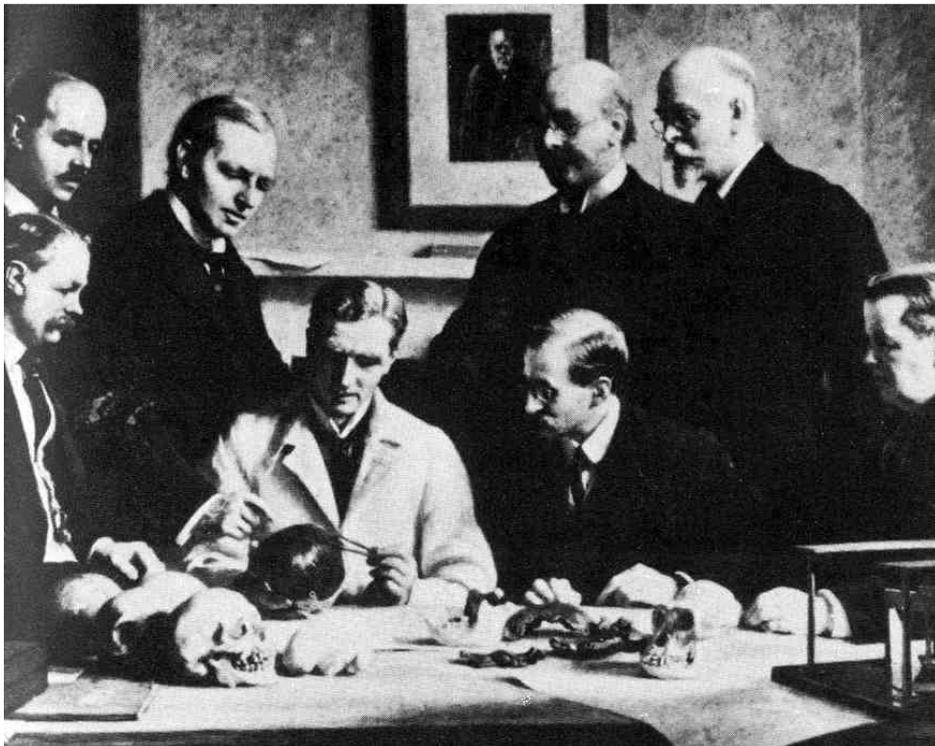




Film Summary

The Boldest Hoax

For some 40 years beginning in 1912, a fossil skull discovered in Piltdown, England was hailed as the “missing link” between apes and humans. Then, in 1953, new scientific tests revealed the truth about “Piltdown Man”—the skull was a fake! This NOVA episode explores the fascinating mystery of who perpetrated the fraud, and uncovers the disturbing truth about one of the single most famous skulls in the history of anthropology.



Transcript of *The Boldest Hoax*

NARRATOR: For 40 years, a fossil skull discovered in Piltdown, a quaint village in England, was hailed as the missing link between apes and humans. It was named Piltdown Man. Later it would be called a forgery and set off a storm of scandal.

RICHARD MILNER (American Museum of Natural History): The scientific world was in an uproar; the public was scandalized. Were monkeys being made out of the scientists?

NARRATOR: Accusations of fraud struck at the heart of the most important questions in science: “Who are we? And where did we come from?”

If it were a hoax, how had it gone unnoticed for so long?

GILES OAKLEY (Son of Kenneth Oakley): Egotism, pride, ambition, rivalry, these things affect even scientific judgments.

ANDY CURRANT (Natural History Museum, London): It's a vicious hoax. It was a terrible thing to do. It really was a horrible, nasty, vicious piece of work.

NARRATOR: Over the last 50 years many suspects have been accused, from England's most respected scientists of the day to Sir Arthur Conan Doyle, the creator of Sherlock Holmes, but the identity of the Piltdown hoaxer has remained a mystery.

With special access to Britain's Natural History Museum archives, NOVA reopens the case and reveals hints of a cover up at the heart of one of England's most revered scientific institutions.

ANDY CURRANT: Maybe somebody in the museum could have been involved in this, and that, that wouldn't be good.

NARRATOR: *The Boldest Hoax*, up next on NOVA.

NARRATOR: The story begins in the early 1900s, in the rolling hills of Sussex, a rural county in southeast England. A laborer, digging at Barkham Manor near the village of Piltdown, unearthed a strange piece of skull. He's reported to have passed it on to Charles Dawson, a local amateur archaeologist. Dawson later claimed he noticed that the skull was extremely thick and appeared rather primitive. This would be the first in a series of discoveries at Piltdown.

They would transform and pervert scientists' understanding of the origins of man for decades. Charles Darwin's theory of evolution had been published just 50 years before, in 1859.

In his *Origin of Species*, Darwin presented evidence that all living things descended from a common ancestry. Through a process of mutation, adaptation, failure and success, he claimed that all life on earth today, including man, is the result of millions of years of evolution. It was a revolutionary idea.

JAMES MOORE: In Darwin's day, the idea of evolution was regarded as highly unorthodox because it went against all of natural history in Great Britain. It jeopardized the standing of science. It did jeopardize the standing of a stable society, the Bible, and the Church as well.

Darwin's most audacious claim was that humans and apes were related. But yet to be discovered was the fossil evidence of the earliest humans and their primate ancestors. The hunt was on for the all important missing link, a creature part ape, part human.

Then in Germany, quarrymen working in the Neander Valley, made a remarkable find: strange bones, skeletal remains that resembled humans, but not those of any living humans. The creature was named "Neanderthal" and Germany the birthplace of early man.

But soon evidence of early man was being found in France and Spain as well. To their annoyance, the British had none.

RICHARD MILNER: The British had no early man. The French had lots of them; the Germans had lots of them. They had Neanderthals all over the place. They had caves full of beautiful pictures. And where was the earliest Englishman? There wasn't any.

NARRATOR: The buildup to World War One intensified the rivalry between Britain and Germany. Believing itself to be the greatest empire on earth, Britain was anxious to prove it was also the birthplace of the human race.

Since many Stone Age tools had been found in Sussex, it seemed a likely place to find Britain's missing link. Charles Dawson had enough experience to realize that the primitive-looking skull that the laborer had given him might be a fossil with extraordinary potential. A lawyer by trade, he was an enthusiastic amateur scientist who was already building his reputation with some unusual discoveries.

MILES RUSSELL (Bournemouth University): Charles Dawson was interested in, in geology, fossil hunting. He was interested in picking up archaeological artifacts. He was very keen in, in finding spectacular, making spectacular discoveries, publicizing them and trying to, I suppose, build up some kind of academic credibility.

NARRATOR: As one of the world's leading scientific institutions, London's Natural History Museum was the obvious place for Dawson to take his finds. There he met up with the eminent geologist, Sir Arthur Smith Woodward.

On the 14th of February, 1912, Dawson wrote with his exciting news.

CHARLES DAWSON (Amateur Scientist, Dramatization): I have come across a very old Pleistocene bed which I think is going to be interesting. I think I have a portion of a human skull which will rival the Germans' ape man.

NARRATOR: Even the staid Woodward realized this might be a crucial British discovery. He set off for a summer of digging with Dawson. They were joined by laborers, countless visitors, and their mascot, Chipper, a goose.

Very few records of what happened that summer exist, but it was incredibly productive. They found the remains of prehistoric animals, and even Stone Age tools. Finally, they struck pay dirt: an ape-like jawbone with human-like teeth that seemed to link it to the skull Dawson got from the laborer. Only one conclusion seemed possible: they'd found the missing link.

On December 18th, 1912, the public eagerly awaited their first glimpse of mankind's earliest ancestor. Sir Arthur Smith Woodward and Charles Dawson presented Piltdown Man to the world. It was nicknamed "the earliest Englishman." British science was triumphant. The Empire swelled with pride.

RICHARD MILNER: Piltdown Man was a really big deal in 1912, because it was a time when very little was known of human fossil remains that were very early, and it was perceived to be the missing link, the fossil that connected humans with apes. It established our place in nature. It was the proof of Darwin's theory.

SIR ARTHUR SMITH WOODWARD (Geologist, Dramatization): Another interesting find is this ancient jawbone.

MILES RUSSELL: In 1912, Charles Dawson gives British paleontologists, British anthropologists exactly what they want: that the earliest human, the missing link between apes and modern humans is, is not African, he's not German, he's not French, he's British, and he comes from the home counties.

NARRATOR: Of all the places in the world where mankind could be born, he had chosen England.

MILES RUSSELL: It was made world news. In America, in Africa, in Australia, all the way across Europe, this small village of Piltdown became the most famous place on earth.

NARRATOR: Journalists fed the public's appetite for images of this amazing creature. Soon Piltdown Man was etched in their minds as the missing link.

SIR ARTHUR SMITH WOODWARD (Dramatization): In recognition of the man responsible for this extraordinary find, I'm delighted to announce that we are to name this creature *Eoanthropus dawsoni*.

NARRATOR: Piltdown Man was the jewel in the Natural History Museum's crown, but some scientists wondered if this oddly matched jawbone and skull were really from the same creature.

CHRIS STRINGER (Natural History Museum, London): Even at the time, there was a lot of doubt amongst the experts about how human-like or ape-like this skull was. And, of course, what was frustrating was on the jaw itself this place of articulation was broken off. So there was no way that you could show whether this jawbone really fitted in this part of the skull.

NARRATOR: Woodward believed the jaw did belong with the skull and that it showed exactly the mix of features to be expected in a missing link. But a crucial piece was absent, the canine tooth.

Back at the dig, Dawson and Woodward invited another amateur archaeologist, a French philosopher and priest named Teilhard de Chardin. He would later become famous for his attempts to marry the science of human evolution with the creation doctrine of the Church.

Hopeless as it might seem to find a single tooth amongst tons of gravel, luck appeared to be on their side.

CHRIS STRINGER: Remarkably, a year later, a canine tooth was found at Piltdown and it more or less matched exactly Smith, Woodward and Dawson's predictions about the size of the canine.

NARRATOR: It was an incredible find. The canine helped silence doubters who had questioned Woodward's reconstruction of the skull. But their luck didn't end there. To the amazement of the scientific world, in 1917 Woodward announced the discovery of a second Piltdown Man.

SIR ARTHUR SMITH WOODWARD (Dramatization): ...a skull and a tooth.

NARRATOR: Just a few miles from the original dig, Dawson had unearthed another skull and tooth. This was Piltdown Man Two.

CHRIS STRINGER: Certainly, for some people this was the clincher, that here, two miles away, at another site, the same antiquity, the same fossilization. Nature couldn't play a trick like that twice. This had to make Piltdown genuine.

NARRATOR: With two family members and the backing of the Natural History Museum, Piltdown Man became the undisputed earliest human ancestor. Newspapers lapped up the story, and soon films appeared with dramatic interpretations of the lives of these early ape men. Winston Churchill even described these earliest Englishmen as the lords of creation.

For more than 40 years, Dawson's "Dawn Man" reigned supreme. But then, in 1953, came a sensational announcement: Piltdown Man was a fake. The world had been deceived.

RICHARD MILNER: The scientific world was in an uproar; the public was scandalized. Were monkeys being made out of the scientists? It even came up in parliament.

AMERICAN NEWSREEL: Britain's august Natural History Museum is all adither over a scandal concerning the Piltdown Man. One of the most famous fossil skulls in the world is declared to be, in part, a hoax. Forty years ago...

CHRIS STRINGER: Feelings were partly embarrassment on behalf of British science that, in particular, British scientists had been fooled by this find for so long, you know, whilst people in other countries had gradually become doubtful about Piltdown, and some of them had seriously questioned his, his authenticity. British scientists had tended to be, and remained, rather uncritical of Piltdown.

AMERICAN NEWSREEL: It was presumed to date back half a million years. Today comes the shocking news that this is skullduggery.

MILES RUSSELL: When Piltdown was first revealed as a hoax, it was horrifically embarrassing. It was probably more embarrassing by people who'd built aspects of their career looking at it, analyzing it and accepting it as being genuine.

AMERICAN NEWSREEL: Mr. Piltdown is branded “a phony.” He isn't one of us. Most of him belongs to the ape side of our family.

NARRATOR: The chain of events that ultimately exposed the fake came from within the museum. Kenneth Oakley applied a chemical test to help authenticate and date the fossils. The result revealed Piltdown Man to be much younger than expected.

AMERICAN NEWSREEL: In the mineral department, on behalf of the Natural History Museum, tests were carried out to estimate the nitrogen content.

GILES OAKLEY: When they tested the Piltdown remains, it emerged that, yes, it was bogus. The skull was not as old as they thought and had been stained. The teeth had been filed down. It was just sort of a, just a random old ape jaw really, to put it very crudely, very simply. It was not some fossil man in that sense at all.

AMERICAN NEWSREEL: ...just what one would expect in fresh bone. Clearly the skull was quite a different age from the jaw.

NARRATOR: Oakley revealed a forgery on a scale that had never been seen before. The jaw was not even human, it was probably an Orangutan's. The teeth had simply been filed flat to disguise them. The fossils had been boiled and carefully stained with chemicals to give them an aged look. But the canine tooth, one of the key discoveries, seemed to have been made in a rush. It was crudely filed and colored with paint.

Every single one of the 40-odd finds at Piltdown had been forged and planted. But who had the audacity to mastermind a hoax that had fooled scientists for 40 years?

The hunt was on to find the culprit. Suspicions first fell on the men at the dig, but some surprising revelations soon brought new faces under the spotlight. The most famous name linked to Piltdown was someone who couldn't have written a better mystery himself, the great writer and doctor, Sir Arthur Conan Doyle.

Historian Richard Milner became fascinated by this great British eccentric when he learned of his connection to Piltdown.

RICHARD MILNER: Millions of people know Sir Arthur Conan Doyle as the creator of Sherlock Holmes and the father of the modern mystery story. But, in fact, most people don't know that he was also a medical doctor, a person who collected fossils, an ardent spiritualist, and perhaps one of the perpetrators of one of the greatest hoaxes of all time, the Piltdown Man.

NARRATOR: Conan Doyle was a colorful character with a theatrical flair. He was as keen on new inventions as he was on hunting fossils. He lived just seven miles from Piltdown, and moved in the same social circles as Charles Dawson.

RICHARD MILNER: Conan Doyle certainly knew the other people who were possible perpetrators and was a familiar figure at the site. He told Dawson that he was very excited about the find and would happily drive him anywhere in the neighborhood in his motor car.

NARRATOR: Conan Doyle often passed close to the dig on his round of golf at the Piltdown course. He could easily have planted the fossils. But what would have motivated him?

RICHARD MILNER: Why would Sir Arthur Conan Doyle want to put on the scientific establishment? Why would he want to sneak around and make fools of some of the most respected people in England? Well, perhaps, because they had tried to make a fool out of him.

NARRATOR: Despite his medical training, Conan Doyle fell out with the scientific community because of his controversial belief in spiritualism, the ability to communicate with the dead. It was the latest craze sweeping the nation, and Conan Doyle became a fervent convert.

RICHARD MILNER: He believed that one could communicate with departed spirits. He believed in spirit photography. He attended seances. When he showed these spirit photographs to scientists they laughed. They said, “These are simple double exposures, this evidence is no good at all. You don't know what evidence is.” And that's when Conan Doyle, I think, got very upset, and he said, “I am the creator of Sherlock Holmes. You don't tell me that I don't know what evidence is. I will show the scientists that they don't know what evidence is.”

NARRATOR: Could the scientists' rejection of the spirit photographs have infuriated Conan Doyle and driven him to perpetrate the forgery? He had both the motivation and the opportunity.

One theory says that he deliberately planted clues in one of his most famous books, *The Lost World*. Published in the year Piltdown Man was discovered, the book featured Conan Doyle in the guise of Professor Challenger, running an expedition to discover a mysterious prehistoric world.

RICHARD MILNER: You have all these wonderful clues peppered throughout the book. Sir Arthur himself, as Challenger, goes, in his imagination, into a lost world in Venezuela, where dinosaurs and ape men still roam. And he wants to bring the proof back to England and show people this fantastic breakthrough. Members of his expedition say, “How will they be believed?” “Well, we have these photographs.” “Yes, but photographs can be faked.” “Well, how about a piece of bone?” And he says in his book, *The Lost World*, if you know your business a bone can be as easily faked as a photograph. Well, if you're trying to figure out who planned Piltdown...somebody says “a bone can be as easily faked as a photograph,” you start to think maybe Sir Arthur is trying to tell us something.

NARRATOR: But if Conan Doyle created Piltdown Man to mock the scientists, why didn't he come right out and reveal how easily he'd fooled them?

RICHARD MILNER: One possible answer is that shortly after Piltdown was really going and captured everyone's imagination, a little something called the First World War came along. At

that time, Conan Doyle was seriously engaged in political talk and in trying to influence the British government in the conduct of the war. So clearly that was not the time in history for Conan Doyle to say to Parliament, “Here's how to conduct the war, and, oh yes, by the way, I sprung that little gag about the ape man in Sussex.”

NARRATOR: Was Sir Arthur Conan Doyle really the type of man to carry out such an outrageous hoax? If his own detective, Sherlock Holmes, were trying to solve the mystery, he would surely consider the culprit's personality.

Conan Doyle was considered a man of truth and integrity. Would he really be prepared to see so many lives wasted in the fruitless study of Piltdown Man without obvious benefit to himself?

RICHARD MILNER: Well, it went so far beyond a joke or a prank that it did serious harm to people's lives. And frankly, that part of it makes me disinclined to believe it was Conan Doyle, because Conan Doyle was such a decent man that I find it impossible to believe that he could watch such suffering and waste on the, on the part of these scientists and not confess to it, even at cost to his own reputation.

NARRATOR: Although Conan Doyle had the means and motive to carry out the Piltdown forgery, it seems totally out of character.

There was another more obvious suspect who stood to gain much more from the discoveries. Most of what is known about Piltdown comes from Charles Dawson, the man who made the initial find. Although only an amateur archaeologist, his ambitions to make a name for himself in academic circles seemed limitless.

MILES RUSSELL: He was one of the foremost amateur antiquarians of his time, and so I think each one of his discoveries and presentations to the Royal Society, and presentations to the Antiquarian Society, presentations to the British Museum, increased his standing to the point where, had he not died in 1916, I'm sure he would have been knighted.

NARRATOR: Although Dawson's reputation in his lifetime was untarnished, once the forgery was revealed, his name began to crop up as a prime suspect. Local gossip quickly revealed a darker side to his character. He was accused of being a cheat and swindler after his dubious purchase of the grand townhouse, Castle Lodge, in Lewes.

Dawson sneakily bought the house from under the noses of the Sussex Archaeological Society, who had previously housed their museum there. He had no qualms about serving them with an eviction notice, despite having been a leading member.

MILES RUSSELL: The society, of course, were up in arms about this. They had nowhere to go, they had nowhere to store their museum, and it took them a good few years to actually re-establish themselves within Lewes. And where they actually ended up a few years later was quite interesting from, well, from the point of view of the Dawson family, because they moved into Barbican House, which is what, 100, 150 yards from the front door of Castle Lodge. And the

Sussex Archaeological Society are still here today. They're still based in here. And you can imagine the Dawsons coming out of Castle Lodge, coming down, what, 150 yards down to the high street...they would have come into daily contact with the members of the society whom they had just only recently evicted. By buying that house and evicting them, he was effectively severing all links with the society.

I think that tells us something interesting about his character, in the sense that if he wanted something he would get it, irrespective of anyone's feelings, and damn the consequences.

NARRATOR: New revelations about Dawson's career proved even more incriminating. Once Piltdown was exposed as a forgery, questions were asked about his other discoveries.

Here at Pevensey Fort in Sussex, Dawson had found an important Roman artifact, a tile dating to the end of the Roman occupation of Britain. It too was a fake.

MILES RUSSELL: For almost 65 years, here was a major discovery, a major find, and everything that had been written about it was wrong. So if anything, if we're looking for anything that that proves, that really is the smoking gun that proves that Dawson was an inveterate hoaxer, forger and liar, then it is the Pevensey tiles that do that.

NARRATOR: But Dawson hadn't stopped there. Suspicions began to fall on the rest of his finds held at Hastings Museum. The Chinese pottery, the Lewes riding-spur, the Beauport Roman statue, the carved antler hammer: they were all exposed as forgeries.

MILES RUSSELL: The cumulative effect of having 46 individual objects which have questionable backgrounds, dubious origins, or have obviously hoaxed aspects to them, would suggest that the bulk, really, of Dawson's discoveries were hoaxed.

NARRATOR: Dawson clearly had the right kind of personality to commit the Piltdown forgery, and ample opportunity. He was often present when discoveries were made, and actually made many of them himself. But could he have perpetrated the hoax alone?

CHRIS STRINGER: We've got a chain of evidence which shows that Dawson really did have the motivation to do this, and certainly was in the right place at the right time to produce and find most of the material. Whether he perhaps had the knowledge and the skill and the access to all of that material or whether someone else was actually providing him with the material that he was finding at the two Piltdown sites...and for me that's the one remaining uncertainty.

NARRATOR: The forger went to enormous trouble to make Piltdown a convincing hoax. There were over 40 individual pieces including genuine mammal fossils that helped give it authenticity.

ANDY CURRANT: I think it's quite plausible that whoever put together this forgery, particularly the fossil mammals, was somebody who knew what they were doing. This material has been very carefully selected to be generally identifiable but specifically, maddeningly difficult to pin down. You can tell that this piece here is a fragment of a stegadon tooth, but you

can't tell which stegadon it belongs to. That takes a little bit of skill to do that. And there weren't too many people around at the time who could have put such a thing together.

NARRATOR: The finger of suspicion points directly to Dawson's colleague, Sir Arthur Smith Woodward, of Britain's Natural History Museum. What makes Woodward a prime suspect is that he was Piltdown's greatest advocate, and, as the most eminent scientist at the museum, it was difficult to challenge him.

ANDY CURRANT: Arthur Smith Woodward was a very important, very well known man. You have to remember that, in those days, there weren't really pop stars, so people like the keeper of geology at the Natural History Museum would have been well known. They would have been publicly known figures.

NARRATOR: Piltdown had made Woodward world famous. But with hindsight, his unscientific behavior looks suspicious. He didn't test the jaw for its nitrogen content, a basic test which would have proven it to be too modern. He even failed to spot the cruder aspects of the forgery, like the filed teeth, things that he could have seen with just a magnifying glass.

Had the desire to find Britain's missing link led him to perpetrate the forgery? Had his ambition blinded his scientific judgment? His grandson, David Hodgson, can't see how Woodward's involvement in the forgery makes any sense.

DAVID HODGSON (Grandson of Arthur Smith Woodward): My grandfather moved to Haywards Heath on his retirement, because he wanted to be near to his beloved Piltdown. He retired in 1924, and every summer from then on, all the way up to 1938, he came here every summer to dig.

NARRATOR: Why would the perpetrator have spent another 20 years digging at the site of his own hoax?

DAVID HODGSON: I think it was a wasted life for my grandfather. From 1916 onwards, nothing of significance was found here.

NARRATOR: Woodward died in 1948, still certain that Piltdown Man was genuine.

ANDY CURRANT: If you think about it, it's a vicious hoax. Some of these people continued to work on Piltdown for years and years and years after it all exploded. It was a terrible thing to do. It really was a horrible, nasty, vicious piece of work.

NARRATOR: Recently, evidence has surfaced inside the Natural History Museum that suggests a scandalous possibility: perhaps a rival deliberately made a fool out of Woodward.

ANDY CURRANT: In my early years at the museum, it was very much part of the, sort of the gossip of the department that maybe somebody in the museum could have been involved in this. And that, that wouldn't be good.

NARRATOR: The atmosphere inside the museum was one of intense competition and rivalry. Kenneth Oakley, the man who'd helped expose the hoax in 1953, suspected the forgery could have arisen out of an internal feud.

GILES OAKLEY: There were grudges held. There was a lot of egotism, a lot of rivalry between, not just between individuals within some departments, but between departments.

NARRATOR: One such rivalry was rumored between Woodward, department head of paleontology, and a man named Martin Hinton. The conflict was said to have begun about a year before the Piltdown discovery was made public, as a disagreement over money when Hinton was working as a junior scientist under Woodward.

Hinton became an accomplished fossil expert and eventually rose to become the Museum's department head of zoology.

ANDY CURRANT: It was part of departmental culture, if you like, that Hinton was in some way involved in Piltdown or knew what was happening at Piltdown. He is the kind of person who would have thought this to be quite an amusing hoax to produce. And we know that he was interested in hoaxes. He was a, he was a bit of a joker himself.

NARRATOR: Hinton carried a beaver skull in his frock coat and for years feigned near-sightedness, though his vision was perfect. Kenneth Oakley had suspicions about Martin Hinton, as his son recalls.

GILES OAKLEY: When going through the potential suspects, Martin Hinton's name kept on bobbing up like a cork. I think he found him a rather strange personality. He seems to have been very eccentric, and he was known to be a bit odd and a bit of an outsider in some ways, a bit of a joker in other ways, quite a strong personality.

NARRATOR: The rumors implicating Hinton really took off when Andy Currant and a colleague, Bob Knowles, during a renovation in the museum, stumbled across an extraordinary piece of evidence hidden away in one of the towers.

ANDY CURRANT: There, in a loft above a room which had belonged to Martin Hinton, was a big trunk, and there had been a lot of papers in it. There were also tubes of dissected mice. This seemed to be some of Hinton's anatomical specimens. They were a pretty gruesome mess. And Bob and I lifted this stuff out, and then we found, right at the bottom of the trunk, this little group of bones that appeared to have been stained. And then many of them have been cut in order to see how far the staining has gone into the bone.

This doesn't appear to be natural coloration. But, as you can see in this particular specimen, it seems to have been deliberately trimmed across the end in an attempt to see how deep the staining has gone.

NARRATOR: Recently, claims were made that the chemicals used to stain the fossils from the trunk were the same as those found on the Piltdown remains. But had Hinton forged the fossils, or was he just experimenting after the forgery had been unmasked to see how it was done?

Either way, the evidence suggests Hinton was skeptical of Piltdown's authenticity all along. In the archives, his letters show that as early as 1916, he was confiding his doubts about the Piltdown finds to an American colleague.

ANDY CURRANT: We know that there was correspondence between him and Miller, who—Miller was an American paleontologist—who had suggested that the jaw and the skull didn't belong together. And Hinton wrote to him and said, “Congratulations, you've exploded the myth of Piltdown Man.” It was a very interesting thing to be saying in those days, and, if he thought it, there are other people in the museum who must have must have been thinking the same kind of thing.

NARRATOR: While Hinton and other experts in the Museum may have suspected Piltdown was a forgery, were they actually involved in planting the material?

ANDY CURRANT: Hinton's role in this is very, very difficult to tie down. He was not a straightforward man. He was obviously quite devious in a number of areas. It's very much in Hinton's character to lead people on thinking things may be so that weren't actually so.

NARRATOR: One of the very last discoveries at Piltdown may hint that the notorious practical joker Hinton was involved. In 1915, Dawson and Woodward found an artifact so bizarre that with hindsight it's laughable.

ANDY CURRANT: The most ridiculous find at Piltdown has to be this, and it's one of the last things that was ever found there. It was found, most of it was found under a hedge nearby. It wasn't even found in the deposit. It was actually written up by Woodward and Dawson as a curious bone implement, but everybody who has ever seen this thing has made the obvious deduction: it's a cricket bat.

I mean, there's no attempt to disguise this at all. These are not the marks made by stone tools. Somebody's got a chopper and just gone hacky-hack-hack at the end of this. They've made a sort of pointy end, where the handle would be. And it's nothing else, is it? It's a cricket bat; it's the earliest Englishman.

NARRATOR: The cricket bat had the hallmarks of one of Martin Hinton's jokes: the missing link was also the earliest English cricketer.

This blatant forgery was crudely thrown together and planted under a hedge. Surely it was obvious that Piltdown Man was a hoax? But Woodward only saw what he wanted to believe.

ANDY CURRANT: When the cricket bat turned up, Dawson and Woodward went to press in good faith, describing it as a Paleolithic artifact. They're not men who saw jokes. Short of writing

a postcard and leaving it on the site and saying, "I'm very sorry, this was all a big hoax," to me, that's a confession.

NARRATOR: It seemed the perpetrator, whoever he was, had done everything he could to wake up the world to the Piltdown hoax, but the desire to find the earliest Englishman had blinded the scientific establishment.

GILES OAKLEY: Scientists are no different from other human beings. They're not all dispassionate seekers after truth in some kind of neutral way, unaffected by the pressures that affect non-scientists. Egotism, pride, ambition, rivalry, these things affect even scientific judgments.

If the cricket bat was an attempt to bring an end to Piltdown, it backfired.

NARRATOR: With the backing of Woodward, the discovery remained undisputed for more than 40 years.

RICHARD MILNER: The forgery lasted so long because people wanted to believe it, because it supported a patriotic world view, and because there were no technological tests to disprove it.

NARRATOR: So for 40 years rumors circulated inside the museum that Hinton and others knew Piltdown was a forgery and yet said nothing.

ANDY CURRANT: I think it's quite likely that a lot of people, even in the early days of Piltdown, knew there was something wrong. The discussion is going on at a higher level, it's going on between the great anatomists of the day. The little people have been forgotten. And in those days Martin Hinton was a little person. He would be relatively insignificant in this great organization.

NARRATOR: There were also rumors that the museum's own investigation into Piltdown had identified the hoaxer on the inside.

ANDY CURRANT: It's been suggested that there was a kind of cover up which went on for quite a long period of time. People have even accused Kenneth Oakley of perpetrating that cover up by not coming out and naming Martin Hinton as the hoaxer. And in private conversations with people in the museum he's known to have said, "I know it's him, I just can't get him to admit it."

NARRATOR: Some of Oakley's notes in the archives suggest that he suspected Hinton's possible involvement.

GILES OAKLEY: I think he suspected, but he had no proof, and without proof he would not say, he would not accuse someone, because he thought that would be unfair and he would not want to be behind an injustice to a man just because he suspected him.

NARRATOR: Hinton, an authenticator of fossils, had the expertise to carry off the forgery, but was his desire to discredit Woodward a strong enough motivation to perpetrate such a nasty deception?

Hinton's letters indicate that he long ago suspected Piltdown was a forgery. One theory is that he could have devised the cricket bat hoax as a humorous attempt to blow the whistle on Piltdown and humiliate Woodward, but the plan backfired when Woodward thought the bat was a genuine artifact. And as Hinton rose up the ranks in the museum, he couldn't implicate himself by confessing to the monster that he'd helped create.

The person with the strongest motive and the most to gain is Charles Dawson. Dawson has since been proven to be a cheat and liar.

MILES RUSSELL: If we look at Dawson and his background, then it is clear that he is the best person to actually produce that forgery. Piltdown is the epitome of his career in fabricating artifacts.

NARRATOR: Dawson was a master forger with enormous ambition, and forging the missing link would have made him, but, his premature death, in 1916, not only brought an end to his ambitions, it also meant he evaded getting caught.

For the next 40 years, the great Piltdown forgery continued to fool the scientific world. One man suspected the truth, another desperately wanted to believe in the lie, and the man who created the monster was dead.

Perhaps Charles Dawson can rest in peace with the consolation that a scientific forgery on this scale has never been seen before or since.

Quiz Questions for Topical Quiz # 2B

1. The skull without the mandible is called the _____.
2. The skull without the face or mandible is called the _____.
3. Extra small bones isolated within skull sutures in some individuals, such as Inca bones, are called _____.
4. A persistent metopic suture results in _____ [*what alteration to the typical skull?*]
5. The bone interface that marks the boundary between the frontal bone and the parietal bones is called the _____.
6. The bone interface that marks the boundary between the parietal bones and the occipital bone is called the _____.
7. The bone interface that marks the boundary between the parietal bones and the temporal bones is called the _____.
8. The bone interface that marks the boundary between the two parietal bones is called the _____.
9. The unpaired bone at the front of the skull that includes the forehead and the brow ridges is called the _____.
10. The paired bone at the side of the skull, which is the only one of the four major bones in the calvaria that has an interface with all of the other three, is called the _____.
11. The paired bone at the side of the skull that includes the external auditory meatus and the mastoid process is called the _____.
12. The unpaired bone at the back of the skull is called the _____.
13. The opening in the skull for the ear is called the _____.
14. The external auditory meatus is found in the _____.
15. The point of the chin is called the _____.
16. The small U-shaped bone in the upper part of the neck is called the _____.

17. The paired bone that includes the inferior margins of the nasal aperture and the sockets for the upper teeth is called the _____.
18. The unpaired bone that is superior (and largely posterior) to the maxilla and that has interfaces on the lateral portions of the cranium with the frontal and temporal bones is called the _____.
19. The unpaired bone that forms the posterior portion of the roof of the mouth is called the _____.
20. The paired bone that interfaces with the temporal bone to form an arch on the side of the head is called the _____.
21. The bony projection on the inferior portion of the temporal bone that serves as a point of attachment for neck muscles is called the _____.
22. The bone that contains the lower teeth is called the _____.
23. The point of articulation between the bone that contains the lower teeth and the cranium is called the _____.
24. The vertical portion of the mandible, which lies at roughly a right angle to the manibular body, is called the _____.
25. The four anterior single-rooted teeth with single cusps whose function is holding and ripping are called _____.
26. The eight anterior single-rooted teeth with straight cutting edges whose function is biting are called _____.
27. The twelve posterior multi-rooted teeth with more than three cusps whose function is chewing are called _____.
28. The eight posterior double-and-single-rooted teeth with two cusps whose function is chewing are called _____.
29. The teeth that dentists sometimes refer to as “bicuspid” are also called _____.
30. The teeth that dentists sometimes refer to as “cuspid,” which are also commonly known as “eye teeth,” are called _____.
31. The TOTAL number of deciduous teeth in the mouth of a normal child is _____.

32. The *total* number of permanent teeth in the mouth of a normal adult is _____.
33. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult? (There will be ten such questions on the exams. For example, you should be able to answer questions such as “What is the number of the left maxillary second molar in the Universal Numbering System?” or “What is the number of the right mandibular first premolar in the Universal Numbering System?”)
34. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
35. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
36. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
37. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
38. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
39. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
40. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
41. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
42. What is the identifying number from the Universal Numbering System for each tooth position in the mouth of an adult?
43. As described in the film *The Boldest Hoax*, the fossil of the original Piltdown Man skull was formally declared to be a fraud in the year _____.
44. As described in the film *The Boldest Hoax*, the fossil skull of the original Piltdown Man was “discovered” in an excavation in Sussex, England in the year _____.
45. As described in the film *The Boldest Hoax*, scientific investigation ultimately revealed that the filed and stained mandible of Piltdown Man was actually the jaw of a(n) _____.

46. As suggested in the film *The Boldest Hoax*, Arthur Conan Doyle (the creator of Sherlock Holmes) _____ [*did* or *did not*] have the motive and opportunity to perpetrate the Piltdown hoax, and perpetrating such a fraud _____ [*would* or *would not*] have been consistent with what is known about Doyle's character and reputation.
47. As described in the film *The Boldest Hoax*, the lawyer and amateur archaeologist who "discovered" the skull of Piltdown Man was _____, and the eminent geologist at the Natural History Museum who became Piltdown Man's most important advocate was _____.
48. As explained in the film *The Boldest Hoax*, the artifact found at Piltdown which the original "discoverers" described as a "curious bone implement" (and which contemporary researchers characterize as "the most ridiculous find at Piltdown") was actually a(n) _____.
49. As described in the film *The Boldest Hoax*, the staff member and eventual Department Head of Zoology at the Museum of Natural History who probably knew from the beginning that Piltdown Man was a fraud, and who may have been involved in the forgery itself (or at least the cover-up), was _____.
50. As suggested in the film *The Boldest Hoax*, it is overwhelmingly likely that the person who was *primarily* responsible for the Piltdown hoax was _____.

Chapter 7

The Thorax, Vertebral Column, & Pelvis

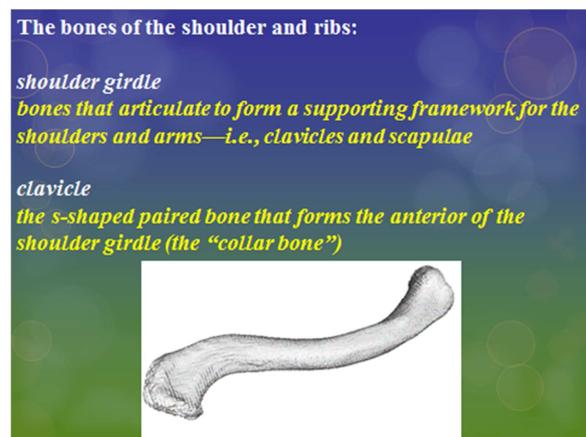
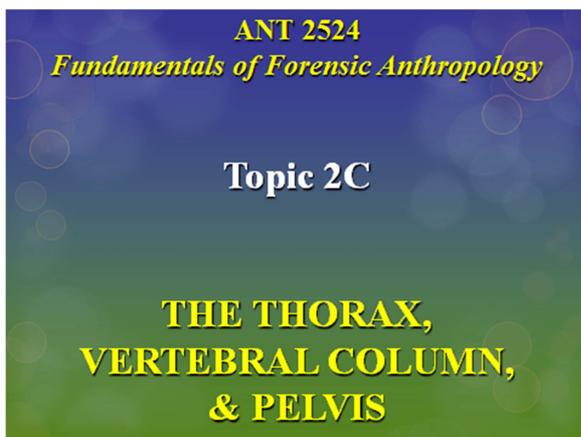
The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 4, 5, & 8 of *Forensic Anthropology Training Manual*), the film that accompanies this topic (i.e., *Child Mummy Sacrifice*), and/or the following website:

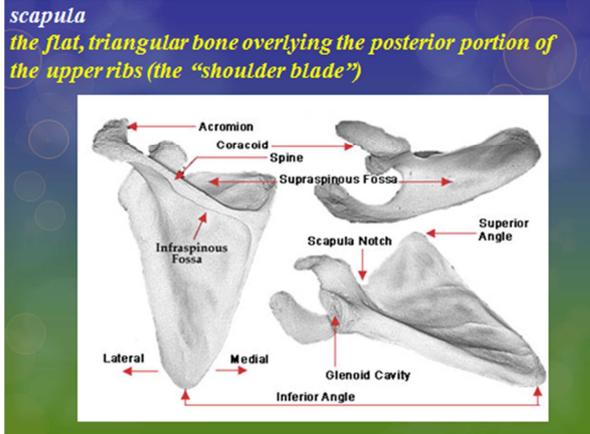
eSkeletons

(When you visit the site, begin by clicking on the human skeleton on the left under the “Taxon” tab. The URL for eSkeletons is <http://www.eskeletons.org/>)

Note: If you can recognize the difference between the *superior* and *inferior* edges of the ribs, and if you know whether the head of the rib is *anterior* or *posterior* to the sternal end of the rib, you will enable you to determine whether any single rib belongs to the *right side* or the *left side* of the body.

Classroom Presentation (PowerPoint Slides)





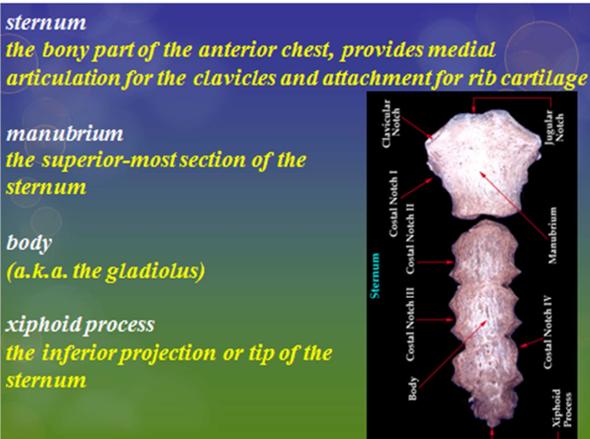
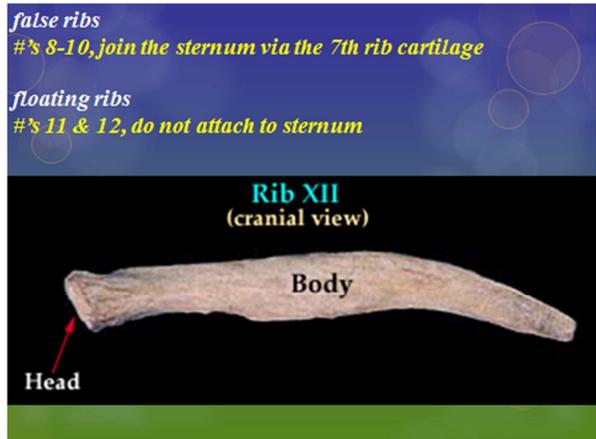
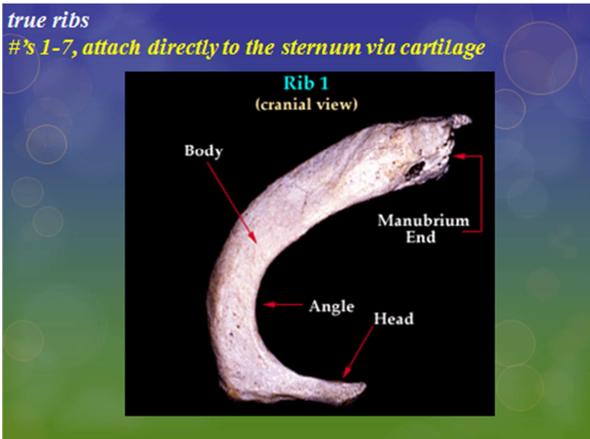
There are 12 pairs of ribs, numbered from 1 to 12 superiorly to inferiorly

head of rib
articulates with the vertebrae

sternal end of rib
articulates with the sternum (the floating ribs have floating ends, rather than sternal ends)

the inferior edge of the rib is the sharper edge

the head of the rib is posterior to the sternal end



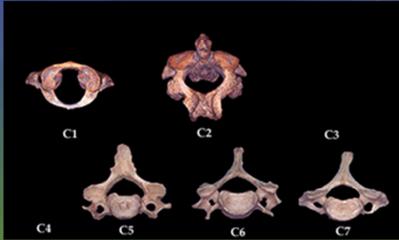
The vertebral column is divided into the cervical vertebrae, the thoracic vertebrae, the lumbar vertebrae, and the sacrum and coccyx.

Common names:

vertebral column = backbone

coccyx = tailbone

cervical vertebrae 7 vertebrae in the neck (atlas-C1, axis-C2, and C3-C7)



all have foramina

thoracic vertebrae

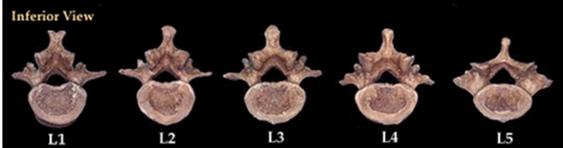
12 vertebrae--connect with the rib cage (T1-T12)



long straight narrow spinous process

lumbar vertebrae

5 vertebrae in the lower back (L1-L5)



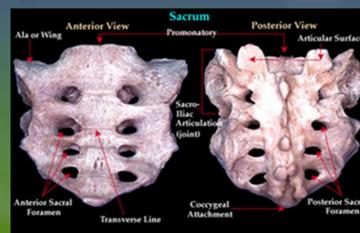
broad hatchet-shaped spinous process

sacrum

five vertebrae fused into one bone in the adult--connects with the pelvic bones and provides the posterior section of the pelvic girdle (S1-S5)

coccyx

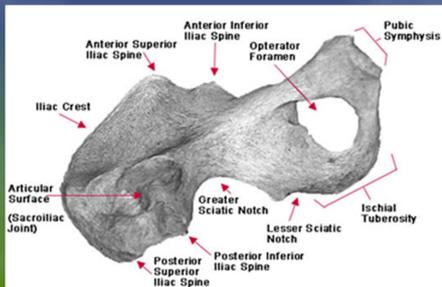
small bones that form the lower extremity of the spinal column...may fuse with each other and/or the sacrum



pelvis

the two innominate bones plus the sacrum (plural pelves) innominate

a paired bone resulting from the fusion of the ilium, ischium, and pubis a.k.a., the os coxae



ilium

the large, flaring portion of the innominate--the "hip bone" (the waist is immediately above the iliac crest) [plural ilia]

ischium

the most inferior bone of the innominate (the bone that carries the weight of the sitting person) [plural ischia]

pubis

the anteroinferior bone of the innominate [plural pubes]

acetabulum
hip socket ("vinegar cup")

iliac crest
superior edge of the ilium

greater sciatic notch
notch in ilium superior to point of fusion with ischium, near sacrum in posterior part of innominate

pubic symphysis
cartilaginous union at the point where the pubes meet

Film Summary

Child Mummy Sacrifice

This film from the National Geographic Society tells the story of three Inca children who were sacrificed to the gods some 500 years ago and left atop the summit of a volcano in the Andes. The unusual environmental conditions allowed their remains to be naturally mummified, resulting in extraordinary preservation of their bodies.



Scientists examine the mummified body La Doncella (“the maiden”)



La Nina del Rayo (“Lightning Girl”)

The Inca civilization flourished in the Andes Mountains of South America in the 15th and 16th centuries. It was a remarkable civilization with many exceptional achievements (including impressive stone architecture and an extensive network of roads), but it also had a dark side—the Inca practiced child sacrifice. This film examines the fate of three such children who were ritually murdered to appease the gods. Their frozen and mummified bodies were recently discovered high in the Andes by National Geographic Society archaeologist Dr. Johan Reinhard, and forensic pathology reveals who these children were and how they died.

In 1999 Reinhard and a team of archaeologists ascended the 22,000-foot peak of the Lulluillaco Volcano in northwest Argentina. Just eighty-two feet below the summit, they uncover an Inca burial site. Beneath some ancient artifacts (including a statue and a rare necklace), they find the remains of a young boy. Nearby on the platform of the mountaintop they find another set of remains, this time a larger body of a female. Then, in a narrow crevice in the bedrock, they discover a third tomb containing the charred remains of a child. All three mummies are exceptionally well-preserved.

The bodies of the three children were taken to the Museum of High Altitude Archaeology in Salta, Argentina. Because of their delicate state, the remains are rarely moved or touched, but the filmmakers are present when the mummies are given a close forensic examination. The lead investigator is forensic pathologist Dr. Angelique Corthals, which has extensive experience in crime scene investigation. All three mummies are among the best-preserved ever discovered—each still has all of its organs, including the lungs, heart, and brain. The body of a seven-year-old boy that the researchers refer to as “El Nino” weighs 22 ½ pounds, about half what he would have weighed when alive. His body is the only one of the three that had been tied up. The other two bodies are those of a six-year-old girl and a fifteen-year-old girl.

Based on historical records provided by the Spanish conquerors, it is believed that the children were marched nearly 1,000 miles before they were sacrificed on the summit of the volcano. Their journey began in Cuzco, the Inca capital city at the heart of the Inca Empire. The trip is estimated to have begun six months before the children died, and their mothers may have been recruited to travel alongside the children to increase their chances of survival.

In her forensic examination, Corthals notices a mysterious stain around the mouth of the boy that could be either blood, vomit, or chicha (chicha is an alcoholic drink made from maize that would have had a sedative effect). If the stain is blood, the inference would be that the boy died a violent death, whereas if the stain is chicha, it could be that the boy died peacefully in his sleep after being drugged. There’s also an indentation on the boy’s back, however, which Corthals detects through the child’s woolen clothing, and she wonders if it could be a stab wound. The examination must be conducted hastily, however, because of the risk of decomposition. Normally the body is stored in a pressurized, temperature-controlled, low-oxygen capsule that had been designed to preserve the mummy by mimicking the conditions of its burial. The circumstances of the burial, which combined volcanic ash, freezing temperatures, and high humidity, had created a perfect storm of conditions favoring preservation of the body. The volcanic ash kept flesh-eating bacteria out and moisture in, and then a permafrost layer sealed the tomb, making it airtight.

The result of the environmental conditions where the bodies had lain for half a millennium was a degree of preservation that meant it was still possible to recover DNA, so Corthals removes one of the boy's eyebrow hairs with the follicle intact. Examination of the hair on the boy's head reveals that he had been plagued by lice when he was alive.

Historical Spanish writings shed some light on the Inca motivation for child sacrifice. Children were considered to be pure and perfect, and thus the most valuable beings to offer to the gods. It was considered unacceptable for parents to display their pain at the loss of their children. After all, the children were about to go on to a glorious afterlife in which they would become gods. The seven-year-old boy was likely provided by his parents or by local leaders to be sacrificed. The fifteen-year-old girl may have been chosen years before her death when she was selected as one of the "virgins of the sun." During an annual census, royal officials would travel to villages throughout the empire to select young girls. The chosen girls were secluded in a guarded compound where they took a vow of chastity. Some of them became priestesses to the sun god, while others were designated as concubines for the emperor—but some of them were selected for a higher purpose as sacrifices to the gods.

At the lab, the forensic team examines the body of the fifteen-year-old girl whom they refer to as La Doncella, the maiden. They plan to take seven biopsies in 45 minutes before returning the mummy to its preservation capsule. The girl's elaborately-braided hair includes a few white hairs, which could have resulted from unusual genetics, or it could have been an indication of perimortem stress. An earlier research team from England had previously examined the hair of all three mummies, analyzing the fibers for chemical signatures that would show what the children ate and how they lived. The results were revealing. One year before she died, La Doncella's diet shifted from potatoes to a diet of maize and animal protein, characteristic of the elite. During Corthals' examination of La Doncella, she inserts a probe into the mummy's back to remove a small sample of muscle beneath the fat that will be submitted for DNA analysis. CT scans of the mummy indicate that the girl suffered from sinusitis and a bronchial infection. Like the mummy of the young boy, La Doncella also had a dark stain on her lips—Corthals takes a sample to see if the stain was caused by chicha. If it was chicha, Corthals believes that the girl would have passed out from the effects of the drink—and if she passed out from the effects of alcohol at an altitude of 600 meters, she would not have awakened.

The film includes a dramatic re-enactment of the 1,000-mile trek that the children would have made from Cuzco in the north to the Lulluillaco Volcano at the southern end of the Inca Empire. Along the way, their journey would have taken them through the driest desert on earth, the 450-mile-long Atacama, where in some places it only rains two to four times every century. The trip would have been extraordinarily arduous, and researchers wonder how the children must have felt as they approached their terrible destiny. Forensic dentists who examined the mummies discovered that the two youngest children had evidence of extensive dental abrasions, which could have been caused by stress-induced teeth grinding.

The third child to be examined is referred to as La Nina del Rayo, the Lightning Girl, because her body is charred where it had been struck by lightning. The lightning bolt hit her tomb, penetrating more than four feet into the ground. It may have been conducted through the ceremonial silver plate the girl was wearing on her head.

Despite the smell of charred flesh, CT scans revealed that the Lightning Girl's internal organs were still perfectly preserved. The Lightning Girl's head had an unusual shape that resulted from artificial cranial deformation. As part of a ritual of tribal marking common to some Andean peoples, the girl's skull had been bound to a board for two months when she was an infant—the resulting profile of her head mimics the shape of a mountain. The boy's head was also deformed, but in a different manner using a different method. The two children were either from different places or they belonged to different families with different social ranks.

The three children would have suffered from their time on the summit regardless of whether they were killed violently or mercifully. At 22,000 feet above sea level, the atmospheric pressure drops by almost 50%. As the brain struggles for oxygen, breathing becomes labored, and hallucinations, crippling headaches, and vomiting can result. To help the children survive the ascent to the top of the mountain, they were given coca leaves. Coca is a stimulant that improves the body's ability to assimilate small amounts of oxygen. All three children showed high levels of coca in their systems.

Could the children have survived the climb to the top of the mountain? CT scans revealed that the lungs of both girls had expanded, suggesting that they were alive and breathing when they reached the summit. Corthals hopes to find evidence that the children did not die a violent death (she would prefer to think that they died in an alcohol-induced coma). She worries, however, that the young boy may have been tied up because he had been severely injured. Using mass spectrometry to analyze the stains on the cloth near the boy's mouth, researchers discover that the cloth had been soaked with a lot of blood, mixed with saliva. This indicates that the blood came from inside the body, demonstrating that the boy had suffered internal injuries. Corthals is saddened by the realization that the boy died a violent death. The chemical analysis of the hair samples for the two girls, however, suggested that they may have ingested coca leaves mixed with alcohol—leaving open the possibility that they died relatively peaceful deaths in their sleep.

Quiz Questions for Topical Quiz # 2C

1. The clavicles and scapulae are collectively called the _____.
2. The shoulder girdle consists of the _____.
3. The s-shaped paired bone that forms the anterior of the shoulder girdle is called the _____.
4. The flat, triangular paired bone that forms the posterior of the shoulder girdle is called the _____.
5. The rib that is in the most superior position is rib # _____.
6. The rib that is in the most inferior position is rib # _____.
7. Ribs # 1 through 7, which attach directly to the sternum via cartilage, are called _____ ribs.
8. Ribs # 8 through 10, which join the sternum via the 7th rib cartilage, are called _____ ribs.
9. Ribs # 11 and 12, which do not attach to the sternum, are called _____ ribs.
10. Ribs that have floating ends rather than sternal ends are called _____ ribs.
11. The head of the rib articulates with the _____.
12. The sternal end of the rib attaches via cartilage to the _____.
13. The superior edge of the rib has a _____ [*sharper* or *duller*] edge and _____ [*a* or *no*] costal groove.
14. The inferior edge of the rib has a _____ [*sharper* or *duller*] edge and _____ [*a* or *no*] costal groove.
15. The bony part of the anterior chest which provides the points of attachment for rib cartilage is called the _____.
16. The superior-most section of the sternum is called the _____.
17. The inferior projection of the sternum is called the _____.
18. In what direction is the body of the sternum located with respect to the manubrium and the xiphoid process?

19. The vertebrae that connect with the rib cage are collectively called the _____.
20. The vertebrae that make up the bones of the lower back are collectively called the _____.
21. The fused vertebrae that form the posterior wall of the pelvis are collectively called the _____.
22. The vertebrae that make up the bones of the neck are collectively called the _____.
23. The common name for the vertebral column is the _____, and the common name for the coccyx is the _____.
24. The total number of thoracic vertebrae is _____.
25. The total number of lumbar vertebrae is _____.
26. The total number of cervical vertebrae is _____.
27. The first two cervical vertebrae, C1 and C2, are nicknamed _____.
28. The two vertebrae that provide both stability and mobility for the head are called _____.
29. The paired bone resulting from the fusion of the ilium, ischium, and pubis is called the _____.
30. The paired bone that makes up the most anterior portion of the innominate (the left and right bones of this pair meet at the lower midline of the trunk) is called the _____.
31. The paired bone that makes up the large, flaring portion of the pelvis is called the _____.
32. The paired bone that makes up the most inferior portion of the innominate is called the _____.
33. Taken together, the paired innominate bones can be collectively referred to as the _____.
34. The major, obvious feature on the posterior side of the innominate that is immediately inferior to the flaring arc of the ilium is called the _____.
35. The “hip socket” is the common name for the _____.

36. The ridge that runs along the outer curve of the superior surface of the ilium is called the _____.
37. The cartilaginous union in the lower midline of the trunk is called the _____.
38. The pubic symphysis can be found in that portion of the innominate where the _____ and the _____ meet.
39. The greater sciatic notch can be found in the portion of the innominate where the _____ and the _____ meet.
40. The waist is located immediately above the _____.
41. The paired bone that carries the weight of the sitting person is called the _____.
42. The point of insertion for the head of the femur is the _____.
43. As described in the film *Child Mummy Sacrifice*, the preservation capsules in the research lab mimicked the environmental conditions in the original tombs of the mummies by maintaining _____ [high or low] temperatures and _____ [high or low] levels of oxygen.
44. As described in the film *Child Mummy Sacrifice*, before the children were sacrificed they were taken on a journey of approximately _____ miles that began in the Inca capital of _____.
45. As described in the film *Child Mummy Sacrifice*, the mummy referred to as La Nina del Rayo was a _____-year-old _____ [boy or girl] who got his or her nickname because _____.
46. As described in the film *Child Mummy Sacrifice*, the three mummies discovered in 1999 had been sacrificed on the summit of the Lullaillaco Volcano, which is _____ feet high and located in the country of _____.
47. As described in the film *Child Mummy Sacrifice*, one year before the children died they were taken off their commoner's diet of _____ and shifted to an elite diet of _____.
48. As described in the film *Child Mummy Sacrifice*, the child nicknamed La Nina del Rayo was _____ [older or younger] than La Doncella at the time of death, and La Doncella was _____ [older or younger] than El Nino.

49. As described in the film *Child Mummy Sacrifice*, the archaeologist who discovered the bodies of the three children on the summit of Llullaillaco was _____, and the forensic pathologist who conducted the postmortem analysis of the mummies was _____.
50. As described in the film *Child Mummy Sacrifice*, before they were sacrificed on the summit of Llullaillaco, the children were taken on an arduous journey that lasted approximately _____ and took them through the extremely dry _____ Desert.

Chapter 8

The Arm, Hand, Leg, & Foot

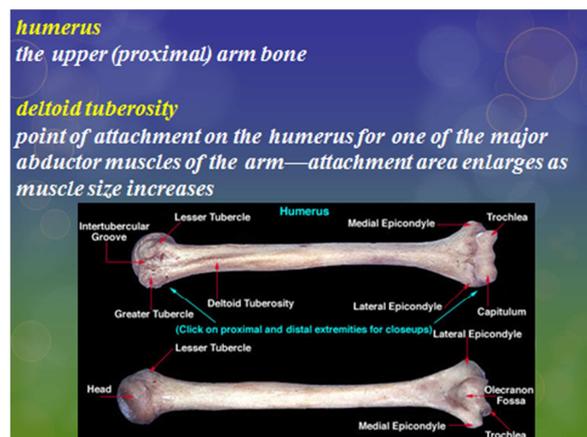
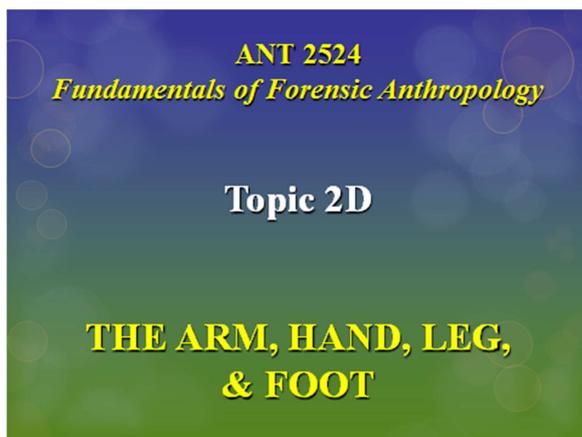
The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 6, 7, 9, & 10 of *Forensic Anthropology Training Manual*), the film that accompanies this topic (i.e., *Secrets of the Dead: Aztec Massacre*), and/or the following website:

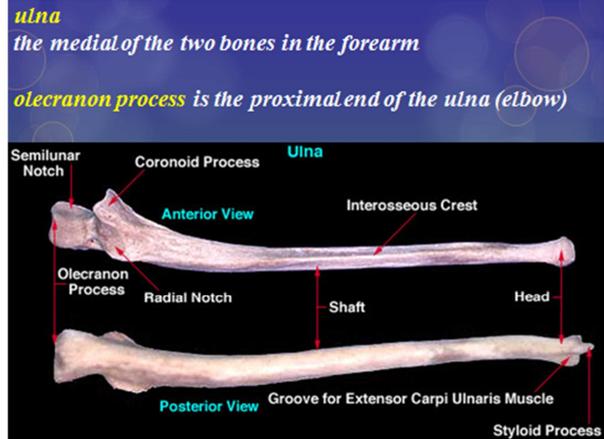
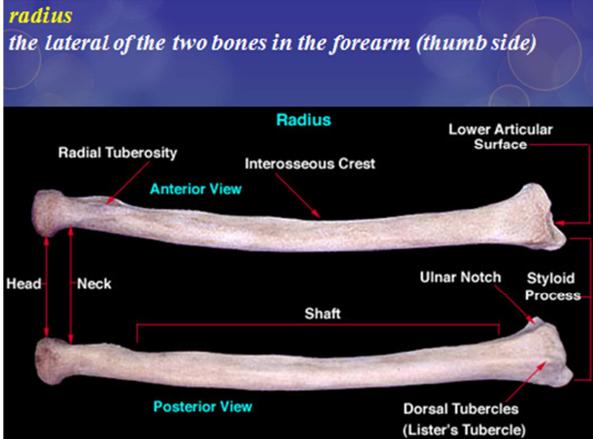
eSkeletons

(When you visit the site, begin by clicking on the human skeleton on the left under the “Taxon” tab. The URL for eSkeletons is <http://www.eskeletons.org/>)

Note: It will be sufficient for our purposes if you know that there are eight carpals and that they constitute the wrist bones; similarly, it will be sufficient for our purposes if you know that there are seven tarsals and that they constitute the ankle and foot bones (you will not be responsible for knowing the names and distinctive shapes of each of the carpals and tarsals). If you plan to take additional courses in human osteology or forensic anthropology, however, you should be aware that this kind of detail will be absolutely essential for any further study.

Classroom Presentation (PowerPoint Slides)



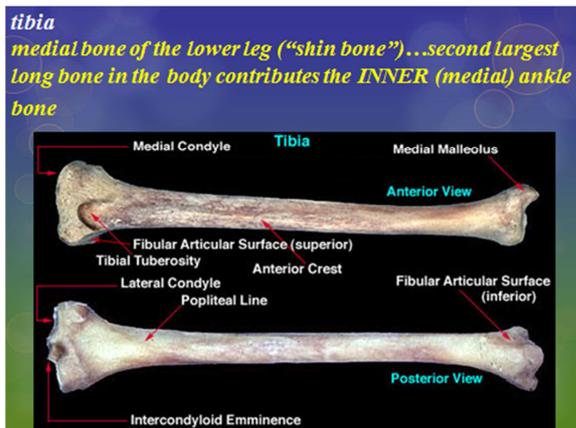
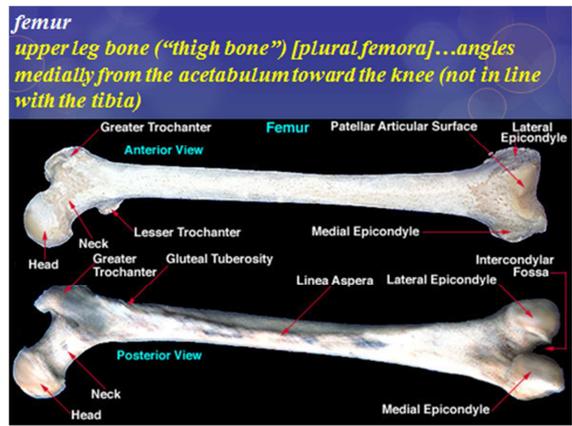


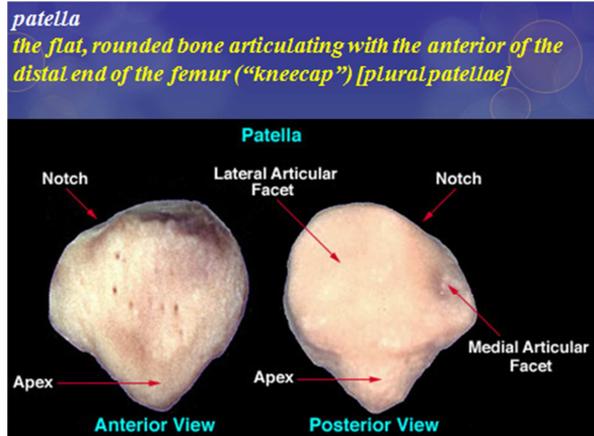
There are 27 bones in the hand

carpals
8 small bones in the wrist

metacarpals
5 bones that support the palm of the hand

phalanges
14 finger bones (2 for the thumb, 3 each for other fingers)
[singular phalanx]





There are 26 bones in the foot.

tarsals

7 small bones in the heel and arch (proximal end of the foot)...only one (the talus) is part of the ankle...the other six are foot bones

metatarsals

5 bones extending from the arch to the toes (longer and thinner than metacarpals)

phalanges

14 bones of the toes [singular phalanx]

Film Summary

Secrets of the Dead: Aztec Massacre

Previously, historians believed that Spanish Conquistadors were seen as gods by the Aztecs, who put up little resistance to their conquest. A new find near Mexico City is turning history on its head. Over 550 bodies were found, more than 40 of which appear to be European, indicating that the Aztecs not only resisted the invaders, they sacrificed them to their gods. *Aztec Massacre* rewrites what we thought we knew about the Aztec civilization.

You can view the entire episode of *Aztec Massacre* on the PBS website at <http://www.pbs.org/wnet/secrets/episodes/aztec-massacre/watch-the-full-episode/1/>

Transcript of *Aztec Massacre*

NARRATOR: Zultepec, Mexico. Archaeologists make a grisly find:

Four hundred skeletons buried in a mass grave. The bodies have lain undisturbed for 500 years, since the time of the Spanish conquest.

But this is no ordinary gravesite. The remains suggest these people met a gruesome end at the hands of the Aztecs, who ruled Mesoamerica in the 14th, 15th and 16th centuries.

But who were the victims and why were they killed? Archaeologist Elizabeth Baquedano has come to find out.

What she uncovers will rewrite history, shatter our understanding of the Aztecs, and reveal the shocking secrets behind the massacre at Zultepec.

With a population of more than 28 million, Mexico City is the largest metropolis in the western hemisphere—the second biggest city in the entire world.

It's a vibrant and chaotic mix of movement and color. But these teeming streets once had a very different look.

Five centuries ago, this was the center of the Aztec world.

A wandering tribe of Aztecs from the north settled on this swampy part of central Mexico in the 1300's.

From migratory beginnings, they rose up to rule an Empire for three hundred years.

The Aztecs were fierce warriors, who ruthlessly conquered and subjugated neighboring peoples to become the dominant force in the region.

Their power and ferocity is well documented, but the scope of the killings at Zultepec has shocked even the most knowledgeable Aztec experts. At the invitation of scientists from the site, Elizabeth Baquedano has come to investigate how these bodies ended up in this mass grave, and how the massacre fits into our understanding of Aztec history.

ELIZABETH BAQUEDANO: What I am hoping to do is not only find out who these people were or how they died, but to answer a much bigger question.

NARRATOR: That question will lead Elizabeth to an unlikely story of colonial invasion, armed resistance, and human sacrifice.

Records show that sacrifice was central to Aztec culture. The Aztecs practiced the ritual with great frequency, using their enemies as the sacrificial lambs.

Could the bodies at Zultepec be evidence of some massive religious ceremony? To find out, Elizabeth must leave Mexico City, and head to the excavation site itself.

The N16 follows an ancient trade route that once connected what is now the Mexican capital and the Atlantic coast.

60 miles down the busy highway, barely noticeable at the edge of the road, lies the scene of the massacre. Once an Aztec stronghold, this is all that remains of the town of Zultepec.

Enrique Martinez has spent more than 15 years as lead archaeologist at the excavation site. His biggest breakthrough was the discovery of the mass grave. It was an incredible find. Even after 500 years in the ground, the bodies have stories to tell about how they ended up here.

So far, 400 have been identified, and the archeologists continue to unearth more remains as they excavate. Each bone contains important clues about the person it came from.

DR. ENRIQUE MARTINEZ: SP: We found something here that's not just a corpse. Its position implies that after it was sacrificed it was mutilated. The pelvis would have been cut along with the femur and we see that those parts are no longer there. Without doubt the lower limbs have been laid out in a special position.

ELIZABETH BAQUEDANO: We can see that some vertebrae are missing here. The pelvis is missing; we also have the femur bone missing so we have clear signs of dismemberment here.

NARRATOR: Other bodies show similar signs of dismemberment. And comparisons reveal a consistent pattern of missing bones. Skeletons had been decapitated, and specific bones had been removed.

These were no ordinary burials.

DR. ENRIQUE MARTINEZ: SP: From the upper vertebrae to the coccyx the bones are disordered. We see that there is no cervical vertebra. After having been sacrificed in the temple this individual was taken here to be mutilated and for people to begin selecting their trophy bones.

ELIZABETH BAQUEDANO: The warrior was allowed to keep certain parts of the body as signs of prowess in the battlefield and he could keep those bones for instance the femur bone. He could hang that bone outside his house in order to show that he was a successful warrior and that he had been able to capture an individual in the battlefield.

NARRATOR: All the bodies display evidence of this kind of ritual killing and post-mortem dismemberment. But they reveal few obvious signs of their identity, or why they were killed in such large numbers.

To our modern eyes, human sacrifice seems like a barbaric practice. But to the Aztecs and other Mesoamerican societies, it was crucial to their very existence. The Aztecs believed the gods had sacrificed themselves to give mankind life, so the ritual was a form of renewal and repayment.

Here in Zultepec, even the location of the bones within the town points to some kind of central ceremony.

DR. ENRIQUE MARTINEZ: SP: This is the south plaza. We can see here the greatest concentration of localized bone evidence. 280-300 individuals.

NARRATOR: Some of the bodies were carefully laid out, while others were grouped together in seemingly random piles.

The majority were buried in shallow graves close to the large temple that had once stood as the centerpiece of the town. The temple was where sacrifices and other religious ceremonies would have been carried out.

Victims usually died on the altar, which was at the top of the structure. The area around the temple would have been walled off, so that only the priests had direct access.

But even so, the entire population would have known what was going on. The rituals were as much for them as they were for the priests, and the killing of this many people would have been a major event in a town like Zultepec.

Today's half-excavated ruins do little justice to the original scene.

After five centuries, it is up to the bones to reveal what took place.

The remains are brought here, to the Anthropological Institute at the National Autonomous University of Mexico.

Artifacts found with the bodies dated the bones to the early 1500s, but scientists are hoping to find out much more about them than just their age.

Forensic anthropologist Magali Cervera has been focusing on one particular analysis:

MAGALI CEVERA: These bones were sent here to the lab just to access the ethnic characteristics. Most of them are shown in the skull.

NARRATOR: When she first started her forensic work, Magali expected to find that all the bodies were indigenous—belonging to members of local tribes who had been captured by the Aztecs.

The skulls of these indigenous people would normally have a broad forehead and wide cheekbones.

But intriguingly, some of the skulls from Zultepec don't fit that profile.

MAGALI CEVERA: You can see for example the shape of the skull. And in this case it has a very long head with a very narrow forehead and we have also the short orbits very quadrangular shape and also you can see these cheek bones which are in a way very light. Also it's important the shape of the palate and the size of the teeth.

NARRATOR: Cervera's analysis leads her to a shocking conclusion. The skulls could not have belonged to local tribes. Their facial characteristics point to an entirely different ethnic and geographic origin.

MAGALI CEVERA: All of these traits make us think that these remains belong to a European.

NARRATOR: Of the 400 skeletons found so far, as many as 40 seem to be from Europe. The discovery is completely unexpected, and immediately raises questions about how the bodies got there.

Back in Zultepec, the results force a re-evaluation of the grave site. New finds not only corroborate the existence of Europeans, they further narrow the field to Europeans from Spain.

The illuminating objects are pieces of iron with telltale signs of Spanish construction and design.

ELIZABETH BAQUEDANO: This is the first iron object to be found at Zultepec. And we know that iron was not actually used by the Aztecs. There is evidence that the horses were with them as well. There are stirrups and we know that the Aztecs didn't have horses; the horses did not exist in the Americas so this is yet another proof that the Spaniards were here at Zultepec.

NARRATOR: The Spanish were the first Europeans to arrive in Mexico. They landed on the Gulf Coast in 1519, searching for wealth and glory. The initial invasion force was made up of just five hundred and fifty men, sixteen horses and a few canons.

PROF. MATTHEW RESTALL: They're not really professional soldiers. Some of them are, but most of them are regular Spaniards they're from middle ranks, the leaders are lower nobility.

They are artisans, professionals of that kind, notaries, tailors, carpenters and so on. I like to think of them as armed entrepreneurs. They were entrepreneurs in that they all invested in this company and that's what the Spaniards called it a company and they invested what they could. So if they were well off and they could provide ships, horses, cannons and so on then they did that even cash investments. If they're poor then they bring themselves, that's their investment, it's a personal investment in their willingness to fight and sacrifice themselves in order to carve out a new province or colony for the, for the Empire.

NARRATOR: Cognizant of a powerful civilization in the Mexican interior, the Spanish Conquistadors didn't linger on the coast for long.

They soon set off inland, and as they traveled, the caravan began to swell. Local people were eager to take up arms against their oppressive Aztec rulers.

After weeks of marching, the column arrived in Tenochtitlan, capital of the mighty Aztec Empire. The Spaniards must have been shocked by what they saw.

Tenochtitlan, with its impressive boulevards and magnificent architecture, had a population of more than 200,000. In the very center of the city was the most significant of all its buildings, the Templo Mayor. This was where the most important Aztec rituals and ceremonies took place. Today, all that remains of the massive structure are these ruins in the heart of Mexico City. They are dwarfed by the metropolitan Cathedral and the surrounding buildings. But back then, they would have presented an imposing sight.

PROF. MATTHEW RESTALL: For me this is one of the great moments in human history. Two civilizations meeting for the first time. Imagine the Spaniards coming through the pass between the volcanoes, and they look down and they see the city laid out before them. Spectacular, beautiful, amazing city, larger than any city in Europe, larger than any other city in the Americas, one of the greatest cities in the world. Tenochtitlan sitting on an island, all the towns around the edge of the lake, combined population of hundreds of thousands of people, they come in to the city, absolutely an incredible moment, cinematic moment.

NARRATOR: Tenochtitlan stood as a testament to the wealth and power of the great Aztec empire.

Into this grandeur walked the Conquistadors. It was to be a fateful confrontation between two very different civilizations.

The Aztecs were ruled by the powerful Moctezuma.

The Spanish were led by the wily and determined Hernán Cortés.

Their first meeting was peaceful but tense.

Cortés was a maverick in his day. He'd already conquered Cuba for the Spanish, but after falling out with the Cuban governor, he had lost his government's support for the mission to the mainland. The lack of backing did little to quell his confidence.

ADRIAN LOCKE: He was not a particularly well educated person he certainly didn't come from the elite, he was just an ordinary working class kind of person really and he was someone who realized quite early I think, the stories that were coming back across the Atlantic were very enticing and he thought well I want a piece of that action you know I want to get out there and I want to grab myself some money and maybe some fame and see what happens, you know.

NARRATOR: Moctezuma, on the other hand, was a sophisticated leader born of Aztec royalty. He was unsure what to make of Cortés and the Conquistadors.

He had been warned of the Spaniard's arrival, and was unsettled by this white-skinned man riding a strange, unknown beast. Moctezuma thought Cortés's appearance might be the fulfillment of an ancient prophesy about a returning Aztec god.

ADRIAN LOCKE: There was part of him that really wanted them to just go away, he didn't want to have to deal with this problem at all and he spent vast amounts of energy trying to encourage the Spanish to just disappear. But there was also part of him that was convinced that this was the return of Quetzalcoatl who was said to have disappeared over the seas in the East and would be returning. Moctezuma was clearly unable to make a definitive decision so he decided the first course of action really would be just to pacify these strangers and give them small gifts.

NARRATOR: These gifts had a profound effect on Cortés and his men.

CORTÉS LETTER: After we had walked a little way up the street a servant of his came with two necklaces, wrapped in cloth, made from red snails' shells, which they hold in great esteem; and from each necklace hung eight shrimps of refined gold almost a span in length. When they had been brought he turned to me and placed them about my neck.

NARRATOR: Though wary, Moctezuma made a great effort to play the perfect host, showing his guests around the city and entertaining them with lavish banquets.

But despite the regal treatment, Cortés remained suspicious—sure that the Aztec leader was planning something sinister. Cortés made the decision to act first...and took Moctezuma captive. The story of what happened next, is still cause for debate among modern-day historians. One version of the events is depicted in extraordinary murals on the walls of the national palace. Famous Mexican artist Diego Rivera, painted the murals in 1929. He used historical sources to make them as accurate as possible.

They represent the traditional view of what happened after the Conquistadors arrived. The paintings illustrate how the great warrior nation of the Aztecs put up little resistance to the invaders, and quickly ceded control of their kingdom to the Spanish.

In this retelling, Moctezuma took too long to admit that the Conquistadors were not resurrected Aztec gods, and that he had chosen the wrong course of action by welcoming them into his realm.

He finally realized they were ruthless enemies, driven by greed and an insatiable thirst for power and wealth. Of course by then, the damage had already been done...

ADRIAN LOCKE: The traditional view of the conquest of Mexico is one great kind of law written into great victories if you like, military victories of world history, how a group of illiterate, largely illiterate, untrained soldiers could march into a nation of some fifteen million individuals and basically lay waste to them and capture the great prize of Mexico, Tenochtitlan and rule over them as if by magic almost. This of course is a very rose tinted view of the reality of the situation.

NARRATOR: It's a classic case of history being written by the victors. But the discovery of the Spanish skeletons at Zultepec, means history might have to be rethought.

The bones have only begun to reveal their secrets. A facial reconstruction lab at the Anthropological Institute is providing additional details about who the victims were.

Edgar Gayton is the forensic artist doing the difficult reconstruction work.

He is painstakingly building a profile of each skull. His endeavors have led to the biggest breakthrough since the discovery that many of the victims were European.

EDGAR GAYTON: SP: Every human is different and the same characteristics that were recognized in life are reproduced in the skull. In this case we can see that this skull is more masculine and this one feminine. It has much more rounded features.

NARRATOR: The analysis has revealed that at least ten of the skulls belonged to European females.

It's an important revelation, because it narrows down the exact time frame in which the massacre could have taken place.

From Cortés' letters, Elizabeth determined that when he first arrived, he led an all-male crew. There were no women at all in his original convoy.

But soon after, a second party of Spaniards followed Cortés to Mexico. They were sent to arrest him, since he had left on his mission without Spanish consent. This group did have women with them.

ADRIAN LOCKE: He'd secured this passage without the knowledge of the governor and the governor was fairly sort of unhappy about the whole thing because he had no control over Cortés or this mission really. I think that this was a very competitive kind of moment and everyone was

quite keen to get out there and be the first to get in to the action if you know what I mean and make the most of the opportunities that were presenting themselves.

NARRATOR: When Cortés heard about the second convoy, he had no choice but to confront them.

ADRIAN LOCKE: He had to do something. He realized he had something pretty special within his grasp really, and this was not something that he wanted to share with anyone and it certainly wasn't something that he wanted taken away from him in terms of the control. Cortés of course leaves Tenochtitlan to go back to Veracruz to find out what it is that the secondary group of Spaniards that had followed him, followed him with the aim of finding out what he was up to and probably to wrestle control from him.

NARRATOR: Leaving a small garrison in charge of the Aztec capital, Cortés marched east with a band of his finest soldiers. He arrived back at the coast and went to battle—quickly vanquishing his would-be captors.

Not wanting to stay away from Tenochtitlan any longer than necessary, Cortés immediately gathered up the defeated soldiers and their entourage of women and slaves, and set off on his return trip.

His urgency was well-warranted. According to most accounts, word reached him during the march that Moctezuma had died. To this day it is unclear whether he was killed by his captors or by his own people, but either way, Cortes recognized the precariousness of his situation. He needed to get back to the Capital.

ADRIAN LOCKE: He knew the situation was tense. He didn't know what was going to happen next but he had seen the city, he had been living in the city, and he knew that there was a lot of wealth there and by you know, by no way was he just going to give that up. He wanted to get back there and claim his rightful share.

NARRATOR: The route Cortés took can still be followed today. It's a long trail that meanders through the Mexican countryside. As had happened on his original journey, the caravan's numbers swelled with locals who were eager to enlist in a campaign against the Aztecs. With few horses and an ever-growing number of men and women in tow, the column's progress slowed to a crawl. The group had safety in numbers, but they weren't moving fast enough to suit the anxious Cortés.

ELIZABETH BAQUEDANO: They traveled through this rugged terrain towards the Aztec capital Tenochtitlan. They had great advantages. The use of weapons of fire and horses.

NARRATOR: These tools must have comforted them, because as they moved farther inland, they could feel the growing Aztec unrest.

Later, Cortés wrote about the journey. He described how he eventually made the crucial decision to leave the slow masses behind, and move ahead faster with just a small group of soldiers. He never mentioned the convoy again.

Cortés knew that if he delayed any longer, he risked a full-blown Aztec uprising and the loss of all the wealth and recognition he so desperately craved.

Hundreds of men and women—both local and Spanish—were left to fend for themselves in ever-more-hostile Aztec territory.

The large group, abandoned by Cortés and still moving slowly, had little choice but to continue making its way west towards the capital. Despite their numbers, they had few weapons and even fewer trained soldiers. They must have seemed like an easy target for the well-trained Aztec warriors.

There are no records about the final attack, but it was only a matter of time before the convoy was overrun. The Aztecs had an intimate knowledge of the area, the element of surprise, and a prowess for ambushing in the dark.

The travelers didn't stand a chance. As was their custom, the Aztecs would have captured their enemies alive. Their fates would be sealed on the altar, not the battlefield.

ADRIAN LOCKE: For the Aztecs warfare was much more of a ritual that was related to their religious worship. They tried to capture the more exalted and honored members of their opposing society and these captures, these captives they would take back to their city where they would be kept and then ritually sacrificed when the time came.

NARRATOR: The Aztecs were known to keep their victims prisoner for months.

For the Conquistadors and their entourage, the wait must have seemed interminable.

The conditions would have been wretched. Little food, little light, and the growing certainty of incomprehensible horrors to come.

The Spanish had no basis for understanding human sacrifice as anything other than an agonizing and barbaric way to die. But for the Aztecs, the ritual was a necessity for survival. To them, sacrifice was not a form of punishment, but the ultimate opportunity to do one's part for the perpetuation of the universe.

The spectacular city of Teotihuacán was one of the Aztec centers of human sacrifice. The magnificent temples and pyramids were all built in devotion to the gods. Each year, hundreds of thousands of visitors would flock to the city to pay tribute to the deities.

Teotihuacán was known as “the city of gods.” It would have been a stunning backdrop for the sacrificial ceremonies.

ELIZABETH BAQUEDANO: Human sacrifice was very important to the Aztecs, because they believed that without it the gods would go unnourished and the world would come to an end.

NARRATOR: Each of the Temples lining the avenue was dedicated to an individual god. There were gods for each season, and for important festivals in the Aztec calendar. Every god was connected to some aspect of the natural world. They required frequent offerings in their honor.

The Aztecs presented food and animals. But the ultimate gift was the sacrifice of a human life.

ELIZABETH BAQUEDANO: According to myth, the gods gathered here at Teotihuacan to create the sun and the moon. Everything was in darkness. It was necessary for the gods to sacrifice themselves. In order to do that they had to throw themselves into a huge fire. In turn, men had to do the same. They had to sacrifice themselves to keep giving that precious nourishment, those precious hearts in order to have the sun moving, in order to have the cosmos in balance.

NARRATOR: The entire Aztec world revolved around this need. Human sacrifice was required to keep their world turning.

One by one, living victims would be brought before the priests.

The actual death blow was forcefully abrupt—it was crucial for the severed heart to remain beating as it was offered up to the gods.

ADRIAN LOCKE: What of course is very difficult for us to understand culturally is what human sacrifice was all about and how it took place and why it was acceptable, because of course to us, human sacrifice seems the most unacceptable of all kind of activities. It's very difficult to look at that in a very kind of realistic way but certainly the Aztec concept of the world and their understanding of the universe and their right to live in it, to participate in it, was based on the sacrifice of the gods themselves.

NARRATOR: Cortés witnessed the bloody ritual with his own eyes. He recorded every graphic detail of the ceremony in his letters.

CORTÉS LETTER: They take many girls and boys and even adults, and in the presence of idols they open their chests while they are still alive and take out their hearts and entrails and burn them before the idols, offering the smoke as sacrifice.

NARRATOR: What Cortés didn't see, was that his own abandoned people were receiving the same treatment.

Back in Zultepec, the Spanish had become the latest offering to the Aztec gods.

DR. ENRIQUE MARTINEZ: SP: This is where they carried out the sacrifices of their captives. Here they suspended people, held by four priests, they removed the heart and offered it up to the sun.

NARRATOR: The sacrifices were only performed by specially trained priests, who were adept with both the ritual...and the knife.

This was their sacrificial altar.

ELIZABETH BAQUEDANO: The victim was laid out on the platform. Four priests were at the back holding each limb, and a fifth priest would actually insert a knife, cut the chest open, tear the heart out and offer it to the sun. The heart was placed on a sacred vessel and then the vessel was brought down the steps. The victim sometimes was rolled down the steps and priests were receiving the victim at the bottom of the temple. When the heart was taken out and it was offered up to the sun, to the god, it was the most precious of all the offerings humans could give to the gods. We know that this very stone witnessed each and every sacrifice at the temple.

NARRATOR: The altar stone remains, and Enrique has even discovered a blade that might have been used in the ceremonies.

ELIZABETH BAQUEDANO: This is the only sacrificial knife that has been found in this ceremonial area.

NARRATOR: The knife was made of flint, with an edge sharp enough to cut through a human chest in a single plunge.

ELIZABETH BAQUEDANO: It had a special box so it was kept and safeguarded every time it was used for human sacrifice.

NARRATOR: The ritual was carefully orchestrated. All the sacrifices at Zultepec took place high on the temple mount. Only the priests took part in the ceremony itself. But once the killing was over and the human offering had been made, the macabre remains were put on show for the general public to see.

DR. ENRIQUE MARTINEZ: SP: They have pieced together this timber rack to reflect what the original Tzompantli would have looked like. Tzompantli is the Aztec word for a skull rack. Once the victims were sacrificed to the gods their heads were hung here like trophies.

NARRATOR: In preparation for being displayed, each head was punctured through the left and right temple.

ELIZABETH BAQUEDANO: The skull rack was an altar which normally was placed in front of the main temples. The skulls would have been placed on these beams like beads on a necklace.

NARRATOR: More than two dozen of these pierced skulls were found at Zultepec. At least half of them were of European origin.

The mutilated Spanish remains have provided a clear picture of what befell this unfortunate band of Conquistadors. The next step for Elizabeth is to see if she can find any historical records that corroborate the physical evidence.

The place to go for such records is back in Mexico City. The Library of Anthropology houses priceless and beautiful codices—painted books that document Aztec stories. Most of the manuscripts that still exist were created by early Spanish settlers, but many of these are based on older Aztec pictograms.

DR. CARMEN AGUILERA: I think I have here the Florentine codex. That has, well the Florentine codex is three volumes, but there are several scenes of sacrifice.

NARRATOR: Historian Carmen Aguilera has some interesting images for Elizabeth to see.

ELIZABETH BAQUEDANO: So which one are you going to show me first?

DR. CARMEN AGUILERA: Well, I think the Florentine picture, because it's very illustrative of how 16th Century people represented human sacrifice. Here we have a picture of sacrifice by taking out the heart of the captive.

NARRATOR: This simple ink drawing, penned by a European scribe not long after the conquest, clearly depicts an Aztec sacrifice of a local victim.

But what Elizabeth wants is any references to the sacrifice of Spaniards.

Carmen can't go back to the original codices, which are kept in temperature-controlled vaults to keep them from disintegrating.

But she does have facsimiles of the important works, and thinks she knows just where to look for entries about the Spanish.

DR. CARMEN AGUILERA: This is the twelfth book of the Florentine codex.

NARRATOR: Buried within this five hundred page tomb is an illustration that, until now, has never truly caught Carmen's attention.

ELIZABETH BAQUEDANO: Yes!

DR. CARMEN AGUILERA: Oh you found it. Instead of showing the heads of the Indians it shows horses' heads and human heads.

NARRATOR: This tiny, crude illustration contains two important clues.

First is the horse heads on the skull rack.

The Aztecs didn't have horses, so they must have been captured from the Conquistadors.

But even more telling is the depiction of the human heads on the rack.

They are heavily bearded.

Since the locals had little facial hair, the beards were a defining characteristic of the Spanish soldiers.

For Elizabeth, this is just the corroborating evidence she has been looking for. It's a direct link between the historical records and the Zultepec bones.

But not all her questions have been answered by the codices.

In the fleeting but tempestuous period of Spanish invasion and Aztec uprising, had there been more to the sacrifices than religious tradition?

Warfare expert Ross Hassig, believes the Aztecs may have had political motives for sacrificing their enemies.

ROSS HASSIG: It's painted as religious, but in fact it was being used for political purposes and the primary purpose of this was to solidify the empire.

NARRATOR: It's well-documented that the Aztec warriors terrorized their weaker neighbors, and governed their empire with intimidation and fear. They exacted heavy taxes from their subjects, and gave them little freedom.

Not surprisingly, the Aztecs flourished under this system. But they also worked hard to consolidate and maintain their power. And that, says Ross, is where the other purpose of human sacrifice came in.

ROSS HASSIG: When they had the opportunity, the Aztecs would take captives and make a public display of them. They actually took the skin off the face and their hands, tanned it and sent it around to a lot of these wavering cities. The whole purpose of this kind of display, sacrifice and display, is to intimidate your friends and your enemies and so the Aztecs would have killed these people publicly, displayed their remains publicly, as a way of ensuring the loyalty and fealty of a lot of towns that may have been wavering in their support.

NARRATOR: Could this have been the motive behind the massacre at Zultepec?

ROSS HASSIG: It maybe really was this incident in 1520 where they had all these Spaniards and they were able to sacrifice them at leisure, display them publicly without fear of any reprisals and then send these materials around to a lot of their allies.

NARRATOR: One can only wonder if Cortés and his men in Tenochtitlan caught wind of what was happening to their brethren in Zultepec. If they did, it would have been a chilling warning at a time of escalating violence between the Aztecs and the Conquistadors.

What we do know, is that Cortés did not stay in Tenochtitlan for long after the death of Moctezuma. With the city in chaos, he was forced to retreat.

The Spanish in Zultepec didn't have that option. And further examination of their bones is revealing that their desecration continued, even after death.

The unfortunate victims had been captured, imprisoned, sacrificed to the Aztec gods and dismembered. Their still-beating hearts had been ripped from their chests.

And now there is evidence they were eaten as well.

Enrique Martinez's storeroom contains thousands of artifacts found at Zultepec. He has obsidian blades and rare pottery burial pots.

Everything has been carefully sorted and catalogued.

One of Enrique's most prized relics is a stone chamber that was used to hold human hearts during the ritual sacrifices.

But even among all these priceless treasures, it is the bones that provide the most information about the massacre.

Whole skeletons tell one story, but individual bones tell another.

Once the captives had been sacrificed, their bodies were dismembered and ritually prepared. The long bones were given to the warriors as trophies. But first, they had to be stripped of flesh and treated.

DR. ENRIQUE MARTINEZ: SP: They put the remains in lime to stop them putrifying and eventually they would be displayed in people's houses.

NARRATOR: Other bones appear to have been cooked at high temperatures.

DR. ENRIQUE MARTINEZ: SP: Some of the bones have been cremated; they would have been put directly on top of the fire.

NARRATOR: The preparation of all these bones suggest that the sacrificial killing was just step one, followed by cooking...and eating...

DR. ENRIQUE MARTINEZ: SP: As well as being ingested the bone has been chewed and eaten too... bit by bit. This is another characteristic that you will notice in the preparation of the bones.

NARRATOR: They display all the hallmarks of having been cooked and consumed.

ELIZABETH BAQUEDANO: We can see some of the marks. These marks actually are of human beings when the person chewed the bones. And we know that the marrow was ritually eaten. It was taken out and eaten.

NARRATOR: Historians have long suspected that the Aztecs indulged in cannibalism. But according to Enrique, this is the first time that actual archeological evidence has been found to back up the claim.

Once again, the discoveries at Zultepec are corroborated by illustrations in the Aztec codices. This time, it's eerie images of Aztec warriors cooking and devouring their enemies.

ADRIAN LOCKE: There were also rituals in which human flesh was eaten. Now whether this was done to strike dread into the hearts of the Spanish, or whether it was done because the Aztecs felt that it might drain the power of the Spaniards. Maybe they felt very strongly that they'd upset the gods and the only way that they could appease them would be to offer the highest form of sacrifice which would be to capture a Spaniard or his horse and sacrifice it, is open to question, but certainly sacrifice of the Spaniards did occur.

NARRATOR: At long last, the full story of the massacre at Zultepec has been wrestled from the bones.

What began as a bold foray into the new world by a band of Spaniards ended up in a bloody execution that defied their European comprehension.

With 21st Century hindsight, the episode sheds new light on the confrontation between the Aztecs and the Conquistadors.

ELIZABETH BAQUEDANO: In my opinion it is certainly a good time to reconsider this important chapter in the history of the conquest of Mexico.

NARRATOR: The widely accepted view, is that the Conquistadors took on the mighty Aztec nation, and brought down their Empire with little resistance. But this history, of course, has been written by the victors.

The truth is not as clear-cut. After fleeing from the Aztec uprising in Tenochtitlan, Cortés and his men regrouped. But it took two long years before they finally conquered the Aztecs. By then, Cortés was back in the Spanish King's good graces, and was appointed governor of the new territory.

In his new role, he demolished the great Aztec capital and laid the foundations for what is today Mexico City. His metropolis soon became a beacon of European influence in the Americas.

The Aztec resistance was all but forgotten, until the ruins at Zultepec provided some balance to the history.

ADIAN LOCKE: I think it's important because it tells an aspect of the story that is not often told. One of those really is to perhaps lay bare the myth that the Spaniards just simply moved in

and the Aztecs rolled over and if you like just gave up because we know that they didn't, they fought hard.

NARRATOR: There can now be little doubt that the Spanish conquest of the Aztec Empire was a bloody affair for both sides. Each nation relied on its own tactics, traditions and beliefs. The Spaniards eventually triumphed, but at least at Zultepec, there is definitive archeological proof that the Aztecs fought back...

This episode can be viewed in its entirety online at the PBS website for the series *Secrets of the Dead*: http://www.pbs.org/wnet/secrets/episodes/aztec_massacre/1/

Quiz Questions for Topical Quiz # 2D

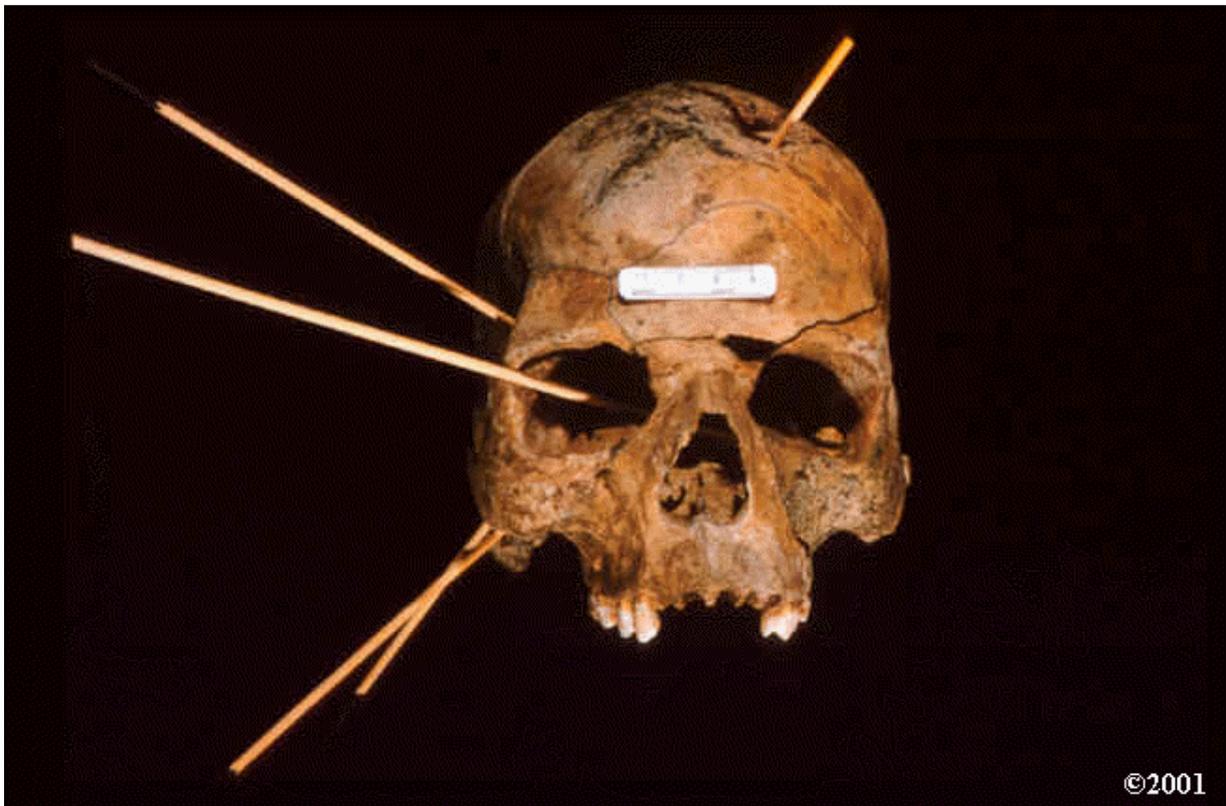
1. The proximal bone of the arm between the shoulder and the elbow is the _____.
2. The area of attachment for one of the large abductor arm muscles that is found on the humerus is called the _____.
3. The lateral of the two bones in the forearm—the one that is closest to the thumb—is called the _____.
4. The medial of the two bones in the forearm—the one that is closest to the fifth finger—is called the _____.
5. What is the common name for the proximal end of the ulna?
6. What is the technical term for the proximal end of the ulna?
7. The total number of bones in one hand is _____.
8. The total number of bones in one foot is _____.
9. The small bones of the wrist are called _____.
10. The total number of carpals that can be found at the distal end of a single limb is _____.
11. The total number of tarsals that can be found at the distal end of a single limb is _____.
12. The bones in the proximal portion of the foot, including the ankle, heel, and arch of the foot, are called _____.
13. The total number of metatarsals that can be found at the distal end of a single limb is _____.
14. The total number of metacarpals that can be found at the distal end of a single limb is _____.
15. The total number of phalanges that can be found at the distal end of a single limb is _____.
16. The bones of the fingers are called _____.
17. The bones that extend from the arch of the foot to the toes are called _____.

18. The bones that support the palm of the hand are called _____.
19. The bone that is commonly referred to as the thigh bone is called the _____.
20. The proximal bone of the leg between the hip and the knee is called the _____.
21. The slender, lateral bone of the distal leg is called the _____.
22. The outer ankle bone is the _____ [*medial* or *lateral*] malleolus of the _____ [*which bone?*].
23. The inner ankle bone is the _____ [*medial* or *lateral*] malleolus of the _____ [*which bone?*].
24. The large, medial bone of the distal leg is called the _____.
25. The bone that is commonly referred to as the shin bone is called the _____.
26. The bone that is commonly referred to as the kneecap is called the _____.
27. The flat, rounded bone that articulates with the anterior of the distal end of the femur is called the _____.
28. The bones of the toes are called _____.
29. Among the ankle, heel, fingers, knee, palm, and toes, which bones are included in the tarsals?
30. Among the ankle, heel, fingers, wrist, palm, and toes, which bones are included in the carpals?
31. The longer of the two bones in the lower arm is called the _____.
32. The bone commonly referred to as the upper arm bone is called the _____.
33. The proximal end of the tibia is the _____.
34. The shorter of the two bones in the lower arm is called the _____.
35. The distal end of the femur is the _____.
36. The distal end of the ulna is the _____.
37. "Olecranon process" is the technical term for the _____.

38. The smaller of the two bones in the lower leg is called the _____.
39. “Deltoid tuberosity” is the technical term for the _____.
40. The proximal end of the tibia is the _____.
41. The plural of *phalanx* is _____.
42. The plural of *patella* is _____.
43. As described in the film *Aztec Massacre*, the former Aztec stronghold of Zultepec is located about _____ miles from the Aztec capital of Tenochtitlan (the site of present-day Mexico City).
44. As described in the film *Aztec Massacre*, Mexico City, which is located on the site of the former Aztec capital of Tenochtitlan, is the largest metropolis in the Western Hemisphere with a population of approximately _____.
45. As described in the film *Aztec Massacre*, the bodies from the mass grave at Zultepec all shows signs of mutilation and dismemberment; the bones that were generally missing (because they had been taken away as trophies) included _____.
46. As described in the film *Aztec Massacre*, approximately _____ percent of the 400 skulls discovered at Zultepec were of European rather than American Indian ancestry.
47. As described in the film *Aztec Massacre*, broad foreheads and wide cheekbones are characteristic of people of _____ ancestry, while long, narrow faces are characteristic of people of _____ ancestry.
48. As described in the film *Aztec Massacre*, the Spanish first landed on the Gulf Coast of the Aztec empire in the year _____ with an initial invasion force of approximately _____ men.
49. As described in the film *Aztec Massacre*, important evidence that the Aztec’s sacrificial victims included Spaniards can be found in a facsimile of a 16th century codex; the book contains an illustration of a skull rack that includes two significant items, namely _____ and _____.
50. As described in the film *Aztec Massacre*, how long did it take Cortes to complete his conquest of the Aztec Empire after he fled Tenochtitlan following the death of Moctezuma?

UNIT III

THE PRACTICE OF FORENSIC ANTHROPOLOGY





Chapter 9

Determination of Sex

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 3, 8, 9, & 13 of *Forensic Anthropology Training Manual* and Chapters 8 & 9 of *Dead Men Do Tell Tales*) and/or the film that accompanies this topic (i.e., *Peru's Mass Grave Mystery*).

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 3A

DETERMINATION OF SEX

Sex Differences in Skull

superior orbital rim
rounded and roughened in males, sharp in females

posterior edge of the mandible
flared in males, not flared in females (gonial angle [ascending ramus/mandible] is vertical and sharp [approaches 90°] in males, angled and obtuse in females)

zygomatic process
extends to the external auditory meatus and beyond in males, ends before the external auditory meatus in females

forehead
sloping & less rounded in males, vertical & more rounded in females

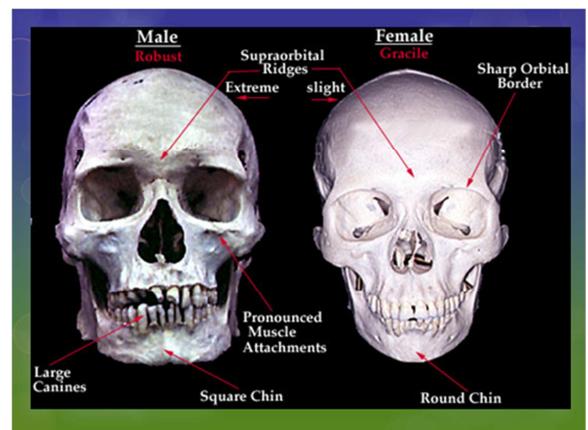
supraorbital ridge
prominent in males, absent in females

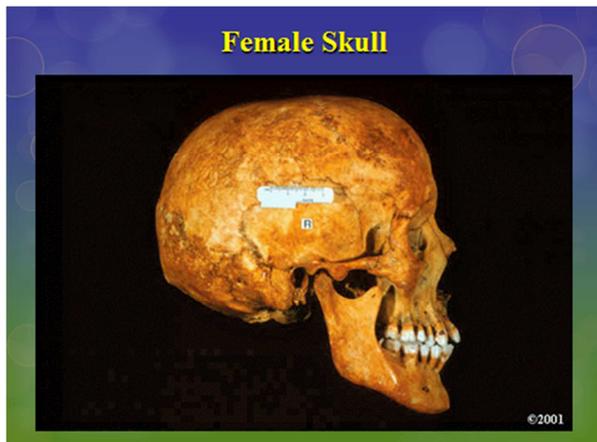
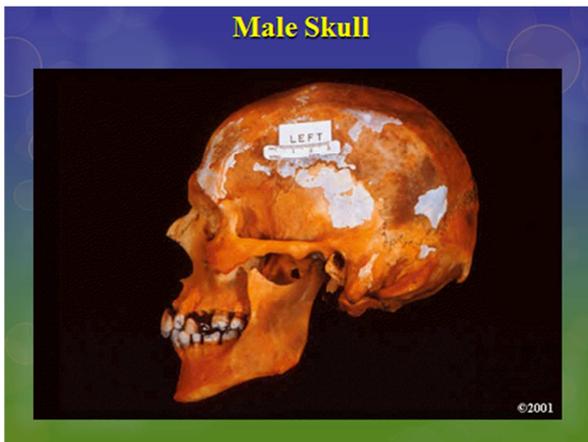
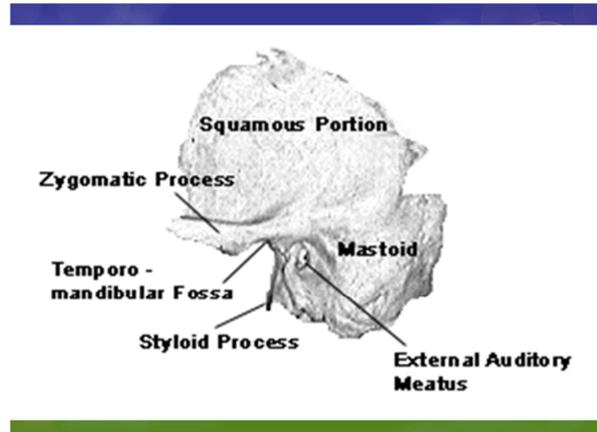
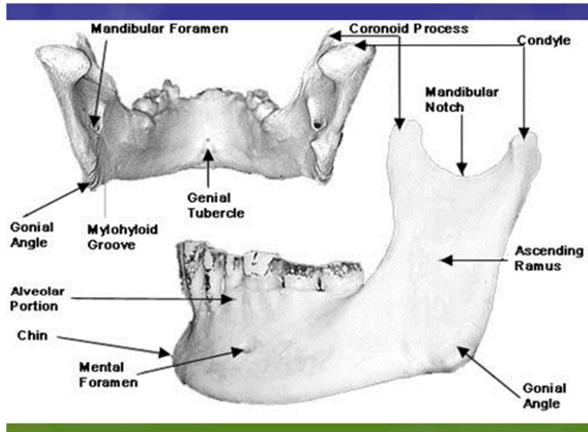
mastoid process
large in males, small in females

ascending ramus
wide & sharply angled in males, narrow & less angled in females

shape of the chin
square in males, rounded or pointed in females

nuchal crest of the occipital
well developed & robust in males, less developed & gracile in females



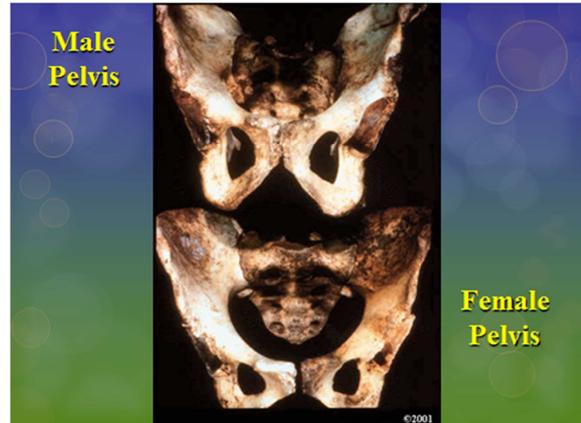


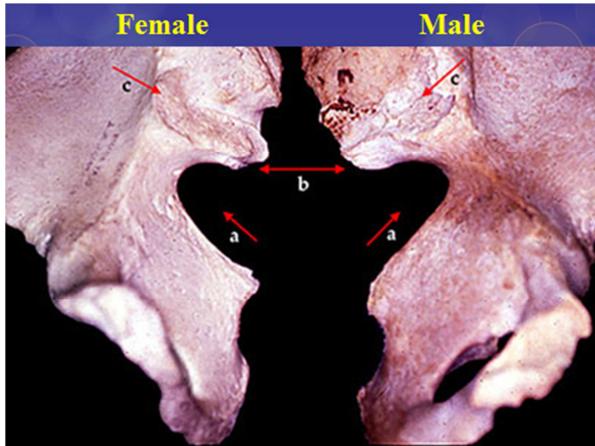
Sex Differences in Pelvis

subpubic angle
narrow in males, wide in females

size of the pelvic inlet
smaller in males, larger in females

sciatic notch of the ilium
narrow in males, wide in females—the preauricular sulcus [groove], usually associated with the trauma of childbirth, is located just inferior to the auricular surface, which is the medial surface of the ilium just superior to the greater sciatic notch





Sex Differences in Femur

femoral head

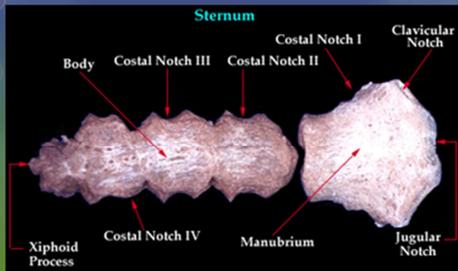
males are greater than 46.5 mm, females less than 43.5 mm

(with an obvious intermediate range; based on sexual dimorphism, which varies among populations...generally used when there is no pelvis or skull and the individual is from a well-documented population).

Sex Difference in Sternum

length of the sternum

the body is MORE than twice the manubrium length in males, LESS than twice the manubrium length in females



collagen

Collagen is an organic substance that gives bone its elasticity, adding to its strength and preventing breakage...gives bone ability to bend and flex within tolerable limits...calcium and other inorganic elements can be leached out of bone by soaking in hydrochloric acid, which leaves behind a substance resembling hard rubber, allowing the long thin fibula to be carefully tied into an overhand knot

osteomalacia

"bone softness" in Greek, characterized by a superabundance of collagen, disproportionate to the inorganic bone matrix...victims able to tie legs in knots, such as "The India-Rubber Man" or "The Boneless Wonder"

osteoporosis

along with hyperthyroidism and *osteogenesis imperfecta* are imbalances in bone chemistry rendering bones brittle as twigs

There is not one precise answer to the question "how many bones are there in the human body" because bones progressively fuse during life.

Parturition scars form in the fourth month of pregnancy when a hormone is released that softens the tendons that knit the pelvic bones together.

"Gracile" (from the Latin *gracilis*) means smoother, less knobby, with edges gracefully planed or beveled, and "robust" (from the Latin *robustus*) means thick, pitted, and bumped with rough irregularities where the muscles and tendons are attached.

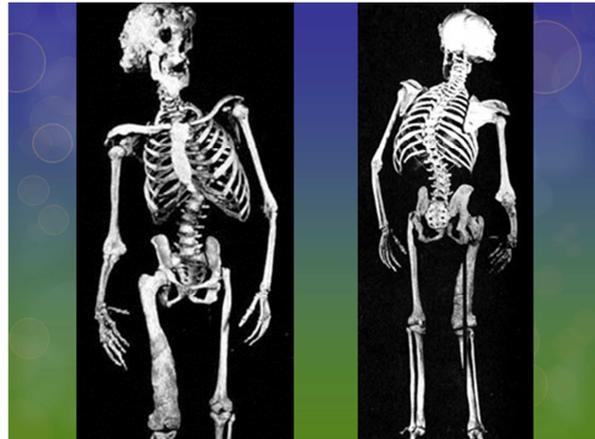
Males are generally robust, and females are generally gracile.

King Robert the Bruce was the hero of the Scottish wars of independence who forced the English to relinquish their claim to Scotland in the 1328 Treaty of Northampton...died 1329 from a mysterious wasting disease...exhumed 1819...upper incisors missing, maxilla eroded...thought in Middle Ages to have died of leprosy, caused by *Mycobacterium leprae*, which hates heat and heads for cooler areas of the body (the buttocks, the nose, the extremities of the limbs, the testicles, where it gnaws away at nerve endings and skin and cartilage tissue)...patient's features collapse, resulting in "leonine" face characteristic of leprosy)...20th century Danish doctor investigated medieval skeletons, identified cast of skull of Robert the Bruce as unmistakable *facies leprosa*, the name he gave to the characteristic deformity of the maxilla caused by leprosy.

Cast of the Skull of King Robert the Bruce



Joseph Merrick was the "Elephant Man" of the 1880's...skeleton prepared immediately after death and kept in the Royal London College of Medicine Museum...genetic disorder might be Proteus syndrome, a newly discovered and rather obscure disorder...short skeleton with bony defects not symmetrical (parts of the left side were spared)...right side of braincase had massive nodules...oversized right hip...hair samples remain in plaster that may eventually provide DNA to solve genetic mystery of disorder (no DNA left in bones themselves, which were burned)



Maples has seen shotguns, rifles, pistols, knives, hatchets, axes, meat cleavers, machetes, ice picks, bayonets, hammers, wrenches, screwdrivers, crowbars, pry bars, two-by-fours, tree limbs, jack handles, building blocks, crutches, artificial legs, brass bedposts, pipes, bricks, belts, neckties, pantyhose, ropes, bootlaces, towels, chains, and more, including a pair of sneakers (stepping on throat), a frozen ham, and a Pepsi bottle used as murder weapons.

He's never seen a *candelabrum* (apparently confined to England!) or an *icicle* (allegedly the perfect weapon, because it melts afterward) used...ditto a *lead pipe*, since lead isn't used to make pipes anymore.

William Maples was able to come to several conclusions about the skull of a 13-year-old Florida girl found inside a paint can in 1978:

Skull found in paint can only a couple of weeks after the girl disappeared from a school bus stop...dried remnant of cartilage covering occipital condyle had been cut while fresh...head had been removed with a knife immediately after death, then skull defleshed with knife...fracture of upper jaw resulting from a blow...all of the *perisoteum* (tough fibrous material covering bone) had been removed before putting bone in paint can, allowing rusty scratches to be made on the surface of the bone which had been scraped clean and boiled before being put into can.

Based on his analysis of the remains of a six-month-old boy who had been killed by his father (the confessed murderer Michael Durocher), William Maples able to come to several conclusions:

1990 death row inmate Durocher decided to get certain matters off his conscience...told about murders and burial of girlfriend, her 5 year old daughter, and their six month old son ten years earlier...but said "that's for you to find out" when asked how he had killed son (others had been shotgunned)...infant bones unmarked...with adults, stab wounds miss bone about 50% of the time...perforation in bib of infant underneath unsnapped jacket, also in t-shirt underneath at same angle...Durocher eventually admitted it.

Maples' observations about various methods of capital punishment:

Hanging can be needlessly cruel, because it can result in anything from a merciful narcosis to an excruciating agony of strangulation lasting several minutes to outright decapitation...brain can live as long as it has oxygen, even if spinal cord has been severed and nervous system truncated, so even an unmoving body may be conscious...

Guillotine doesn't extinguish life in an instant, merely cuts the windpipe and blood supply and nerve endings, but brain may take a few seconds to feel the effects of the sudden deprivation of oxygen and blood...consciousness may remain for several seconds.

Gas chamber no more humane, because hydrogen cyanide gas doesn't have an instantaneous effect...prolonged gasping instead...method that uniquely requires cooperation of the condemned, to draw fatal breath...some of them hold their breath for as long as possible.

Electrocution least cruel of all methods, except for one...Maples believes the tremendous charge of electricity sent into the brain probably scrambles the nervous system, making it impossible to sense any pain.

The most humane is lethal injection...although occasional difficulty of finding a vein (esp. with chronic drug abusers), and many physicians balk at administering fatal injection

Film Summary

Peru's Mass Grave Mystery



Anthropologist Marla Toyne examines some of the nearly 16,000 bones found at Kuelap

In the cloud forests of Peru are the remains of a lost civilization and an ancient legend of mass murder. This National Geographic Society film explores the evidence to solve the mystery of who or what filled the residents of a remote outpost on the fringe of the Inca Empire.

High in the Peruvian Andes (9,800 feet above sea level), archaeologists are excavating the forgotten city of Kuelap, where a mass grave with more than 100 bodies has been found. The city contains hundreds of houses that were once home to thousands of people. The residents, who were known as Chachapoya or Cloud Warriors, vanished overnight under mysterious circumstances. In August 2007, archaeologists discovered more than one hundred skeletons in a small area of less than twenty square meters on the edge of the city. The skeletons were tangled, crumpled, and singed with fire. The bodies had not been buried, but simply deposited on the floors of the houses. It's clearly a scene of carnage, but exactly what happened here more than 400 years ago has long been a mystery. Bioarchaeologist J. Marla Toyne has made many trips to Kuelap, and she joins the investigative team after the mass grave is discovered.

The region surrounding Kuelap lies on the northern fringes of the ancient Inca Empire. For centuries, it was home to a loose confederation of Chachapoya tribes who were often in violent competition with the Inca. Shortly before the Spanish conquistadors arrived, the Inca managed to gain essential control of the Chachapoya homeland. Thus the historical evidence suggests two possible culprits for the mass slaughter at Kuelap: either the Inca or the Spaniards.

Kuelap is a fortress city with walls that are 60 feet high. The external walls are filled with human bones—for centuries the city served as a sacred cemetery for the Chachapoya. Hundreds of additional graves are found in the steep cliffs immediately beneath the fortress. The researchers have to rappel down the face of the cliff some 200 feet to reach the tombs they want to investigate. It's unclear how the Chachapoya accessed these grave sites, or why they went to the trouble to make such elaborate burials. However, it appears that Kuelap was a sacred site for a wide region—people from far away would make the pilgrimage to Kuelap to bury their dead in this revered place.

Dr. Toyne arrives at Kuelap after the excavation has been concluded, but she is able to examine detailed records created by the archaeologists, including drawings that show the exact position of each and every bone fragment (in addition to the exact location of every artifact, such as tools and pieces of pottery). The skeletal positions indicate to Toyne that the bodies were in the original positions they had been in when they were deposited fully-fleshed on the ground. The bodies were not seated and flexed in mummy bundles in accordance with standard Chachapoya burial practices. There had been no ritual burial—each body lay crumpled on the ground where it had fallen. The researchers' goal now is to determine the circumstances of the deaths of the people: were they the victims of a mass suicide, epidemic disease, or homicidal violence?

The Chachapoya were traders whose geographic location allowed them to control vital trade routes from the coasts to the Amazon jungles. They exchanged spices, seeds, medicines, and poisons from the Amazon with silver, gold, and grain from the Inca to the south. Perhaps most importantly, they traded in pottery. The various styles of pottery found at the site allow archaeologists to date precise points in history. Most of the pottery found at Kuelap is Chachapoya pottery, made in the distinctive local style—but a small portion of the pottery is Inca, indicating that the site dates to the time after the Incan influence was established, around 1470 C.E. However, archaeologists also find a piece of Spanish colonial pottery with a characteristic glossy finish. Based on this fragment of pottery, archaeologists can conclude that the mass slaughter at Kuelap took place during the early colonial period, sometime after 1570 C.E. This raises the possibility that the victims at Kuelap succumbed to a weapon of mass destruction brought by the Spaniards: disease. Spanish conquistadors carried with them diseases to which the Native Americans had no natural immunity, including small pox, influenza, and measles. Historical evidence indicates that disease was in fact the most destructive element in the Spanish conquest, killing nine out of ten Indians who inhabited the Andes before the Spaniards arrived.

If disease was responsible for the mass grave at Kuelap, Dr. Toyne would expect to see little or no evidence of trauma to the skeletons, and she would expect to see a wide range of individuals including both sexes as well as children and adults, since epidemics result in indiscriminate death. However, there are no women among the victims at Kuelap, so Toyne is able to rule out disease as the cause of death. Then she discovers hard evidence of trauma on the skull of one of the victims, indicating the man had died a violent death. Toyne collects several of the 450-year-old skulls that show evidence of trauma, and takes them to the nearest hospital for radiographic analysis. As Toyne explains, the implement used to cause trauma often leaves a distinct impression that allows the particular weapon to be identified. Projectiles from firearms,

for example, generally leave two impressions in a skull: a smaller entry wound and a larger, ragged exit wound. If there is evidence of gunshot wounds in the skulls, it would identify the Spaniards as the culprits rather than the Inca, because only the Spaniards had firearms. A similar conclusion would follow from evidence of trauma from steel swords or spears. Examining the x-ray of a typical skull from the collection, Toyne observes that the trauma-induced hole is much too large for a Spanish musket ball, and there is no evidence of a sharp-edged cut that would result from steel weapons. The wounds to the skulls were not inflicted by firearms or swords, but were instead the result of powerful blunt force trauma. Whatever or whoever killed the victims at Kuelap, it was not mass suicide by poisoning, epidemic disease, or attack by Spaniards. But that still leaves a mystery. Who killed the people at Kuelap, and why? Were they victims of ritual sacrifice, or were they warriors who were killed in battle?

One of the skulls, for example, showed massive blunt force trauma to the rear of the skull, with no evidence of defensive wounds to the rest of the skeleton, indicating that the victim was facing away from his attacker when the fatal blow was delivered. If all of the skulls show a similar pattern, it could be indicative of execution or sacrifice. Supporting that hypothesis is the fact that the bodies were found a few feet from an important temple, and the fact that Inca peoples were known to practice human sacrifice. A circular opening in the floor of the temple leads to a shaft that descends 40 feet below ground. At the bottom of the shaft, archaeologists find a small chamber littered with offerings including obsidian and fertility figurines. There are also dismembered human bones, but that's not necessarily evidence of ritual sacrifice—it could be simply that the chamber was a location for sacred burials.

There is an obvious pattern to the injuries among the 100 bodies in the mass grave at Kuelap: many of the skulls show evidence of devastating blunt force trauma. Some of the skulls are so badly fragmented that it's impossible to discern exactly what sort of weapon was used, but Marla Toyne finds one skull that has a very clear circular impact with radiating cracks. The damage was done by blunt force trauma that actually penetrated the bone—the kind of damage that would have been inflicted by a star-shaped mace, a weapon used by the Inca. One of the skulls that Toyne examines provides conclusive evidence—it has two side-by-side puncture wounds that corresponded exactly to the size of an Inca star-shaped mace. The pattern of wounds on yet another skull confirms the analysis, making Toyne confident that she has identified the murder weapon. If the victims were ritually sacrificed, Toyne would expect to find a pattern of ritualistic wounds—all of the victims would likely have been struck at the same point on the skull from the same angle, for example, indicating that they were in the same position when they were ceremoniously sacrificed, and likely restrained in some way at the time.

The evidence from the bones tells a different story, however. Some of the skulls received more than one blow, and many of them have multiple injuries to the left side of the skull—the kind of injuries that would be received from a right-handed assailant facing his victim (and 70% to 90% of the human population is right-handed). In addition, many of the victims' forearms are fractured—the kind of defensive wounds that would be received by someone trying to fend off an attacker. None of this is consistent with the hypothesis of ritual sacrifice, but all of it is consistent with a scene of violent, face-to-face combat. Kuelap was a fortress under attack, and the victims were driven to the rim of the city where they were pinned at the edge of an abyss with no possibility of escape.

When Toyne completes her profile of the 100 bodies found at Kuelap, she finds a disturbing fact: while many of the bodies are men, a little more than half (nearly 56%) are bodies of children, some as young as two. The level of violence may indicate that the attackers wanted to eradicate the Chachapoya, not simply to defeat them. In any event, the archaeological evidence suggests that the victims of the attack may have been the last residents of Kuelap. No one remained to bury the dead—if there were any survivors, they likely scattered, either enslaved or relocated. The archaeological evidence also shows that a major fire swept through the mountaintop fortress, possibly years after the attack. Kuelap was never again an active metropolis.



Quiz Questions for Topical Quiz # 3A

1. Which bone would be *most* useful in determining sex?
2. Which of the following would be *least* reliable in determining sex for most human populations: shape of the chin, size of the femoral head, size of the mastoid process, superior orbital rim, subpubic angle?
3. How do males compare to females with regard to the shape of the orbital rim and the degree of flaring in the mandible?
4. How do females compare to males with regard to the shape of the orbital rim and the degree of flaring in the mandible?
5. How do males compare to females with regard to the length of the zygomatic process and the shape of the subpubic angle?
6. How do females compare to males with regard to the length of the zygomatic process and the shape of the subpubic angle?
7. How do males compare to females with regard to the size of the pelvic inlet and the width of the sciatic notch?
8. How do females compare to males with regard to the size of the pelvic inlet and the width of the sciatic notch?
9. How do males compare to females with regard to the size of the femoral head and the prominence of the supraorbital ridge?
10. How do females compare to males with regard to the size of the femoral head and the prominence of the supraorbital ridge?
11. How do males compare to females with regard to the size of the mastoid process and the angle of the ascending ramus?
12. How do females compare to males with regard to the size of the mastoid process and the angle of the ascending ramus?
13. How do males compare to females with regard to the shape of the chin and the relative lengths of the sternum and manubrium?
14. How do females compare to males with regard to the shape of the chin and the relative lengths of the sternum and manubrium?

15. How do males compare to females with regard to the presence of the preauricular sulcus and the nature of the muscle attachment on the nuchal ridge?
16. How do females compare to males with regard to the preauricular sulcus and the nature of the muscle attachment on the nuchal ridge?
17. How do males compare to females with regard to the slope of the forehead and the presence of a ventral arc?
18. How do females compare to males with regard to the slope of the forehead and the presence of a ventral arc?
19. The organic substance that gives bone its elasticity is called _____.
20. The circus sideshows described by William Maples that were advertised as “The India-Rubber Man” or “The Boneless Wonder” would have suffered from what condition?
21. An overabundance of collagen is characteristic of what disease?
22. An insufficient supply of collagen is characteristic of what disease?
23. Where do parturition scars appear? (On what bone[s] of the body, and as a result of what?)
24. How many bones are there in the human body? Is the number the same for every individual? Does the number change during life?
25. How would a skeleton consisting of a set of bones that were smoother and less knobby with edges that are gracefully planed or beveled would be described? (i.e., What descriptive adjective would be applied to such a skeleton, and what sex would it be characteristic of?)
26. How would a skeleton consisting of a set of bones that were thick, pitted, and bumped with rough irregularities be described? (i.e., What descriptive adjective would be applied to such a skeleton, and what sex would it be characteristic of?)
27. How and when did King Robert the Bruce of Scotland die?
28. *Facies leprosa* is a condition characterized by _____.
29. Who was Joseph Merrick?
30. Describe the skeleton of “The Elephant Man” (including the identity of the skeleton, its characteristics, and its present location).

31. List some of the things that William Maples has observed in his experience that have been used as murder weapons.
32. List the rest of the things that William Maples has observed in his experience that have been used as murder weapons.
33. In the case of a 13-year-old Florida girl whose skull was found inside a paint can in 1978, what was William Maples about to conclude about the perimortem trauma and the postmortem fate of the remains?
34. What were the other details of the case described by William Maples of a 13-year-old Florida girl whose skull was found inside a paint can in 1978?
35. In his analysis of the remains of a six-month-old boy who had been killed by his father (the confessed murderer Michael Durocher), William Maples was able to conclude that _____.
36. What does William Maples argue is the most humane method of capital punishment?
37. What form(s) of capital punishment does William Maples argue is/are needlessly cruel?
38. Describe the methods and consequences of the various methods of capital punishment discussed by William Maples.
39. As described in the film *Peru's Mass Grave Mystery*, if epidemic disease was responsible for the deaths of people in a mass grave, you would expect to see a _____ [wide or narrow] range of individuals, and you would expect to see _____ [little or extensive] evidence of skeletal trauma.
40. As described in the film *Peru's Mass Grave Mystery*, the pattern of wounds on the skeletons of the victims in the mass grave at Kuelap _____ [was or was not] consistent with ritual sacrifice, and it _____ [was or was not] consistent with violent combat.
41. As described in the film *Peru's Mass Grave Mystery*, the mass grave that was discovered on the rim of Kuelap in 2007 covered an area of approximately _____ square meters and contained a total of approximately _____ bodies.
42. As described in the film *Peru's Mass Grave Mystery*, the damage done to the skulls in the mass grave at Kuelap _____ [was or was not] consistent with wounds from a firearm, and it _____ [was or was not] consistent with wounds from a steel sword.
43. As described in the film *Peru's Mass Grave Mystery*, following the deaths of the victims in the mass grave at Kuelap, the fortress continued to be occupied by the Chachapoya for _____ year(s) before it was finally abandoned.

44. As described in the film *Peru's Mass Grave Mystery*, archaeologists who excavated the mass grave at Kuelap _____ [*did* or *did not*] make detailed records of the exact position of every bone fragment, and the bodies _____ [*had* or *had not*] been ritually buried in accordance with standard Chachapoya practice.
45. As described in the film *Peru's Mass Grave Mystery*, the anthropological profile of the victims in the mass grave at Kuelap revealed that approximately _____ per cent of the bodies were children and approximately _____ per cent were women.
46. As described in the film *Peru's Mass Grave Mystery*, the presence of Spanish colonial pottery in Kuelap indicates that the event responsible for the mass grave took place sometime after the year _____.
47. As described in the film *Peru's Mass Grave Mystery*, the entry wound to a skull caused by a gunshot is _____ [*larger* or *smaller*] than the exit wound, and the skulls of the victims from the mass grave at Kuelap _____ [*did* or *did not*] include evidence of gunshot wounds.
48. As described in the film *Peru's Mass Grave Mystery*, diseases carried by the Spanish conquistadors killed approximately _____ per cent of the Native Americans who inhabited the Andes prior to the arrival of the Europeans, and disease _____ [*was* or *was not*] responsible for the deaths of the people in the mass grave at Kuelap.
49. As described in the film *Peru's Mass Grave Mystery*, the weapon that killed most of the victims in the mass grave at Kuelap was a(n) _____.
50. As described in the film *Peru's Mass Grave Mystery*, the Inca city of Kuelap is located in the Andes Mountains approximately _____ feet above sea level in the country of _____.

Chapter 10

Estimation of Age at Death

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 4, 5, 8, 11, & 13 of *Forensic Anthropology Training Manual* and Chapters 10 & 11 of *Dead Men Do Tell Tales*), the film that accompanies this topic (i.e., *The Perfect Corpse*).

Here are a few additional pointers that you might find useful in the study of this topic. As the textbook explains, the pubic symphysis can be very useful in estimating age, but it's an especially complex matter: there are trends rather than clearly delineated steps in the age-related changes to the pubic symphysis, and there is no simple "cookbook" approach to describing each age range. Thus forensic anthropologists rely upon their extensive experience in examining large numbers of pubic symphyses when making age estimations—unfortunately, however, this course will not provide you with the opportunity to gain that kind of experience. Therefore you should be aware that forensic anthropologists make use of comparative *casts* of pubic symphyses from individuals of known age when using the pubic symphysis to estimate age (casts are substantially superior to pictorial illustrations), and you should be able to answer these general questions: Should you rely solely on the pubic symphysis to estimate age? When using the six-phase system of pubic aging, what happens to the information obtained from the pubic symphysis as you move to higher phase numbers?

As the textbook also explains, *degenerative* changes in teeth are much more complicated than *formative* changes; for our purposes we will concentrate on estimating age using *formative changes*. Thus you should be able to identify the age at which each of the following ten developments occurs: (1) no teeth have erupted, but the maxilla and the mandible are packed with growing teeth; (2) the deciduous incisors have erupted; (3) the deciduous dentition is completely erupted, but the roots are incomplete; (4) the deciduous dentition is complete including root tips; (5) the first permanent molar is erupting; (6) exfoliation (loss) of deciduous teeth has begun, and permanent incisors have erupted; (7) exfoliation and replacement of deciduous teeth is complete *except* for the upper deciduous canine and second deciduous molars; (8) no deciduous teeth remain and the second permanent molar has erupted; (9) the root tips of the erupted permanent teeth are all complete and the root of the unerupted third molar is developing; (10) all thirty-two permanent teeth have erupted. (Notice that each of these ten stages has an *age range* that could be from months to years; you should remember, of course, that none of these ten stages has an *exact* age associated with it, but for our purposes at this introductory level, you may ignore the details of the range—in other words, it will be sufficient to know that stage #5 occurs at age 6, without having to specify exactly how many months plus or minus age 6 it could be).

Finally, the two chapters from *Dead Men Do Tell Tales* that are assigned for this unit do not extensively address the question of determining age, as do the chapters in *Forensic Anthropology Training Manual*. Instead, these two chapters from *Dead Men Do Tell Tales* focus on topics that are of occasional significance to forensic anthropologists, namely cremation and fragmentation of human remains, and as such provide a useful context and background for this unit.

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 3B

**ESTIMATION OF
AGE AT DEATH**

Age Indicators

medial clavicular
fuses in mid-20's, with a range from 15 to 32 (last epiphysis to fuse)

bone-cartilage interface at the sternal end of the rib
males are more likely to ossify along the margins of the rib cartilage, females more likely to ossify outward from the rib and through the center of the rib cartilage

rib ends of elderly (older than mid-50's) males
likely to be "crab claw" in appearance



(Age 18)

Four stages of the vertebral bodies & their corresponding age ranges:

child (under 16): epiphyseal ring completely absent

late teenager (16-20): epiphyseal ring in the process of fusing

young adult (20-29): epiphyseal ring fused, but no osteoarthritis visible

older adult (over 30): osteoarthritis is obvious and the vertebral body is beginning to degenerate



Aging using the Pubic Symphysis
The higher the phase number, the less it tells you, because the age range increases between phase 1 and 6.

<i>Phase 1:</i>	<i>15 to 23 years</i>
<i>Phase 2:</i>	<i>19 to 35 years</i>
<i>Phase 3:</i>	<i>22 to 43 years</i>
<i>Phase 4:</i>	<i>23 to 59 years</i>
<i>Phase 5:</i>	<i>28 to 78 years</i>
<i>Phase 6:</i>	<i>36 to 87 years</i>

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(1) no teeth have erupted, but the maxilla and the mandible are packed with growing teeth; *age birth +- 2 months*

(2) the deciduous incisors have erupted; *age 1 year +- 4 months*

(3) the deciduous dentition is completely erupted, but the roots are incomplete; *age 2 years +- 8 months*

(4) the deciduous dentition is complete including root tips; *age 4 years +- 12 months*

(5) the first permanent molar is erupting; *age 6 years +- 24 months*

(6) exfoliation (loss) of deciduous teeth has begun, and permanent incisors have erupted; *age 8 years +- 24 months*

(7) exfoliation and replacement of deciduous teeth is complete *except* for the upper deciduous canine and second deciduous molars; *age 10 years +- 30 months*

(8) no deciduous teeth remain and the second permanent molar has erupted; *age 12 years +- 30 months*

(9) the root tips of the erupted permanent teeth are all complete and the root of the unerupted third molar is developing; *age 15 years +- 30 months*

(10) all thirty-two permanent teeth have erupted; *age 21 years or more*

Six-Year-Old Child

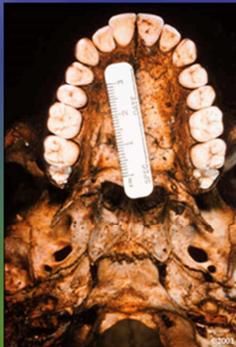


Proximal Humerus—Unfused Epiphysis



(Fusion at 13-17 for females, 16-20 for males)

Under 25



Synostosis of Sagittal Suture



Professional Cremation

As the skeleton emerges, the flames turn different colors, as various salts and chemicals are burned...pelvis usually remains articulated, and the skull is left largely intact and unexploded, although it may be cracked open slightly...remains generally enclosed in a large cardboard box, casket-sized, stapled or glued at corners...natural gas heats temperature to 1700° F...usually takes several hours...all organic components destroyed... then a large hoe-like scraper & brush sweep cremains into groove in center of floor...heavy magnetic iron used to crush bone...large debris removed (hip prostheses, orthopedic plates, bridgework, pacemakers, hardware from cremation containers)...

silicone breast implants burst and melt messily (every effort is made to find & remove them before cremation)...“processor” grinds the cremains, screened to about 5 mm in diameter, a bit smaller than a kernel of corn...usually a metal plate or disk with identifying number placed with body before cremation...dental gold does not melt in crematoria temperatures...“cremation slag” usually forms (small lumps of grayish shapeless material, various explanations)...only one individual cremated at a time (but in practice difficult to remove all traces of the previous occupant of the retort).

Calcined bone is bone that has been burned to white—extremely brittle, shrunken by as much as 25%, but they may appear more or less normal. In calcined condition, fire does not destroy the identifying characteristics (race, sex, age)...but the crushing does.

A *retort* is a crematorium oven, lined with firebrick, and *cremains* are cremated remains, for most adults weighing about 2.2 to 8.8 pounds, about 50/50 ash & bone fragments.

Forensic anthropologists commonly become involved in the analysis of professionally cremated remains when lawsuits are filed (the work is often contracted by attorneys).

When identifying an individual from cremated remains, the common evidence includes the baggage they carried with them...surgical clips, dental posts, steel sutures, screws in bones.

Cremains



William Maples considered the Meek-Jennings case to be the most fascinating, perplexing, and complex case of his career.

Maples was not able to recover the remains *in situ*—the investigator from the medical examiner's office gathered every bone she could find and placed them in a single body bag.

There were 10,000 bone fragments, commingled, crushed, intermixed with dust, cinders, stray teeth, and sand. Maples spent a year and a half working on the case.

The burn pattern on a bone with a thin outer layer, such as the tibia, will split into a crisscross checkerboard pattern, and a bone with a thick outer layer, such as the femur will crackle up into little crescent moons—results in curved, not right-angled bits of bone that can be reassembled with model airplane glue.

Gold dental inlays are likely to survive a fire that reduces the body to calcined bone, because pure gold melts at 1945° F, dental gold (alloy) even stronger...a hot structural fire after 8 hours reaches just under 2300° F...the shack would have had to rage for 3 hours to reach 1945 degrees...didn't happen...shotgun barrel undeformed by heat of fire...Meek's gold filling clearly recognizable (he hadn't flung his jaw into the fire!).

William Maples able to positively identify the two individuals in this case—tooth clearly identified as Meek's, fibula, humerus, and palate as Jennings'.

Maples' personal conclusion was that Meek murdered Page Jennings, then committed suicide (brainpan of the male skeleton had several lumps of heavy buckshot—clearly the shotgun barrel had been inserted into the mouth of the male).

Film Summary

The Perfect Corpse

Here's how NOVA describes this episode:

In this morbidly fascinating documentary, NOVA gains exclusive access to forensic scientists and local police authorities investigating two mysterious murder cases. As police unearth stunning evidence of brutal, ritualistic killings, they quickly realize they are the wrong people to solve these crimes. Archeologists step in and soon find evidence pointing to violent deaths in the prehistoric Iron Age, over 2,000 years ago. In this program, NOVA probes how these people lived and why they died.

This will be no ordinary investigation, because this is no ordinary ground. Found by accident in waterlogged Irish peat bogs, the corpses are almost perfectly preserved. Although the ancient perpetrators are now well beyond the reach of law, the bog bodies will yield fascinating secrets if modern science asks the right questions.

“The Perfect Corpse” enters the lab with experts pushing archeological forensics to its limits in an 18-month investigation. The Conservation Department of the National Museum of Ireland coordinates the project, and NOVA goes behind the scenes with key players, including archeologist Isabella Mulhall, pathologist Marie Cassidy, and conservator Patrick Doyle. Both of these bizarre cases will test every team member's experience and expertise, and there is not a lot to go on: the last body to emerge from the Irish bogs was in 1978.

Now, the team is confronted with two murdered men and an assortment of perplexing clues. The injuries to the bodies are devastating: stab wounds, broken bones, skull-crushing blows, and dismembered appendages. One of the victims has an elaborate hairstyle. On the other, a simple leather band with metal clasps adorns the upper left arm. No small detail is overlooked as NOVA examines the corpses up close in the laboratory.

Make no mistake, these are not skeletons or mummies but the intact soft tissue of people trapped in time. The fine details of fingerprints and individual skin pores show up perfectly under magnification. The team uses high-tech CAT scans to deliver 3-D body images and even probes nasal passages to search for pollen inhaled during one of the victim's last breaths. They use hair analysis to figure out diet and even magnify the edges of fingernails to assess if the victims were engaged in hard manual labor or a life of privilege.

One of the two bog bodies is named Old Croghan Man after the locale in which it was found, at the foot of a rolling hill with ritual monuments and burials dating

back for millennia. Irish archeologist Ned Kelly discovers that many bog bodies are found buried along ancient Irish tribal boundaries first recorded by medieval monks. If these were not simple acts of execution, perhaps the killing sites were carefully chosen for their sacred significance and the victims offered up as sacrifices to appease the gods of antiquity.

From radiocarbon dating to paleodietary analysis, every advance in archeological forensic science is applied to the case. “The Perfect Corpse” assembles the puzzle of how two men's lives came to such violent ends, and the experts agree it is an astonishing glimpse into a vanished prehistoric era.

Additional information about the film can be found on the PBS website for the NOVA episode **The Perfect Corpse** (the URL for *The Perfect Corpse* is <http://www.pbs.org/wgbh/nova/bog/>)



Tollund Man

Transcript of *The Perfect Corpse*

NARRATOR: From the swampy depths of an Irish bog emerges a body from the distant past. A second body is found, as well. Both show the same strange signs of a brutal and ritualized killing. These ancient murders are the subject of a modern scientific investigation, an investigation that goes back in time to enter the world of the Celts, the ancestors of today's Irish people.

Irish legends celebrate the Celts as an ancient mystical society, ruled by warrior kings, queens and druid priests. But since the Celts had no writing, their oral traditions from pagan times were written down by medieval Christian monks, centuries later. The manuscripts tell of heroic

struggles between rival warriors and gods, but the bodies tell a darker tale of torture, beheadings and human sacrifice. Forensic studies will explore in detail how these men lived and died and why they met such a brutal and horrific end.

An 18-month archeological adventure brings us face-to-face with the disturbing truth of our distant past. Up next on NOVA, *The Perfect Corpse*.

Google is proud to support NOVA in the search for knowledge: Google.

What would you ask an oil company? What is being done to make us less reliant on oil? That's a question. "If we're going to keep our dependency on oil, primarily, for the coming years, the initial future years, where's it coming from?"

Major funding for NOVA is provided by the Howard Hughes Medical Institute, serving society through biomedical research and science education: HHMI.

And by the Corporation for Public Broadcasting, and by contributions to your PBS station from viewers like you. Thank you.

NARRATOR: Central Ireland: A gruesome find is made by a workman digging a ditch. Detective Eadaoin Campbell is summoned to investigate.

DETECTIVE EADAOIN CAMPBELL: When we got up to the crime scene tent, it was just on the far side of a drainage ditch that had been cut.

NARRATOR: The discovery was hidden under a plastic tarp.

EADAOIN CAMPBELL: We removed that, and under that we were confronted with probably one of the most amazing sights I've ever seen in my life. What I saw were the partial remains of a human being. The head was missing, the body from the hips down...lower limbs were missing. The arms extended out in front of the body in a semicircular pattern.

NARRATOR: The fingerprints are so distinct, it appears as if the murder could have happened yesterday, but with a skin like leather and no bones left in the body. It's clear that the perpetrators of this crime are now far beyond the reach of the law, for this headless torso is not the victim of a modern murder. Whoever it is has been dead hundreds or even thousands of years.

He's named Oldcroghan Man, after the region where he was found. And his body is taken from the crime scene to Dublin, 45 miles away. Here, Oldcroghan Man finds a new home in the Conservation Department of the National Museum of Ireland. With the police investigation now over, a scientific one is about to begin...

ISABELLA MULHALL (National Museum of Ireland): One, two, three, up.

NARRATOR: ...to find out who he is, when he lived, and how and why he died. The first clue comes from where the body was found, a peat bog, a marshy area characterized by its unique chemical composition. In a normal burial, a human body quickly decomposes from the bacteria in the soil, but in a peat bog, waterlogged sphagnum moss produce a chemical reaction that tans the skin and can preserve organs, a process closely resembling the tanning of leather. Over time, the preserved body is covered with layers of moss and vegetation which turn into peat, providing a natural coffin. Up to this point, peat has kept Oldcroghan Man's body moist to help preserve it.

Archaeologist Isabella Mulhall is organizing the investigation.

ISABELLA MULHALL: The body, as you can see it here—we just have a torso and two arms—it's in extremely good condition in terms of preservation, although the body is not complete. And the body's head, as you can see, has been decapitated and severed just below the diaphragm.

NARRATOR: Oldcroghan Man appears to be a peculiar kind of mummy, the soft tissue remains of a human being trapped in time, known to archeologists as a “bog body.”

Bog bodies are not a uniquely Irish phenomenon; there have been at least 2,000 reported discoveries throughout the British Isles and Northwestern Europe. Perhaps the most famous is Denmark's Tollund Man. So fantastically well preserved in the bog, Tollund Man appears to be dreaming serenely, but his appearance belies the circumstances his death. He was hanged.

MIRANDA ALDHOUSE-GREEN (University of Wales, Newport): He was then cut down and laid carefully in the bog, as though sleeping, in a kind of fetal position, legs drawn up, the eyes closed. He looks incredibly peaceful.

NARRATOR: Tollund Man is not alone in the violent manner of his death. Grauballe Man of Denmark had his leg broken and his throat cut with such severity he was almost decapitated. Huldremose Woman, also of Denmark, had her right arm hacked off and was stabbed repeatedly in the legs and feet. The guts of one of the Bourtangere Men, from the Netherlands had been torn open and his innards pulled out. Yde Girl, also from the Netherlands, was strangled and stabbed to death.

Many bodies, dating to around 2,000 years ago, show this same pattern of gruesome, violent death. To know whether or not Oldcroghan Man fits into this pattern, the team in Ireland will need to investigate further. They call in Marie Cassidy, Ireland's State Pathologist, to ascertain the full extent of the assault Oldcroghan Man suffered.

MARIE CASSIDY: (Department of Justice, Ireland): Hi there.

NARRATOR: Can modern forensic science shed light on this mystery from the distant past? Marie Cassidy quickly establishes that the body is male and probably in his early to mid-20s. Measuring his arm span gives her a good approximation of Croghan Man's height: six-foot-six.

MARIE CASSIDY: Six-foot-six.

ISABELLA MULHALL: Six-foot-six? That's massive.

MARIE CASSIDY: It's incredible—large man.

ROLLY READ (National Museum of Ireland): It's no wonder his hands are so big.

MARIE CASSIDY: We are being fooled because he's so squashed. You think he's a small person but he's actually a big...obviously he was a big man.

NARRATOR: But can the pathologist determine how Old Croghan Man actually died? She discovers evidence it may have been murder.

MARIE CASSIDY: There is something interesting about this wound that was discovered the other day.

NARRATOR: There's a wound on the arm and chest that looks like evidence of a stabbing.

MARIE CASSIDY: It's in roughly the right place. If, for example, we have him in this position here, if someone is coming at him to stab him, then if he put his arm up, and the guy came across with a knife, it can slice across the arm as it's going down into the chest, so it is going down.

NARRATOR: She demonstrates on Mulhall.

MARIE CASSIDY: It's going down quite steeply, which means that it will go down into the chest cavity. It will probably cut the lung and down on into the heart, so, potentially, that could be a fatal stab wound.

NARRATOR: This evidence points to murder. And there's worse to come.

MARIE CASSIDY: ...nothing on the hands I can see. And there's a rib's been sliced through.

ROLLY READ: That's a cut, is it?

MARIE CASSIDY: That's a cut. That's a nice sharp cut. And there is a slightly more irregular cut through the rib here. We've got two small symmetrical lesions, which appear to be little superficial cuts in the skin just about where the nipples, you would expect the nipples to be, might be an indication that he has been tortured.

ROLLY READ: Blimey. Ow!

NARRATOR: Tortured, stabbed to death and dismembered—Cassidy and the team establish that Old Croghan Man suffered a horrible end. Further examination reveals more details of his

gruesome story. Unlike Tollund Man, who was buried in the bog wearing a hat, no clothes were found with Old Croghan Man.

PATRICK : The skin is actually in very good condition.

NARRATOR: But around his left bicep is a braided leather arm band with metal clips. And lying next to the Croghan body at the burial site was a withy, a length of hazel branches twisted to form a rope, again, remarkably preserved.

PATRICK : Looks like quite a clean cut.

NARRATOR: When the peat is finally removed from the deepest folds in Old Croghan Man's skin, another discovery is made.

ROLLY READ: That's definite cut edges to the wound, and it pierces right through the arm.

NARRATOR: Tiny fragments from the withy are embedded in both of his arms. Sticks through his limbs are a sure sign of a bog body, for this was the method by which the body would be secured beneath the surface.

Clearly, Old Croghan Man fits the pattern of most other bog bodies, but who would execute, torture, dismember and stake a body down in the bog? And why?

The most likely suspects are the early inhabitants of the British Isles, the ancestors of the Irish, a mysterious people called the Celts. Over 2,000 years ago, the Celtic people and their pagan culture were widespread across much of northern and central Europe. Traditional Irish lore paints a picture of Celtic warriors ruling from sacred hilltop citadels, with the bogs below, an entryway to the supernatural.

MIRANDA ALDHOUSE-GREEN: From the archaeology, we think it was a very sophisticated religious system with a number of different gods, perhaps gods associated, for the most part, with the natural world, and, indeed, the supernatural world, of course.

NARRATOR: But the Celts in Ireland never developed a written language, so much of what's known about them is based on oral tales of warrior kings, queens and heroes that were written down many centuries later by medieval monks. The tales are full of epic, often brutal combat.

MIRANDA ALDHOUSE-GREEN: These are medieval stories, and they are written by Christians who are trying to put over Christianity as being the religion to go for, so they're going to project paganism as being, essentially, something which is bad and wild and barbarous.

NARRATOR: Can bog bodies shed light on the Celts' strange rites and practices?

Remarkably, more evidence emerges from a peat bog at Clonycavan, just 25 miles away from where Oldcroghan Man had been found. Another body is unearthed. Its forearms, hands and

lower half are missing. If whole, the body would be quite short, five-foot-two inches. Though not quite as well-preserved as Oldcroghan, it is in one area much more complete.

PATRICK : Okay, what you can see here is the back of the head here, the front of the head towards here. You can see, very clearly, the eye there. Here we can see an ear.

NARRATOR: Clonycavan has a head with clearly defined features, and it's topped with a mass of hair.

PATRICK : What's here is a large matt of hair, which is completely covered in peat. The hair is extremely fine. You can see it running this way.

NARRATOR: Although Clonycavan is contorted and flattened, from time spent under the weight of the bog...

LAB TECH : ...and lift.

NARRATOR: ...he's still clearly recognizable as a fellow human being.

VALERIE HALL (Queen's University, Belfast): There's a very good chance that I am looking at the face one of my ancestors. So, when one has been involved in tracing the past, you have a genuine affection for who these people were and how they lived. One has a relationship, and one treats a person like that with great respect and genuine tenderness.

NARRATOR: Because of the exceptional rarity of these finds, the museum has decided to bring in Don Brothwell, a world authority on soft tissue human remains. When the last bog body was discovered, over 20 years ago, in 1984, it was Brothwell who oversaw the investigation.

Found in a peat bog in the north of England, Lindow Man, like other bog bodies, had suffered a gruesome and premeditated death. He had his skull smashed, had been strangled by garroting and finally had his throat cut. Lindow Man was a huge story in England. The tabloids affectionately referred to him as "Pete Moss". Brothwell never expected another case as interesting to come around.

DON BROTHWELL (University of York): It's 20 years since Lindow Man was discovered; I certainly didn't expect any more bodies to turn up. And, lo and behold, in Ireland, we have two turning up, more or less at the same time, in different localities, so it's an exciting development. And then, on the top of that, of course, they look as if they are going to be extremely interesting from a forensic point of view and so on. So this is good news from my point of view.

NARRATOR: After cleaning the Clonycavan body, the team now concentrate on his hair.

DON BROTHWELL: There might be some design in there.

ISABELLA MULHALL: It's coming from the front and swept back. Maybe that's been used to keep his hair out of his face.

NARRATOR: Although the hair is tangled and thick with peat, they can distinguish a particular style.

DON BROTHWELL: It looks like some sort of intentional preparation, doesn't it?

ROLLY READ: It does.

NARRATOR: Clonycavan Man's hair has been pulled back, to form a bun on the top of his head.

ISABELLA MULHALL: You wonder whether they used a substance, just to keep it all together, some sort of resin or something.

ROLLY READ: He had well-defined strands; it isn't just a chaotic mess of hair.

NARRATOR: But cleaning the hair uncovers something shocking.

DON BROTHWELL: Well you can see brain, possibly, in the injury there.

NARRATOR: The skull appears to have been smashed open. Incredibly, in amongst the hair and shattered skull, they discover some of Clonycavan Man's brain.

Perhaps, once again, the expertise of forensic pathologist Marie Cassidy can shed light on how Clonycavan died.

MARIE CASSIDY: We've got an injury to the back of the skull. And there's a cut, or a split in the skin, which would indicate that this is due to a blow from something heavy with a sharp cutting edge. There is a similar sort, type of injury towards the front of the head. And then we've got a third injury to the head, which is over the face, over the bridge of the nose and running under the right eye. And the nose has been literally crushed, and the bone's been broken. But, again, there is a sharp cut running across the cheekbone, under the eye. Again that tells us that the weapon used had a sharp cutting edge.

NARRATOR: One side of his head was shaved, possibly to prepare for the three lethal ax blows. From the angle of the blows, it seems he may have been kneeling in front of his attacker.

MARIE CASSIDY: Some people think that it was just today that you see all these horrible things, but it was obviously going on a long time—keeps forensic pathologists in a job.

NARRATOR: As part of the forensic investigation, Clonycavan and Oldcroghan Man will be scanned in a clinic using high resolution C.T. and M.R.I. scanners.

DON BROTHWELL: Because museums, now, are very sensitive to the whole question of how far you investigate and open bodies up and so on, it's important to use whatever non-destructive techniques you can.

NARRATOR: For the team, it's a first chance to see the internal damage to Clonycavan Man's head.

DON BROTHWELL: The stuff we see is, in fact, that: extruded brain.

NARRATOR: The scans are processed to produce a 3-D image. From the pressed and distorted skull and flesh of Clonycavan Man, computers digitally re-create his head and face. Free from the distortions caused by his time in the bog, the investigators come face to face with Clonycavan Man and see how he might have looked when he was alive. Now the team will try to discover when he lived, and, perhaps, why he died such a gruesome death.

Around 100 bog bodies are known to have emerged from the peat bogs in Ireland, the last one in 1978. That body was sent to the National Museum of Ireland, where archaeologist Ned Kelly is a curator of antiquities.

NED KELLY (National Museum of Ireland): This is the body of a young woman in her late 20s or early 30s. The burial appears to be a formal burial. The body was wrapped in a woolen cloak and interred in a bog at Meenybradden in County Donegal. We have dated the body to the end of the 16th century, 'round, say, 1570 or thereabouts.

NARRATOR: Meenybraddan Woman shows no sign of violence and, at more than 400 years old, is a relatively recent mummy, unlike another, much older example at the Museum.

NED KELLY: This is probably the best known of the Irish bog bodies. It was found in 1821, in a bog beside Gallagher Castle, in County Galway in the west of Ireland. It dates to the period around 200 to 400 before Christ. It's the body of a young man, aged about 25 years.

NARRATOR: Gallagher Man was found in a remarkable state of preservation, but without modern conservation techniques, many of his secrets have been lost. Still, it's clear his death was a violent one.

Like most bog bodies, Gallagher Man dates back to the Iron Age. It's about a thousand year period between 700 B.C. to 400 A.D., a time in Ireland and Northern Europe when the Celtic way of life took root.

MIRANDA ALDHOUSE-GREEN: Within Europe, the Iron Age is exactly what it says: it's the period of time when people first started using iron as a commonplace metal, replacing much of the bronze that had been used before.

NARRATOR: Much of what we know about the Iron Age Celts is from the finely crafted objects they left behind. Many of these works of art survived because they were deposited in the bogs, as gifts to the gods.

MIRANDA ALDHOUSE-GREEN: The archaeology tells us we have a relationship between these people and the gods which is signified, very often, by the giving of gifts, whether it is a precious metal sword or a piece of jewelry or an animal sacrifice or indeed sometimes even human sacrifice.

NARRATOR: Indeed, Julius Caesar, who fought the Celts in Gaul, described their grisly rituals of human sacrifice, although some of it could be propaganda. An earlier Greek author wrote that the druids, the Celtic priests, would stab a man through the gut and could foretell the future by watching his limbs convulse and blood pour out. And in Greek and Roman sculpture, Celtic warriors are depicted as fierce and formidable adversaries. Though Rome conquered much of Asia Minor, Northern Africa and Europe, the Romans never attempted a major invasion of Ireland.

Are Oldcroghan Man and Clonycavan Man Iron Age bog bodies? And if so, what can their tortured, dismembered bodies tell us about these mysterious warrior Celts?

There is one technique that will give the team a definitive date: radiocarbon dating. By measuring the amount of radioactive carbon-14 in any once-living material, scientists can determine how long ago it died. The team chooses the withy in Oldcroghan Man's arms, for testing, and a piece of the gut from Clonycavan Man.

ROLLY READ: It's basically to get a date for when the body was deposited. It will give us a hard date, which is what we are lacking at the moment.

NARRATOR: But while they wait for the carbon-14 results, the team performs other tests which may help them discover the age of Oldcroghan Man.

X-ray fluorescence uses a beam of x-rays to reveal the chemical composition of a piece of metal—in this case, the clasps on the armband from Oldcroghan Man. The percentage of copper, lead and tin in an object, can often indicate when the metal was forged and suggest when the armband was made.

LAB TECH : Looking at it, at the moment, it looks like bronze with a small lead peak there, as well, so small amounts of lead.

NARRATOR: The results reveal that the bracelet clasps are 86 percent copper, 12 percent tin, and contain a small amount of lead.

ISABELLA MULHALL: So, effectively, the tinning would seem to indicate an early medieval date.

NARRATOR: The mix of metals in Oldcroghan Man's bracelet looks medieval, at least 1,000 years later than what they'd expect in an Iron Age bog body. They'll need to compare these results with the more reliable carbon-14 date.

ISABELLA MULHALL: Hello. Can I speak to Dr. Higham, please?

Hello. How are you? Oh, this is the big moment.

NARRATOR: Mulhall receives news that the carbon-14 dating results are about to be faxed through to her. She hopes that at least one of these bog bodies can be dated to the Iron Age.

ISABELLA MULHALL: Oh, god, unbelievable. The news is great, excellent, absolutely. These, basically, are the non-calibrated dates, so Oldcroghan bog body...there's a 95 percent probability that it's 262 to 175 B.C., making it early Iron Age, so...

DIRECTOR: Two thousand, two hundred, fifty years old...yeah. And the next one?

ISABELLA MULHALL: And the Clonycavan, County Meath bog body, 392 to 201 B.C., again early Iron Age.

NARRATOR: The carbon-14 test shows that both Oldcroghan and Clonycavan Man are over 2,000 years old.

DIRECTOR: So that's 300 B.C., so that's 2,300 years old.

ISABELLA MULHALL: I'm very surprised that Oldcroghan Man is so old.

NARRATOR: They set aside the bracelet results. Perhaps their assumptions about the compositions of metals in different eras were wrong. Amazingly, the carbon-14 tests confirm the extraordinary nature of this discovery. Oldcroghan Man and Clonycavan Man are definitely bog bodies from the Iron Age.

Now, perhaps they can help the team understand if and why the Celts, the ancestral people of Ireland, were torturing, killing and burying men and women in the bogs.

Dr. Andrew Wilson is a bioarchaeologist with an interest in hair. By analyzing Clonycavan's hair, Wilson hopes to find out what he ate before he died.

DR. ANDREW WILSON (University of Bradford): Look at his face. We can see on his upper lip the remains of short stubble and slightly longer stubble, just under his chin.

NARRATOR: Hair is biomaterial that grows at a relatively constant rate, about half an inch per month.

Using a scanning electron microscope, Wilson can analyze the surface of a single strand in extraordinary detail. The preservation of the hair is a testament to the preservative chemicals in the peat bog.

ANDREW WILSON: You are seeing here an image of Clonycavan's scalp hair. And if we move in magnification, you start to see some of the detail of that fiber.

NARRATOR: But in order to learn more about Clonycavan Man's diet, Wilson will need to subject a sample to a destructive process. This single strand of hair, about eight inches long, is cut into equal lengths. Then each segment is analyzed for its chemical composition and then compared to each other.

ANDREW WILSON: Working from the root end of the fiber, you can build up a timeline of diet and, potentially, seasonal variation in diet. You may be able to tell what time of year a person died, what types of food they were eating.

NARRATOR: The findings show that Clonycavan Man had a healthy diet, rich in vegetables, especially during the months leading up to his death.

The hair on Clonycavan's head offers more evidence about how this Celtic man lived and, perhaps, why he died such a violent death. At the University of York, Dr. Joann Fletcher has been looking at Clonycavan's hairstyle.

DR. JOANN FLETCHER (University of York): The more that we were looking at the hair, the more we realized there was no actual knot-work in, there was no plaiting, no actual intricate styling of the hair itself, and yet the hair appeared to have been set up on top of the head in a rather tall arrangement.

NARRATOR: To keep his hair in place, Clonycavan Man was using some sort of Iron Age hair gel.

JOANN FLETCHER: When we did the analysis on the material from Clonycavan's hair, we found out it was essentially a vegetable plant oil mixed with a resin.

NARRATOR: Results showed that the resin was from a pine tree, but from a species not native to Ireland. It's resin from a type of pine tree that only grew in Southern France and Spain. It appears that in 300 B.C., Clonycavan was wealthy enough to import beauty products from abroad.

In addition to resin hair gel, there's further evidence of how Clonycavan styled his hair, fragments of a hair tie.

JOANN FLETCHER: It's clear that this so-called hair tie, the thing which had been used to keep the hair in place, had actually been attached, wrapped around the hair to secure it on top of, towards the back of the head in some fashion.

NARRATOR: Fletcher offers a theory on why Clonycavan wore his hair up.

JOANN FLETCHER: We know he was only 5'2" so the fact that he had been going to such lengths to increase his height is sort of a twist on the old platform boots for short men. Why bother with that when you can pile the hair up and fix it in place, and that adds to the height?

NARRATOR: In fact Fletcher's "elevated status" theory does have historical credibility. Tacitus, a Roman scholar wrote about the Celts and describes a particular hairstyle: the Swabian Knot. That style survives on a German bog body now known as Osterby Man.

Tacitus reports that elaborate hairstyles gave Celtic warriors a larger presence on the battlefield and served as a badge of social status. From his hairstyle, imported hair products and good diet, Clonycavan appears to be a member of the Celtic upper class.

But what about Oldcroghan Man?

While hair can provide a wealth of information relating to Celtic lifestyle, unfortunately none can be found on Oldcroghan's headless torso. Professor Don Brothwell instead looks for clues in his remarkably preserved stomach. Here he hopes to find remains from Oldcroghan's final meal.

DON BROTHWELL: We have used old techniques, just looking at the chewed up remains of the food, and that means looking at the actual plant tissue in the stomach contents. In the case of Oldcroghan Man, it seems to be mainly wheat that was consumed.

NARRATOR: But, using more advanced techniques, Brothwell is able to find more than just solid remains.

DON BROTHWELL: We have advanced these studies by looking at the chemistry of the foods, as well, and so we have been able to reveal, for the first time, using chemical analytical techniques, that the individual was taking in some sort of milk or milk products, as well as the cereals in his last meal.

NARRATOR: A diet of grains and milk products, and the absence of autumn fruits or leafy summer vegetables, may suggest that Oldcroghan Man died in winter or spring. Bioarchaeologist Wilson searches for clues in Oldcroghan's fingernails.

ANDREW WILSON: The nice thing with Oldcroghan Man is that he has beautifully preserved fingernails, and we know the fingernail grows at roughly three millimeters a month. With Oldcroghan Man, we are dealing with roughly six months of growth.

NARRATOR: The chemical composition of nails is directly affected by diet. Wilson, by measuring the amount of nitrogen in Oldcroghan Man's nails, will be able to discover how much protein Oldcroghan Man was eating in the last six months of his life.

ANDREW WILSON: And what we see is that the nitrogen values tell us a little bit about the protein component of diet, so the dairy components, the meat components in diet...we start to see that Oldcroghan Man was getting more of those components closer to death.

NARRATOR: In the Iron Age as winter approached, meat became the dominant source of food. Based on the nitrogen values in Oldcroghan's nails, it appears he died in winter.

A winter burial in a cold bog may also account for his extremely well-preserved skin tissue. And further evidence for a winter death comes from Roman sources, who report the Celts observed winter festivals with gory ceremonies including, perhaps, human sacrifice.

But the season of death is not all the nails can reveal. They also provide clues of Oldcroghan Man's lifestyle, how he might have used his hands.

ANDREW WILSON: What we are interested in is what sort of lifestyle Old Croghan Man had. What I might expect to see here, under the electron microscope, if we were dealing with heavy use and heavy wear, would be striations, little lines and little dents on the surface. The polished nature, the burnishing to the margins of the nail may suggest that we are dealing with an individual that has quite well manicured nails.

Oldcroghan's nails show no signs of wear and tear. This suggests that he might have been an individual of high status and didn't perform any manual labor. Curiously, finely manicured fingernails, styled hair, and a good diet are a commonly occurring feature among other European Iron Age bog bodies.

MIRANDA ALDHOUSE-GREEN: If we look at the bog bodies, for example, where the soft tissue remains, we do sometimes have an inkling, by looking at the hands and the feet, that these people were not engaged in manual labor. They were special. They were well-nourished. They were perhaps different and of higher esteem than others.

NARRATOR: Are individuals of high status being singled out to be brutally tortured, murdered and staked to the bottom of a bog? The team reviews the evidence.

Both Oldcroghan and Clonycavan Man were Celts who lived around 300 B.C., during the Iron Age period of ancient Ireland. Oldcroghan, at 6-foot-6 was unusually tall. Clonycavan at 5-foot-2 was fairly short. Both men were upper class.

We learn this in Clonycavan from his hair which reveals a rich diet and a style and grooming that hint that he was a warrior or of high social status. And headless Oldcroghan Man's high status is revealed in his manicured nails and hands that show no evidence of manual labor. The remains in his stomach show he also ate a rich diet and was well-fed before his death, like Clonycavan Man.

Both men were killed with excessive violence, in what looks like premeditated assaults: Clonycavan with three massive blows to the head shattering his skull, and Old Croghan tortured,

with cuts to his nipples, fatally stabbed and dismembered. His head and lower limbs have still not been found.

Shortly after dying, both men were carefully placed in the swampy bog, and, as evidenced by the hazel rope threaded through Old Croghan's arm, and like other Iron Age bog bodies, staked to the bottom of the bog. There, the chemicals in the peat preserved their brutalized bodies until they were discovered, about 25 miles from each other, over 2,000 years later.

Why did these Iron Age men die such violent deaths? Was there a connection between their social status and their murders? Could these carefully choreographed deaths and bog burials have been a form of capital punishment? Or is it possible these early Europeans were practicing a religious rite involving human sacrifice?

Archaeologist Tim Taylor has been pouring over evidence surrounding the deaths of Old Croghan and Clonycavan Man. He suggests the way they were killed, the sheer brutality of their deaths, is a clue to why they were killed.

TIM TAYLOR (University of Bradford): The deaths that the bog bodies themselves have been subjected to, I don't think can be considered honorable deaths in any way. Some people, I think, have thought about them as being sacrifices to the gods, perhaps. But I find that hard to believe, and I think we should look, rather, at the issue of ritualized judicial killing.

NARRATOR: Taylor believes the bog bodies were executed for crimes against society. To support his case he calls on the Roman historian, Tacitus, a contemporary of the Celts.

TIM TAYLOR: Punishments varied according to the nature of the crime, so traitors who were political criminals would be hung, to be on display to others as a warning not to do that, whereas he says that those who commit shameful crimes, those are crimes against honor, would be put into a bog and pinned down with wicker hurdles out of sight of society.

NARRATOR: Shameful crimes included cowardice, laziness and sexual deviance. To the Celts, Taylor believes the bog represented a kind of purgatory or limbo.

TIM TAYLOR: It's neither underground nor the above-ground. It's something in between Heaven and Earth or Heaven and Hell, where the body will not rot. And I believe that is because they were trying to trap the soul, to freeze it, put to these people into a social limbo so that they could not join the realms of the ancestors. They did not go to the gods, but they did not stay in the world of the living either.

NARRATOR: But Ned Kelly from the National Museum of Ireland doesn't think the bog bodies were executed criminals. He believes the evidence to solve the mystery of why they died such brutal deaths lies in the areas where the bog bodies were discovered.

Croghan Hill, the weathered top of an extinct volcano, is an ancient sacred site. It was in the bog lands below, where the headless body of Oldcroghan Man was found.

NED KELLY: Croghan Hill is, I think, immensely significant in this area. First of all, it dominates the whole area. It's visible for miles and miles around.

NARRATOR: Throughout the Iron Age, Croghan Hill was one site for the inauguration of Celtic kings and other political and religious rituals. Celtic beliefs remained a powerful force, even after Saint Patrick brought Christianity to Ireland in the 5th century.

NED KELLY: There is a whole panoply of Christian monuments here. You can see the triumph of Christianity over the old pagan order. It's on St. Patrick's Day, 17th March, that people come to the Holy Well. And they pray, come up here, and they literally set fire to the hill.

NARRATOR: Kelly is convinced that the death of Oldcroghan Man so close to this sacred Celtic sacred site was more than a public execution. He also believes the location of bog body burials, on what were medieval tribal borders, may be significant.

NED KELLY: The Oldcroghan body is on the border of what was the royal estate of the O'Connors in the Middle Ages. When I looked at the Clonycavan Man, he is buried on the border between the modern counties of Meath and West Meath, which were also very significant tribal boundaries in the early medieval period. Now, I think that's not coincidental.

NARRATOR: Kelly discovered that more than 40 other Irish bog bodies were buried on these same traditional borders.

NED KELLY: I think these tribal areas were equally important in the Iron Age.

NARRATOR: But why would the ancient Celts murder people of high social status and stake them down on these tribal borders?

NED KELLY: My belief is that these burials are offerings to the gods of fertility, by kings, to ensure a successful reign. And if the king couldn't guarantee the fertility of the land, he could be deposed.

NARRATOR: If Kelly is right, these bog bodies weren't just murdered, they were sacrificed, the community giving up the well-born to appease the gods. But why were their deaths so violent?

MIRANDA ALDHOUSE-GREEN: I subscribe to the view that the violence is itself a sacred act. It's an energizing thing. It's something which actually imbues the body with particular currency, giving it a particular force. But I think it is also to do with collective responsibility, the idea that the whole community is involved in the killing.

NARRATOR: If the bog bodies are the result of a community-sanctioned ritual sacrifice, then to the ancient Celts, the bogs may have represented the entry way to the afterlife.

MIRANDA ALDHOUSE-GREEN: The bog is a kind of threshold between worlds, a bit like the water in general. So it may be considered to be a gateway to the other world. But the bog

itself is neither one thing or the other. It's neither land nor water, and it's both. And it's treacherous. And it shows a face to the world that isn't real, so there is an idea of treachery, of ambiguity about it. And I think that attracts people to use the bog as a sacred place.

NARRATOR: More than 2,000 years ago, the Celts could not have imagined that their sacrificial victims would become the subjects of a modern forensic investigation.

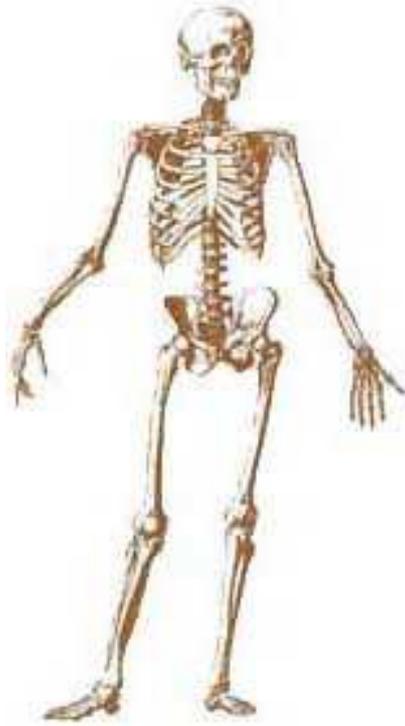
After 12 months, the Irish bog bodies project is drawing to a close. For five weeks the bodies have been soaked in a solution called "PEG," polyethylene glycol.

PATRICK : It seems to be going very well.

ROLLY READ: It is, isn't it?

NARRATOR: The PEG will prevent the bodies from shrinking when they are freeze-dried, the preferred method of long term preservation.

Since their burial in the Iron Age, the chemicals in the bog have preserved the bodies; now the Museum must continue what the ancient Celts and nature began. After 2,300 years hidden in the peat bogs, Old Croghan Man and Clonycavan Man are prepared for their final resting place. It's another kind of afterlife, on display at the National Museum of Ireland.



Quiz Questions for Topical Quiz # 3B

1. The medial clavicular epiphysis fuses between the ages of _____ and _____.
2. The *last* epiphysis to fuse in the skeleton is the _____.
3. How does the pattern of ossification at the bone-cartilage interface at the sternal end of the rib differ between the sexes?
4. How can ribs be used to estimate age? How do the ribs differ between the sexes?
5. If the epiphyseal rings of the vertebrae are fused but no osteoarthritis is visible, that would correspond to an age range of:
6. If the epiphyseal rings of the vertebrae are in the process of fusing, that would correspond to an age range of:
7. If the epiphyseal rings of the vertebrae are completely absent, that would correspond to an age range of:
8. If the vertebrae exhibit obvious osteoarthritis and the vertebral bodies are beginning to degenerate, that would correspond to an age range of:
9. What are the fundamental principles with regard to using the pubic symphysis to estimate age? (For example, how do casts compare with pictorial illustrations in terms of their usefulness for recognizing age-related changes? What happens as you move to higher-numbered phases in the six-phase system for pubic aging?)
10. What are the fundamental principles with regard to using the pubic symphysis to estimate age? (For example, is the method generally reliable? Are the age-related changes clearly delineated?)
11. The age at which all thirty-two permanent teeth have erupted would be:
12. The age at which the root tips of the erupted permanent teeth are all complete and the root of the unerupted third molar is developing would be:
13. The age at which no deciduous teeth remain and the second permanent molar has erupted would be:
14. The age at which exfoliation and replacement of deciduous teeth is complete *except* for the upper deciduous canine and second deciduous molars would be:
15. The age at which exfoliation of deciduous teeth has begun, and permanent incisors have erupted, would be:

16. The age at which no teeth have erupted, but the maxilla and the mandible are packed with growing teeth, would be:
17. The age at which the deciduous dentition is complete including root tips would be:
18. The age at which the first permanent molar is erupting would be:
19. The age at which the deciduous incisors have erupted would be:
20. The age at which the deciduous dentition is completely erupted, but the roots are incomplete, would be:
21. Modifications that occur to the skeleton as a result of age, wear, and disease are called _____ changes.
22. Modifications that occur to the skeleton during processes of growth and development are called _____ changes.
23. Which of the following aging methods is/are 100 percent accurate: medial clavicular epiphysis, ossification of cartilage at the sternal rib, presence or absence of osteoarthritis?
24. Which of the following aging methods is/are 100 percent accurate: epiphyseal ring of vertebrae, pubic symphysis, tooth eruption and exfoliation?
25. When providing an estimate of age, is it better to err on the side of a narrow or wide range, and why?
26. When should you use one method alone to estimate age?
27. What are the general principles of age estimation in forensic anthropology? For example, do the growth plates for different bones all turn off at the same time during life? Does the timing of epiphyseal fusion for any one growth plate vary tremendously across populations?
28. What are the general principles of age estimation in forensic anthropology? For example, do male skeletons typically mature faster than female skeletons? Can childhood malnutrition negatively affect skeletal growth and development?
29. Most forensic anthropologists agree that the best age estimate that can be determined for adults from the cranial sutures would be an age within a range of _____ years.
30. In forensic anthropology, the most commonly used age indicator for adults is _____.
31. The proportion of ash to bone fragments in typical cremains that have been produced by professional crematoria is about:

32. The term “retort” refers to _____.
33. What are calcined bones?
34. What are the characteristics of calcined bones?
35. As William Maples explains in *Dead Men Do Tell Tales*, the most common reason that forensic anthropologists are asked to identify the remains of individuals who have been professionally cremated is _____.
36. What did William Maples consider to be the most fascinating, perplexing, and complex case of his career?
37. What were the details of the Meek-Jennings case described in *Dead Men Do Tell Tales*? (What do William Maples do at each stage of the investigation, and what was he able to conclude about the case?)
38. What are the characteristics of the burn pattern on the surface of bones?
39. How does the burn pattern on the surface of bone vary from one kind of bone to another?
40. What is the melting temperature of gold dental inlays? How does that compare to the melting point of aluminum? Is that temperature commonly reached in house fires? Are gold dental inlays very useful for personal identification?
41. In the Meek-Jennings case described in *Dead Men Do Tell Tales*, what did William Maples personally conclude about the probable manner of death for the two individuals?
42. In identifying an individual from cremated remains that have been professionally processed, forensic anthropologists rely primarily upon _____.
43. As described in the film *The Perfect Corpse*, perhaps the most famous of the bog bodies from the British Isles and northwestern Europe is _____, who was recovered from a peat bog in the country of _____.
44. As described in the film *The Perfect Corpse*, how old was Oldcroghan Man when he died, and how tall was he during life?
45. As described in the film *The Perfect Corpse*, waterlogged sphagnum moss that’s found in peat bogs produces a chemical reaction that preserves soft tissue in a process that closely resembles _____.
46. As described in the film *The Perfect Corpse*, what was the cause of death for Clonycavan Man?

47. As described in the film *The Perfect Corpse*, carbon-14 tests revealed that Oldcroghan Man and Clonycavan Man both died approximately _____ years ago, placing them in the _____ Age.
48. As described in the film *The Perfect Corpse*, hair grows at a fairly standard rate of approximately _____ per month, while fingernails grow at a rate of approximately _____ per month.
49. As described in the film *The Perfect Corpse*, what social class did Oldcroghan Man and Clonycavan Man both belong to in ancient Celtic society? Why does archaeologist Tim Taylor think the men were killed by the other members of their society?
50. As described in the film *The Perfect Corpse*, why does researcher Ned Kelly think Oldcroghan Man and Clonycavan Man were killed by the other members of their society?

Chapter 11

Estimation of Ancestry

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to the questions can be found in the assigned readings for this topic (i.e., Chapters 3, 11, 13, & 14 of *Forensic Anthropology Training Manual* and Chapters 12 & 16 of *Dead Men Do Tell Tales*) and the film that accompanies this topic (i.e., *China's Secret Mummies*).

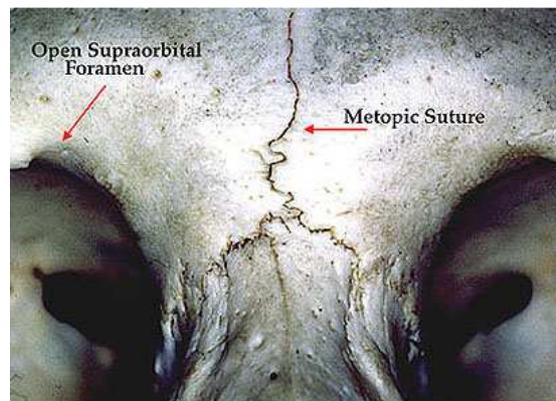
Here's some additional information that you might find useful as you prepare for this quiz. "Race" (or, more appropriately, *ancestry*) can be estimated using either metric or nonmetric methods (in most instances, forensic anthropologists would employ both methods to estimate an individual's ancestry). The metric methods for estimating ancestry are described in Chapter 14, but for our purposes we'll focus primarily on the nonmetric methods. The table on the following page summarizes the essential information you're responsible for knowing about the estimation of ancestry:

Finally, some of the quiz questions from Chapter 12 of *Dead Men Do Tell Tales* refer to "CILHI," because that's how Maples referred to the military's forensic anthropology laboratory. For your own information, you should remember that the facility's name has since been changed to the Central Identification Laboratory at **JPAC** (the URL for JPAC is <http://www.jpac.pacom.mil/>).



African skull

<i>Feature</i>	<i>Asian Ancestry</i>	<i>European Ancestry</i>	<i>African Ancestry</i>
<i>Nasal Aperture</i>	medium	narrow	wide
<i>Nasal Spine</i>	medium, tilted	large, long	little or none
<i>Nasal Border</i>	less sharp sill	distinct sill	guttered
<i>Eye Orbits</i>	round	sloping	rectangular
<i>Profile</i>	moderate prognathism	little prognathism	strong prognathism
<i>Palatal Shape</i>	elliptic (rounded)	parabolic	hyperbolic (rectangular)
<i>Palatal Suture</i>	straight	z-shaped	arched
<i>Cranial Sutures</i>	complex, with Wormian bones	simple	simple
<i>Metopic Suture</i>	rare (10%)	rare (10%)	absent
<i>Maxillary Incisors</i>	shovel-shaped	blade-form	blade-form
<i>Chin</i>	blunt median chin	square bilateral, projecting	retreating chin
<i>Cranium</i>	low, sloping	high	low, with post-bregmatic depression



persistent metopic suture

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 3C

ESTIMATION OF ANCESTRY

RACE

There is no such thing, biologically, as race.
 Race is a cultural concept, not a scientific concept.

There is polytypic variation within the human species (*i.e.*, local populations differ in the expression of one or more traits), but that variation is *continuous* across the human species for any genotypic or phenotypic trait (*e.g.*, skin color), and that variation cannot be neatly divided into clearly defined categories with distinct boundaries.

Different cultures define racial categories differently—but no matter how the categories are defined, there is more genotypic and phenotypic variation *within* each category than there is *between* any two categories.

It is true that forensic anthropologists attempt to identify the “race” of an individual from skeletal remains, but that’s because “race” is an important identifying element to the forensic anthropologist’s clients (*e.g.*, law enforcement officials).

Forensic anthropologists know that “race” is not a valid scientific concept (which means they realize that there’s no scientific test that could possibly identify a person’s “race,” because “race” is not something that actually exists).

When forensic anthropologists try to identify an individual’s “race,” they are trying to predict how that individual would have been classified in life by members of his or her culture using that culture’s definition of “race.”

Forensic anthropologists generally use the term “ancestry” rather than “race” (*i.e.*, they try to identify the geographic population that most of an individual’s ancestors would have come from over the past few thousand years).

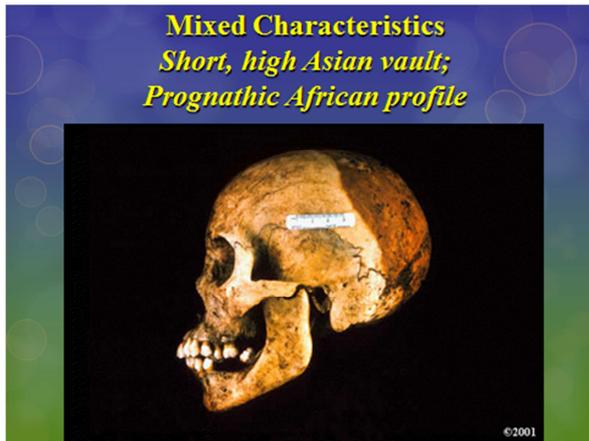
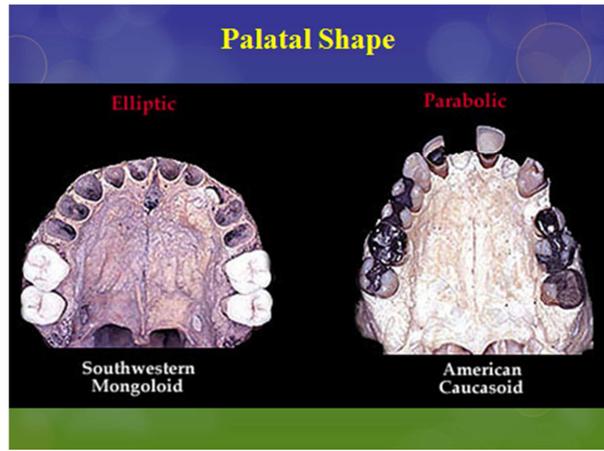
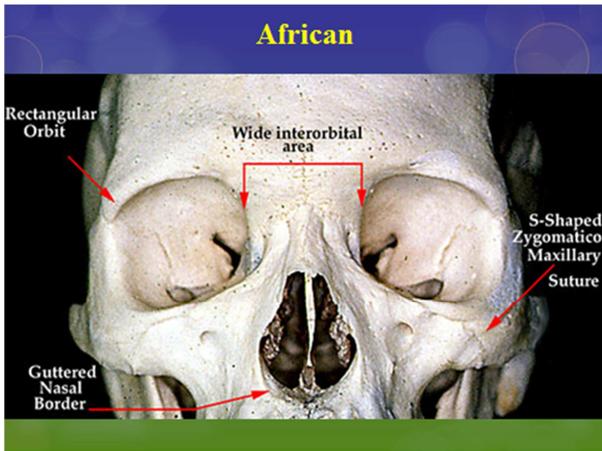
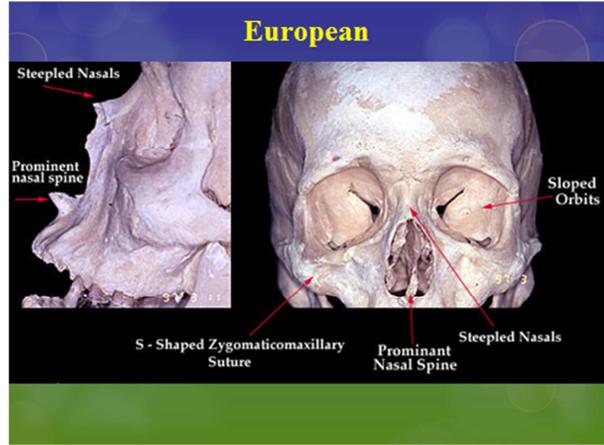
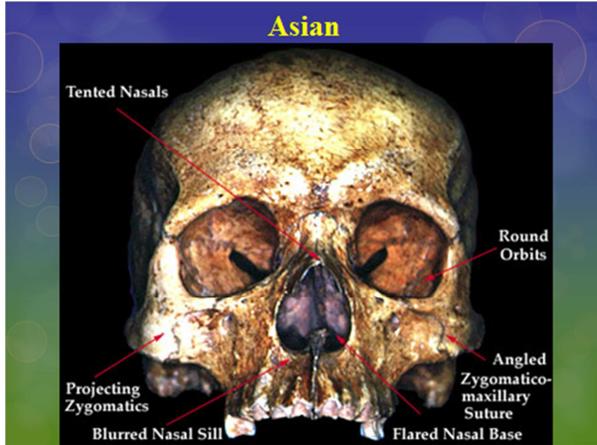
Typically, forensic anthropologists identify three stereotypical ancestral groups (Asian, European, and African) based on features of the skull, and then attempt to determine which of the three stereotypes any given skull most closely resembles.

Worldwide, however, *very few* individual skulls fit *any* of those three categories *exactly*, and *many, many* skulls fit *none* of the three categories. (For example, it would be impossible to classify the skull of Tiger Woods as either European, Asian, or African, because his father was of predominantly African and European ancestry while his mother was of predominantly Asian ancestry—thus, *like most people*, his skull exhibits a mixture of ancestral features.)

Finally, with the gene flow that goes on between various human populations (gene flow that has considerably increased in the modern age), *the phenotypic features of any population are constantly changing*. Thus, just because some individual might have predominantly “European” features in their skull, *it doesn’t mean that they necessarily came from Europe*.

“European” features are simply a particular set of phenotypic traits that may have appeared and disappeared many times in many places in the history of the human species (the same is true of “Asian” or “African” features—and it’s also true that the overall pattern of phenotypic traits in *most* populations in the history of the human species did not conform to *any* of those three stereotypes).

Feature	Asian Ancestry	European Ancestry	African Ancestry
Nasal Aperture	medium	narrow	wide
Nasal Spine	medium, tilted	large, long	little or none
Nasal Border	less sharp sill	distinct sill	guttered
Eye Orbis	round	sloping	rectangular
Profile	moderate prognathism	little prognathism	strong prognathism
Palatal Shape	elliptic (rounded)	parabolic (diverging arch)	hyperbolic (rectangular)
Palatal Suture	straight	jagged (z-shaped)	arched
Cranial Sutures	complex, with Wormian bones	simple	simple
Metopic Suture	rare (10%)	rare (10%)	absent
Maxillary Incisors	shovel-shaped	blade-form	blade-form
Chin	blunt median chin	square bilateral, projecting	retreating chin
Cranium	low, sloping	high	low, post-bregmatic depression



Details of the notorious 1990 Gainesville murder case that William Maples helped investigate:
 5 UF students murdered August 1990 by Danny Rolling, drifter from Shreveport, Louisiana...identified by DNA analysis of traces of semen at horrific crime scene...Maples' work centered on the murder weapon, since bone can take and hold an impression from a murder weapon far longer (skin is elastic and can stretch, distort, relax, and then decompose)...a large knife, 7-8 inches, smooth, non-serrated cutting edge...Marine Corps utility knife, Ka-Bar...Rolling pleaded guilty before trial began, given five death sentences...Maples concludes that the lamp of science can shine rays into the very heart of darkness to accuse and identify the agent of death...Moral: forensic anthropology is a discipline useful to society.

Film Summary

China's Secret Mummies

You can watch the film online at the National Geographic Society website:
<http://channel.nationalgeographic.com/channel/explorer-25-video-1>

In the late 1980's, well-preserved 3000-year-old mummies began appearing in a remote Chinese desert. They had long reddish-blond hair, European features and didn't appear to be the ancestors of modern-day Chinese people. Archaeologists now think they may have been the citizens of an ancient civilization that existed at the crossroads between China and Europe.



Mummified remains of "Cherchen Man"



Cherchen Man is carried to his burial (film re-enactment)

The giant province of Xinjiang lies in the remote northwest corner of China. The topography is divided between the high grasslands of the north and the arid wastes of the Taklamakan Desert in the south. People began to inhabit the region as early as 4,000 years ago. Today the area contains a complex mixture of various ethnicities, but the archaeological and historical evidence indicates that the earliest settlers came from Europe. Recent discoveries of well-preserved mummies from the Taklamakan have provided proof of the western origins of the original inhabitants.

In 1988, Victor Mair, a scholar of Chinese texts from the University of Pennsylvania, traveled to a provincial museum in China's western hinterlands. He was startled by what he found. In a room filled with 3,000-year-old mummies, he saw the remains of several individuals with strikingly western features, including one six-foot-tall man who was Caucasoid in appearance. Mair knew that ancient Chinese texts described a race of people in the west who were very different from the Chinese, and he was looking at dramatic proof that the texts were accurate. It had long been thought that the West and China developed in isolation from one another, with no significant contact or trade for thousands of years. The presence of European-looking people in western China 3,000 years ago was clear evidence that those long-held assumptions were erroneous.

The Tarim Basin, a harsh desert surrounded by mountains in western China, was home to Caucasian settlers thousands of years before Marco Polo journeyed to China. A Chinese archaeological expedition in 1978 first uncovered the western-looking mummies and re-opened a long-forgotten chapter in Chinese history. However, the Caucasian mummies did not fit the traditional story of the separate and unique origins of the Chinese Civilization, so the well-preserved bodies lay neglected in an obscure museum until they were rediscovered by western scholars. When the mummies were found, archaeologists uncovered artifacts that may not have been known in China at the time, including the wheel, bronze, and wool cloth.

One mummy is especially striking. Known as the Beauty of Loulan, she was wearing a fur-lined skirt and a felt hat decorated with a goose feather. Another mummy, known as Cherchen Man, is wearing the world's oldest known pair of pants. The clothing of the mummies, that includes distinctive boots, belts, and decorative bands, hints at their cultural origins. A fragment of fabric with a twill weave had a plaid pattern whose colors and design were very similar to European fabrics dating to the same time period from Germany, Austria, and Scandinavia. Who were these people, and where did they come from?

By 1,800 B.C.E. humans had settled virtually all of the world's habitable regions. The formidable Tarim Basin was one of the last places to be populated by humans. People first arrived to the Tarim Basin some 4,000 years ago. One of the first mummies, dating to the time of the original settlement of the area, is the Beauty of Loulan, who is 3,800 years old. Nicknamed for her regular facial features, she may have been a weaver in life—a craft that might have been regarded as an art form in her culture. They clearly valued their clothing, as evidence by the sumptuous garb worn by the mummies. Looking at the fibers of the clothing under a microscope, researchers determine that the threads were made of wool from sheep and goats, providing some of the earliest evidence of wool technology in the region. The cloth was not Chinese, but reflected instead a technology from the west.

Geneticist Spencer Wells has spent years collecting DNA samples from human populations all over the world. He explains that contemporary DNA can be used to track ancient migration patterns. If it is possible to obtain DNA from the mummies, it might be possible to pinpoint their origin.

The Tarim Basin was a harsh environment, alternating between extreme heat and bitter cold, and plagued by extreme drought. The Beauty of Loulan suffered during her life. Her lungs showed signs of smoke and sand damage, and she was intensely infested with lice. She was probably in her early 40's when she died. Chinese geneticist Felix Jin joins Spencer Wells in the effort to investigate the DNA of the mummies to learn even more. In February 2007, Jin and a small team travel to the Tarim Basin to take samples from the mummies. It is difficult to retrieve DNA from ancient bodies, however. His team carefully operates on the Beauty of Loulan. The skin is leathery and the muscle tissue is dry, which does not bode well for DNA preservation. They turn their attention elsewhere.

Almost one-third of the corpses found in the Tarim Basin died before reaching adulthood. The mummy of one young boy who lived about 4,000 years ago showed that he had lived a difficult life. He was buried with a magnificent shroud that was a masterpiece of weaving for its time. Nearby his tomb, investigators found tantalizing artifacts, including fragments of bronze. Bronze is an amalgam of copper and tin, and it was first used in Mesopotamia around 3,500 B.C.E. At the time, bronze technology was unknown in China, suggesting the possibility that it may have been the Tarim People who brought bronze to the Chinese.

Jin and his team continue their efforts to extract DNA samples from other mummies. Probing deeper into a mummy, they excise a small amount of muscle tissue that is redder in color, making it more likely that it contains recoverable DNA. Their greatest hopes, however, lie with the mummy of Cherchen Man, because of its exceptional preservation. Cherchen Man was six feet tall with light hair and fair skin. He wore brightly colored robes in addition to the world's oldest known pair of pants. A saddle was found in his grave, and the skull of a horse was nearby. It is a possible clue to the origin of the Tarim People on the steppe at the border between Europe and Asia, where the horse was first domesticated some 5,500 years ago. The horse allowed people from the Tarim Basin to move across vast distances, opening the possibility that Cherchen Man made at least occasional contact with the Chinese to the east.

At the Hermitage Museum in St. Petersburg, Russia, Spencer Wells investigates a mummy that had been found frozen in Siberia. The mummy comes from the Pazyryk People who lived 600 miles north of the Tarim People. The Pazyryk were steppe nomads, and the mummy at the Hermitage had been buried with a chariot, woven rugs, and a mummified horse complete with saddle. He lived during the time that the Tarim People's existence was coming to an end, but the Pazyryk technology was similar to that of the Tarim Basin hundreds of miles away.

Felix Jin's effort to recover and analyze DNA from the Tarim mummies pays off. The breakthrough comes with a new mummy that had been found in 2003. A handful of unusual objects had been found in his tomb, including musical instruments, bells, and a wand. He is known as the Yunghai Shaman, and he lived in the 8th century B.C.E., during the final chapter of the Tarim People's existence. He probably served his people as a healer, fortune teller, and

mystic. The head of the Yunghai Shaman was adorned with small seashells that came from the Indian Ocean more than 1,000 miles to the south. These clues reinforce the conclusions of the DNA analysis: the Tarim Basin People show a mixture of genetic lineages from all over Eurasia (they were not a pure group of European immigrants). [This is exactly what you'd expect for all but the smallest and most isolated human societies, because human populations constantly mix and evolve. We are *all* a mixture of many lineages.] The Tarim Basin was a crossroad of human migrations for thousands of years. That's why the Beauty of Loulan showed unexpected marks of east Asian ancestry when her DNA results were in. Cherchen Man also had an east Asian lineage, while the Shaman's lineages could be traced to the Himalayas and India.

Quiz Questions for Topical Quiz # 3C

1. With regard to the nasal aperture, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
2. With regard to the nasal spine, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
3. With regard to the nasal border, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
4. With regard to the eye orbits, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
5. With regard to the profile, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
6. With regard to the shape of the palate, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
7. With regard to the palatal suture, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
8. With regard to the cranial sutures, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
9. With regard to the metopic suture, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
10. With regard to the maxillary incisors, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
11. With regard to the chin, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
12. With regard to the overall shape of the cranium, what are the distinctive characteristics of individuals whose ancestry is predominantly African?
13. With regard to the nasal aperture, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
14. With regard to the nasal spine, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
15. With regard to the nasal border, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?

16. With regard to the eye orbits, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
17. With regard to the profile, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
18. With regard to the shape of the palate, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
19. With regard to the palatal suture, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
20. With regard to the cranial sutures, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
21. With regard to the metopic suture, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
22. With regard to the maxillary incisors, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
23. With regard to the chin, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
24. With regard to the overall shape of the cranium, what are the distinctive characteristics of individuals whose ancestry is predominantly Asian?
25. With regard to the nasal aperture, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
26. With regard to the nasal spine, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
27. With regard to the nasal border, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
28. With regard to the eye orbits, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
29. With regard to the profile, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
30. With regard to the shape of the palate, what are the distinctive characteristics of individuals whose ancestry is predominantly European?

31. With regard to the palatal suture, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
32. With regard to the cranial sutures, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
33. With regard to the metopic suture, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
34. With regard to the maxillary incisors, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
35. With regard to the chin, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
36. With regard to the overall shape of the cranium, what are the distinctive characteristics of individuals whose ancestry is predominantly European?
37. What do the initials “CILHI” stand for? What is the mission of CILHI?
38. Who works at CILHI? What procedures does CILHI follow with regard to making its final determinations?
39. As William Maples explains, the term “Missing in Action” (MIA) has been superceded at CILHI by the more correct expression _____.
40. How many unsolved cases are likely to be under review by CILHI at any one time?
41. Why was William Maples asked to be present at the autopsies of the five students murdered in Gainesville?
42. How do bones and soft tissue compare when it comes to preserving evidence of trauma, such as that experienced by the five students murdered in Gainesville?
43. In his examination of the remains of the five students murdered in Gainesville in 1990, what was William Maples able to determine about the murder weapon?
44. Based on the case of the five students murdered in Gainesville in 1990, what did William Maples conclude about the value of forensic science in general and forensic anthropology in particular?
45. As described in the film *China’s Secret Mummies*, if the mummies that have been found in the Tarim Basin are a representative sample of the ancient society, then the rate of childhood mortality for the people who lived there around 3,000 years ago was approximately _____ percent.

46. As described in the film *China's Secret Mummies*, DNA analysis of the mummies established that the Tarim Basin People had genetic lineage(s) that came from _____.
47. As described in the film *China's Secret Mummies*, the Beauty of Loulan was approximately _____ years old when she died approximately _____ years ago.
48. As described in the film *China's Secret Mummies*, the Yunghai Shaman lived in the _____ [early or late] stages of the existence of the Tarim Basin People approximately _____ years ago.
49. As described in the film *China's Secret Mummies*, the Beauty of Loulan lived in the _____ [early or late] stages of the settlement of the Tarim Basin, and she _____ [would or would not] have been a lousy bedmate.
50. As described in the film *China's Secret Mummies*, the Tarim Basin People _____ [did or did not] have domesticated horses, and they _____ [did or did not] have bronze technology.

Chapter 12

Trauma Analysis, Taphonomy, & Estimation of Time since Death

The questions for this quiz will be taken directly from the list of questions that appears below. The answers to most of the questions can be found in the assigned readings for this topic (i.e., Chapters 13 & 15 of *Forensic Anthropology Training Manual* and Chapters 4 & 5 of *Dead Men Do Tell Tales*) and/or the film that accompanies this topic (i.e., *Secrets of the Dead: Headless Romans*). For the answers to a few of the questions regarding **taphonomy** and the **postmortem interval (PMI)**, you should refer to the information below (which is adapted from *Hard Evidence: Case Studies in Forensic Anthropology* by Dawnie Wolfe Steadman).

Taphonomy is the study of postdepositional processes—i.e., the factors that modify the body after death (including everything from decomposition to insect and scavenger activity to natural geological and meteorological processes). **PMI**, or **postmortem interval**, is the term generally used in the forensic sciences for the estimation of the time since death.

At death, several gross morphologic changes are triggered by circulatory stasis and autolysis, including *livor mortis*, *algor mortis*, and *rigor mortis*. **Livor mortis** is discoloration of the body due to circulatory stasis—the blood pools in the capillaries where the body is experiencing gravitational pull (e.g., the feet of a hanging victim). **Algor mortis** is the cooling of the body to the ambient temperature of the environment. **Rigor mortis**, which is one of the most commonly utilized time-since-death indicators in forensic pathology, involves the stiffening of muscles from the biochemical binding together of muscle fibers. Rigor mortis is a temporary phenomenon which dissipates over time; a rough timeline for rigor mortis would be initial development at one to two hours after death, complete stiffness at twelve hours postmortem, and waning over the next twelve hours (or longer).

Thanks in large part to studies at the University of Tennessee’s “Body Farm,” forensic anthropologists now have a good understanding of the phases of human decomposition and the various factors that affect the rate of decay. (Many of those studies involve human cadavers that have been donated to the **Forensic Anthropology Center at the University of Tennessee** (<http://web.utk.edu/~fac/>), but many other studies have involved observations about the rate of decomposition for pigs. Pigs make the best substitute for human cadavers, because the size, shape, and internal anatomy of the thorax are similar in pigs and humans, and because domesticated pigs, like humans, generally do not have a thick covering of fur.) The table on the following page summarizes some important variables that influence the rate of decay of human remains; each variable is given a score which rates it on a 1 to 5 scale, with 5 being the most influential.

Variable	Score	Effect
Temperature	5	Faster decay in higher temperatures due in part to insect activity; slowed or ceased decay process in cold temperatures (especially below freezing)
Access by Insects	5	Very rapid decay if weather conditions are warm enough for oviposition and maggot activity
Burial and Depth	5	Bodies buried one foot or more will decompose much slower (months to years) than bodies laid on the surface (a few weeks to a few months)
Carnivores and Rodents	4	Can consume and destroy specific tissues (e.g., face, hands) and remove smaller skeletal elements
Trauma (penetrating & crushing)	4	Increases decay rate in wound areas due to insect activity
Humidity/Aridity	4	Higher humidity correlated with increased insect activity
Rainfall	3	Little or no effect on maggot activity; decreased fly activity during heavy rains
Body Size & Weight	3	No strong connection between body size and decay, though body composition does play a role (obese individuals lose mass quickly due to liquefaction of fats)
Clothing	2	Slightly increases rate of decay because it protects maggots

Forensic entomology is the study of the succession, activity, and longevity/maturity of a variety of carrion arthropods (i.e., insects and other invertebrates that feed on decomposing flesh). Forensic entomology is a crucial component in the determination of the postmortem interval—in fact, it’s generally more accurate in evaluating the PMI than the gross morphological changes caused by decomposition. Larval maturity, for example, is an excellent measuring tool for time since death (even though the rate of larval maturity is affected by ambient temperature). The first carrion insect to be interested in the corpse is generally the blow fly (*Calliphoridae*), which is present on the body within the first hour of deposition; oviposition (egg laying by the blow fly) has been observed immediately (flies typically lay their eggs in natural orifices or artificial openings of the body, such as wounds). If death near occurred near the time the body was deposited, the maturity level of *Calliphoridae* larvae provides a sensitive indicator of time since death. Flies, however, are not the only insects that are attracted to carrion. As the maggots (fly larvae that have recently hatched from eggs) reduce the soft tissues of the body, various other species, including first beetles, and then ticks, ants, and cockroaches, are attracted in sequence. This orderly attraction of different insect species to a corpse throughout the decomposition process is called **succession**, and forensic anthropologists (assisted by forensic entomologists) can use the pattern of succession to estimate the time since deposition.

Classroom Presentation (PowerPoint Slides)

ANT 2524
Fundamentals of Forensic Anthropology

Topic 3D

**TRAUMA ANALYSIS,
TAPHONOMY,
& ESTIMATION OF
TIME SINCE DEATH**

antemortem trauma
bony surfaces show signs of callus formation or the thickly rounded surfaces characteristic of bony remodeling

perimortem trauma
no sign of healing, and any staining or weathering should be consistent with that of the surrounding bone

postmortem trauma
dry bone breaks differently...the outer surface of bone that has been exposed to dirt and weather is usually different from the protected inner surface—therefore a recent mark will reveal an inconsistent color

trephination: cranial surgery resulting in holes cut into skull

simple fractures: a clean break with no skin penetration

compound fractures: broken ends of bone protrude through an open wound in skin

comminuted fractures: the bone is broken into many pieces

compression fractures: crushed bone (common in porous bone)

depressed fractures: broken bone is pressed inward (as in blunt force trauma to the skull)

Distinctive patterns of damage produced by...

knives
the wound is small, clean, and sharp-edged...characterized by straight lines (which are seldom found in nature)

machetes
the wound is long, deep, and sharp-edged

hacksaws, hammers, and ice picks
the wound is related to the form of the tool (e.g., repetitive and somewhat parallel striations from a hacksaw)

The characteristic appearance in bone of a low-power gunshot wound involves *less expansion and fewer cracks*

The characteristic appearance in bone of a high-power gunshot wound involves a "starburst" pattern of cracks

The entrance wound is smaller and beveled inward, the exit wound is larger and beveled outward

shotgun wound: scalloped margins and small starburst cracks, with only slight inward beveling of the entrance wound; shotgun pellets rarely exit the body

blunt force injury: concentric cracks in addition to the occasional starburst cracks, with fragments of bone bent inward (because of more complete fracture of the outer table than the inner table of bone)

Perimortem Sharp Force Trauma (Machete)



Antemortem Trauma to Nasal Bones



**Perimortem Fracture of Pubic Bone
(Taphonomic Discoloration)**



Perimortem Cuts on Mandible



Exit Wound with External Beveling



Endocranial View of Entrance Wound



**Exit Wound
(Note Unbeveled Edge at Suture Margin)**



**Gunshot Exit Wound to Rib
(External Beveling)**



Gunshot Exit Wound with Lodged Projectile



Postmortem Trauma



Taphonomic Study of Porcine Decomposition



**Taphonomic Differences
(Cranium in shade, Mandible in sun)**



**Taphonomic Differences
(Cranium sun bleached,
Mandible discolored by soil)**



Film Summary

Secrets of the Dead: Headless Romans

“It was an amazing moment. I remember standing with our site manager and we looked at the first decapitated burial. ... The skull had been taken off and put down by the feet, as I recall. Then we started finding other things, which were rather unusual, like a skeleton with these great, thick iron rings—shackles, if you will—around its ankles.” Patrick Ottaway, archaeologist

In 2005, in the English city of York near the ancient ruins of Hadrian’s Wall, archaeologists unearthed more than 30 Roman-era skeletons. The skeletons are posed in a gruesome tableau of violent death, their heads hacked off and placed between their knees, at their feet or in other odd places, suggesting desecration and humiliation, even in death. One is found with heavy iron rings around its ankles, an aberration in the Roman world. Who were they? Pagan prisoners savagely murdered? Soldiers killed in battle or executed for crimes against Rome?

To solve the mystery, a team of investigators posits compelling theories and puts each one to the test. *Headless Romans* follows the progress of the team’s researchers as they examine the evidence within the context of a key, transitional period of Roman history marked by fierce sibling rivalry over the imperial throne.

“Modern forensics, ancient relics, historical records, and re-enactments all come together and make for high drama in this documentary about one of the more baffling archaeological discoveries in recent memory,” said Jared Lipworth, executive producer of SECRETS OF THE DEAD. “It’s fascinating to watch as science and scholarship converge and a vague chapter of ancient Roman history is essentially re-written.”

SECRETS OF THE DEAD: *Headless Romans* opens with a high-angle shot of the grand interior of York’s medieval guildhall, where rows of decapitated skeletons from the excavated site are laid out on steel tables for examination. The program juxtaposes this startling image with scenes of magnificent Roman ruins, connecting the skeletons to the greatest civilization ever to rule the ancient world, with an empire that stretched from North Africa to present-day England and beyond. At this point, the investigators know the general period of the skeletons, but not much else.



Scientists discovered that vertebrae fragments on the skulls were marked by the blade of an axe, sword or similar weapon.

First, human bone specialists Katie Tucker and Charlotte Roberts are called in. They quickly determine that all of the skeletons are male. A state-of-the-art microscope reveals stunning, three-dimensional images of vertebrae fragments marked by the blade of an axe, sword or similar weapon. But was this the cause of death? Or were the heads removed posthumously as part of some mysterious Roman burial rite? Archaeologist Robert Phillipot and historian and author Miranda Green discuss Roman superstitions and beliefs about death and the afterlife, offering a possible context for the latter theory. But the skeletons show signs of extreme violence. One was found buried face down with a large hole in its skull. This evidence seems at odds with the deliberate, surgical cuts that would have likely been used in a ritual

decapitation or burial rite.

Pottery from the site dates to the early third century, when Septimius Severus used violence to bring stability to an empire previously fragmented and weakened by civil war. Severus and his army led brutal campaigns against the Caledonian tribes of Scotland beyond Hadrian's Wall, which had been built by the Romans to mark the limits of their empire and keep out those they deemed "barbarians." By A.D. 208, Severus's efforts assured that the prosperous, pluralistic city of Eboracum, at present-day York, became a military stronghold and a key center of the Roman world.

The enamel of a tooth, which scientist Janet Montgomery describes as "a little archive, a little snapshot...that people carry around with them wherever they go," helps determine the origins of the skeletons. She uses the advanced technology of an electron spectrum device to cull data from many different samples and discovers that these men came from Germany, the Alps, the Mediterranean, and Africa. Her findings help dismiss one theory that the skeletons are those of local Scottish soldiers or prisoners. It is a major breakthrough for the investigative team.

But what about the skeleton with the iron shackles around its ankles? Archaeologist Patrick Ottaway doesn't believe that the shackles, which were soldered onto the legs without chains, were designed for a prisoner. "It conjures up an awful picture," he says, speculating that the shackles were meant to contribute to a terrible and humiliating death. "You would have an open wound as a result of putting the things on in the first place, and then the things chafe and cause further inflammation, so by the time the poor fellow finally passed on he would have been in considerable pain."

Back at the dig in York, more human remains are being unearthed. Even the particular spot where the skeletons were found is a piece of the puzzle. These men were buried in the cemetery's "Mount," an exclusive section reserved for wealthy, prominent citizens, not common soldiers.

Headless Romans introduces the Emperor's inner circle, the key players in the story behind the decapitated skeletons, including his sons, Caracalla and Geta; the family tutor, Euwodus; and Castor, the Emperor's chamberlain and most trusted official. The bitter rivalry between Caracalla and Geta is vividly recounted. After an ailing Severus made the brothers joint emperors, Caracalla embarked on a bloodthirsty campaign to seize the throne exclusively for himself. He killed scores of people, and even made attempts on his own father's life. Ultimately, he would kill his brother and rise to the throne as sole Emperor.

In the end, it is historian Anthony Birley who combines the forensic and archaeological evidence with the writings of another historian -- the ancient Roman Cassius Dio -- to solve the puzzle. The skeletons discovered just a few years ago in York were the victims of Caracalla's blood-thirsty purge in the early third century, the result of a public execution carried out in the spring of A.D. 211. Birley's research even enables two of the victims to be named: Castor, who had been Severus' loyal chamberlain, and Euwodus, the tutor.

Caracalla stopped at nothing in his jealous quest to rule the Roman Empire, but ultimately, his reign would be short. After only five years as emperor, he was killed by one of his commanders. But now, thanks to modern forensics, Caracalla's victims are speaking out, telling their secrets and sealing his callous legacy.



Photo of skeletal remains. Archaeologists have unearthed more than 30 Roman-era skeletons in the English city of York, near the ancient ruins of Hadrian's Wall.

Quiz Questions for Topical Quiz # 3D

1. If the damaged surface of the bone showed signs of healing, such as the thickly rounded surfaces characteristic of bony remodeling, that would be indicative of _____ trauma.
2. If the damaged surface of the bone is a different color from the surrounding bone, that would be a likely indication of _____ trauma.
3. What is trephination?
4. If the damaged surface of the bone shows no sign of healing, and if the color of the damaged area is consistent with the color of the surrounding bone, that would be a likely indication of _____ trauma.
5. Damage to bone that was caused by a careless excavator would likely be an example of _____ trauma.
6. Damage to bone that was caused by a hungry scavenger would likely be an example of _____ trauma.
7. Bone that has been broken into many pieces is described as a _____ fracture.
8. Broken bone that has been pressed inward (as in blunt force trauma to the skull) is described as a _____ fracture.
9. When broken ends of bone protrude through an open wound in the skin, the break is described as a _____ fracture.
10. Broken bone that has been crushed (especially common in porous bone) is described as a _____ fracture.
11. If the cut marks on bone are characterized by small, clean, sharp-edged, straight lines, they were likely made by a(n) _____.
12. If the cut marks on bone are characterized by long, deep, sharp-edged, straight lines, they were likely made by a(n): _____.
13. What is the characteristic shape of an *entrance wound* in gunshot wounds that pass through the body?
14. What is the characteristic shape of an *exit wound* in gunshot wounds that pass through the body?

15. What are the characteristics of low-power gunshot wounds to bone with regard to the size and shape of entrance and exit wounds?
16. What are the characteristics of low-power gunshot wounds to bone with regard to the direction of beveling and the pattern of cracks?
17. What are the characteristics of high-power gunshot wounds to bone with regard to the size and shape of entrance and exit wounds?
18. What are the characteristics of high-power gunshot wounds to bone with regard to the presence or absence of expansion or bursting at the point of penetration?
19. A gunshot wound to the skull that featured a large, rounded wound with scalloped margins, small starburst cracks, and only slight beveling would probably have been produced by a(n) _____.
20. What pattern of damage to the bone would likely result from blunt force trauma to the skull?
21. The study of postdepositional processes (i.e., the factors that modify the body after death) is called _____.
22. What is taphonomy?
23. Forensic scientists refer to the time since death as the _____.
24. What is meant by the term “postmortem interval” (PMI)?
25. Among the following variables, which would have the LARGEST effect on the rate of decomposition of human remains: access by insects, body size & composition, clothing, rainfall, or trauma?
26. Among the following variables, which would have the LARGEST effect on the rate of decomposition of human remains: body size & composition, clothing, rainfall, trauma, or temperature?
27. How do temperature and burial affect the rate of decay of human remains?
28. How do carnivore/rodent activity and clothing affect the rate of decay of human remains?
29. How do insect activity and humidity affect the rate of decay of human remains?
30. How do trauma and rainfall affect the rate of decay of human remains?
31. The orderly attraction of different insect species to a corpse throughout the decomposition process is called _____.

32. What can the evidence provided by insects found on a corpse reveal about the cause of death and the manner of death?
33. What can the evidence provided by insects found on a corpse reveal about the time the body was deposited, the geographic origins of the body, toxins in the body, and trauma to the body?
34. The stiffening of muscles that occurs shortly after death as the result of the bio-chemical binding together of muscle fibers is called _____.
35. The animal that makes the best substitute for human cadavers in regional studies of human decomposition rates is the _____.
36. Why do pigs make excellent substitutes for human cadavers in studies of human decomposition rates?
37. Postmortem cooling of the body to ambient temperature is called _____.
38. Postmortem pooling of the blood is called _____.
39. The study of the succession, activity, and longevity/maturity of a variety of carrion arthropods is called _____.
40. Describe the details of forensic entomology as they apply to forensic anthropology (e.g., what are the basic principles and principal observations of forensic entomology?).
41. In the case of the La Belle drug murders that William Maples investigated, which of the three bodies that Maples excavated was the best preserved?
42. What conclusions and generalizations does William Maples make about burial and decomposition?
43. What conclusions and generalizations does William Maples make about dismemberment (e.g., what are the typical tools and methods of dismemberment)?
44. What conclusions and generalizations does William Maples make about dismemberment (e.g., what are the consequences of dismemberment for forensic identification)?
45. As described in the film *Headless Romans*, the person who ordered the deaths of the headless Romans was _____.
46. As described in the film *Headless Romans*, the thirty-or-so decapitated bodies found in the grave in 2005 included two individuals who could be historically identified, namely _____.

47. As described in the film *Headless Romans*, _____ percent of the decapitated skeletons found in the grave in 2005 were male, and _____ percent of them had died violent deaths.
48. As described in the film *Headless Romans*, analysis of the tooth enamel of the headless Romans established that the men originally came from _____.
49. As described in the film *Headless Romans*, the skeletons of the headless Romans were discovered in a grave located in the English city of _____, and they dated to approximately _____ years ago.
50. As described in the film *Headless Romans*, the heads associated with the skeletons _____ [were or were not] removed posthumously as part of a burial ritual, and the bodies _____ [did or did not] belong to soldiers who had been killed in battle.