In general, the pelvic bones of a female are less massive, less sloped and wider than that of a male. The cavity in the center, called the aperture, is larger and more circular than that of a male, providing more space in birth canal. These are, however, relative terms and are defined by the averages for males and females. There is great variation not only between females and males but also among members of the same sex. For example, there are female pelvis that are more massive than some males and visa versa. This means that determining sex from skeletal remains is approximate but as more "markers" are found pointing toward one sex, the more secure is the determination. Additionally, skeletal changes between males and females really only begin during puberty so sex determinations from bones in children are particularly difficult.

One of the most important differences between males and females can be observed at the front of the pelvis - an area called the symphysis pubis, which is the front point of connection between the two hip bones (where the pubic bones meet and are held together by cartilage). In males, the arch formed at this point of juncture is rather sharp and narrow (typically less than 90°) while that for a typical female is much broader and less narrow (typically greater than 90°) as shown in Figure 9.1.15. Other
difference between males and females can be observed at the sciatic notch, ventral arc (front), and auricular surfaces. An example of the differences in the sciatic notch in the pelvic bones is shown in Figure 9.1.16. Occasionally, marks associated with giving birth can also be found on the pelvic bones. These are sometimes seen as small pits inside the pelvis but are not observable in all cases.

The skull is another place where differences between male and female skeletons can be observed. Like the pelvis, the skull is composed of a number of bones, normally about 22 bones in all (Figure 9.1.17). Also like the pelvis, the male skull tends to be more massive and solidly build with the female skull less angular and more delicate. The points of the attachment of muscles to the skull, the ridges, are typically more pronounced and larger in males. The jaws of males tend to be more square and the jawbone larger and thicker.

While the pelvic and skull bones are usually considered to be the best in determining the sex of the remains, other bones of the body can also be used (sometime it is all that is available). They are, however, more prone to uncertainty. The long bones, such as the femur and humerus, have been studied most extensively, although the sternum, clavicle, and scapula have also been used. As with other bones, the long bones of the body tend to be larger, thicker and stronger since they typically have to bear the greater weight of the male body. The
differences in the femur tend to be more readily observed as shown in Figure 9.1.18. The female bones tend to be lighter with less pronounced muscle attachment ridges and with a more nearly right angle between the shaft and neck of the bone. Also, the two knobs at the bottom of the femur (the femoral condyles) tend to be shaped differently between the sexes, with a notch wider for females than males.

As mentioned above, there is great variation of these features within a sex and a population (ancestry) so that care must be taken when using these skeletal bones in the determination of sex.

**Age of the Decedent.** The age of a person at the time of their death is a particularly important piece of information in identifying the remains. While our bones undergo constant change from birth until death, the type of change varies as we age. For example, from our earliest childhood through puberty, our bones continue to grow, morph, and merge until a person is around 25 years old when growth essentially stops and a slow degenerative development tends to begin. Unlike the other information determined from bones, the most useful bones in figuring out the age of a person varies by the period of life of the person being studied. For example, in young children, tooth development and the ends of long bones are particularly important while the pubic bones are most valuable in aging older adults. To some extent, it also varies by the sex of the individual. So, here we’ll briefly look at some age markers for people of different ages from youngest childhood through older adults.

When we first develop as a fetus, our bones are mostly cartilage. This cartilage is gradually replaced with hard bone during development through childhood to puberty. This process, called ossification, follows a relatively straightforward sequence of events, leading to adult bone structures by the end of puberty as shown in Figure 9.1.19. In long bones, for example, the shafts begin the ossification process first (called the diaphysis) followed by secondary centers at the ends of the bones (called the epiphyses). These secondary centers develop until, eventually, they fuse with the long shaft to form one complete bone. Importantly, the fusion of the main shaft with the secondary centers tends to be completed at different times during our childhood development.

![Figure 9.1.18. Comparison of femur bones of male (left) and female (right)](http://medlib.med.utah.edu/kw/osteo/forensics/sasta.html)
bones in our bodies, therefore, follows a fairly well understood sequence and timing and allows us to estimate the age at death of the person. For example, from Table 1, it can be seen that complete fusion of the humerus begins when a person is about 17 years old. Females generally complete the fusion development process about two years faster than males. The process of fusion is dependent upon the specific bone, sex, nutritional and medical history, and ancestry. An early fetus may have 800 ossification centers which fuse to about 405 centers at birth that ultimately fuse further into our adult 206 bones.

Our skulls also undergo a similar bone fusion process as we develop. Between most of the bones of the skull are tiny juncture lines, called sutures. When a child is born, the sutures are rather loose and in some places the bones may not even touch - sometime called a baby's "soft spots" (Figure 9.1.20). This provides the necessary expansion space as our brains grow within the confinements of our skulls. As we develop, however, these sutures become progressively more rigid and eventually fuse together sometime in adulthood. The timing of these sutures can be effectively used to determine the age of younger people depending upon the nature and extent of the suture fusion.

|| Bone                | Complete fusion Male | Earliest fusion male | Complete fusion female | Earliest fusion female | Comments |
|---------------------|----------------------|----------------------|------------------------|------------------------|----------|
| Humerus (proximal)   | 25                  | 17                   | 25                     | 17                     |          |
| Humerus (distal)     | 21                  | 16                   | 21                     | 16                     |          |

Figure 9.1.20. Cranial sutures in an infant (http://health.allrefer.com/health/cranial-sutures-skull-of-a-).
Probably one of the best methods for dating the remains for a young person involves looking at their teeth. In our lives, we have only two sets of teeth - baby teeth (deciduous teeth) and permanent teeth. The baby teeth of a newborn are located just below the skin but begin erupting at about six months. This process occurs in a regular sequence until all 20 deciduous teeth have erupted (Figure 19.1.21). During this time, the 32 permanent teeth form below the deciduous teeth and eventually push the deciduous out. The front teeth are usually the first deciduous teeth lost and the first permanent teeth to erupt. The third molars in the back of the mouth are usually the last, sometimes called wisdom teeth because they erupt at about 18 years old - sometimes these teeth never erupt (Figure 9.1.22).

Once a person reaches adulthood, the changes are more gradual and less certain in terms of onset time. One of the best indicators, however, involves looking at the surface of the bones in the pelvis, specifically the pubic symphysis and auricular surfaces. As a person ages, these surfaces gradually change from relatively smoothly contoured and "billowed" to a more flattened, rough, and porous appearance. Researchers have developed
models that can be used to estimate age based upon comparing the bones in the remains to a set of "standards", as shown in Figure 9.1.23. It is important to note, however, that the older a person is the wider the estimated age range. It is often only barely possible to assign an older adult to within one decade of life while assigning a child's age might be within a year or two.

Other changes in bone and cartilage occur as a person age and can be used to help determine age. In general, bones lose density gradually as we age, especially for post-menopausal women. This bone loss is very dependent on factors such as sex, size (weight), and nutrition.

Osteoarthritis, caused by the wearing of the cartilage in joints, can also be seen in the bones. Osteoarthritis can occur in any joint but is most commonly found in the knee, elbow, shoulder, hip and spine (Figure 9.1.24). This condition is rather rare in individuals under 40.

**Ancestry of the Decedent.** One of the most difficult jobs forensic anthropologists are called upon to perform is a determination of the ancestry of a decedent. All humans are members of the same species, *homo sapiens*, but we recognize different races as being ethnically important. Due to migration and the merging of populations, skeletal differences attributed to particular ancestral groups is, at best, an educated guess. Even members of the "same" population group may show a wide range of differences in their skeletal remains. Nonetheless, such information is still keenly sought by investigators.

When examining skeletal remains in an attempt to gain ancestral information, anthropologists most commonly examine the nose, face and head shape, stature, and body proportions. The most typically used bones are those of the skull and teeth (Figure 9.1.25). For example, Negroid populations tend to have a broader and flatter nasal opening than those typically found for Caucasians. Asian populations tend to show "shovel" shapes on the rims of their incisor teeth that are not observed with many other populations. Other features can help lead to a particular determination but it is not based upon any single skeletal feature.

**Occupations and Habits of the Decedent.** Sometimes it is possible to learn something about the possible lifelong occupations or habits of people from their skeletal remains. If a person engages in stressful,
repetitive motions for very long periods, such as in a lifelong physical job, there may be observable wear and stress marks on the skeleton. For example, a long career at the computer typing can lead to observable wear on the bones of the arms and hands or a career as a laborer using a shovel can result in spinal, shoulder and arm wear that is not normally observed. As presented before, repetitive motions may also lead to arthritic conditions readily observable in the remains.

Long-term habits may also leave their marks on the bones. It may be possible to determine if someone is right or left handed using this same approach if they greatly favor the use of one arm over the other. The skeletons of athletes or people chronically overweight also often show as wear or thicker than usual bones, especially in the bones that carry most of the athletic strain or weight. Therefore, the leg and foot bones of such people are often noticeably thicker with particular wear at the ends of the bones.

**Medical History Information** (pathology). A person's medical history may be clearly reflected in their skeletal remains. The most obvious example of this comes from a person's dental history as discussed earlier. The arrangement of the teeth, missing teeth, and any subsequent wear or dental repairs are usually noted carefully by dentists when the patient is still living, occasionally with detailed molds or X-ray records of a person's dentition and any restorations. Comparison of these records with the dentition of the remains can lead to an individual identification with a very high degree of certainty as seen in Figure 9.1.26. In addition, if the person needed dental appliances, such as bridges, dentures, implants, and braces, these items may be found with the remains and compared with dental records (Figure 9.1.27).

Sometimes people have either congenital defects or injuries that leave lasting records on the skeleton. For example, broken bones can easily be spotted and compared with "in life" X-rays and medical histories. Prosthetic devices are sometime required to repair damage or wear, such as hip replacement, implants and metal plates from injuries. These devices often have durable serial numbers engraved on them that can lead to a definitive identification. For example, the identification of a skeleton was made from the serial numbers of a breast implant found on the body (Figure 9.1.28).
Some diseases also can be observed from the bones and compared with known medical histories of patients. Tuberculosis, osteoporosis, Paget's disease, syphilis, cancer, and others change bones in well understood ways and may be readily diagnosed from remains (Figure 9.1.29).

**Facial Reconstructions.** In identifying remains, it is sometimes very helpful to try to construct a facial image of what a person looked like when they were alive. This especially aids with matching possible missing persons with the remains. The goal is to use the skeletal remains, coupled with the biological profile of the person and our understanding of the human body, to build a graphic likeness of the person. Several techniques have been used to aid in this process, including photographic overlays, 2-D drawings, 3D modeling and computer aided reconstructions.

**Overlay Process.** In the overlay process, a photograph of a person from life is scaled to the same dimensions as a photograph of the skull obtained from the remains. The trick is to have the two scaled photographs taken from the same perspective. The two pictures are then superimposed and the extent of overlap and agreement between the features of the two photographs may support the identification of the remains made using other information. For example, shown in Figure 9.1.30, the partial skull remains of a missing soldier are compared with a photograph taken shortly before his disappearance. From this comparison it can be seen that there is generally good agreement between the somewhat unusual features of the found cranial bone and the soldiers picture, supporting the identification of the remains. This method is most effective when the person's skull has some unique features of size or structure that can be seen in the photograph taken in life.

**2D Facial Reconstruction.** A second method involves using either the actual skull or a copy of the skull and tissue depth markers in positions on the skull using data from anthropological tables. The picture of the skull with the tissue depth markers then is used as a template for an artist who...
constructs a drawing matching the depth markers and completing the likeness based upon pictures of a suspected person from life. An example of this is shown in Figure 9.1.31. The upper left shows the skull with the small tissue depth markers in place. A piece of tracing paper was then laid over the picture and the person's profile constructed. Then using the known photograph (bottom right) and the traced profile, the artist draws a composite consistent with both the skull and the known photograph.

**3D Facial Reconstruction.**

This process begins similarly to that used in creating a 2D likeness with either the skull or a digital 3D image of the skull (such as from a CT scan). The process then builds up tissues using clay by a sculptor or digitally in the computer. In either process, typically, at least 20 tissue depth markers are used to build up the missing tissues based upon what is known about the person (sex, ancestry, weight, etc.). By gradually adding known facial muscles, the underlying structure of the face can be created. Finally, the skin and other surface features (e.g., wrinkles, skin tone, hair, and eyes) can

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**Figure 9.1.31.** Examples of 2D hand-drawn facial reconstruction by Karen T. Taylor compared with the actual skull and photograph of the suspected victim (http://en.wikipedia.org/wiki/Image:KTT2D.jpg).

**Figure 9.1.32.** Skull (L) found at Table Mt., South Africa. The 3D facial reconstruction (C) and the later identified victim (R) are shown (http://www.fbi.gov/hq/lab/fsc/backissu/jan2001/phillips.htm#Case%201). This is believed to be a case of suicide.
be added. One important advantage of using a computer to complete the process is that it can be done relatively rapidly from digitized skull bone images to provide a complete 3-dimensional rendering. This process has recently been used to recreate the face of King Tutankhamen. An example is shown in Figure 9.1.32 comparing a 3D facial reconstruction with a photograph from a missing person from South Africa. While not exact, it does show an overall similarity with the missing person - enough to convince her parents that the found remains were hers.

**Problems with Facial Reconstructions.** Facial reconstructions are currently among the most subjective and controversial of forensic techniques. One problem with these reconstructions is that available tissue depth information, upon which the reconstruction is built, is very incomplete, sometimes questionable, and highly variable from person to person and among ethnic, sex, and age groups. Another problem is that some facial features have very little skeletal basis for creating an accurate reconstruction. For example, very little information regarding the shape and size of a person's nose, lips and ears come from the skull and the reconstruction of these features is primarily the artist's best guess. Further complicating the utility of these likenesses is the fact that often a person's nose, ears, eyes, lips, hair and similar features, those that are least reliable in a reconstruction, are the most readily remembered features of a person.

Because of these difficulties, facial reconstructions are typically not allowed in court for the identification of remains. They are used, however, especially in TV and in the movies, but have their place as investigative tools.

**QUESTION FIVE: How Did They Die?**

Pathology and Cause of Death. Sometimes anthropologists are asked by medical examiners or coroners to assist in their quest to find out how someone died. Their primary concern, of course, is to discover whether the person died by the action of someone else or by "natural" causes. This, however, may be one of the toughest questions to answer from the skeletal record.

In trying to piece together the clues to help determine how someone may have died, the forensic anthropologist typically seeks to answer several more focused and specific questions: (1) what can be found in the bone record: type of injury, (2) when did the injury occur, (3) what was the cause of the injury, and (4) was the injury the cause (or contributing cause) of death?

**BRIEF ON FIVE CENTRAL QUESTIONS:**

1. Is it bone?
2. Is it human bone?
3. How old is the bone?
4. Whose bone is it (bioprofile)?
5. How did they die (pathology)?
   - what can be found in the bone record: type of injury,
   - when did the injury occur,
   - what was the cause of the injury,
   - was the injury the cause (or contributing cause) of death?

Figure 9.1.33. Healing of a fractured bone (source: Unknown).
cause (or contributing cause) of death? Each of these questions will be looked at separately here.

**What can be found in the bone record: type of injury?** The anthropologist's job here is to carefully examine the remains to simply look for signs of damage, particularly damage that might have resulted from a significant trauma. If a trauma was isolated solely in the soft tissue, then little or no evident damage might be recorded in the bones. Trauma of a more violent nature, however, such as from an assault, gunshot, stabbing, or automobile injury, can often leave behind bone evidence of this injury. The nature and extent of bone scars and breakage can help to inform the other questions.

**When did the injury occur?** This question is quite different from the question already posed of how old are the remains. In this case, we look to see if we can learn if the injuries found on examination of the remains occurred before the time of death (antemortem trauma), at about the time of death (perimortem trauma), or after death (postmortem trauma). Typically, injuries either before or after death are of less immediate concern in determining if a crime had been committed than those that occur near the time of an unattended death. Postmortem damage can, however, have important lessons to teach an investigator about the crime itself (see forensic taphonomy later in this chapter).

During a person's life, they may experience a number of events that may leave a record in the bones. In England, for example, a recent health survey showed that the annual rate of bone fracture is almost 4% of the population! Accidental bone fractures are relatively common and, even when long healed, can be detected at a site of fracture. The process of healing of bones is a relatively slow, long-term process, as shown in Figure 9.1.33. The rate of healing also varies a great deal with age, nutrition, and overall health - with children have amazing powers to repair bone tissues (see Figure 9.1.34).

The pathway to bone healing is a wonderfully complex process. Immediately after a break in a bone, blood surrounds the affected site and forms a large blood clot (hematoma) around the break. Within a few weeks, the blood cells in the clot die and are replaced by a fibrocartilage callus that serves to "splint" the broken bones together. During this time, capillary blood vessels reform in the callus and the dead blood cells are cleaned up. Over the following several months, this initial cartilage callus is slowly replaced by a bony callus, forming a strong reunion of the bone pieces. The final steps in bone healing takes place over about the following year in which any excess of the bony callus is removed, compact bone deposited, and the surface of the bone smoothed and reshaped, referred to bone remodeling (especially seen in...
If a broken bone is found in human remains, an assessment of the extent of healing can indicate how long healing had progressed before death and, therefore, provide an estimate of the postmortem interval. Thus, if a bone fracture is found to be completely healed and remodeled, then the injury that caused this fracture must have taken place long before the death of the person.

Completely healed bone may still be of forensic interest, however. If a series of bone fractures, at various stages of healing are found, this may indicate a case of systematic physical abuse over a long period of time. It can also be used, like dental records, to match a known medical history with what is found in the remains.

Unlike trauma to soft tissue, it is usually not possible to determine the exact point of death relative to bone healing since the timeline of bone restoration is so long. Bone injuries at the time of death would not show healing but such injuries are often difficult to differentiate from postmortem bone damage (taphonomy). Some type of postmortem bone damage, however, can be differentiated from trauma. For example, if the remains were scavenged by other animals, such as coyotes, rodents, or birds, then telltale marks are often found on the bones from their action. Carnivores tend to leave conical holes while rodents leave concave scraping (often shown two or three tooth groves) in the bone. These animals also attack the bones in characteristic patterns and may strew the bones about the investigation site. The accidental breakage of bones also occurs by being tread upon by larger animals - especially common where farm animals are found. Damage also occurs from simple weathering as the bones become progressively more brittle and fragile upon exposure to the elements.

It is also occasionally possible to determine if the body had been dismembered and even what type of instrument had been used in the process, as shown in Figure 9.1.35. In this microscopic image, the clear striations show that a saw had been used in the process.

**What was the cause of the injury?** By examining the fracture, it may be possible to shed light upon how the injury might have happened - or especially how it did not happen. It's all a matter of a careful examination of the record.

Skeletal trauma is often divided into two broad categories; blunt force trauma and sharp force trauma. Blunt force trauma (sometimes called BFT or non-penetrating trauma) occurs when a...
A blunt object strikes a person with sufficient force to cause physiological damage. This type of trauma may occur from a personal assault (e.g., fist, foot), leveraged assault (e.g., baseball bat, gun stock, or furniture), massive assault (e.g., automobile injury, airplane crash) or from a gunshot. A sharp force trauma may result from an attack with a knife or other sharp object. These two types of trauma often leave marks on the bones and look quite different from one another.

Gunshot wounds are common examples of forensic blunt force trauma. With bullet wounds, it is often necessary to first confirm the wound came from a gunshot and second to determine things such as the bullet's trajectory, the sequence of multiple gunshots, and the type of gun employed. An important goal is to determine the entrance and exit sites of the bullet. Typically, the entrance wound of a bullet is smaller than the exit wound, but there are situations in which this can be misleading. The best evidence for the direction of the bullet, however, comes from looking for beveling of the bone (Figure 9.1.36). Beveling occurs on the side of the bone away from the origin of the bullet and appears as a concave crater (away from the entrance side). Thus, a bullet entrance wound in a skull, for example, would show beveling on the inside of the cranial chamber and the exit wound would show the beveling on the outside of the skull.

Information regarding the trajectories of the bullets can be deduced by lining up the entrance and exit wounds (Figure 9.1.37). The order of bullets can sometimes be determined
by looking at the fracture lines from bullets and applying similar reasoning to that used for
determining the order of bullets through a pane of glass: the cracks (fracture lines) from a later bullet
does not cross already existing fracture lines from earlier bullets. In this fashion, the sequence of
events, such as the presence of multiple shooters, the order of attack, and the relative positions of the
shooter and victim, can be built up in a way consistent with the bone evidence. The evidence can, of
course, also "shoot" holes through false alibis.

Scientific studies have shown that we usually cannot tell the caliber of bullet by inspecting the
wound, although a shotgun can usually be determined from other gunshot wounds. Bullets from
rifles may apply so much force that the bones are shattered too much to even allow for any type of
reconstruction. Gunshot damage essentially always shows an entrance hole but other types of can
blunt force trauma can show deceptively similar hole formation. Only experience and careful
observation can help to distinguish between the origins of these types of trauma.

In examining other types of blunt force trauma damage to bones, it may be possible to even
arrive at a general description of the weapon used in the assault. For example, a physical assault
from someone's fist cannot cause the type or extent of damage possible by an assault with
a baseball bat. The amount of energy necessary to cause a particular type of injury
can be estimated and determined to be either consistent or inconsistent with a description
of the events. Additionally, it may be possible to provide a detailed picture of the
irregular shape of the object used in the assault. Figure 9.1.38 shows an example of
the type of bone injury seen from an attack
with a hammer.

Blunt force trauma typically begins
with in-bending of the bone at the impact site
and the fracture starts away from the impact
site. As impact continues or is stronger, the
fractures radiates into the point of contact
between the bone and the weapon. If
insufficient force is applied, the fracture may
never reach the actual site of the impact and
can be misleading. This is especially clear in attacks involving the skull.

Sharp force trauma may result in bone chipping, scoring, or scraping. As with BFT, the
damage may also lead to a description of the weapon that caused the wound.

_was the injury the cause (or contributing cause) of death?_ Determining the cause of
death, or discovering the way in which someone died, from skeletal remains is, at best, very difficult.
For example, people have been known to survive a massive assault with multiple fracture and other
bone injuries only to die from other causes. In contrast, trauma that may lead to very little bone
damage can easily cause death. There are times, however, when severe bone damage is clearly
inconsistent with life and must be associated with the death of the individual.

Gunshot wounds to the skull or massive cranial fracture can usually be places in this category.
Another example of fairly definitive bone evidence leading to a determination of the cause of death is
strangulation. In our necks there is a small bone, the hyoid bone (Figure 9.1.39) that is the only bone
in our bodies not directly associated with another bone. This bone is held in place by cartilage and
muscle and helps give our throats and tongue their observed large degree of motion and flexibility. It
is, however, a rather delicate bone that is easily broken in the process of strangulation. While not always present, the observation of a broken hyoid bone leads to the strong suggestion that strangulation probably occurred.

As mentioned before, the observation of multiple bone wounds (fractures, assaults, etc.) in various stages of healing suggest long term abuse might have occurred.

While the anthropologist can shed light on what might have happened around the time of death of a person, it is ultimately the job of the medical examiner or coroner to make the final determination of cause of death.

**Crime Scene Processing.**

Ideally, in a forensic investigation involving skeletal remains, a trained forensic anthropologist would have the responsibility of properly excavating and processing the site. While field work by a trained forensic anthropologist is desirable, it is often not possible. More commonly, the anthropologist is called in to examine remains that have been already recovered by the police or medical examiner's office.

When work at the site of the discovery of the remains is possible, anthropologists use the well developed methods of archeology to conduct the recovery of the remains. The proper excavation, collection, and treatment of bones are critical steps to a good forensic anthropology investigation. The most important rule at the site is to prevent any further damage from occurring with the remains. This involves the careful search, survey, documentation, labeling and field storage of the specimens for transportation to the laboratory for later study. A careful map needs to be prepared that shows the location and orientation of each individual part recovered - such information can often be quite helpful in recreating the sequence of events that lead to the observed crime scene. Care must be exercised to make sure that small bones, such as teeth, that have worked loose are also recovered. Sometimes, work in the lab will suggest that an important bone or tooth is missing that requires a return to the site to search for the missing item.

When the remains are brought into the laboratory (Figure 9.1.40), the work usually begins by a careful examination and cataloging of the remains, making special note of any flesh, cartilage, soil, plants, insects and other materials that are associated with the remains - especially if the anthropologist has not been part of the recovery team. In skeletized remains, it is important to note any odor, discoloration or bleaching of the bones since this can give valuable clues as to their age.

Once these materials have been examined and samples removed for later study, it is often desirable to completely clean and preserve the bones to allow for a close examination of the bones themselves. This can be accomplished in a variety of ways that include the use of insects, bacterial decomposition, and manual cleaning. Once the flesh has been removed, the bones can be dried, and in some instances preserved by applying a resin coating, to provide clean bones. Occasionally it's desirable to try to restore the bones in order to better understand how they might have been broken or damaged.
Sometimes the remains of multiple people or people mixed with animal remains are found together, referred to as co-mingled remains (Figure 9.1.41). The first task often is to determine how many individuals are present in the collection of bones. One way is to determine the number of the corresponding bones present (e.g., the number of right humerus bones) - this gives an estimate of the minimum number of individuals (MNI) present in the remains. Sometimes, this MNI value underestimates the number of people represented in the collected remains so a different number, the most likely number of individuals (MLNI), can be alternatively used. The next task is to arrange the remains so that the bones for each individual person are separate from the others. This can be a daunting and time consuming task but can often be accomplished by careful study of the remains. For example, the human body is remarkably symmetric such that comparable bones on the left and right side should be about the same size and shape. For example, a person’s right humerus is about the same size and mirror-image shape as their left humerus. Other aids would be the stature, age, sex, medical history and other indicators presented before to aid in the separation process.

In some investigations, a forensic odontologist is brought in to assist the medical examiner and anthropologist in examining dental remains. Their area of expertise is especially important in examining any dental restoration or other work.

It is important the carefully keep track of all work and observations in dealing with the remains. This is necessary since these observations and conclusions are part of a larger legal investigation. This is the point of departure between an historical archeological and a forensic investigation. In forensic work, an anthropologist may be called into court to present and explain their work and observations. Careful notes, adherence to acceptable practices, and chain of custody considerations are critical to allowing the testimony into legal proceedings.
Wolfgang Amadeus Mozart, born in 1756, is an enigma both in his life and in his death. His life was short and tumultuous, but one filled with splendid music, dazzling virtuosity, and missed opportunities. Many of his works are today recognized as among the greatest achievements of all western music. He died just before his 36th birthday in 1791, leaving behind over 600 compositions and a whole raft of rumors about his demise. He succumbed to a miserable death after a relatively short illness of several weeks; his body so swollen that he could hardly move, racked with fever, suffering from black vomit, and other terrible symptoms. The "medical" report indicated his death from "severe military fever", a diagnosis that could mean almost any type of infectious disease. He was buried in a communal grave - but rumors ran wild about the "true" cause of his death ranging from murder to political assassination for his slander of the Masons in his opera Die Zauberflote (The Magic Flute).

In the cemetery where Mozart was buried, the tradition at the time was to dig up the graves after 10 years and remove the bones - rich people had the bones labeled and stored while the poor had their bones crushed and reburied to make way for more bodies. The sexton who oversaw the burial of Mozart, however, claimed to have tied wire around his corpse so he could find it when later exhumed. When the 10 years had passed, he claimed to have found the body and saved Mozart's skull from the crusher. This skull passed from person to person over the years until it was finally given to the International Mozarteum Foundation in Salzburg in 1901, where it remained on display until 1955. In 2006, a forensic investigation was launched to try to determine if the skull indeed belonged to Mozart. Overlay images, correlations with Mozart's reported dental records (he had only a reported 7 teeth), and the observance of a hematoma on his skull all have supported the claim. A recent DNA study, however, proved inconclusive in identifying it as Mozart's skull. So, the jury is still out as to if it is indeed his skull.

A curious footnote to this is that other famous composers have experienced a bit of Mozart's fate. The skulls of Beethoven (shown at left), Haydn, Schubert, and Liszt all have been "collected" and put on display from time to time.