

GRAVE EVIDENCE

A UNIT ON FORENSIC ANTHROPOLOGY, FORENSIC ARCHEOLOGY, AND FORENSIC ODONTOLOGY

Unit:

Forensic Anthropology, Forensic Archeology, and Forensic Odontology (Focus on skeletal evidences)

Subject:

Forensic Science (Career and Technical Program: Health Occupations)

Instructor:

Renee Parker, RN

Hixson High School, Hixson TN

Grade Level(s):

10, 11, 12, CTE

Duration:

Nine activities

Twelve 90 minute sessions

Description: Students will be introduced to the ideas and techniques of how forensic anthropologists and forensic archeologists apply their knowledge of biology, science, and culture to the legal process. Students will examine the history of forensic anthropology and forensic archeology, while developing an understanding of how trained forensic specialists can use their knowledge and skills to identify gender, ethnicity, age, and stature from skeletal remains as they reconstruct past events.

Instructional Objectives:

Students will:

1. Develop an understanding of forensic anthropology and forensic archeology while examining key individuals who have been instrumental in advancing each field.
2. Examine the process of decomposition and how mummification occurs in nature.
3. Utilize deductive and inductive reasoning while conducting experiments.
4. Realize key features of a skeleton that aid in determining gender, age, and ethnicity.
5. Determine how using osteometric measurements can give clues to identity of the victim.
6. Understand how forensic anthropologists use information regarding skeletal features, climate, soil conditions, and topography to aid in criminal investigations and victim identification.
7. Recognize the steps involved in crime scene investigation when skeletal evidence is the concentration of focus.
8. Discuss the pros/cons of facial reconstruction as an aid in determining identity.
9. Explore the concept of dental forensics and how forensic odontology is used for victim identification and bite mark analysis.

Standard Correlations:

Health Science Education *Forensic Science* Course Code #5514

Standard 1.0 *Students will know and apply the academic subject matter required to understand the history and development of the field of forensic science.*

- FS 1.1, 1.2, 1.3, 1.4

Standard 3.0 *The students will demonstrate proficiency in understanding of the science behind forensic identification of individuals, including facial recognition, DNA markers, fingerprints and other unique human features.*

- FS 3.1, 3.2

Standard 9.0 *Students will examine the range of careers available in the forensic science and related fields. Careers such as forensic anthropology, entomology, pathology, nursing, district attorney, and police work.*

- FS 9.1, 9.2, 9.3, 9.4

Related Academic Areas: Language Arts/Reading, Math, Science

Math

Students measure, convert, and estimate to solve theoretical and practical problems related to forensic science.

Students utilize graphs and coordinates to facilitate skeletal evidence recovery and proper processing.

Science and Technology

Students explain the relationships among scientific process and how it pertains to forensics.

Students develop and apply skills of observation, data collection, analysis, pattern recognition, prediction, and scientific reasoning in designing and conducting experiments.

Students utilize technology in researching information and data collection.

Communication

Students respond orally and in writing in regards to information and ideas gained by reading narrative and informational texts and use the information and ideas to solve problems.

Students exchange information orally, including understanding and giving spoken instructions, asking and answering questions appropriately, and promoting group communications.

Citizenship

Students demonstrate skills of communicating, negotiating, and cooperating with others as they work in groups to complete a common goal.

Safety Considerations:

Each student should pass with 100% a safety quiz geared toward laboratory environment safety procedures and general classroom safety.

Materials & Resources:

See specific lessons for needed materials

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Activity 1: Introduction to Forensic Anthropology

Duration: Two 90 minutes sessions (this may take more time depending on ability of student(s) and if instructor wants students to create multimedia presentation in place of drawn timeline)

Materials:

- computers with internet capabilities
- graphic organizer (timeline version)
- paper/construction paper
- markers/pens/pencils
- any other “creative” materials for timelines

Instructional Strategies: Students conduct research on forensic anthropology and forensic archeology; determining the similarities/differences in each career field as it relates to forensics. Students will research what forensic anthropologist and archeologists do, what type of training is required in each field, and key forensic individuals who have advanced each of the fields (i.e. how Dwight’s comparative anatomy has evolved into present day osteometric techniques used by forensic anthropologists like Dr. Bill Bass). Students will create a timeline documenting the development of forensic anthropology and key individuals who have been instrumental in advancing the field. Students should be prepared to discuss their findings with the class.

Objectives/Procedures:

The student will:

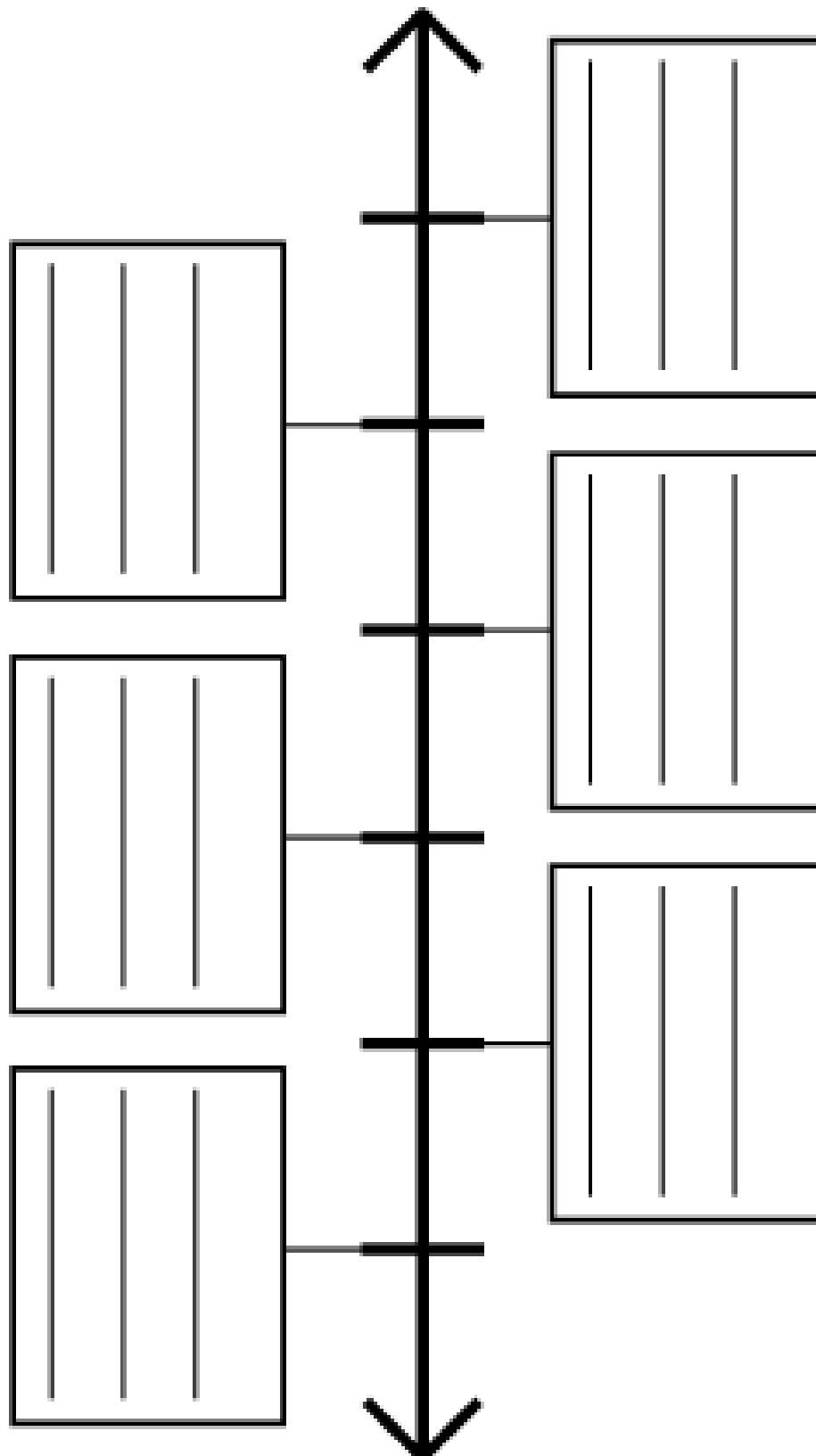
1. Use the following link http://www.smithsonianmag.com/issues/2000/april/mall_apr00.htm to access/read article on how a Smithsonian anthropologist applies his expertise to forensic cases. Students should use a graphic organizer while conducting research and developing timeline.
2. Research the field of forensic anthropology; what forensic anthropologist do (and don’t do) and what type of training and skills are required (using the listed URLs).
3. Research the field of forensic archeology; what forensic archeologists do (and don’t do) and what type of training and skills are required (using the listed URLs).
4. Discuss internet findings with small group. Then each group will discuss with teacher/class as whole.
5. Determine key individuals who have helped advanced the study of forensic anthropology cases.
6. Create a timeline documenting the development of forensic anthropology and key individuals who have been instrumental in advancing the field.

Related URLs:

<http://www.aafs.org/>
http://en.wikipedia.org/wiki/Forensic_anthropology
<http://web.utk.edu/~anthrop/FACwhatish.html>
http://www.pbs.org/opb/historydetectives/techniques/forensic_ml.html
http://www.crimelibrary.com/criminal_mind/forensics/anthropology/1.html
<http://www.nlm.nih.gov/visibleproofs/index.html>

Evaluation: Objectives 1, 2, 3, and 4 will be evaluated by student ability to discuss what forensic anthropology/archeology is, what each career entails, and what training/skills are necessary. Objectives 5 and 6 will be evaluated by completing timeline.

Graphic Organizer for Internet Research/Timeline



Activity 2: Who's Your Mummy?: A Lab on Mummification*

Duration: Students need 30 minutes on the first day, 15 minutes on the 2nd and 7th days, and 30 minutes on the 14th day. Because this activity requires time for desiccation, an instructor may choose to have samples already prepared to show students all the stages of decomposition for comparison without students conducting the experimentation themselves. If this option is used, the entire activity may be completed in one 90 minute session.

Materials for each student or group of students:

- Who's Your Mummy? Info sheet and Lab Packet
- 5 meat samples cut into strips (do not use ground meat)
- ruler
- plastic spoons
- forceps (students use these to pick up meat samples)
- paper towels
- sodium chloride
- potassium chloride
- sodium carbonate
- sodium nitrate
- goggles
- wax paper
- scale
- labels
- scissors

Instructional Strategies: Students will be introduced to the science of mummification and be given the opportunity to examine and document the process of mummification using various desiccants. They will be able to discuss why a dead organism decays and different ways in which the decay process is delayed.

Procedures:

1. Begin by discussing what a mummy is and how the mummification process happens by either using the Who's Your Mummy Info Sheet or accessing <http://www.newtonsapple.tv/video.php?id=1422>. This website explains the mummification process and shows examples of mummies.
2. Assemble students into lab groups; four students per group should be the maximum.
3. Pass out copies of Who's Your Mummy Lab Packet including data table.
4. Caution students to wash their hands after the lab and to follow all lab safety rules even though they will be conducting the lab outside.*

Objectives:

The student will:

1. Use the Who's Your Mummy info sheet to define the term mummification examine the process how and why flesh decays.
2. Conduct experiments on mummification to determine the most effective means of preserving flesh.
3. Determine what causes a dead organism to decay.
4. Compare appearance, color, odor, and mass of decaying samples on Days 1-14.

Related URLs: <http://www.newtonsapple.tv/video.php?id=1422>

Evaluation: Objectives 1 will be evaluated by determining understanding during class discussions. Objectives 2, 3, and 4 will be evaluated by correct answers to post-lab questions and correct evaluations on Lab Data Table.

*Due to the foul odor, this lab should be conducted outdoors. To prevent animals from taking the meat, cover the pieces with wire or screen. Be sure to contact the local health department and school officials to be sure you may conduct this lab and that all appropriate measures are followed to ensure safety.

Who's Your Mummy?

A mummy is a dead person or animal that has been preserved by nature or intentionally by people. Normally when we die, bacteria and other germs eat away at the soft tissues (such as skin and muscles) leaving only the bones behind. Since bacteria need water in order to grow, mummification usually happens if the body dries out quickly after death. Placing a body in an oxygen-free environment, such as a peat bog, will also cause mummification, because microorganisms can't live without air. Yet another way to create a mummy is to bury it in soil containing chemicals that kill bacteria and fungi. The body may then be so well preserved that we can even tell how the dead person may have looked in life.

Mummies are made naturally or by embalming, which is any process that people use to help preserve a dead body. Mummies can be dried out by extreme cold, by the sun, by smoke, or using chemicals. Some bodies become mummies because there were favorable natural conditions when they died. Others were preserved and buried with great care.

Ancient Egyptians are perhaps the best known mummy-makers — though initially, it was their climate, not their skill, that preserved their dead. Arid desert winds and blazing hot sand could dry corpses out quickly enough to mummify them. In fact, the oldest-known Egyptian mummy, dated around 3500 BC, is believed to have been created this way. The first “artificial” Egyptian mummies were made around 3000 BC. These early efforts at embalming were crude, but reflected the culture's emerging beliefs about preserving the dead to achieve eternal life.

Initially, mummification was so expensive that it was a privilege enjoyed only by the Pharaoh and a few favorites. Everybody else was given a simple grave burial in one of the vast cemeteries or “necropolises” of the time. But the promise of eternal life was so alluring, that it wasn't long before wealthy Egyptians began signing up for mummification, too. By 1550 BC, every Egyptian who could afford it was mummified.

Embalming became an art — practiced in booths set up along the banks of the Nile river. A top notch embalming job took seventy days. The first forty of these were spent drying out the corpse. The process began with the removal of the lungs, stomach, liver and intestines through an abdominal incision on the left side of the body. The brain was removed through the nose with an implement called a brain hook, which looked something like a crochet needle. The heart, believed to be the source of thought, was left inside the body.

After the organs were removed, the body was rinsed with wine, which helped kill any remaining bacteria. It was then covered and packed with a form of natural salt called natron and left to dry on the embalming table. When preserved, the body was removed from the natron, washed, and rubbed with oils to soften the skin. The dried body was wrapped in many layers of linen cloth and placed in a coffin. The mummy in its coffin was then entombed with objects of daily use that the Egyptians believed the body would need in the next world.

Today, scientists are able to examine a mummy without even touching it. By taking x-rays and magnetic resonance imaging (MRI) pictures of the body, scientists can often determine age, sex, and cause of death without damaging the mummy in any way.

Who's Your Mummy?

Lab Packet

Objectives:

You will:

- Conduct experiments on mummification to determine the most effective means of preserving flesh.
- Determine what causes a dead organism to decay and what can prevent the decaying process
- Compare appearance, color, odor, and mass of decaying samples on Days 1-14.

Background Information:

“Mrs. Milsap, I’m Detective Lawrence, and this is Dr. Odom from the anthropology department at the university. I brought him along after we go the call about old human remains in your basement. Old remains are Dr. Odom’s specialty.”

“Thank you for coming. We haven’t moved the body since we found it.”

“Good, Mrs. Milsap. Tell me how you found the body.”

“We are remodeling the basement, which has a dirt floor. We were trying to smooth the floor so we can pour concrete. But we found lots of rocks and old bricks that had to be removed. Under a large, flat rock, we found part of a cloth sack with a dried-up-looking person in it. We have no idea how it got there.

Mrs. Milsap leads Detective Lawrence and Dr. Odom down the stairs to the basement, where her husband is standing vigil near the body. Dr. Odom kneels down beside the body and examines it closely.

“Well, the person can’t have been dead long. The flesh is still on the body and there’s hair sticking out of the scalp. Must have died recently,” offers Detective Lawrence.

“Not necessarily detective,” Dr. Odom responds. “This body is very dry and the basement is cool and dry. Without testing there is no way to know for sure, but this body could be several hundred years old. It is well preserved because it has mummified down here. It may have been here before the house was even built.”

“What do you mean ‘mummified’? Mr. Milsap asks. “I thought mummies were only found in Egypt.”

“Yes, there are a lot of mummies there. But mummification can occur anyplace where conditions are right. The earliest Egyptians mummified their dead by placing them in the desert in a sitting position. The dry climate removed all the moisture from the bodies and preserved them. Later they soaked the bodies in salts to dry them. This technique is very similar to the one we now use to preserve some meats. In other cases, bodies are mummified by cold weather.”

“No matter how old this body is, or how it got her,” Detective Lawrence interjects, “I feel certain that a crime was committed. Look at the skull-there’s a hole in the back. I think we have a murder case on our hands.”

Materials needed:

- Who's Your Mummy? Lab Packet
- 5 meat samples cut into strips
- ruler
- plastic spoons
- forceps
- paper towels
- sodium chloride
- potassium chloride
- sodium carbonate
- sodium nitrate
- goggles
- wax paper
- scale
- labels
- scissors

Remember: Follow all Lab Safety Procedures

Procedure Day 1

1. Cut 5 small squares of wax paper, about 12cm x 12cm. Label these squares A,B,C,D,E.
2. Place a little piece of meat on each square of wax paper. Find the mass of each meat and paper sample (A,B,C,D, and E) by using the scale. Record each of those masses on the Data Table under Day 1.
3. Place two spoonfuls of sodium chloride on the meat located on square A.
4. Place two spoonfuls of potassium chloride on the meat located on square B.
5. Place two spoonfuls of sodium carbonate on the meat located on square C.
6. Place two spoonfuls of sodium nitrate on the meat located on square D.
7. Do not place anything on the meat located on square E; it will serve as the control.
8. On the Data Table, under Day 1, record the appearance, color, and odor of each piece of meat.
9. Set aside these pieces of meat overnight in a dry place. Consult with the instructor on where your samples should be placed.
10. Wash your hands before leaving the lab.

Procedure Day 2

1. Observe each meat sample. Record the appearance, color, and odor of each sample on the Data Table under Day 2.
2. With a pair of forceps, pick up meat sample A, hold it over a paper towel and gently shake any loose sodium chloride from it. Pour any sodium chloride on paper A onto the same paper towel.
3. Place meat sample A back onto paper A and find their combined masses by using the scale. Record this mass on the Data Table under Day 2.
4. Replace the sodium chloride you saved on the paper towel onto meat sample A.
5. Repeat steps 1-4 with samples B,C,D, and E. (Remember sample E doesn't have anything on it because it is our control).
6. Wash your hands before leaving the lab.

Remember: Follow all Lab Safety Procedures

Procedure Day 7

1. Observe each meat sample. Record the appearance, color, and odor of each sample on the Data Table under Day 7.
2. With a pair of forceps, pick up meat sample A, hold it over a paper towel and gently shake any loose sodium chloride from it. Pour any sodium chloride on paper A onto the same paper towel.
3. Place meat sample A back onto paper A and find their combined masses by using the scale. Record this mass on the Data Table under Day 7.
4. Replace the sodium chloride you saved on the paper towel onto meat sample A.
5. Repeat steps 1-4 with samples B, C, D, and E. (Remember sample E doesn't have anything on it because it is our control).
6. Wash your hands before leaving the lab.

Procedure Day 14

1. Observe each meat sample. Record the appearance, color, and odor of each sample on the Data Table under Day 14.
2. With a pair of forceps, pick up meat sample A, hold it over a paper towel and gently shake any loose sodium chloride from it. Pour any sodium chloride on paper A onto the same paper towel.
3. Place meat sample A back onto paper A and find their combined masses by using the scale. Record this mass on the Data Table under Day 14.
4. Replace the sodium chloride you saved on the paper towel onto meat sample A.
5. Repeat steps 1-4 with samples B, C, D, and E. (Remember sample E doesn't have anything on it because it is our control).
6. Wash your hands before leaving the lab.
7. Complete the Post-lab questions.

Post-lab Questions

1. What causes a dead organism to decay?

2. What are some ways decay can be prevented?

3. Why did some of the meat samples lose weight during this experiment?

4. Which meat sample lost the most weight during this experiment?

5. Sample E was not treated because it was the control in this experiment. Describe what happened to Sample E. Why did this happen?

6. If you were going to mummify a body, which salt would you choose to use? Why?

Who's Your Mummy?

Data Table

Meat Sample	Day 1: mass, color, appearance, odor	Day 2: mass, color, appearance, odor	Day 7: mass, color, appearance, odor	Day 14: mass, color, appearance, odor
A				
B				
C				
D				
E				

Activity 3: The Mystery Box: A Lab on Mummies and Deductive/Inductive Reasoning

Duration: Students need around 50 minutes to complete this lab. This activity may be used in conjunction with the **Who’s Your Mummy** activity if the teacher elects to give students 14 days to observe changes in samples. This activity may be supplemented by viewing Discovery’s video **Forensics: Who Killed the Iceman?** VHS #772814

Materials for each student or group of students:

- The Mystery Box handout
- 1 mystery box per group (6 mystery boxes total)
- 1 small flashlight per group
- 1 empty box per group (must be identical to boxes used for mystery boxes)
- scales
- 1-2 wooden skewers per group

Instructional Strategies: Students will examine how deductive and inductive reasoning skills are used to determine what objects are in several “mystery boxes.”

Procedures:

1. Use six small boxes with lids to prepare the mystery boxes. The boxes should be of the same size, shape, and weight.
2. Punch a few holes into each box using the wooden skewers
3. Fill each box with a different object, then securely tape the top to the box. Some examples of items that can be placed in the box include an onion, an orange, a golf ball, etc.
4. Pass out Mystery Box handouts and discuss the background information. Utilizing these scenarios will intrigue students and give them a “purpose” for conducting the lab experiments and putting the experiments into a forensic scenario.

Objectives:

The student will:

1. Examine how each sense should be used when an item is examined in a forensic case.
2. Determine what items are contained in each “mystery box” by utilizing all senses.
3. Decide if certain scenarios utilize deductive or inductive reasoning to make conclusions.

Related Videos: **Forensics: Who Killed the Iceman? (Discovery Video)**

Evaluation: Objectives will be evaluated using the following rubric.

Evaluation Rubric		
<i>Criteria</i>	<i>Points Available</i>	<i>Points Received</i>
Examined all 6 boxes	33	_____
Reasonable answers for contents of all 6 boxes in Data Table	33	_____
Answered post-lab questions correctly	34	_____

The Mystery Boxes

Objectives:

You will use deductive/inductive reasoning to determine the contents of a closed container.

Background information:

The National Museum received a call from a wealthy man, Mr. Khayat of Cairo, who claims to have the mummy of King Tut's grandson in his home. According to Mr. Khayat, he bought the mummy from an Egyptian family who had been granted the right to keep it by the Department of Egyptian Antiquities. Ordinarily, all ancient artifacts are maintained by the Egyptian government, but this one was an exception. Because the family had suffered difficult financial problems in recent years, they were willing to sell the mummy to a buyer. Now Mr. Khayat is ready to deal with Dr. Fisher, curator of the museum.

"Thank you for calling, Mr. Khayat, but how do we know that the mummy in your possession is really the grandson of King Tut? What proof do you have? Would you let our forensic anthropologist examine it?"

"Of course not, Fisher! Why once those scientist unwrap this mummy and poke it with their needles, they will destroy it! I will check with other agencies for a more cooperative buyer."

"Wait, Mr. Khayat. You do not understand my meaning. We can examine the mummy without unwrapping it or damaging it in any way. Of course we cannot get direct proof that it is the mummy you claim it to be, but we can get plenty of indirect proof. Once we have completed our inspection, we can organize all the clues we've gathered and make some logical deductions. If you have been misled into purchasing a mummy under false pretenses, that is fraud-a serious crime. For your own sake, we should examine this mummy. What do you say?."

Materials needed:

- 1 mystery box per group (6 mystery boxes total)
- 1 small flashlight per group
- 1 empty box per group
- scales (can be shared by more than one group)
- 1-2 wooden skewers per group

Procedure:

1. Examine the mystery box. Notice that the top is taped closed. Do not remove the tape or try to open the box.
2. Your assignment is to determine what is in each mystery box without opening it. You may shake the box, turn it, smell it, shine a light on it, weigh it, push wooden skewers into it, tap on it, or examine it in any other way as long as you don't damage the box or the contents inside.
3. Determine the mass of each mystery box by following these steps:
 - a. Find the mass of the empty box and the mass of the mystery box.
 - b. Subtract the mass of the empty box from the mass of the mystery box to determine the mass of the contents. Write this down on the data table.

Procedure continued:

4. Once you think you know what is in your box, write it down on the data table. Then exchange boxes with another lab group and repeat steps 1 through 3.

Data Table
Mass and contents of mystery boxes.

Mystery Box	Mass of Contents	Contents of Box
#1		
#2		
#3		
#4		
#5		
#6		

Post Lab Questions:

1. Which sense—touch, smell, taste, sight, or sound—helped you the most in determining what was in each box? Why?

2. How many times did you correctly determine the contents of the box?

3. How does a closed shoe box represent a mummy?

Post Lab Questions continued:

4. Was it helpful to know the mass of the contents of each shoe box? Why or why not?

5. Deductive reasoning involves making inferences or drawing conclusions based on available evidence. If you hear the sound of water falling on the roof and notice that everyone entering the building is wet, you might deduce that it is raining outside. Another type of reasoning is inductive reasoning; which is based on clear evidence. For example, if you walk to the window and see the rain, you have inductively concluded that it is raining.

Read the following examples and label them as “I” for examples of inductive reasoning or “D” for examples of deductive reasoning:

- _____ a. When you walk in the front door, you smell peanut butter and conclude that someone is baking peanut butter cookies.
- _____ b. You find your math notebook lying on the floor with teeth marks on it. You feel your puppy has been chewing on your notebook.
- _____ c. You used a thermometer to determine that the temperature of the lake water is 25 degrees Celsius.
- _____ d. Early scientist bombarded atoms with positively charged particles, and found that the nucleus of those atoms repelled the positive charges. This led the scientists to believe that the nucleus of an atom contains one or more positively charged particles.
- _____ e. In an experiment, you measured the volume and mass of an unknown liquid, and used this information to calculate the liquid’s density to be 1.2g/ml.

Activity 4: What Bones Can Tell Us: A Lab on Male and Female Skeletons

Duration: 90 minutes

Materials:

- Bone Bonanza handout
- Male and female skeleton handout
- Scissors
- Rulers or vernier calipers
- White Paper
- Glue Sticks
- Pen/pencil
- Skeletal model for classroom discussion

Instructional Strategies/Procedure: Begin by discussing the differences found when examining male/female skeletons; utilizing Chapter 10 of Forensics for Dummies and skeletal models. Use the Graphic Organizer while discussing/reading. Pass out the Bone Bonanza and male/female skeleton handouts; the background information is included on the handout. Students will label, separate, and reassemble bones from the male and female skeleton handout. Students will then use knowledge gained to answer postlab questions about male/female skeletons on Bone Bonanza handout.

Objectives:

The student will:

1. Correctly label the major bones in the body.
2. Compare/contrast skeletons and make inferences on identities.
3. Identify correct bones and their placement in skeletal framework.
4. List differences between male and female skeletons.

Evaluation: Objectives 1 will be evaluated by student labels of skeletal evidence. Objectives 2 and 3 will be evaluated by determination of male/female skeletal evidence and reassembly of skeletons on white sheet of paper. Objective 4 will be evaluated using postlab questions.

Forensics For Dummies: Chapter 10 Identifying John and Jane Doe
Graphic Organizer

What We Know	What We Want to Find Out	What We Learned

Bone Bonanza

Identifying Male and Female Skeletons

Objectives:

You will reassemble bones of a male skeleton and a female skeleton and label each bone using proper terminology.

Background information:

Two months ago, police were called to investigate the destruction of a section of Pine City's cemetery. Several gravestones were overturned, graves dug up, and coffins emptied. Based on an eyewitness report, police were able to capture two perpetrators shortly after the incident.

Following their trial, the judge sentenced these two vandals to a term in prison. He also required them to pay for the damage to the cemetery and the costs of reburying each unearthed body.

Two of the victims of this senseless desecration were Sam's grandparents. Sam had volunteered to be the family member who took care of their cemetery plots. Because his grandparents had never been embalmed, all that remained of their bodies were skeletons. When the cemetery vandals emptied their coffins, their bones were dumped together and mixed. So, reburying Grandmother and Grandfather will prove to be a more difficult task. To sort things out, Sam hires the archeology professor from the community college. The bill for the archeologist's services will be sent to the jailed vandals.

Materials:

- Bone Bonanza handout
- Male and female skeleton handout
- Scissors
- Rulers
- White Paper
- Glue Sticks
- Pen/pencil

Procedure:

1. Cut out all the bones on the Bone Bonanza handout
2. Determine which bones belong to Grandmother and which bones belong to Grandfather.
3. Reassemble the bones into complete skeletons, using the male and female skeleton handouts as a guide.
4. As you assemble the skeletons attach each piece to the white paper and label each bone using proper terminology.
5. Once you have reassembled each skeleton, complete the post lab questions.

Post Lab Questions:

1. What is the width of Grandmother's pelvis, measuring from the pelvic brim? How does her pelvis differ from Grandfather's?

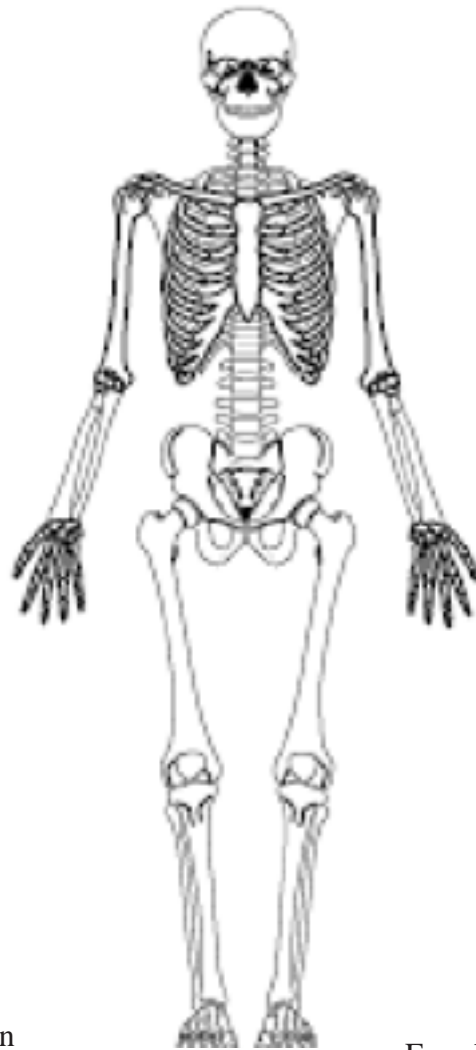
2. Examine the arm bones of the two skeletons. Was Grandmother right or left-handed? How about Grandfather?

3. How would you expect the sternal ends of Grandmother's and Grandfather's ribs to look? Why?

4. What distinguishing characteristics would you expect to find on Grandfather's skull that makes it different from Grandmother's?

5. How can an archeologist assist a forensic scientist in a criminal investigation?

Male/Female Skeleton Handout

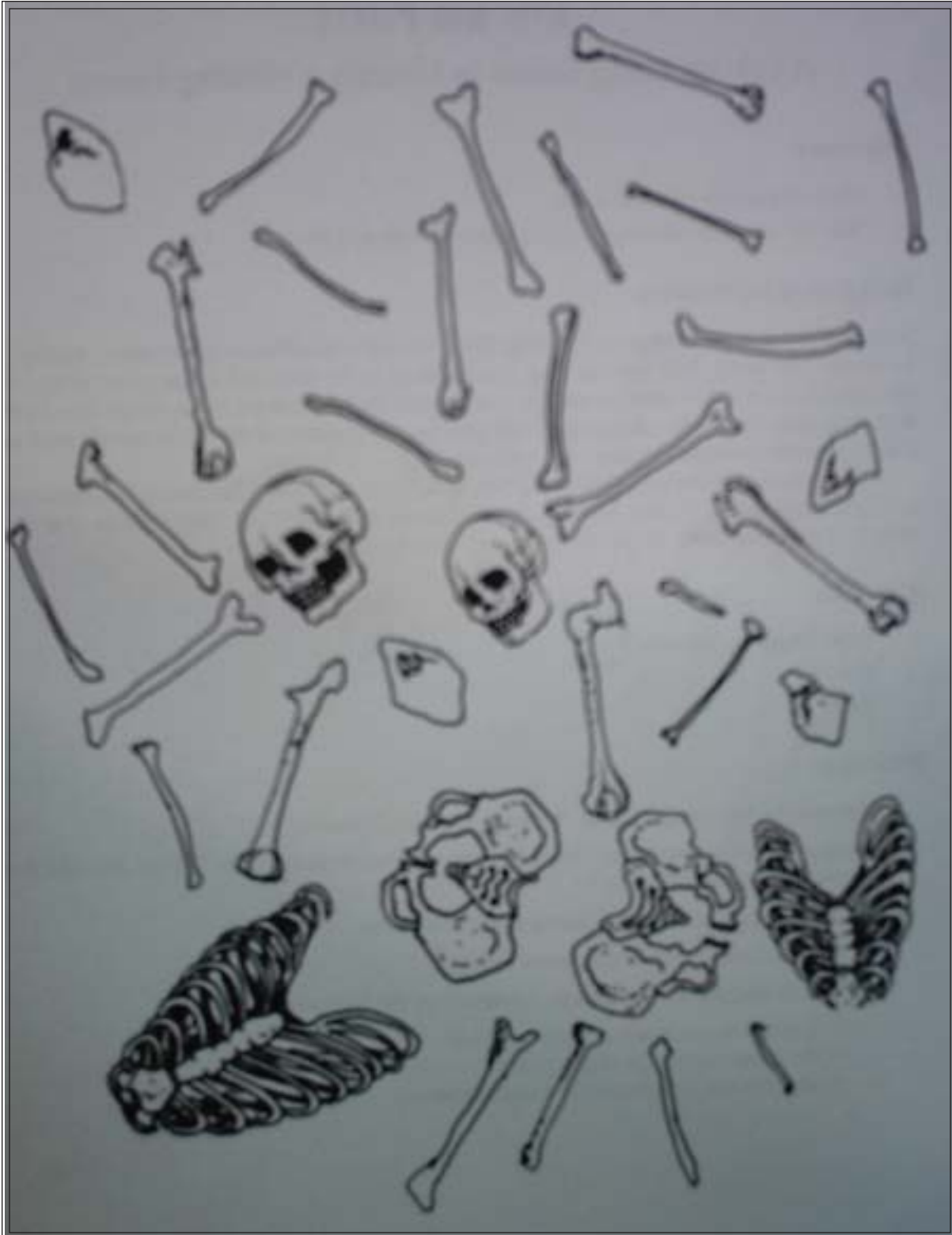


Male Skeleton

Female Skeleton



Bone Bonanza Handout



Activity 5: How Bones Measure Up: A Lesson On Osteometrics

Duration: 80-90 minutes

Materials:

- copies of Exhibit A bone
- copies of Crime Report sheet
- rulers or vernier calipers (make sure they have centimeter increments)
- calculators (optional)

Instructional Strategies/Procedure: Begin the lesson by discussing the relationship between the size of an individual's bones and their stature. Students are given a scenario in which a human humerus has washed ashore at a fictional location. They have been told that this humerus may belong to one of twelve individuals listed by the FBI as missing. The life insurance policies that covered the twelve individuals have not been paid yet; as their death has not been confirmed. The students must determine if the humerus could belong to any of the twelve individuals. The students will then test their formula by researching total height and length of humerus of at least 8 other persons in class. (You can assign students into groups before the activity.)

Objectives:

The student will:

1. Measure the length of the humerus bone in centimeters and record the length on the Crime Report Sheet.
2. Convert the height of each missing individual into centimeters. (1 inch = 2.54cm), then calculate the length of each individual's humerus (use the formula given in Step 3) Record findings on Crime Report Sheet.
3. Use the following formulas to determine whether or not the humerus bone could have belonged to one of the missing persons.
$$\text{Height of male} = (\text{Length of humerus bone in cm}) \times (2.89) + 70.64\text{cm}$$
$$\text{Height of female} = (\text{Length of humerus bone in cm}) \times (2.79) + 71.48\text{cm}$$
4. Test the given formula by researching total height and length of humerus of at least 8 other persons in your class. (You can assign students into groups before the activity.)

Evaluation: Objectives will be evaluated by student Crime Report Sheet. The next session will incorporate procedures and formulas learned here so that students will build on knowledge levels.

How Bones Measure Up

Objective:

You will try to identify a missing person by using the humerus bone length to find the height of that individual.

Materials:

- Tape measure or ruler (use metric)
- Exhibit A
- Calculator (optional)

Procedure:

1. Exhibit A is a life size sketch of the humerus bone that washed up on Seagull Beach. You and your team of experts will determine the owner of the humerus.
2. Measure the length of the arm bone in centimeters. Record the length of the humerus .
3. The families of the 12 missing persons have provided information regarding the height of their missing family member to the FBI. Their information is provided on the Data Table. Convert the heights in feet and inches to centimeters. Remember that 2.54cm equals 1 inch.
4. Use the following formulas to determine whether or not the humerus bone could have belonged to one of these missing persons. Record this information on the Data Table.

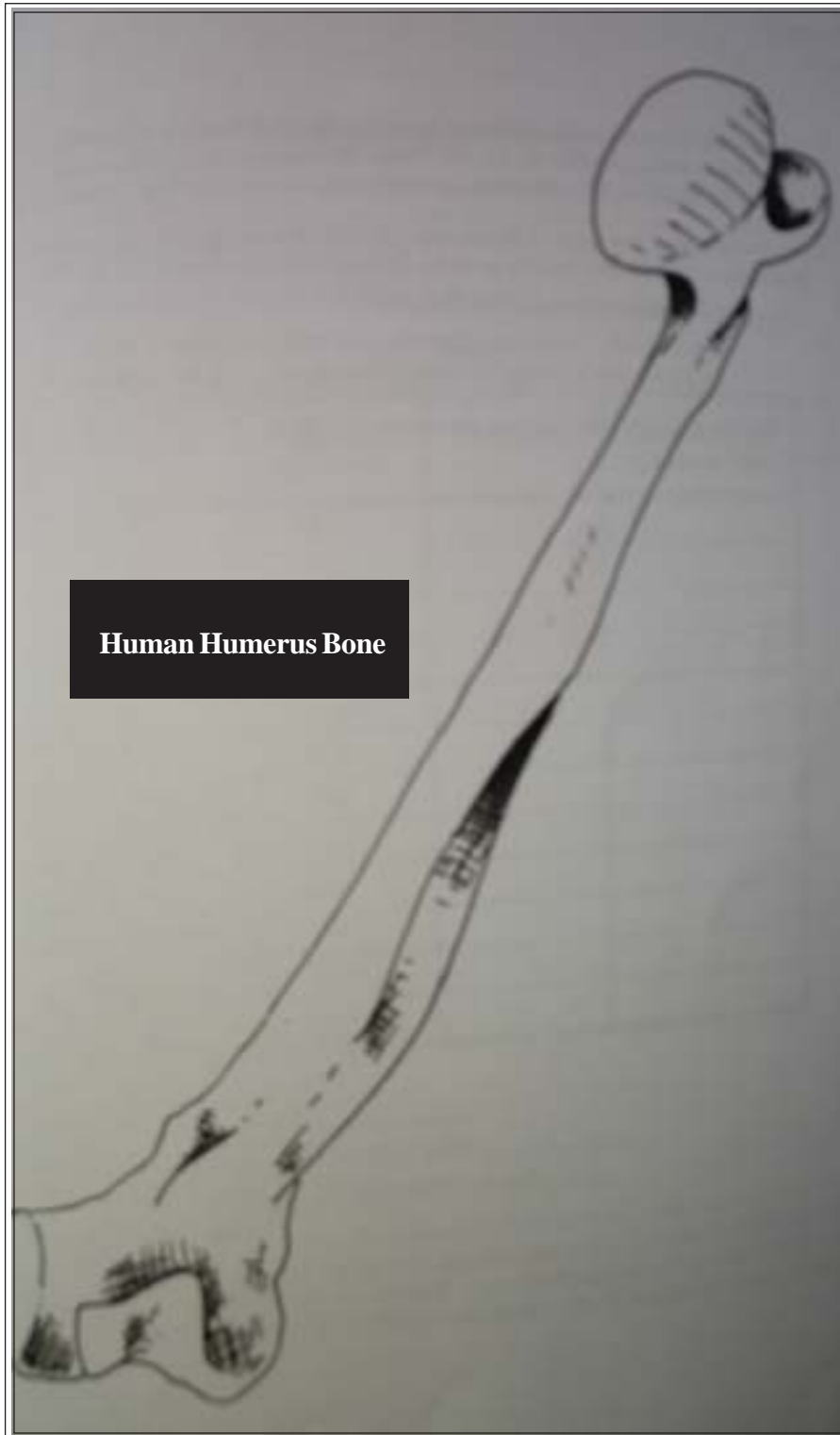
$$\text{Height of male} = (\text{Length of humerus bone in cm}) \times (2.89) + 70.64\text{cm}$$

$$\text{Height of female} = (\text{Length of humerus bone in cm}) \times (2.79) + 71.48\text{cm}$$

5. Test the given formula by researching total height and length of humerus of at least 8 other persons in your class. Record your results on the Data Table.
6. Indicate the owner of Exhibit A.

Crime Report Sheet			
1. Length of Exhibit A Humerus: _____ cm			
2. Data Table:			
Missing Person	Height	Height (cm)	Calculated length of humerus (cm)
Bill Boston	5'11"	_____	_____
Jane Caldwell	5'5"	_____	_____
Ernest Bass	5'6"	_____	_____
Jill James	4'10"	_____	_____
Gary Burnes	6'10"	_____	_____
Lily Walker	5'9"	_____	_____
Mary Zimm	4'8"	_____	_____
Billy Jenkins	6'2"	_____	_____
Jesse Agan	6'0"	_____	_____
Gladys Thomas	5'7"	_____	_____
Don Harris	5'7"	_____	_____
Lenny Aires	6'4"	_____	_____
3. Name of the probable owner of the humerus bone: _____.			
4. To prove to the insurance company that this formula works, find the height in cm of at least 8 persons in your class. Then measure the length of each person's humerus. Use your calculation to show that the humerus bone length can be used to determine height. Write your calculation on the back of this sheet.			

Exhibit A Bone



Human Humerus Bone

Activities 6 & 7: Dig A Little Deeper: A Lab on Investigating at a Forensic Anthropological Dig Site

Duration: Three 90 minute sessions

Materials Activity 6: Copies of Death's Acre by Dr. Bill Bass, or audio recording of Chapters 1 and 2. MP3 is available on www.audible.com

Materials Activity 7:

- string
- scissors
- rulers
- gloves
- tape
- graph paper
- shoe covers
- plastic spoons
- 1 large box of dirt (1 for each group of 4 students)
- laminated skeletal remains (at 1/10th scale) of male and female skeleton
- 2-3 empty buckets
- Dig a Little Deeper Lab Packet/Post-Lab Questions (contains rubric)

Teacher Preparation:

Run off copies of skeletal remains and laminate both sheets. Once laminated, cut out each bone. This will only need to be done once as you will be able to use same laminated pieces each time. Set up skeletal dig sites by filling each box with dirt and placing skeletal remains inside. Note the location of skeletal remains on your own graph paper key. Place other items with each box or in a general location where all students have access to lab supplies. (Hint: Place large plastic tarp down under boxes to keep lab area neat. Do not attempt this lab in a carpeted area. If weather permits, you may want to do the lab outside.)

Instructional Strategies/Procedure: On the first day, students will read/listen to Chapters 1 and 2 from Death's Acre. This will introduce students to the techniques involved in conducting a search for skeletal remains at a dig site. Use the graphic organizer before and during the reading for students to organize the main points. On the second and third days students have been called to a possible crime scene where they will conduct a dig; removing skeletal evidence, labeling and graphing its location correctly. Step-by-step instructions and rubric are included in lab packet.

Objectives:

The student will:

1. Record the dig of a forensic anthropological site.
2. Create a graph; using it to identify where each skeletal remain is found.
3. Retrieve any skeletal remains and correctly identify parts and whether the remains belonged to a man or a woman.
4. Determine approximate height of victim(s) and compare/contrast findings with those of missing persons' records.
5. Complete Dig A Little Deeper: Postlab questions.

Dig a Little Deeper/Death's Acre Graphic Organizer

What We Know	What We Want to Find Out	What We Learned

Names _____

Date _____

DIG A LITTLE DEEPER

A Lab on Investigating a Forensic Anthropological Dig Site

Objectives:

- You will record the dig of a forensic anthropological site.
- You will create a graph using it to identify any skeletal remain finds.
- Retrieve any skeletal remains and correctly identify parts and whether the remains belonged to a man or a woman.
- Determine approximate height of victim(s) and compare/contrast findings with those of missing persons' records.

Background Information:

“Thanks for coming out here, Dr. Moshier. I know that you have anthropology classes to teach and I appreciate your willingness to drop everything and help. It looks like we’re going to need your kind of advice and expertise on this one,” Sheriff Taylor said.

“Glad to be of help here Sheriff. What have you got?”

“Steve Jackson is that kid over there. His mom called me when he got home from school today. It seems he took a short cut through the woods, and found part of a bone that looks as though it has been chewed on by some sort of animal...it looks human to me but I’m not sure, so I decided to call you. We’ve gone ahead and roped off the area just in case.”

“Well, its a good thing you did, Sheriff. What you have here is a human clavicle bone and yes, it appears some type of animal has been chewing on it. Let’s hope this clavicle bone hasn’t travelled too far from its original location. We’ll start the search in the area you’ve secured; where the bone was found. I don’t want anyone walking across that area until it is completely mapped. I’ll enlist the help of some of my anthropology students...is that OK with you?”

“You bet, just let me know what I can do to help.”

“Here are some of the materials I’ll need.....”

Materials:

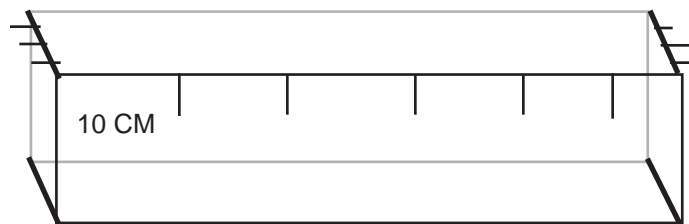
String	Tape	Graph Paper (one piece for each member of your group)
Rulers	Scissors	Spoons
Gloves	Shoe Covers	Small Tupperware containers/Empty Buckets

Rubric Grading:

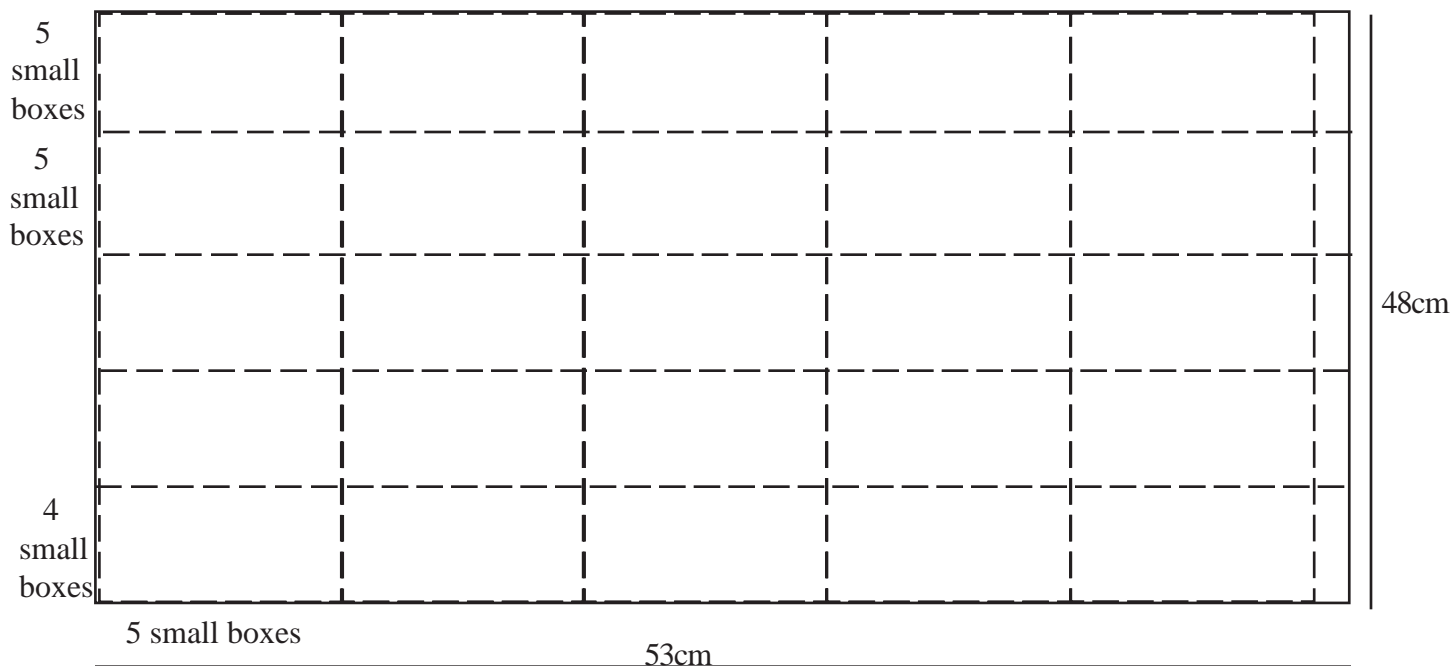
Collect 32 pieces of skeletal evidence	35 points (additional pieces receive bonus points)
Correctly graph, identify and label pieces	30 points
Keep area neat and clean during lab	10 points
Correctly answer post lab questions	25 points

Procedure

1. Measure the length of the sides of the box with a ruler. Mark the sides in 10 centimeter intervals.

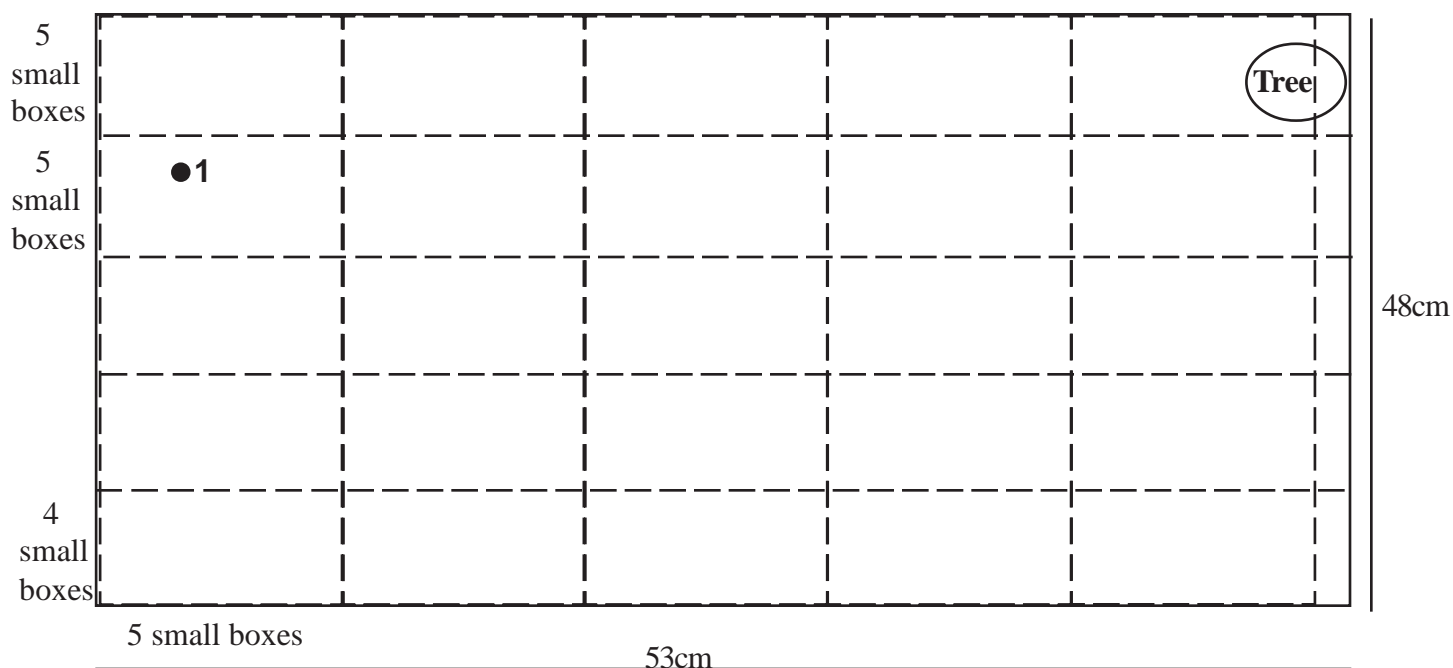


2. Run a piece of string across the box from one mark to another so that it touches the dirt. (You will need to cut the pieces and tape them to the inside of the box.) Make sure the string is fairly level. Continue this way until you have formed a grid of strings across the box.
3. Each member of your team needs to construct a graph depicting the grid that you have just formed. Each small box of your graph should represent 2cm. The interior of each plastic container measures approximately 53cm x 48cm. Each 10cm should be depicted using dashed lines.



4. Begin digging by removing a single layer of dirt from the box. Use your spoons to accomplish this. Dirt that is excavated should be put into a small plastic container, searched for evidence, then emptied into larger bucket for disposal. Remove just a spoonful at a time. Recall that according to Dr. Bass, dirt must be removed at the same depth across the entire box before beginning to dig at a greater depth. This prevents loose soil from falling back into the dig site. Gently push the strings aside to dig under them.

5. Continue removing one thin layer (no more than 1cm of depth at a time) until you find something. When you do, measure the depth from the string grid to the object you found. Record the first piece of skeletal evidence as Evidence 1 on the back of your graph. Try to identify which bone it may be by attaching the bone onto one of the skeletal drawings contained in this packet.. Record this next to the Evidence 1 entry. Record the depth at which it was found and label the correct location on your graph. Remember everything is on a 1/10th scale.



Back of graph paper:

Evidence 1 - Skull (appears to be male) Depth found 7cm (7 x 10 = 70cm)

6. There are approximately 35 pieces of skeletal remains to discover. If you discover all 35 pieces you will receive bonus points. You must find at least 32 pieces to receive 35 points.

7. Once you have discovered, graphed, and labeled all skeletal remains you need to finish the following post-lab questions.

Questions:

1. Are the skeletal remains that of a man, a woman, or both? _____

2. How can you tell if the remains are that of a woman or man? What were some of the clues?

3. Measure the humerus of each skeleton and multiply the measurement by 10...

What are the approximate measurements in centimeter for the male humerus? _____

What are the approximate measurements in centimeter for the female humerus? _____

4. Using the following formulas, determine the approximate height of each victim.

Remember 1 inch = 2.54 cm

Height of male = (length of humerus bone in cm) x (2.89) + 70.64

Height of female = (length of humerus bone in cm) x (2.79) + 71.48

Height of female _____

Height of male _____

5. Compare/contrast information on the following missing persons. Based on your collected evidence could any of these individuals be one of the missing persons listed here? _____

If yes, who? _____

Missing persons

Bill Boston 5'11

Jane Caldwell 5'3"

Gary Burnes 6'6"

Billy Jenkins 6'2"

Gary Shadow 6'0"

Jill James 5'7"

Jessica Harris 4'11"

Activity 8: Facial Reconstruction Lab

Duration: Two 90 minute classes plus pre-lab homework assignment

Materials:

- Pre-lab homework: Students need to access the following website and read about how forensic science uses facial reconstruction (print off the information for those who do not have internet)
http://library.thinkquest.org/04oct/00206/pti_facial_reconstruction.htm
- Day of Lab: 1 facial reconstruction kit per group of two students (each kit should contain skull with facial accessories, modeling clay, sculpturing tools, molded pegs to give skin depth, instruction booklet, and pictures of missing individuals. The pictures of the missing individuals should be removed from each booklet so that the student will not be imprinted with a particular face prior to the reconstruction process.)
- Forensic Facial Reconstruction Kit Instruction Manual which includes:
 - Facial Reconstruction Rubric
 - Facial Reconstruction Questions

Instructional Strategies/Procedure: Students investigate how forensic sculptors use the skull of a corpse to try to reconstruct how the deceased person appeared in life. Students will work in pairs to create a facial reconstruction. Their finished sculpture will then be compared/contrasted to four pictures of missing individuals.

Objectives:

The student will:

1. Investigate the field of forensic facial reconstruction.
2. Create a facial reconstruction using a plastic skull, depth guides for skin, and modeling clay.
3. Compare/contrast their reconstruction with four pictures of missing individuals to determine if the skull could belong to one of the individuals.
4. Discuss the pros/cons of facial reconstruction as it is used in forensic science.
5. Complete Facial Reconstruction Questions

Evaluation: Objectives will be evaluated using Facial Reconstruction Rubric and Facial Reconstruction Questions.

Forensic Facial Reconstruction Kit



Activity 9: Crime Bites: A Lesson On Forensic Odontology

Duration: 90 minutes

Materials:

- copies of Crime Bites handout
- 12 pieces of 6cm x 12cm white paper per each lab group (Six students)
- 12 pieces of 6cm x 12cm carbon paper per each lab group (Six students)
- (Optional) 12 pieces of dental bite wax may be substituted for white paper and carbon paper...the carbon paper/white paper is a less expensive alternative.

Instructional Strategies/Procedure: Begin the lesson by discussing what forensic odontology is and how it is used in forensic cases where victim identification is necessary or as evidence in cases where suspects may have left their bite marks on a victim (such as the Ted Bundy case). After students create their bite marks, label six of one student's bite marks as A, six of another's as B, and so on, until you have six sets of six bite marks. Decide which student will be the criminal. Take this student's other six bite marks and label them as "Crime Scene." Throw away the extra six bite marks from all other students. All of this should be done in secret so as the students will not know who is the "criminal." Give each lab group one copy of bite marks A-F and one copy of the Crime Scene bite mark.

The Universal System of Numbering can also be discussed to provide students with more details regarding dental charting. Information on the Universal System can be found in the Diversified Health Occupations text.

Objectives:

The student will:

1. Explore the field of forensic odontology and how it is helpful in victim identification and in bite mark analysis left by suspects in a crime.
2. Describe how bite marks can be used to help solve crimes.
3. Create bite mark impressions using either dental wax or carbon/white paper.
4. Analyze bite mark impressions; comparing and contrasting each sample with sample left at crime scene.
5. Correctly identify the bite mark sample that matches the one left by the suspect.

Evaluation: Objectives 1, 2, 4, and 5 will be evaluated using the post lab questions. Objective 2 will be evaluated by student ability to correctly create bite mark impressions with materials given.

Crime Bites

Forensic Odontology

Objective:

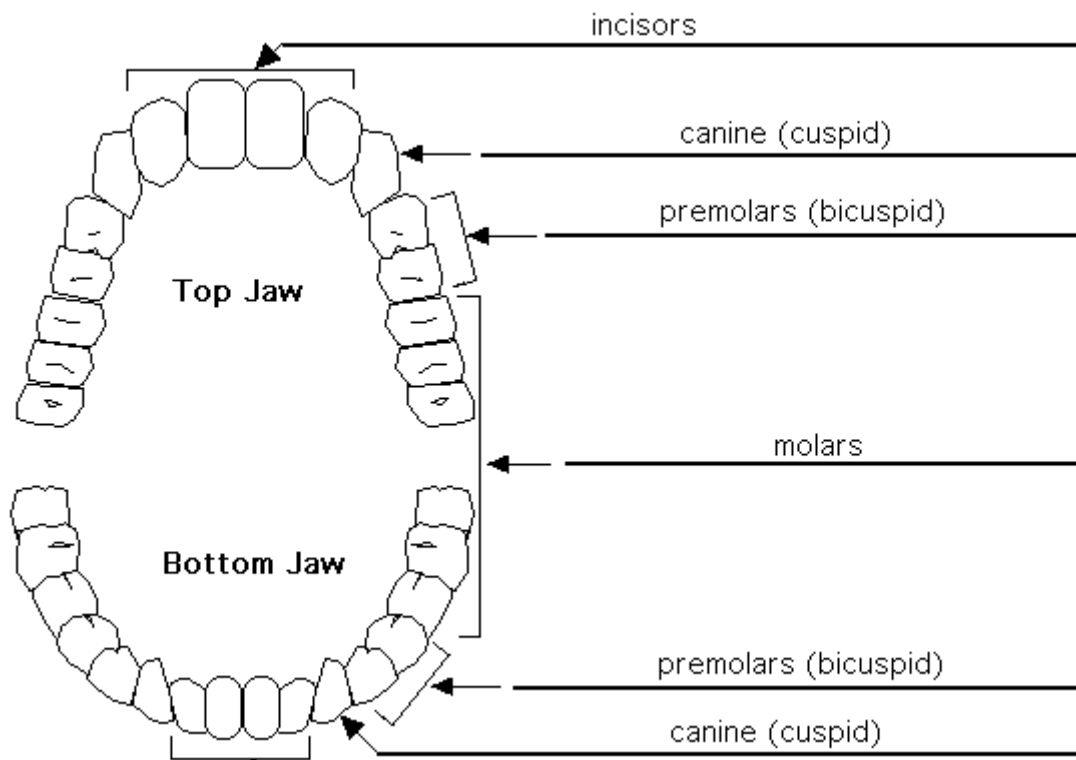
You will explore the field of forensic odontology, then you will create and analyze bite marks to solve a mystery.

Background Information:

Forensic Odontology is the art and science of dentistry applied to the law. Forensic odontology is also referred to as forensic dentistry.

Because teeth are so durable, they are ideally suited as means of identification. A person's dentition receives uniqueness through use and wear. These features can aid in the identification of remains or identify criminals if bite-mark evidence is left at a crime scene.

The average human adult has 32 teeth (see figure below). Since almost everyone has been to a dentist, most people have a dental record. This makes teeth a better identifier than fingerprints, since many people have never been fingerprinted.



Background Information continued:

“Dr Johnson, would you introduce yourself to the jury, please, and explain why you are qualified to testify in this trial?”

“Of course. I am a forensic dentist. That means that I use my knowledge of dentistry to help in criminal cases or to help identify unknown persons. I’ve been involved in dental forensics for the last twenty years, and have testified in many cases.”

“Thank you Dr. Johnson. Let me turn your attention to exhibit #34—a piece of used chewing gum. Do you recognize this?”

“Yes I do. This piece of gum was found at a murder scene. I was asked to examine the gum, and when I did I found several marks made by teeth on the gum. The police were holding two suspects in jail, so I made impressions of their teeth. I also made impressions of the victim’s teeth. I then made test marks in silicone to compare with the marks left in the chewing gum.”

“Was the gum dropped by the murder victim, Dr. Johnson?”

“No it was not. The marks in the chewing gum were made by very sharp teeth, one of which was chipped. The victim had rounded, smooth teeth due to his advanced age. You see, younger people have sharper teeth. But as a person ages, his or her teeth are continually worn down..”

“Did the chewing gum marks match either of the test marks from the suspects’ teeth?”

“Yes they did. Both of the suspects are young men and have sharp teeth. However, that is the only similarity in their teeth. One suspect has an undamaged set of teeth with no nicks or breaks. The other suspect has a broken tooth; his teeth marks perfectly match the marks in the chewing gum.”

Materials:

12 pieces of 6cm X 12cm white paper.

12 pieces of 6cm X 12cm carbon paper.

Procedure:

1. Fold the pieces of carbon paper in half, carbon side out.
2. Fold the pieces white paper in half and place one carbon paper inside each piece of white paper.
3. Choose one member of your group to bite down on all twelve pieces of folded paper. Throw away the carbon, and lay the white pieces of paper with bite mark impressions out for your teacher to collect.
4. Your teacher will provide you with bite marks from six suspects labeled A-F and one bite mark from a crime scene. While you are waiting for this, examine the teeth figure on the front of this sheet.
5. Analyze each bite mark and record information about each on the diagrams. For example, if bite mark A has a broken incisor, draw a broken incisor on diagram A. When you finish drawing details on each diagram they should look very similar to the respective bite mark examples.
6. Analyze all of your diagrams to determine which suspect bite mark matches the bite mark from the crime scene.
7. Answer the post lab questions.

Bite Mark Diagrams

Crime Scene

Sample A	Sample C	Sample E
Sample B	Sample D	Sample F

Post Lab Questions:

1. How can bite marks be used to help solve crimes?

2. Who has sharper teeth, young people or older people? Why?

3. In the lab today, whose bite mark matched the bite mark from the crime scene?

4. Name the teeth that left the best impressions in the crime scene bite mark.

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