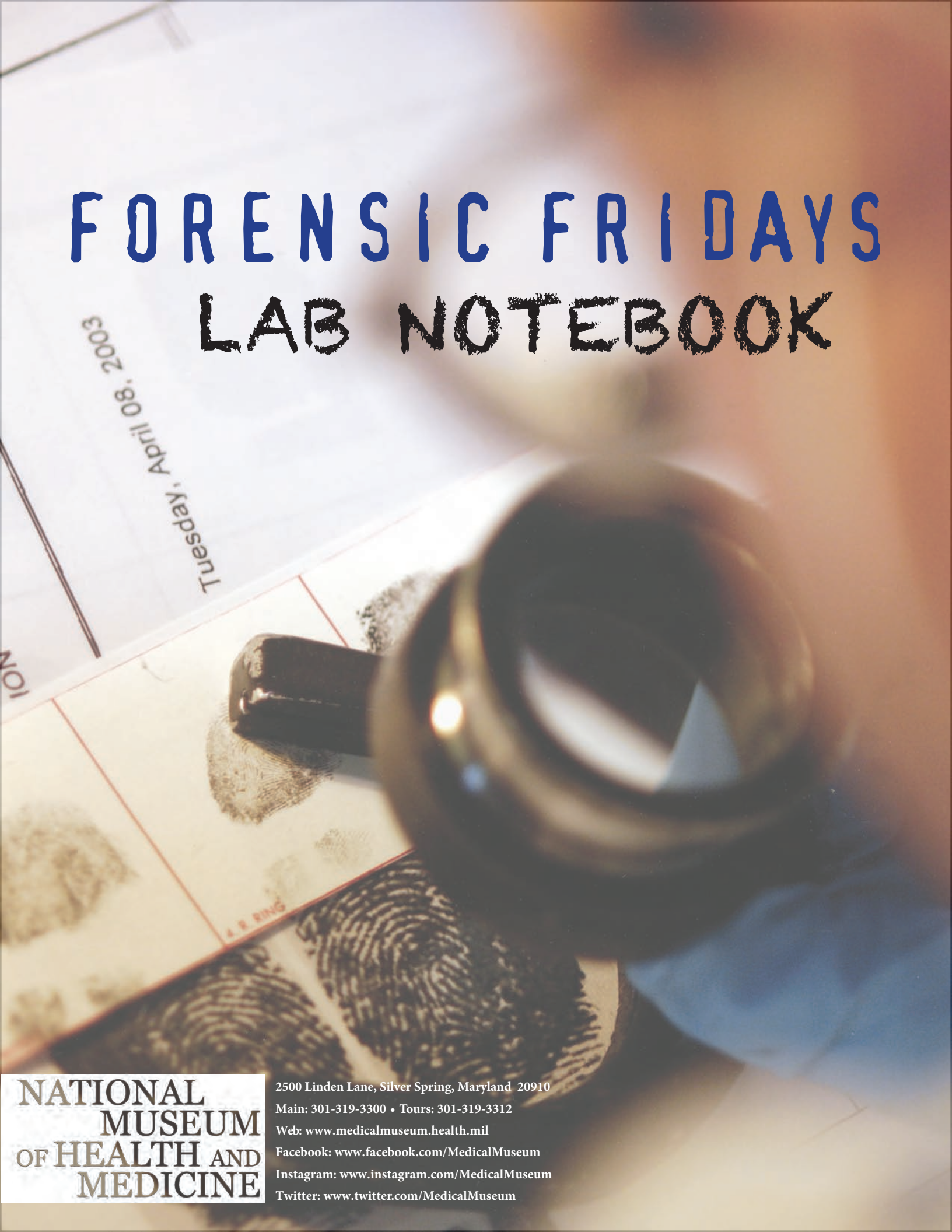
FORENSIC FRIDAYS
LAB NOTEBOOK



NATIONAL MUSEUM OF HEALTH AND MEDICINE

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MEDICAL MUSEUM CASE #1862

BACKGROUND:

During the Vietnam War, on 21 May 1970, a UH-1H (Huey) helicopter (tail number 52-11862) from B Company, 150th Assault Helicopter Battalion (AHB), was shot down by enemy ground fire while on a routine surveillance mission. Last radio contact was received at 1200 hours when the air traffic controller received a "May Day" from the aircraft 862. Search and Rescue (SAR) efforts were launched in search of the downed aircraft in the Kampong Cham Province in Cambodia. The aircraft and remains from three individuals were not recovered.

Individuals onboard the aircraft included Warrant Officer **Brinton** (Pilot), Warrant Officer **Woodward** (co-pilot), Private **Otis** (passenger), and Capt. **Russell** (passenger). Brinton survived the crash and escaped to a local base.

MISSION:

You are working for the Defense POW/MIA Accounting Agency (DPAA). You have been asked to go to Cambodia to excavate, identify, and repatriate the remains of the missing members of the downed Huey to the family.

Figure 1

Figure 2

INK CHROMATOGRAPHY AND THE SCIENTIFIC METHOD

TEAM:

INTRODUCTION:

You work for the chromatography division of a forensics lab. You have been asked to analyze accounting documents that may have been altered. You have pens from three possible suspects. You must determine which suspect altered the documents. Since pen manufacturers use different combinations of ink formulations to produce black pens, there may be variation in the mixture of colors. This activity will help you determine which suspect altered the documents. *This activity does not relate to the case study.*

MATERIALS:

1 large beaker
1 bottle of water
3 paper clips
3 pieces of litmus paper or coffee filters
1 ruler
1 pencil
Pens of different types (felt tip, ball point, permanent, etc.)
Paper towels
Hole punch
Sample letter

PROCEDURE:

1. Fill out the top portion of the data sheet. As a team, you will hypothesize which suspect's (pen) altered the documents.

2. Cut a piece of litmus paper or coffee filter from the "sample letter."

3. Use the hole punch to punch a hole in the piece of the paper at the opposite end of the pen marking.

4. Thread one opened paper clip through the hole.

5. Hook the paper clip to the pencil and place the pencil across the top of the beaker.

6. Slowly add water to the beaker until it makes contact with the paper. Do not cover the ink marks.

7. Wait for the water to be absorbed by the paper.

8. Remove the paper from the water and set on a paper towel to dry.

9. To test the potential pens, make a mark on three separate pieces of paper and label each paper. Repeat steps 2-8. Make sure the three samples do not touch each other.

10. Record your observations on the data sheet.

SCIENTIFIC METHOD:

A method of investigation where data are collected and a hypothesis is tested.

STEPS:

- Ask a question
- Research the question
- Make a hypothesis
- Test your hypothesis by doing an experiment
- Analyze your data and draw a conclusion
- Communicate your findings

DATA SHEET

QUESTION:

HYPOTHESIS:

TYPE OF EXPERIMENT:

STRIP 1	STRIP 2	STRIP 3

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ANALYSIS:

1. What did you observe on the paper strips after you added water?

2. Did all the ink dots move?

3. Did all the ink dots form the same pattern (shape and color)?

4. Were you able to identify the ink used to alter the documents?

ADDITIONAL RESEARCH

WHAT CAN WE WORK OUT FROM CLUES?

INTRODUCTION:

In this experiment you will study coins, looking closely at a large heap of pennies. Is it the horde of a counterfeiter? Have you found the hiding place of a bank robber, imprisoned years ago? Have the coins come straight from the bank? You will see that the pile of coins all belong to a single classification, i.e., all are pennies. Look at the coins more closely and discover additional individual identifying features you might not previously have thought to be important and display your findings graphically. Then, draw conclusions about what you have observed.

TIME: 30 minutes

MATERIALS:

50 pennies
Graph paper
Pencil
Colored pencils

PROCEDURE:

1. Look at the side of the coin with Lincoln's head on it (this side of the coin is called the "obverse"). Observe the date to the right of his head.

2. Place the coins in groups, separating out each group that has the same date.

3. Count the numbers of coins in each group and enter the number in the data table below.

DATA TABLE:

DATE	NUMBER OF COINS WITH THIS DATE

ANALYSIS:

1. If the collection of coins shows a range of dates, what is the main difference in appearance between the old and new coins?

2. Using the results from the data table and a sheet of graph paper, produce a bar chart displaying the numbers of coins with different dates. (Alternatively, you might like to use a computer program to draw your chart.) What does the chart show?

3. What can you deduce from your chart?

NMHM RECOVERY PROJECT
MEDICAL MUSEUM CASE #1862

TEAM:

Figure 3

INTRODUCTION:

You are part of a recovery team working for the Defense POW/MIA Accounting Agency and have been approved to travel to Cambodia for a recovery mission. You have been provided with an approximate area of the Huey helicopter wreckage site. You have done the investigation and spoken to eyewitnesses. You have also tested the area, tentatively marking it with flags where you located evidence. You will now excavate the site, collect any items found and record your findings.

MATERIALS:

2’ x 2’ box filled with potting soil
Roll of string
Roll of tape
Pencil
Graph paper
Bucket
Mesh wire
Spoon or Trowel
1 gallon resealable bag
Ruler
Level

PROCEDURE:

1. Using the graph paper, draw a map of the surface of the dirt. Note any objects or mounds.

2. Measure the sides of the box with a ruler. The sides will be marked in 10-centimeter intervals.

3. Run a piece of string across the box so that it touches the dirt. The string must be level, so test the string with a level. Continue until a grid of strings is created.

4. Work in one section at a time, removing small layers across the box. The dirt must be removed at the same layer across the box.

5. Continue to remove thin/small layers across the box until an artifact is exposed. Record the depth from the string grid to the location of the object found. Record the depth in the data table.

6. Sketch the location of the object on the graph paper.

7. Place recovered artifacts in the plastic bag.

DATA TABLE:

OBJECT	DEPTH

ANALYSIS:

1. Did you find any objects or clues on the surface of the dirt?

2. What objects did you uncover during your excavation?

3. Based on objects excavated, describe what you "know" about the individual.

4. Why was it important to remove one layer at a time and to record your findings?

5. Why are the skills of an archaeologist useful in helping to solve forensic cases?

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MATERIAL EVIDENCE ACTIVITY
MEDICAL MUSEUM CASE #1862

TEAM:

INTRODUCTION:

After performing an excavation or "recovery," you discover several pieces of material evidence that may relate to the unknown service member. You must first "re-create" the events of the crash and determine if the evidence uncovered belongs to one of the missing individuals.

Figure 4

PART A: LEGO® BRICK ACTIVITY

MATERIALS:

Bag of Lego® Bricks
Paper
Pencils
Boards

PROCEDURE:

1. In your group, choose one person to create an object with the Lego® bricks, the other person will "re-create" the object later.

2. With a divider between you, the "creator" will create a small object with the Lego® bricks.

3. The "creator" will develop a map or instructions to recreate the object.

4. After creating the map, the "creator" will deconstruct the object and pass the Lego® bricks and map to the "re-creator."

5. The "re-creator" will then reconstruct the object based on the map.

ANALYSIS:

1. What was the Lego® brick object?

2. Did the map help you to rebuild the Lego® brick object?

3. How difficult was it to "re-create" the object?

PART B: MATERIAL EVIDENCE

INTRODUCTION:

Your team has completed an initial excavation of a site of a downed Huey helipcopter in Cambodia. You have collected several pieces of material evidence from the recovery mission. You must now record all the items collected, and determine if these objects are relevant to the case.

MATERIALS:

Evidence bag containing objects excavated during the dig
Reference document

PROCEDURE:

1. Empty the contents of the evidence bag on the table.
2. On the data sheet, record the objects in the data table.
3. Next to the list in the data table, make inferences about the owner, last date of use and past events relating to the evidence.
4. Using the reference sheet, determine if the material evidence collected is relevant to the case.

DATA TABLE:

OBJECT	OWNER, DATE, OR USE

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ANALYSIS:

1. What types of objects were recovered from the excavation site?

2. Were there any objects that didn't fit the case or story?

3. What can these objects tell you about the individual(s) involved in the crash?

4. Which of the three unknown service members do you believe the materials belonged to? Did the research help you to narrow the identity of the remains?

ADDITIONAL RESEARCH

You have collected several coins as material evidence from a recovery site. Using the pennies and the information from the first activity, write a fictional news report based on this information. Include information on the individuals and events of the crash and recovery mission.

HEADLINE:

ARTICLE:

BIOLOGICAL PROFILE: SEX ESTIMATION MEDICAL MUSEUM CASE #1862

TEAM:

INTRODUCTION:

You are working for the anthropology division of the Defense POW/MIA Accounting Agency in Hawaii. You have received a set of remains from the case #1862. You are tasked to create a biological profile of the individual. Your first task is to estimate the sex of the unknown individual.

MATERIALS:

Male and female cranium images from PowerPoint (PPT)
Male and female pelvis images from PPT
Reference image from PPT (starred)
Sex estimation reference sheet
Skeleton worksheet

PROCEDURE:

1. Begin by reviewing the anatomy of the human skeleton and fill out the skeleton worksheet.
2. Using the sex estimation reference sheet, record your findings in the data table.

DATA TABLE:

BONE	FEATURES

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ANALYSIS:

1. Which bones did you use to estimate the sex of the individual?

2. What features on the bone(s) led to your conclusion?

3. What is the estimated sex of the individual?

ADDITIONAL RESEARCH

Forensic Friday: Word Search

H T Z A J Y K X L N J C U D Z G W O A D S R Y U Z G Z Q W I
T R A N S F E R C A S E M U I R Q U Y E C E B F D M L G Q E
F M E T R O M T S O P C M O P Q T U F C I N H E P T E K M S
Q I J B W R X P Z H G G D R R O U R A E S I Z F Q U D U E W
A X N U I V A A G U Q C H W P T S C Z D N M E C B N D P S O
M G T G A T Y K G E Q Q F S I C U I K E E A E I S S A L B J
M T Z Y E F Q S V U C N Y P R A T A I N R X N Q E U T X U U
T F D B L R K I U K J N G P K O M O R T O E A P F Y Z S O U
D Q F N Z F P L P S V M E H J W Q D F Y F L R P J R R V G S
V T I A A N J R U Y Z B O D L J X O J E W A M R Q R P Z B U
N N N H L Z U D I S W S S W I U W N N S H C R E Y P W Q V O
G P U J E F N G D N L X W R Z V E T V S J I Y E T R T Z Y K
E R Z D T A G R Q M T O K U L U E O X H P D O A F M E J D Q
S R G G G K V G L Z Q S K N S Q S L S E A E P I Y V C B D U
E J E D H O U A I S K B E K A K X O A C C M N G M L P U Q K
T O R V F R Y T O W C U N K H Y K G G I T A O D E O A B V A
V C L J E K Y G N N T L O Z F X A Y U Q R L M Q J N V F V T
D D T D V R B O F G F N Z S Q I Z M A D O E O C T K D V W J
N T Y C W M L D Z O Z V X D P K E Y U H K O T E C M L U T R
U G C U I E Z U R E S O L V E D G O T A A O M A W Y W B L E
L W S S H B Y T A Y B M W T L O D A V L R O X H M V O R A T
I T S A U Z P F A P U R N V L S P C T M R T S O K V A W F R
D L F D K G A E G J B D G O X A V Q O T W D H Z S P G K V C
I Q C Y E Z K D M W R U P H I V A W E Z C I P B Y N D O V X
D H T K D X F Y V K K O S R J E S M H A R V D G G V F U F F
N C I I B V D A W F R X C O G N N U F T L K S W S C M H O L
X R P Z O E A N A H W Y W X S G R G I N R D L D X I J W M Q
S M K A I Q V E T W I H N Y B L D C T Y D W P O F U F Q P G
F O Y Z Y X U N G F I B Y S D Z J I W B R B D M D Q T S H Z
I E N R Q O A S K S X K F U K Z N X B F R L V Y N Z Z F O N

ANTEMORTEM
ANTHROPOLOGY
AUTOPSY
BLASSIE
DECEDENT
DNA
DOG TAG
FINGERPRINTS
FORENSICS
MATERIAL EVIDENCE
MEDICAL EXAMINER
MORTUARY
MTDNA
ODONTOLOGY
PATHOLOGY
PAUL REVERE
POSTMORTEM
RESOLVED
TRANSFER CASE
TRAUMA

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BIOLOGICAL PROFILE: AGE ESTIMATION MEDICAL MUSEUM CASE #1862

Figure 5

TEAM:

INTRODUCTION:

You are currently working in the anthropology division of the Defense POW/MIA Accounting Agency. You have received a set of remains from a crash site in Cambodia. After recording the estimated sex of the individual, you are now tasked with estimating the age of the individual.

MATERIALS:

Image of humerus with epiphysis from PowerPoint (starred)
Age estimation reference sheet
Skeleton worksheet

PROCEDURE:

1. Compare the bones to the age reference sheet.
   Record your findings in the data table.

ESTIMATED SEX:				
PROXIMAL END:	☐	FUSED	☐	UNFUSED
DISTAL END:	☐	FUSED	☐	UNFUSED
ESTIMATED AGE RANGE:				

ANALYSIS:

1. What was the estimated age of the individual?

2. What parts of the bone were you able to use to estimate the age?

3. Why did you provide a range of ages?

4. Why would the age ranges be different for different sexes?

BIOLOGICAL PROFILE: HEIGHT ESTIMATION MEDICAL MUSEUM CASE #1862

Figure 6

TEAM:

INTRODUCTION:

You work in the anthropology division at the Defense POW/MIA Accounting Agency. You are tasked with creating a biological profile of an unknown service member. The final part of creating the profile is to estimate the height of the individual. You will use a long bone to complete the profile.

MATERIALS:

Osteometric board and ulna image from PowerPoint (starred)
Calculator
Skeleton worksheet

PROCEDURE:

1. The ulna measures 25 centimeters. You will need to convert the height of the individual into feet and inches.
   Multiply the length in centimeters by 4.27.
   _____ centimeters x 4.27 = _____ centimeters

2. Take the converted inches and add 57.97.
   _____ centimeters + 57.97 = _____ centimeters
   What is the approximate height in centimeters? _____

3. Convert the approximate height in feet and inches.
   Multiply by .3937 and divide by 12.
   The approximate height is _____ feet and _____ inches

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ANALYSIS:

Figure 7

1. Which bone did you use to estimate the height?

2. What is the estimated height of the individual?

3. Why are long bones or weight-bearing bones used to estimate height?

4. Even though you measured the bone and used an equation, why is this still considered an estimation?

5. What is the biological profile for this individual?

SEX:
AGE:
HEIGHT:

ADDITIONAL RESEARCH

HEIGHT ESTIMATION ACTIVITY

INTRODUCTION:

Weight-bearing bones or long bones are used to estimate the height or stature of an individual. Through specific equations you will estimate the stature of a partner.

MATERIALS:

Metric ruler or tape measure
Calculator

PROCEDURE:

1. What is the estimated biological sex of the individual?_____

2. Determine the type of long bone: _____

3. Record the length in centimeters.
   Length_____ cm.

4. Using the provided stature chart, multiply the length in centimeters by the corresponding number for that bone in the chart.
   _____cm. **x** _____ **=**_____cm.

5. Using the above number in centimeters, add the number in the second column from the chart. _____cm. **+** _____**=**_____ cm.

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6. Convert your final number from centimeters to inches by dividing the above number by 2.54. _____cm. / 2.54 =_____ in.

7. Convert the new number from inches to feet by dividing the above number by 12. _____in. / 12 =_____ or_____ft. and _____in.

Stature Chart for Females

BONE	MULTIPLY	ADD
HUMERUS	3.36	57.97
RADIUS	4.74	54.93
ULNA	4.27	57.76
FEMUR	2.47	54.74

Stature Chart for Males

BONE	MULTIPLY	ADD
HUMERUS	3.08	70.45
RADIUS	3.78	79.01
ULNA	3.70	74.05
FEMUR	2.38	61.41

ANALYSIS:

1. What was the height of your partner? Did you include shoes in the height?

2. Was there a difference between the actual height and the estimated height of your individual? Explain.

3. Did you consider sex as a factor in computations? Do you think the estimated sex could make a difference in the estimated height?

4. How could the accuracy of this equation be improved? What factors would you consider?

DNA IDENTIFICATION MEDICAL MUSEUM CASE #1862

TEAM:

Figure 8

INTRODUCTION:

You are part of a team of analysts that work for the DoD DNA Operations division of the Armed Forces Medical Examiners System. You have received a bone sample of an unidentified service member killed in the Vietnam War. Maternal family reference samples have been collected from the families of the possible unknowns. After extracting the DNA, you must compare the unknown to the family reference samples.

MATERIALS:

1 quart-size resealable plastic bag
Frozen or fresh strawberries (frozen work better)
Cheesecloth
Wooden skewer
Funnel
Buffer solution (liquid dish soap mixed with water and salt)
Test tubes
Vials
10ml ethanol, chilled

PROCEDURE:

1. Place the strawberries in a plastic bag.
2. Add 20ml buffer solution to the bag and seal it. Mash and mix the strawberries and buffer solution.
3. Filter the seeds and excess pulp from the mixture by placing the cheesecloth over a test tube and pouring the solution into the tube. Squeeze the juice into the test tube.
4. Add 10ml of chilled ethanol to the test tube and wait 5-10 seconds.
5. Extract the DNA by pulling/spooling the DNA onto a wooden skewer. Place this in a vial and view the strawberry DNA.

ANALYSIS:

1. Match the unknown sample to the family sample.
   The unknown matches _____.

   Unknown Sample: AAGTCCCTCTAAG
   Woodward Family Sample: AGGTCCCCCTAAGATG
   Otis Family Sample: AAGCCCTCTTAAGAGG
   Russell Family Sample: AAGTCCCTCTAAGAGG

2. What is the difference between mtDNA (mitochondrial DNA) and nDNA (nuclear DNA)?

3. Why is it important to have reference samples?

ADDITIONAL RESEARCH

GUMDROP DNA MODEL

INTRODUCTION:

The structure of DNA is called a double helix. This is similar to the shape of a twisted ladder. Create a model of DNA by using candy.

MATERIALS:

Twizzlers
Small colored gumdrops (or small colored marshmallows)
Toothpicks

PROCEDURE:

1. Select four different colors of gumdrops or marshmallows, two Twizzlers, and a handful of toothpicks.

2. The Twizzlers will represent the sugar/phosphate backbone of the model; the gumdrops will represent the nitrogen-containing bases.

3. Create a key for each of the four bases with their corresponding gumdrop color:

Adenine: _____ **Thymine:** _____

Guanine: _____ **Cytosine:** _____

4. Create one DNA strand by attaching the gumdrops (alternating bases) with a toothpick to one Twizzler. Make sure to push the gumdrops down the toothpick close to the Twizzler.

5. Leave enough room to attach the second strand to the toothpick. Make a second DNA strand. Make sure they have complementary base pairings (AT, GC).

6. Continue the pairings and attached the two DNA strands together with the toothpicks.

7. Twist the model into a double helix.

8. Once completed, feel free to eat your model!

ANALYSIS:

1. Where can DNA be found in the human body?

2. What does "DNA" stand for?

3. Why is it important to pair the same color of gumdrops each time?

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DENTAL RECORDS AND IDENTIFICATION MEDICAL MUSEUM CASE #1862

TEAM:

INTRODUCTION:

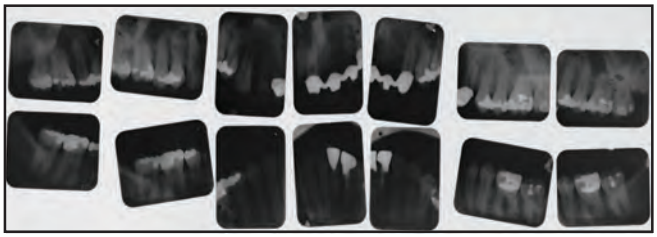


Figure 9

You are a forensic odontologist working for the Defense POW/MIA Accounting Agency. You have been given the dental records of three individuals who are suspected to have been involved in a Huey helicopter crash in Cambodia, as well as the mandible of an unknown individual. You have taken post-mortem X-rays of the mandible to compare with the radiographs (X-rays) in the records. You must determine if there is a match with the unknown mandible and the possible individuals.

MATERIALS:

Figure 10

Antemortem radiographs from PowerPoint (PPT)
Postmortem radiograph from PPT
Dental charting form
Mandible image from PPT (starred)

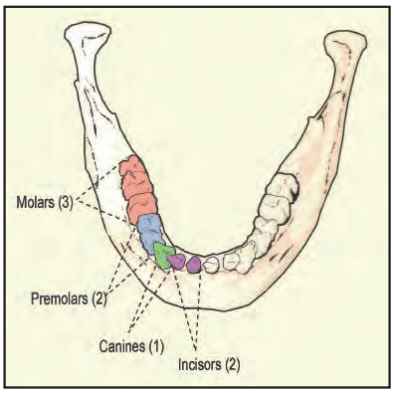
PROCEDURE:

1. Compare the antemortem radiographs to the unknown postmortem radiograph. Record your findings:

DECEDENT	MATCH	
WOODWARD	☐ YES	☐ NO
OTIS	☐ YES	☐ NO
RUSSELL	☐ YES	☐ NO

Figure 11

2. Using the dental charting form, record data related to the unknown mandible.



3. Using your dental charting form, record the information in your notebook.

Tooth type	Fillings (Yes/No)	Braces (Yes/No)	Erupted or Unerupted
Incisors			
Canines			
Pre-molars			
Molars			

ANALYSIS:

1. When comparing the radiographs or X-rays, what features or dental conditions did you observe?

2. Why do you need to use radiographs and dental charting forms?

3. After collecting the information, which individual matched the unknown mandible?

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FINGERPRINTING

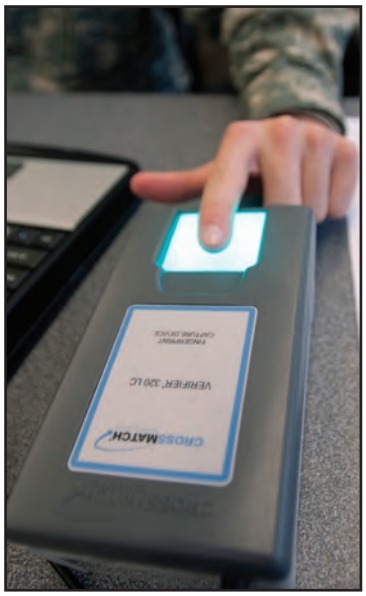

Figure 12

TEAM:

INTRODUCTION:

You are currently working for the Federal Bureau of Investigation in the fingerprint identification department. You have been asked to help match fingerprints to individuals of a mass casualty airplane crash. *This activity is not part of the case study.*

MATERIALS:

Makeup or paint brush
Cocoa powder
Clear tape
Clear drinking glass or jar
Fingerprint cards or white paper
Black ink
Hand wipes
Ruler
Scissors

ARCH

LOOP

WHORL

PROCEDURE - PART 1:

1. Make a fingerprint on the glass.
2. Lightly brush some cocoa powder on the glass using the brush.
3. Pull off a piece of tape large enough to cover the print, plus at least one inch on each end (total should be about three inches). You may use a ruler to measure the tape.

4. Place one end of the tape on the glass. Slowly begin pressing down the tape onto the slide using finger pressure. Note: try to avoid creating air bubbles under the glass.

5. Cut the tape from the roll and carefully, using the free end of the tape, remove the tape from the surface of the glass.

6. Mount the lifted print here:

PROCEDURE - PART 2:

1. Create a fingerprint card. Begin by filling out some of the information at the top of the card.

2. Roll your finger from left to right on the ink pad, making sure to cover as much surface of your fingertip as possible.

3. Place the print (also rolling left to right) in the corresponding location on the card. Repeat this for all 10 fingers.

4. Record your observations of loop, whorl, or arch for your print. Make sure to mark left or right hand.

FINGER	TYPE OF PRINT
THUMB	
INDEX	
MIDDLE	
RING	
LITTLE	

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ANALYSIS:

Figure 13

1. Why do investigators collect fingerprints?

2. What did you notice about your fingerprints?

3. What are some reasons that people may need to be fingerprinted?

ADDITIONAL RESEARCH

VISIBLE PROOFS: FORENSIC VIEWS OF THE BODY

INTRODUCTION:

Visit the website for the National Library of Medicine's past exhibit, *Visible Proofs: Forensic Views of the Body* at http://www.nlm.nih.gov/visibleproofs/education/index.html
Look for the Juan Vucetich case and types of technology used in forensics.
Perform the activities listed in the "Education" section.

ANALYSIS:

1. When were fingerprints first recognized as a unique individual identifier?

2. Where was the first use of fingerprint evidence and identification used in a murder case?

3. What does "AFIS" stand for?

4. What could be one problem with relying ONLY on fingerprints?

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TRAUMA IDENTIFICATION MEDICAL MUSEUM CASE #1862

Figure 14

TEAM:

INTRODUCTION:

You are a forensic anthropologist working with the Defense POW/MIA Accounting Agency and have been asked to create a biological profile for an unknown service member repatriated from the Vietnam War. You have already estimated the sex, age, and height of the individual. You also have patient records from the three possible decedents in the crash and eyewitness testimony from the survivor, Brinton. As part of the biological profile, you must determine if the individual had any antemortem trauma and probable cause of death.

MATERIALS:

Image of decedent's bone from the PowerPoint (starred)

Examples of bones with trauma from the PowerPoint

PROCEDURE:

1. Compare the unknown bone(s) with the bones showing examples of trauma. Record your observations:

BONE	DISEASE	FRACTURE	WOUND

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3. Compare the above findings to those of the three possible decedents.

DECEDENT	DISEASE	FRACTURE	WOUND
WOODWARD	NO	YES	NO
OTIS	YES	NO	YES
RUSSELL	NO	NO	NO

ANALYSIS:

1. What information can be observed by looking at bones with trauma?

2. Was there anything unique about the unknown individual's bones?

3. Did you observe any visible signs of trauma on the unknown service member's bones?

4. Which decedent did your observations match?

MICROSCOPIC ANALYSIS

TEAM:

INTRODUCTION:

You are working with the Trace Evidence Unit of the Federal Bureau of Investigation. You have collected various types of trace evidence from a crime scene. You must compare the evidence found to those of the suspects.

This activity is not part of the case study.

MATERIALS:

Compound microscope
6 collected hair samples
Unknown trace evidence slide
Tweezers
14 microscope slides

PROCEDURE:

1. Look at the color of hair sample **A**. Record your observations in the **Data Table A**.
2. Using the tweezers, place the hair sample on the glass slide. Cover the hair sample with a second slide (like a sandwich), so that it can be viewed under the microscope.
3. Place the slide under the microscope. Be sure to adjust the settings to give a sharp image of the hair.
4. Draw a picture of the hair sample in **Data Table A**.
5. Repeat steps 1-4 for the other hair samples.

DATA TABLE A:

SAMPLE	COLOR	DRAWING OF HAIR STRUCTURE

6. Look at the unknown sample under the microscope. Draw the unknown sample to the right. Compare this to your known samples.

ANALYSIS:

1. Were you able to see variations in color of the samples?

2. Were you able to see variations in structures of the samples?

3. What do you think the hair samples can tell you about the organism?

4. Did the unknown hair sample match any of the known samples? If so, which one?

5. How were you able to determine a match?

ADDITIONAL RESEARCH

REAL FORENSIC CASE STUDIES

Choose a book from the list below. These books can be found in your local library.

- *The Forensic Casebook: The Science of Crime Scene Investigation*, Ngaire E. Genge, 2002.
- *The Bone Detectives: How Forensic Anthropologists Solve Crimes and Uncover Mysteries of the Dead*, Donna M. Jackson and Charlie Fellenbaum, 1996.
- *Talking Bones: The Science of Forensic Anthropology (Facts on File Science Sourcebooks)*, Peggy Thomas, 1995.
- *Crime Scene: The Ultimate Guide to Forensic Science*, Richard Platt, 2003.

ANALYSIS:

1. List three things you learned from reading the book.

2. What was your favorite chapter/section of the book(s) and why?

3. What was your least favorite chapter/section of the book(s) and why?

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IDENTIFICATION REPORT
MEDICAL MUSEUM CASE #1862

Figure 15

TEAM:

INTRODUCTION:

You are the Scientific Director of the Defense POW/MIA Accounting Agency and you are tasked with compiling the information on the unknown service member. You have received scientific analysis of an unknown service member that was killed in a Huey helicopter crash in Cambodia. You must compile all of the evidence and determine the identity of the unknown service member. This report will be sent to the Service Casualty Office which will contact and explain the results to the family.

MATERIALS:

Decedent information
Autopsy data sheet

PROCEDURE:

1. Review the information in the identification data sheet and compare it to the information about the three possible decedents.

2. Compile your information and determine the identity of the unknown service member.

ANALYSIS:

1. Was there any material evidence collected at the crash site? If yes, please list.

2. What is the biological profile of the individual?

   Sex:

   Age:

   Height:

   Trauma:

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3. The unknown sample matched which mtDNA family reference sample, **Woodward, Otis,** or **Russell?**

4. The unknown dental sample matched which decedent's dental records, **Woodward, Otis,** or **Russell?**

5. Were fingerprints or trace evidence found with the remains?

6. From your observations and collected information, record the identity of the individual and explain your answer:

ADDITIONAL RESEARCH

VIETNAM VETERANS MEMORIAL – THE WALL

INTRODUCTION:

The Vietnam Veterans Memorial was built to honor the men and women who sacrificed their lives during the Vietnam War. Over 58,000 names of those killed or missing in action are etched onto the wall. The Wall was dedicated on November 13, 1982.

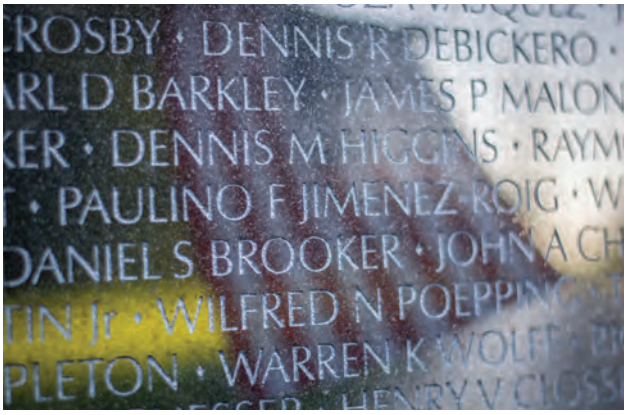

Figure 16

Figure 17

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PROCEDURE:

1. Visit the Vietnam Veterans Memorial in person:
   http://www.nps.gov/vive/planyour visit/index.htm
   Or the virtual Wall: http://thewall-usa.com/ or http://www.vvmf.org

2. Choose a name on the Wall and research this individual.

ANALYSIS:

1. What is the name of the individual?

2. What is the status of the individual: KIA (Killed in Action), MIA (Missing in Action), and/or POW (Prisoner of War)?

3. In what location of Vietnam or Cambodia was the individual KIA or MIA?

4. If the individual was KIA, were the remains returned to the family? If the individual was MIA, were their remains recovered, identified, and returned to the family?

5. Write a brief report on the information that you gathered from the research on the individual.

GLOSSARY

KEY CONCEPTS

ANTEMORTEM DATA:
Records of physical characteristics that a person is born with and which they acquire throughout life.

DPAA:
Defense POW/MIA Accounting Agency. DPAA's mission is to provide the fullest accounting for our missing personnel to their families and the nation.

EXCLUSION:
Identification results when postmortem data matches an individual's antemortem data to the exclusion of every other person (i.e. the comparison of data rules out the possibility that the remains are anyone other than the person identified).

FORENSIC IDENTIFICATION:
The application of science to establish personal identity, where the methods and results used can withstand scrutiny in a court of law. Every method of identification is based on a process of comparison of two data sets.

LINES OF EVIDENCE:
Scientific disciplines that contribute to identification and may include material evidence, fingerprinting, dentistry, anthropology, DNA, and pathology.

LOCARD'S EXCHANGE PRINCIPLE:
This principle states that when two objects come in contact with each other an exchange of materials occurs between them.

POSTMORTEM DATA:
An individual's physical characteristics recovered and recorded by scientists from a body's remains after death.

REPATRIATION:
To send back a person's remains to his/her own country.

RESOLVED:
A case is RESOLVED when (1) the American returns alive; (2) remains are recovered, repatriated, and identified, or (3) when there is convincing evidence that neither (1) nor (2) is possible.

GLOSSARY

SERVICE CASUALTY OFFICE:
Military Department that serves as a liaison for families concerning personnel recovery and accounting.

MATERIAL EVIDENCE

CASUALTY INCIDENT:
The event surrounding a soldier's death.

DECEDENT:
A general scientific term that refers to a deceased individual (a person that has died).

IDENTIFICATION TAG:
A tag worn by soldiers as a means of identification. These tags may include the name of the soldier, social security number, home address, and other important information. This is often called a "dog tag."

MATERIAL EVIDENCE:
All non-living items associated/found with the remains of a person.

ANTHROPOLOGY

ALLOMETRY:
The correlation of the size of a bone to a person's height.

BIOLOGICAL PROFILE:
The estimation of the skeleton's (or unidentified person's) age, sex, stature, ancestry, and any signs of trauma or pathology.

ENDOCHONDRAL OSSIFICATION:
The replacement of cartilage with bone.

EPIPHYSES:
The rounded end of the long bone, where growth plates are located.

FORENSIC ANTHROPOLOGY:
The field of science that analyzes the human skeleton to create biological profile for legal purposes.

GLOSSARY

MASS FATALITY INCIDENT:
An incident that has a high fatality count that local emergency personnel cannot handle on their own (ex: hurricanes, airplane crashes, acts of terrorism).

MEDICO-LEGAL:
The intersection of law and medicine in the process of making a scientific identification of human remains.

MINIMUM NUMBER OF INDIVIDUALS:
The total minimum number of individuals or people found among the remains or at an incident site.

OSTEOLOGY:
The study of the structure and function of the skeleton and bony structures.

POPULATION:
The collection of people or organisms of a particular species living in a given geographic area.

PUBIC SYMPHYSES:
The midline cartilage joint that joins the left and right pubic bones.

RETURN OF THE WORLD WAR II DEAD PROGRAM:
Post World War II program to recover, return, and identify the remains of World War II service members.

SEXUAL DIMORPHISM:
The differences between the sexes of the same species.

SKELETAL DEGENERATION:
Natural deterioration of the skeleton.

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GLOSSARY

DNA

AMPLIFICATION:

The process of making copies of a sample of DNA using an enzymatic reaction called the polymerase chain reaction (PCR) so that there is enough DNA to see for analysis.

ARMED FORCES REPOSITORY OF SPECIMEN SAMPLES FOR THE IDENTIFICATION OF REMAINS (AFRSSIR):

Since 1992 the Armed Forces Medical Examiners System has maintained a deep-freeze warehouse which contains blood cards for U.S. service members and reservists that can be used as a reference to establish identification.

DNA:

Deoxyribonucleic acid that is found in cells and can be analyzed to aid in the identification of human remains.

DNA SEQUENCE:

The succession of letters representing a structure of a strand of DNA, including a combination of the letters A, G, C and T (A= adenine, G=guanine, C=cytosine, T=thymine).

EXTRACTION:

The process of extracting DNA from a specimen. To extract DNA from bone, a technician cuts it into fragments, sands it clean, pulverizes it into a powder with a blender, and dissolves it in solutions to release the DNA.

GEL ELECTROPHORESIS:

The process of separating DNA fragments by size. Each base (A,G,T,C) is labeled with a dye. An electrical field forces the fragments to travel through a gel. The rate and distance at which the fragments travel depend on their size. After separation the DNA fragments can be viewed through an ultraviolet light.

ISOLATION:

The process of removing and purifying DNA that is extracted from specimens.

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GLOSSARY

JUNK DNA:
Also known as "spacers," the portion of a DNA sequence that has no known function. They often contain repeated sequences of nucleotides called Short Tandem Repeats (STRs). The STRs of a person can be compared to the STRs of their mother and father to establish identification.

MITOCHONDRION:
A round organelle within the cell but outside the nucleus, which produces energy for the cell. Mitochondria contain their own DNA that is different from nuclear DNA.

MITOCHONDRIAL DNA:
DNA found in mitochondria outside the cell nucleus. mtDNA is most commonly used in the identification of damaged or older skeletal remains.

NUCLEAR DNA:
DNA found in the nucleus of human cells, consisting of long strings of the nucleotides A, C, T, and G.

NUCLEOTIDE:
The structural units of DNA, including the bases adenine, guanine, cytosine, and thymine.

POLYMERASE CHAIN REACTION (PCR):
The process through which DNA is "amplified" or copied using an enzymatic reaction so that there is enough DNA available for analysis.

REFERENCE MATERIALS:
Items such as blood cards, cheek (buccal) swabs, or samples from family members that can be compared to samples from human remains to establish identity.

SHORT TANDEM REPEATS:
A short tandem repeat in DNA occurs when a pattern of two or more nucleotides (AGTC) are repeated and the repeated sequences are directly adjacent to each other. By examining enough STR loci and counting how many repeats of a specific STR sequence there are at a given locus, it is possible to create a unique genetic profile of an individual.

VISUALIZATION:
The process of analyzing or viewing DNA after it has been processed through electrophoresis.

GLOSSARY

DENTAL

ANTERIOR TEETH:
Incisors and canines, designed for biting and tearing.

CARIES:
Cavity or decay.

DENTITION:
The development of teeth and their arrangement in the mouth.

DISTAL:
Away from the midline.

ENDODONTICS:
The sub-field of dentistry that deals with the tooth pulp and the tissue surrounding the root—endodontists specialize in root canals.

FACIAL:
Surface toward the cheek or lips.

INCISAL:
Biting edge of the front teeth (canine and incisor).

LINGUAL:
Surface toward the tongue.

MANDIBLE:
The mandible or "jawbone" is the strongest bone of the face. It forms the lower jaw and holds the teeth in place.

MAXILLA:
The bones that form the upper jaw.

MESIAL:
Toward the midline of the mouth.

OCCLUSAL:
The biting surface of the posterior teeth.

GLOSSARY

POSTERIOR TEETH:
Molars and premolars, used for grinding and chewing.

RADIOGRAPH:
X-ray image.

WINID:
A postmortem identification software that facilitiates the comparison of multiple antemortem dental records to postmortem charts made from recovered remains. This software also includes the use of digital radiographs.

FINGERPRINTS

FRICTION RIDGES:
Contours in the skin's surface of the palms or soles of the feet that allow for better gripping action as a result of friction.

FRICTION SKIN:
Areas of the skin that contain friction ridges.

RIDGE FLOW:
The flow or pattern of the friction ridges on the skin.

MINUTIAE:
Points of interest in a fingerprint, such as bifurcations (a ridge splitting into two) and ridge endings.

ACE-V:
The acronym for the scientific methodology used to analyze fingerprints (analysis, comparison, evaluation and verification).

AFMES:
The Armed Forces Medical Examiner. AFMES is the center of medical-legal investigations for the Defense Health Agency, and is responsible for determining the cause and manner of death for all active duty members who die within federal jurisdiction, as well as for identifying the deceased.

FINGERPRINT KIT:
A portable kit used to retrieve fingerprints from an individual or an object

LINKS

All About Forensic Science:
http://www.all-about-forensic-science.com/

AFMES: Armed Forces Medical Examiner
http://www.health.mil/afmes

DNA Information:
http://www.dnai.org/

DPAA: Defense POW/MIA Accounting Agency:
http://www.dpaa.mil

FBI: Federal Bureau of Investigation
https://www.fbi.gov/

NMHM: National Museum of Health and Medicine
https://www.medicalmuseum.health.mil

Vietnam Veterans Memorial
http://www.nps.gov/vive/planyourvisit/index.htm

VVMF: Vietnam Veterans Memorial Fund
http://www.vvmf.org/

Virtual Wall:
http://www.thewall-usa.com/

Visible Proofs:
https://www.nlm.nih.gov/exhibition/visibleproofs/index.html

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SUGGESTED READINGS

- *Criminalistics: An Introduction to Forensic Science*, Richard Saferstein, 2011.
- *Crime Scene: The Ultimate Guide to Forensic Science*, Richard Platt, 2003.
- *The Bone Detectives: How Forensic Anthropologists Solve Crimes and Uncover Mysteries of the Dead*, Donna M. Jackson and Charlie Fellenbaum, 1996.
- *The Forensic Casebook: The Science of Crime Scene Investigation*, Ngaire E. Genge, 2002.
- *Forensic Science (DK Eyewitness Books),* Chris Cooper, 2008.
- *Talking Bones: The Science of Forensic Anthropology (Facts on File Science Sourcebooks)*, Peggy Thomas, 1995.

DISCLAIMER:
These links are suggested by the author and are not the opinion or suggested by the Department of Defense or the National Museum of Health and Medicine.

IMAGE CAPTIONS

Figure 1: Map of Cambodia from the CIA World Factbook. https://www.cia.gov/library/publications/resources/the-world-factbook/geos/cb.html. June 18, 2020.

Figure 2: UH-1H Medevac Helicopter. Vietnam War. (Swan Vietnam Slides, 130-3).

Figure 3: Burial of war dead in a temporary overseas cemetery. Korean War. (Courtesy of Quartermaster Corps Museum).

Figure 4: Material evidence on a tray in the Material Evidence Lab at Offutt Air Force Base, Nebraska. Nov. 13, 2017. The evidence is recovered from areas where past U.S. conflicts occurred. (U.S. Air Force photo by Josh Plueger).

Figure 5: Tail numbers and serial numbers from aircraft wreckage used to research possible decedents. (Courtesy of the Office of the Armed Forces Medical Examiners System).

Figure 6: Two U.S. physicians measuring the length of a bone. 1950s. (Courtesy of the Becker Archives, Washington University).

Figure 7: Osteometric Board used by Dr. Ellis Kerley at the Central Identification Lab Hawaii (now the Defense POW/MIA Accounting Agency). 1950s. (NMHM 2009.0004).

Figure 8: Illustration of DNA. https://ghr.nlm.nig.gov/handbook/basics/dna. July 17, 2013.

Figure 9: Periapical radiograph. (Courtesy of Patricia Scharf).

Figure 10: Tooth chart being used to identify remains. Strasbourg, France. 1945-1947. (Courtesy of the National Archives Records Administration).

Figure 11: Patients in dental chairs at the 20th General Hospital dental clinic. India. World War II. (MAMAS A43 16-2).

Figure 12: Students learn how to use the Crossmatch 300, a fingerprint scanning device part of a biometrics automated toolset, during a three-day class on biometrics. The U.S. Army utliizes biometrics to identify enemies by using unique identifying features: fingerprints, irises, and facial features. (Photo by Staff Sgt. Lewis Hilburn, 20th Public Affairs Detachment. March 7, 2012).

Figure 13: Collection of postmortem fingerprints from the wars in Iraq and Afghanistan. 2000s. (Courtesy of the Office of the Armed Forces Medical Examiners System).

Figure 14: Burial services for men of the 33rd Division. Boi Dechaume, southeast of Sivry-Sur-Meuse, Meuse, France. World War I. (Reeve 13507).

Figure 15: Sgt. Gary Redlinski, Mortuary Supervisor, inspects an ID card and fingerprint chart of a deceased individual. Saigon, Vietnam. June 1969. (Courtesy of the National Archives Records Administration).

Figure 16: The American flag is reflected in some of the 58,307 names etched into “The Wall” of the Vietnam Veterans Memorial in Washington D.C. July 22, 2015. (U.S. Army photo by Sgt. Ken Scar).

Figure 17: Some of the 58, 307 names etched into “The Wall” of the Vietnam Veterans Memorial in Washington D.C. seem to disappear into a vanishing point looking toward the Washington Monument as the sun rises. July 22, 2015. (U.S. Army photo by Sgt. Ken Scar).

NOTES

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