

Body of Evidence

Adapted from an activity © 2014 Texas Instruments

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Objectives

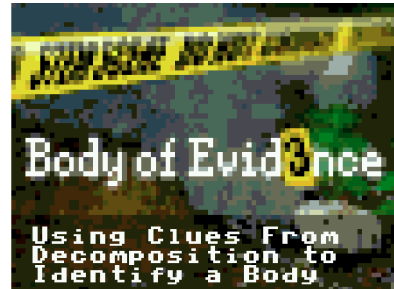
- Students will analyze forensic clues in a story to infer the identity of a decomposing body.
- Students will interpret histogram plots to deduce the correct missing person.
- Students will understand the relationships between temperature, humidity, and decomposition rate.

Vocabulary

- | | |
|---------------------------|---------------------------------|
| • Decomposition | • Humidity |
| • Stages of decomposition | • Arid |
| • Scavengers | • Temperature |
| • Blow fly lifecycles | • Postmortem interval (PMI) |
| • Maggot | • Accumulated Degree Days (ADD) |
| • Larvae | • Total Body Score (TBS) |
| • Pupa/pupate | • Forensic pathologist |
| • Mummification | |
| • Forensic anthropologist | |
| • Forensic entomologist | |

About the Lesson

- The lesson follows a fictitious scenario about a dead body found in a field. There are four missing persons that fit the description. Students must use data and clues from the story to determine the correct missing person.
- This lesson introduces the concepts of decomposition and decomposition rates. It explores how temperature, humidity, and other environmental factors affect decomposition as well as how forensic anthropologists use this information to determine postmortem interval.
- Teaching time: one to two 45-minute class period(s)
- As a result, students will:
 - Interpret graphs to make inferences.
 - Use simulations to understand the decomposition process.



What Page Am I On?

When you see the ? (question mark) symbol above **GRAPH** key, you can press it to find out what page you're on.

Tech Tips

- This activity includes screen captures taken using jsTifed, a calculator emulator that runs in your browser (<http://cemete.ch/emu>)
- This lesson applies only to the TI-84 Plus C Silver Edition.
- The activity requires about 7KB of RAM to run. If students encounter ERR: MEMORY, they should use Doors CSE or the Mem menu to delete programs and variables or move them to the Archive.



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Lesson Files

- Student Activity: Body_of_Evidence_Student.pdf
- Teacher Notes: Body_of_Evidence_Teacher.pdf (this document)
- BODYEVDC.8xp and BOETD.8xv: Activity program files. Must be sent to handheld's Archive.
- Doors CSE 8.1, which provides necessary extra program functionality. *(Not included: download at <http://dcs.cemetech.net>).*

Send files to your TI-84 Plus C Silver Edition

Using TI-Connect 4.0 or higher, or a TI-84 Plus C Silver Edition calculator that already has this activity, send the program BODYEVDC (BODYEVDC.8xp) and the AppVar BOETD (BOETD.8xv) to your TI-84 Plus C Silver Edition. Both files should go to your calculator's Archive.

- **Using TI-Connect:** Open TI DeviceExplorer and select your calculator. Drag BODYEVDC.8xp into the item labeled "Flash/Archive" and wait for the transfer to complete. Drag BOETD.8xv into "Flash/Archive" as well.
- **From another calculator:** Put the receiving calculator in Receive mode by pressing **2nd** **XTN** **▶** **ENTER**. On the sending calculator, go to the Link menu with **2nd** **XTN**, choose 2: All-..., then find "BODYEVDC PRGM" and "BOETD AVAR" and press **ENTER** next to each one. Each one should be marked with a square, indicating that it will be sent. Press **▶** **ENTER** to send the files over.

You will also need Doors CSE 8.1 or higher, which can be found at <http://dcs.cemetech.net>. The process of sending Doors CSE to your calculator is the same as above, and is also detailed in the Doors CSE readme document.

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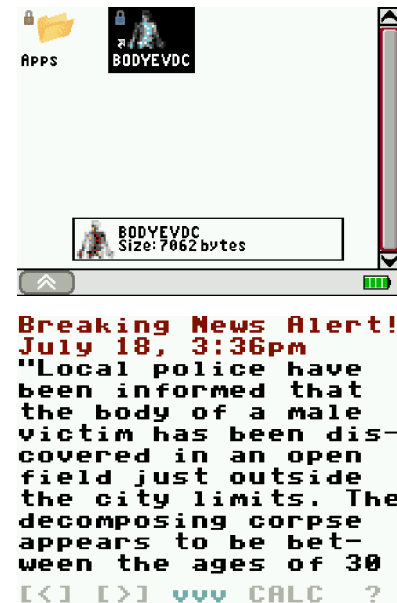
Discussion Points and Possible Answers

STEM CAREER – In this activity, the student will portray a forensic anthropologist who is called to the scene of a dead body. The student must use the stages of decomposition, data from the simulation, and information within the scenario to infer the identity of the dead body. References to related careers of forensic pathology and forensic entomology are also part of the lesson.

SIMULATION - This particular activity starts with a simulation of the decomposition process. Students can manipulate the humidity and temperature in an environment to observe the effects of these variables on the rate of decomposition. Data are collected and displayed in various graphs. They will also explore the amount of blowflies, maggots, and odor throughout the various stages of decomposition. Students can use this information to make decisions about the correct missing person.

Run the BODYEVDC program; move to pages 2-4.

1. Run Doors CSE 8 from the Apps menu of your calculator, select BODYEVDC, and run the program. You should see the Body of Evidence title screen. Throughout the Body of Evidence activity, you can press the arrow keys (◀ ▶) to move between pages, or **ENTER** to advance to the next page.
2. On a text page, press the ▼ and ▲ arrows to scroll down and up, and **ZOOM** or **ENTE** to scroll down.
3. Students are introduced to a fictitious scenario of a dead body found in a field. The student plays the role of a forensic anthropologist who is called to the scene to investigate.
4. As students go through these pages, they learn about the five stages of decomposition, and they will use this information to later identify the victim. Discuss with students that once Stage 5 “Dry Decay” is reached, the skeleton will remain in this condition unless disturbed. Over time, the skeleton may become fossilized.



Move to pages 5.

Have students answer question 1 on the activity sheet.

- Q1. Based on what you've read so far, match the following terms-**skeleton, insects, cause of death** to the following occupations-**forensic anthropologist, forensic pathologist, forensic entomologist** in the space below.

Answer: forensic anthropologist – skeleton, forensic pathologist – cause of death, forensic entomologist - insects.

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Move to pages 6-9.

5. Page 8 introduces a concept called postmortem interval (PMI), which is the amount of time that has passed since the person's death.

As you are examining the body, a nearby officer notices and comes over...
 Officer: "What are you both doing?"
 You: "There are 5 stages of decomposition. We are determining which of the stages this body has gone through."
 [<] [>] vvv CALC ?

6. On page 9, students will notice images of four missing persons that have been identified as possible matches to the victim. The dates on which each person went missing are very important to this case. Students will determine the PMI from evidence offered through local weather conditions and the stages of decomposition, and then they will compare the PMI to the amount of time each person has been missing to identify the victim.



Move to pages 10 and 11.

Have students answer questions 2-3 on the activity sheet.

- Q2. What information will be necessary to determine which of the four missing persons the body may belong to? Check all that apply.

Answer: A. average daily temperature and humidity, B. current stage of decomposition, C. dates that each person went missing and number of days that have passed

- Q3. The decomposition rate of a body depends on many factors, including the air temperature. Check all that may also play a role in the rate of decomposition.

Answer: A. humidity of the air, C. how much of the skin is exposed, D. the presence of scavengers in the area

Move to pages 12-15.

7. Page 12 sets the students up to run a simulation on page 13, where they'll explore the effects of temperature and humidity on the rate of decomposition.

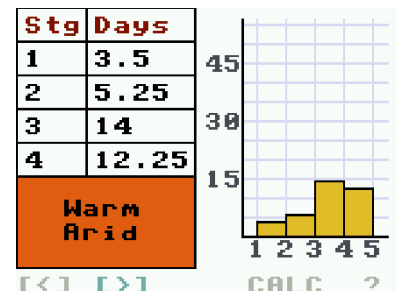
As you explain decomposition to the officer, you pull out your tablet to demonstrate the five stages of decomposition with a simple simulation. Explore the next page to see how temperature and humidity affect the
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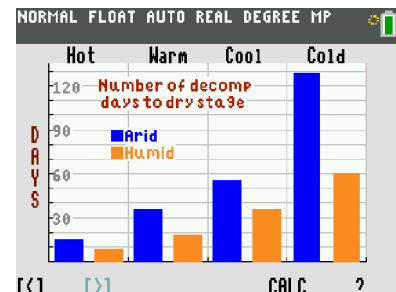
8. In the simulation on page 13, students can change the temperature and humidity in an environment. They should try all of these combinations to get a sense of how temperature and humidity play a role in the decomposition rate. Students will see blow flies, maggots, and odor represented since these characteristics are important in identifying the correct stage of decomposition.



9. Page 14 shows data generated based on the simulation. The data show the number of days it takes the body to decompose to each stage based on the settings of the simulation. This information will be important to the investigation of the case.



10. The chart on page 15 shows the number of decomposition days until reaching the dry stage (stage 5) for each temperature and humidity setting.



Move to pages 16-24.

Have students answer questions 4-11 on the activity sheet.

Q4. What environmental conditions were present where this body was found?

Answer: B. warm and humid

Q5. Based on what you have seen in the simulation and graphs, what can you conclude about the relationship between decomposition and temperature?

Answer: B. Temperature and decomposition rate are directly related.

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Q6. What likely happened to the fingers and ribs?

Answer: B. Scavengers, such as coyotes, ate them.



Q7. Based on body position and which parts are clothed or protected from the elements, which of the following statements would you predict is true?

Answer: A. Different parts of the body could decompose at different rates.

Q8. Think about the "big picture" of the cycle of life and death in the environment. Although maggots may be disgusting to many people, they serve a very important purpose. What is their role (niche) in the environment?

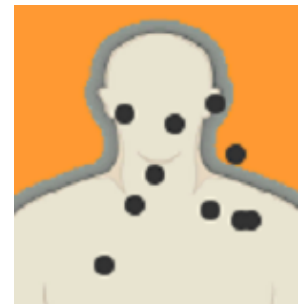
Sample Answer: Maggots help break down animal tissue and return the nutrients to the soil.

Q9. Because the blow fly lifecycle (egg, larva, pupa, adult) is so consistent with the various decomposition stages of a human, it is a reliable data source for investigators to determine PMI of the deceased.

Answer: A. true

Q10. Blowflies tend to lay their eggs in the eyes, nostrils, mouth, and open wounds of dead bodies. Why is this?

Sample Answer: Blowflies will look for areas of the body that offer the most moisture and softest tissues. When the eggs hatch, the maggots will feed on the soft tissue and work their way into the other parts of the body.



Q11. Occasionally, incredibly well-preserved, mummified, remains of mammals (such as mammoths or humans) are found in areas that have varying temperatures. How is it possible that you can find mummified animals or humans in hot or warm climates?

Sample Answer: Evaporation of bodily fluids will happen much more quickly in hot arid or semi-arid locations. Because the fluid in the body evaporates so quickly, many of the chemical reactions and blow fly activity will greatly decrease. This will leave the skin and

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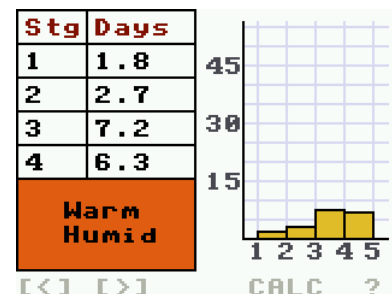
muscle tissue preserved. There have been mummified bodies from hundreds and even thousands of years ago that are well preserved.

Move to pages 25-32.

11. Students will now move into the portion of the activity where they are asked to solve the case and identify the correct missing person. They will set the simulation to the correct conditions based on the clues in the case (warm, humid). They will then run the simulation where they should realize that the body is at active decay stage 1.



12. Students should take the data from the graph on page 27 for stage 3 to determine the PMI. Since the body was found on July 18th, (see page 2), the students can determine PMI and identify the correct missing person.



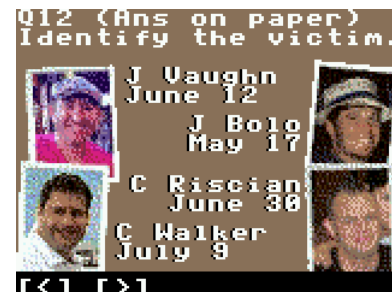
13. Page 29 is a summary of information students could gather from the case.

Q12. Identify the correct missing person.

Answer: B. Cy Walker – July 9th. The body was found on July 18th. The body was found to be in active decay stage 1 during a warm and humid summer. Students should see that the body was at stage 3 (active decay stage 1) for 7.2 days.

Since the body had to go through stages 1 and 2 before it got to stage 3, they should add the total days up to stage 3. They will add 1.8 (stage 1) + 2.7 (stage 2) + 7.2 (stage 3) = 11.7 days. Since there is variability in stage 3, they should consider the beginning part of stage 3 as starting at the end of day 4.5 and moving into stage 4 on day 11.7.

So, July 18th (date body was found) – 11.7 days (12 days) = July 6th (the earliest date the person died). To determine the latest the body died you would take July 18th – 4.5 (5 days) = July 13th. At this point, students should see that the time of death is estimated to be between July 6th to July 13th. The only missing person that falls in that range is Cy Walker.



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Q13. To determine identity in this case, you used the PMI from recent weather and dates from a missing persons report. What are some other ways to determine identification? Choose all that apply.

Answer: A. markers on the skeleton, such as healed injuries compared to medical records, B. DNA markers, C. clues at the scene such as clothing & tattoos, D. dental records

14. The activity concludes with page 2.9 congratulating the student on determining the identity of the victim. A further explanation gives background on the cause of death and the importance forensic anthropologists can play in helping people identify their loved ones.

Congratulations!
Your efforts identi-
fied the decomposing
body. Later in your
investigation you
find trauma to the
head, which was
resting next to a
large rock. An ex-
posed root was near
his feet. You infer
that Cy Walker was
[<] [>] vvv CALC ?

Move to pages 33-40: Extension Questions & Background Notes (Optional)

Further background information is available starting on page 33, which deals with some more advanced topics in forensic anthropology. Questions that are a bit more challenging are also located here.

EQ1. What would happen if a dead body were wrapped in a sheet or a tarp or some other material? Defend your answer.

Sample Answer: It would decompose more slowly because if the body is wrapped tightly, it would be hard for the blow flies to lay eggs. The bacterial activity would still occur as this happens from the inside of the body and is the main cause of bloating. However, after the body releases the gases and begins to flatten, it would likely stay in stage 3 and 4 for a while. Humidity would still affect a body even tightly wrapped but it would likely decompose more slowly if blow flies are not able to penetrate the wrap.

EQ2. A body has been found in "The Bloat Stage" of decomposition. What are some things that might be done at this point to determine the actual identity of the victim?

Sample Answer: Answers may vary but at this stage it is possible that the victim will still have a good amount of tissue remaining. Identifying features such as scars and tattoos should be visible. The face, although discolored, should also be identifiable. Investigators will also consider DNA tests, fingerprints and dental records.

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EQ3. Why do dead organisms undergo decomposition but living organisms do not?

Sample Answer: In order for living organisms to remain living they must have a constant input of energy to their cells. As soon as the energy is removed, entropy takes over and the system starts to become more random, chaotic, and disorganized. In the case of a dead organism, the nutrients are released back into the environment through a series of chemical reactions and mechanical digestive from decomposers and scavengers.

Background Notes:

- **Accumulated Degree Days** - In this case, the PMI is fictitious since the case is not real. In fact, although forensic anthropologists use temperature, humidity, and other factors to determine PMI, they also use a concept called Accumulated Degree Days (ADD), which is the sum of the average temperatures for each day the person has been dead. They determine ADD and eventually PMI by first starting with Total Body Score (TBS). TBS is determined by giving each section of the body a score (often different scores) that relates to a stage of decomposition. The TBS is used to determine ADD, which is then used to determine PMI.
- **Bones Tell a Story** - Although this case was fictitious, in reality forensic anthropologists spend a large amount of time studying the bones of corpses found in many different places. The information from these bones can help determine a person's sex, approximate age, approximate stature, ancestry, previously healed fractures, evidence of infection, and many other characteristics.
- **Mummification** - One of the conditions of a body not called out in this activity is the process of mummification. Typically in arid climates, a body never fully decomposes. Instead, it rapidly dries out, losing so much moisture that blow flies may not lay their eggs in the tissue. Skin and muscle are preserved, leaving a mummified body typically "stuck" in stages 3 or 4 of decomposition for months, years, or even hundreds of thousands of years.

Wrap-Up

A great follow-up discussion for this activity could refer to the possibility that the missing person may not have died soon after they went missing, thus introducing the possibility that Cy Walker was not the correct missing person. You could also consider discussing other variables such as whether a body was kept in cold storage prior to being dumped in a field. How would that have affected the outcome of this case?

Assessment

- Students can create a labeled timeline of events that took place from the time the body went missing to the time it was found. Students should show calculations and explain the reasoning for each stage of the timeline.

Image Credits: Adapted from work by Texas Instruments. See readme.txt for acknowledgements.