Forensic Investigation Research Station

Technical Manual Series

Maceration

FIRS Technical Manual 2
Third Edition

Forensic Investigation Research Station
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Forensic Investigation Research Station (FIRS) Maceration Protocol

FIRS Donors are critical to research far beyond the data they provide in the outdoor research facility. All FIRS Donors provide our facility with *in vivo* biological data (e.g. age, sex, weight, ancestry, trauma, pathology, etc.) and agree to the curation of their skeleton by our facility for education and research purposes. All Donors are collected at the end of the decomposition event and macerated in our wet laboratory, followed by photography, and skeletal analysis. Analysts come from across the United States to use this collection for osteological training and research. The data potential of a remains is limited to the quality of the biological material, making maceration one of the most critical tasks performed at FIRS. Skeletal elements may be altered by age, pathology, trauma, and taphonomic processes, making every maceration unique. This manual provides instruction on warm water maceration protocols using an incubator, slow cookers, pressure cookers, and pots. If employed properly, all these tools can be effective and lead to clean skeletons suitable for curation. The attached protocol provides general direction in the policy and procedure for soft tissue removal however, the condition of the skeleton will ultimately dictate the methods used.

Initial tissue removal and disarticulation

When a body is first brought in, soil, insects, pupal casings, and plant material may adhere to it, and desiccated tissue, residual brain tissue, and decomposition fluid remain in addition to the bones. Appropriate personal protection equipment (PPE) is critical in this stage. Those performing initial maceration are required to wear**:**

- Scrubs
- Disposable lab coat or plastic apron with Tyvek sleeves
- Extended cuff nitrile gloves
- Designated maceration shoes (rubber, bleachable) or Tyvek booties
- Surgical mask
- Face shield/lab glasses (optional)

Figure 1: Standard maceration attire for first cleaning (PPE)

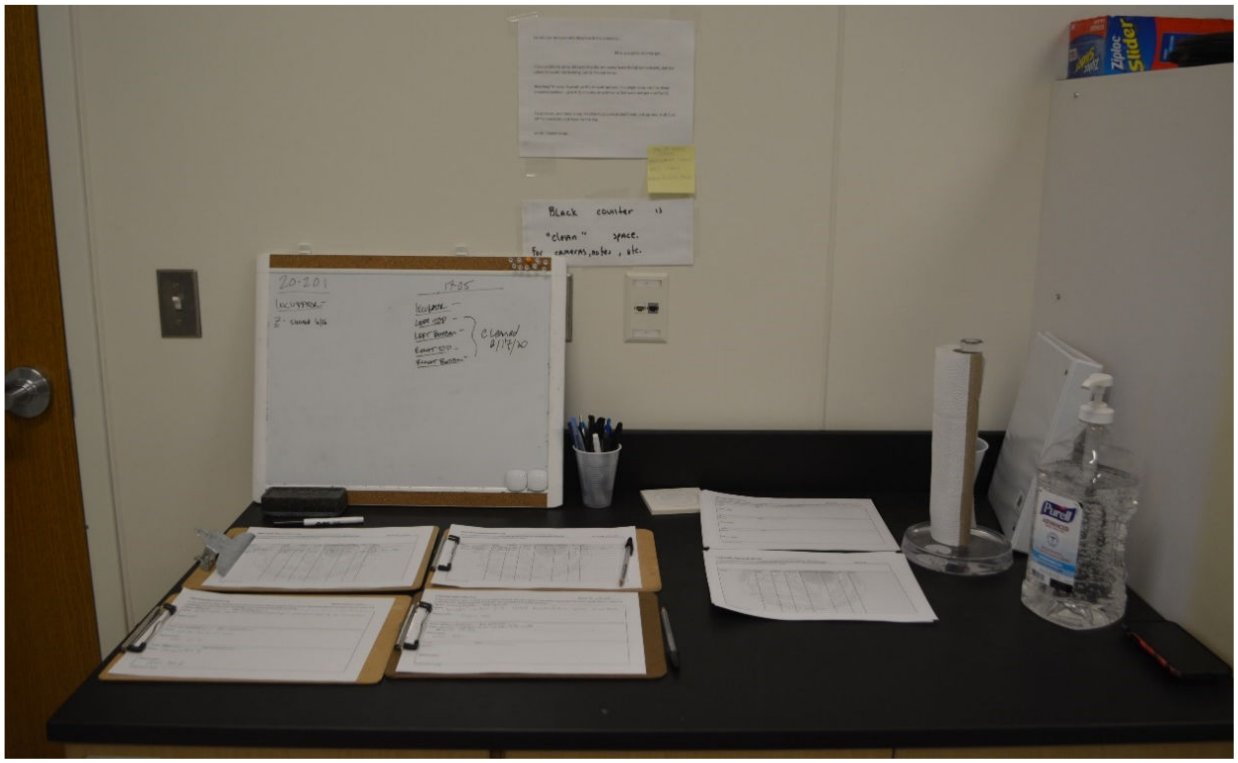
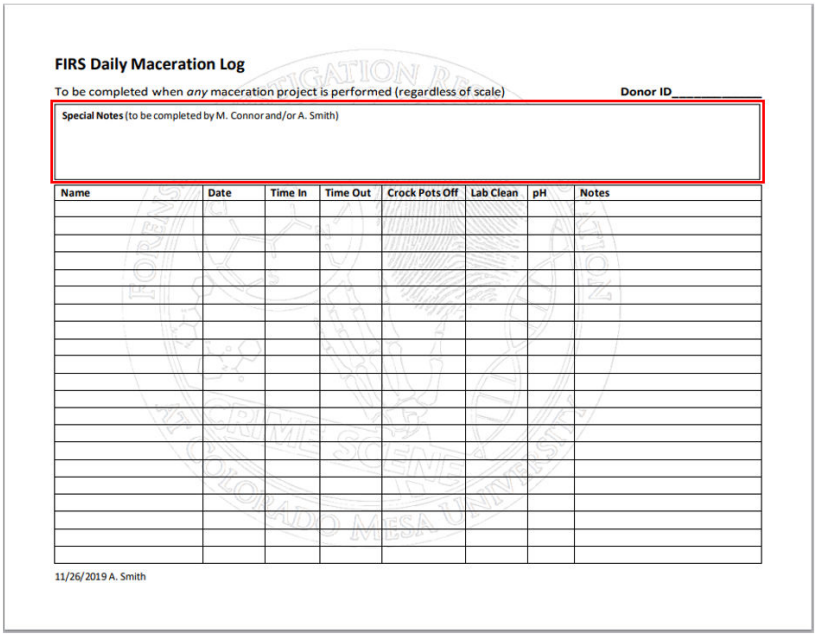


Figure 2: Clean counter with maceration logs and personal items.

1. Before beginning maceration, put on protective gear and place personal items on a 'clean' counter.
2. Begin a new maceration log for each body. This log is composed of three parts: (a) A daily sign-in/sign-out form; (b) a daily log; and (c) a whiteboard:
    a. Sign-in/sign-out: Sign in/out of the lab to document all maceration activities. This ensures that every action preformed in the lab, regardless of scale, is recorded in case questions arise later.
        i. Each maceration has parameters placed on it by the condition of the bones (e.g., chemicals that can/cannot be used, temperature maximums, etc.).
        ii. Use the box at the top of the sign-in sheet to note these general guidelines (Figure 3, indicated in red); refer to this box before beginning any maceration task.



FIRS Daily Maceration Log

To be completed when *any* maceration project is performed (regardless of scale) Donor ID_____

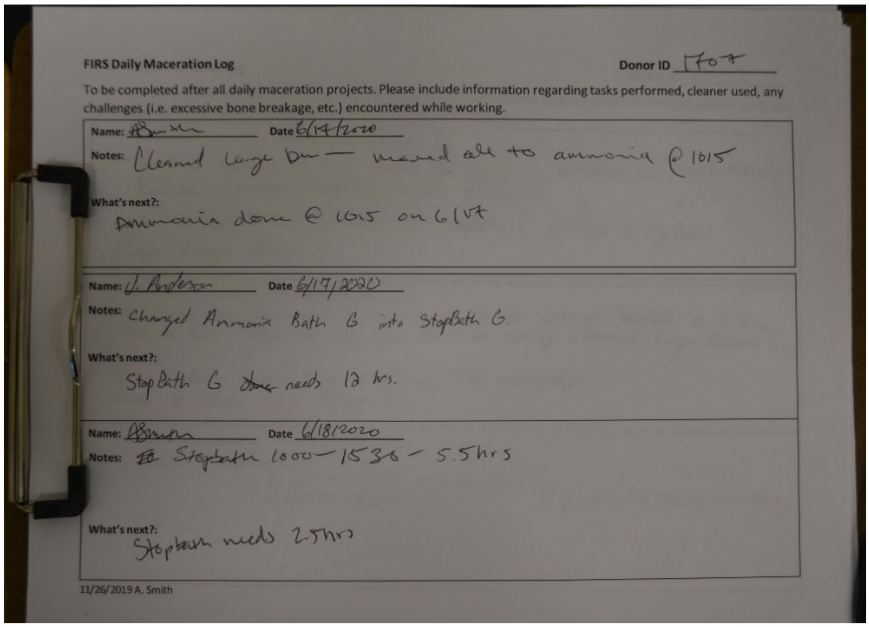
Special Notes (to be completed by M. Connor and/or A. Smith)

Name	Date	Time In	Time Out	Crock Pots Off	Lab Clean	pH	Notes

11/26/2019 A. Smith

Figure 3: Maceration sign-in/sign-out log; special notes section indicated in red.

b. The daily log (Figure 4) should be completed at the end of maceration activities. Make sure the Donor ID and date are recorded. Include a brief description of all activities performed and an explanation of the current state of the lab (e.g., if bones are removed from water, why – and where were they placed? Was the water in the slow cookers changed - what cleaner do they contain?). End with a sentence as to what needs to be done next, so that the next person knows where to pick up the process. Anyone entering the lab should know exactly what is going on after reading the log.



FIRS Daily Maceration Log Donor ID 170-7

To be completed after all daily maceration projects. Please include information regarding tasks performed, cleaner used, any challenges (i.e. excessive bone breakage, etc.) encountered while working.

Name: [redacted] Date 6/17/2020

Notes: Cleaned large bin — moved all to ammonia @ 1615

What's next?: Ammonia done @ 1615 on 6/17

Name: L Anderson Date 6/17/2020

Notes: Changed Ammonia Bath G into StopBath G.

What's next?: StopBath G done needs 12 hrs.

Name: [redacted] Date 6/18/2020

Notes: StopBath 1000 — 1530 — 5.5hrs

What's next?: Stopbath needs 2.5hrs

11/26/2019 A. Smith

Figure 4: Daily maceration log with sample notes

c. A whiteboard (Figure 5) is helpful to show a summary of everything happening in the lab. All active pots, pans, and bins are listed on the board. For everything in the cleaning stage (pre-ammonia bath), list the most recent date the pot/pan/bin was cleaned. For ammonia baths, the time and date the ammonia bath will be finished is listed. For stop baths, the time remaining is listed. Check the white board at the beginning of each maceration day to see what needs cleaning. For a more detailed report of maceration activities, check the daily log.

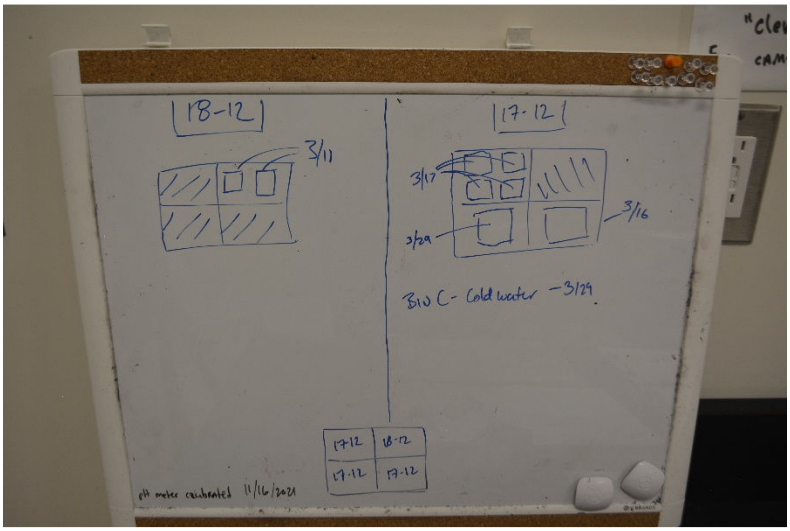


Figure 5: The whiteboard listing all active pans and most recent clean date.

3. Once all logs are prepped and in place, begin body preparation. Depending on intake conditions, the donor will be contained in a body bag, or a series of plastic bins.
    a. **Body bag:** Place the body bag a gurney or lab table in the maceration lab. Unzip the bag so that the entire remain is visible and the state of disarticulation can be assessed.
        i. Begin by removing any loose bones or limbs.
        ii. Limbs attached to the trunk by desiccated tissue will have to be removed using more invasive techniques, these may include:
            1. EMT scissors to carefully cut desiccated tissue
            2. Dissection scissors
        iii. Scissors should only be used by individuals who have completed advanced courses in human anatomy and osteology. Individuals uncomfortable or unfamiliar with anatomical landmarks should never use invasive techniques.
            1. Never use invasive techniques in the wrist or ankle joint capsules.
        iv. Remove as much flesh from the body as possible by hand, taking care not to damage the bone. If the flesh does not come off and there is a risk of damaging the bone, do not continue trying to remove it.

v. Once a body has been disarticulated, assess items for size and tissue content. If possible, place all elements in pans in the incubator. If not, items that are small enough can be placed in slow cookers, larger items will be cold soaked or boiled on commercial hot plates.

b. Plastic bins

i. If a preliminary disarticulation was performed in the field, then the remains will be moved to the lab in the plastic bins.
ii. Repeat the steps above to prepare individual bones and/or limbs for tissue removal.

4. When disarticulation is complete bones can be prepared for heat treatment. The primary method used at the FIRS is the incubator. Secondary methods include: slow cookers/pressure cookers (smaller elements such as hands/feet, vertebrae, ribs), boiling on commercial hotplates (long bones), and cold soaking (os coxae, or taphonomically or pathologically compromised bone).

a. Incubator

i. Separate hands and feet, placing each one in a *separate* pan; each pan should have only one hand or foot. This prevents mixing the phalanges during maceration.
    1. Contain all elements of a given hand or foot in a mesh bag.
ii. Fill the pan leaving 1-2" at the top (enough space to carry the bin to the incubator), adding approximately 2 tablespoons of dish soap and 1 tablespoon of meat tenderizer.
    1. If elements in the pot are particularly fragile, omit the meat tenderizer.
iii. Cover pans with aluminum foil or lids and place them in the incubator ensuring all doors are fully closed (Figure 6).
iv. Keep the incubatory set to 65 degrees Celsius. *Do not unplug or turn off the incubator* until the entire maceration is completed and there is nothing left in the incubator.
    1. Lower temperatures should be used for especially fragile bone or juvenile bones.

Figure 6: The incubator, with pans covered with aluminum foil and set to 65 Celsius.

b. Slow Cookers

i. Separate the hands and feet, placing each one into a *separate* slow cooker; each slow cooker should contain only one hand or foot.
   1. Label the pots according to element (hand/foot) and side
   2. Do not mix the contents of the pots throughout the duration of maceration.

ii. Fill the slow cooker 2/3 of the way with water and add approximately 1 tablespoon of dish soap and 1 teaspoon of meat tenderizer.

iii. Do *not* lock the clasps on top of the pot

iv. Plug in and turn on the slow cooker. Refer to the maceration notes to determine the appropriate heat level.
   1. As a general rule, slow cooker temperatures should be set as follows:
      a. Hands/feet (Carpals, metacarpals, phalanges): High
      b. Long bones: Medium
      c. Skull, hyoid, tracheal cartilage, vertebrae, ribs, sacrum: Low
      d. Os coxae: If disarticulated: Low; if articulated, cold soak only

v. *Note:* The pressure cookers may be used as per the above instructions with some adjustments:
   1. The lid should be fully sealed and locked in place (Figure 7).
   2. There are far more settings available on the pressure cooker, as a general rule use the “Slow Cook” setting (Figure 7). The heat can be adjusted by pressing the slow cook button multiple times. Set the heat to Low.
   3. Clean elements or change water after each 4-hour slow cook.

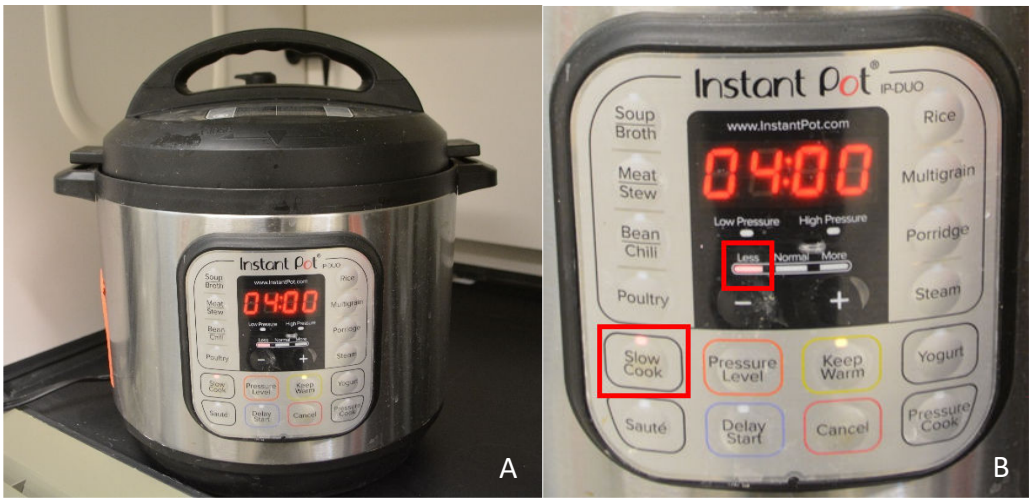


Figure 7: Left: The pressure cooker with the lid locked in place. Right: Put the pressure cooker on slow cook, low heat.

c. Boiling on commercial hotplates

i. Place a large empty pot onto a hot plate
ii. Use the hose to fill the pot approximately ¾ full of water.
iii. Turn on heat to medium high.
iv. Find the correct strainer for the pot and arrange long bones inside; it is not unusual for bones to stick up over the water level (Figure 8).
v. Submerge the strainer full of bones in the pot.
vi. Use the hose to fill the remainder of the pot so that the strainer is fully submerged.
vii. Add about 1 tablespoon of dish soap and 1 teaspoon of meat tenderizer.
viii. Clip the thermometer to the edge of the pot, so that the length of it is submerged in the water between the pot and the colander.
ix. Monitor the temperature as the water heats (it may take up to one hour); **water temperatures should never exceed 180º F**
    1. The temperature may need to be lower for more fragile bones, refer to maceration log notes.
x. When heating is complete, turn the hotplate off and place an empty plastic bin parallel to the hotplate.
xi. Use heat resistant, rubber oven gloves to grip the colander handle and remove it from the pot.
xii. Place the colander in the plastic bin and transport it to the sink.
xiii. Remove the colander from the bin and place it in the sink.
xiv. Allow bones to cool before attempting to handle or performing any mechanical tissue removal.

Figure 8: Boling pot and strainer; fill the strainer with long bones prior to submersion in the pot.

d. Cold water soak

i. Place the body parts (pelvis, vertebrae, and ribs) into separate plastic bins (Figure 9)
ii. Fill the plastic bins approximately 2/3 of the way full. It is normal to have bone sticking out over the water line.
iii. Add approximately 1 tablespoon of dish soap to each bin.
iv. Wash the skull out as much as possible, then place the skull (and any still attached bones such as the mandible or vertebrae) into a large pot.
v. Fill with water until the skull is covered and add 1 tablespoon of dish soap. Set it aside.
vi. Elements that will fit into slow cooker may be added as long as the temperatures of mixed elements are compatible (i.e. vertebrae should not be mixed with a foot if the slow cooker temperature is set to “high”).

Figure 9: Cold water soak for fragile elements.

5. Throughout maceration be mindful of pathological/unusual ossification, medical implants (metal pins, small staples, pace-makers, etc.), tiny accessory (sesamoid) bones, small skeletal elements (coccyx, distal phalanges), etc.
    a. Any material that cannot easily be classified as non-bone and non-medical should be retained for further examination.
    b. If any medical implants/anomalous elements are found, keep them in the same container as the body part they were found with and document them (with location in body) in the maceration log. **Some of these medical implants are very small, so be careful not to lose them down the drain or to throw them away.** Figure 10 shows variation in found elements.
6. Record all activities in the maceration log.
7. Turn off the heat on the hot plate and slow cookers before leaving the lab. **The only appliance left on when no one is in the lab is the incubator.**

Figure 10: Variation in size and shape of items recovered during maceration. A. Medical implants; B. Eggshell calcification; C. Carpals, metacarpals, phalanges. Note the small size of the sesamoid bones (circled in yellow); D. Various bone fragments.

Subsequent maceration washes

After the initial maceration wash, there will be a series of subsequent maceration washes to remove all remaining tissue and cartilage from bones. Between washes the skeletal elements will be cleaned as described below.

Preparing the maceration lab

1. Wear protective gear such as a lab coat, maceration shoes/shoe covers, gloves, and a mask.
    a. If there is not much danger of contamination, then scrubs can be worn instead of a lab coat.
2. Review the maceration log to confirm prior maceration activities and designated next steps.
3. Place flat sieve or square of screen over the sink drain and place a colander over the sieve.
4. Place the water hose in the sink and turn on the water so that it runs steadily.
5. Gather the maceration tools (scoopula, tweezers, forceps, scissors, toothbrush, etc.)

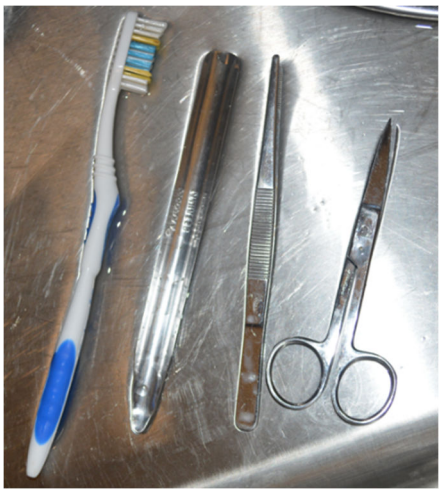


Figure 11: Maceration tools typically used in mechanical tissue removal; from left to right: toothbrush, scoopula, tweezers, scissors.

Long Bones

1. After the long bones have been boiled once, take the bones out and place them in the sink, allowing them to cool prior to processing.
2. Assess each bone before processing. The cartilage lining the joint surfaces will be the most difficult to remove and, in some cases, will be left in place as removal will result in damage.
    a. Cartilage that will lift is opaque in appearance, while cartilage that is desiccated and tightly adhering to bone has a translucent quality (Figure 12). Do not attempt to remove translucent cartilage, even if it is cracking and lifting (pictured), this will result in breakage of subchondral bone.

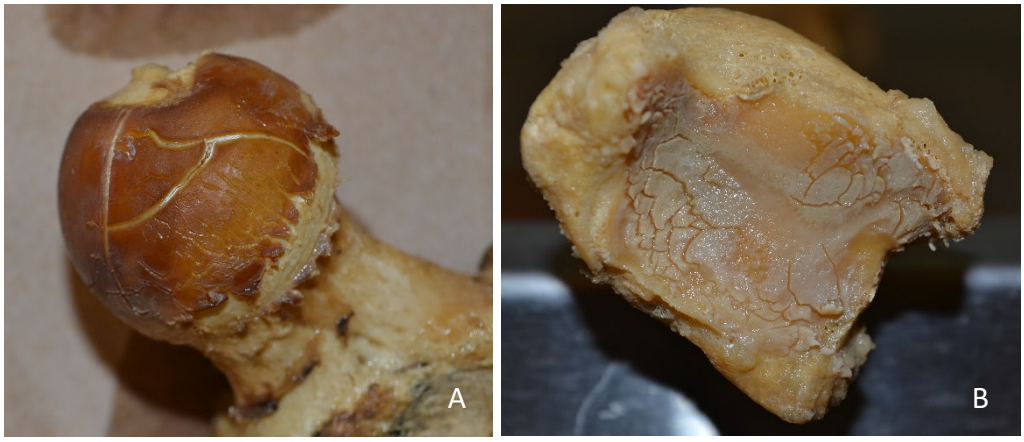


Figure 12: (a) Translucent (not ready for removal); (b) opaque (ready for removal) cartilage.

Figure 13: Mechanical tissue removal using scoopula; note the parallel position of the tool.

3. Using the wide end of the scoopula, scrape the tissue and cartilage away from the bone (Figure 13).
    a. The articular cartilage is notoriously difficult to remove. While the cartilage itself may be tough, the subchondral bone will be weakened by heat treatment. If cartilage cannot be removed with *light* pressure, move on to another surface.
    b. Keep the scoopula as parallel to the bone's surface as possible to avoid damaging/gouging out parts of the bone.
    c. If trauma or pathology is observed (i.e. any surface that just looks 'weird') avoid scraping that area and handle with caution.
4. If any tissue requires more than moderate effort to remove, move onto the next area.

5. Superficial (surface) stains can be removed using a toothbrush and warm soapy water (Figure 14).
    a. Fill a container with water and dish soap
    b. Scrub the cortical surface using a gentle circular motion.
        i. Do not scrub areas of exposed trabecular (spongy) bone.
    c. Some stains are the byproduct of the bones position during decomposition and involve the microstructure of the bone (Figure 15).
        i. These stains are typically located at the proximal/distal aspect of long bones and may be found in circumscribed areas of flat (including the skull), and irregular bones (e.g., carpals/tarsals).
        ii. No amount of heating or scrubbing will remove these stains; remove overlying soft tissue structures and move on to other elements.

Figure 14: Superficial (surface) stains may be removed using warm soapy water and a soft bristle toothbrush.

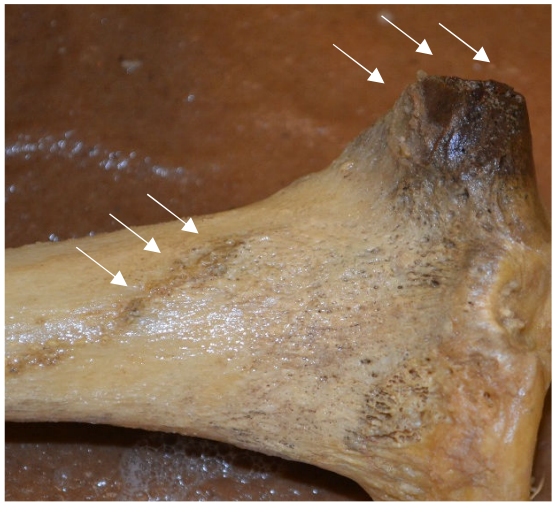


Figure 15: Deep stains (indicated by arrows) are a byproduct of decomposition and cannot be removed. Avoid over processing these areas; remove overlying soft tissue structures only.

6. Return all bones that are not ready to progress to the next stage to the pan they were removed from. Add water and dish soap. If there is still a large amount of soft tissue, add meat tenderizer.
7. Repeat this process until all tissue has been removed; this will take several consecutive processing sessions and some articular cartilage may never be removed.
8. When tissue removal is complete, transfer elements to an ammonia bath.
    a. See “Ammonia baths” below for further instruction.

Ribs, Pelvis, and Vertebrae

1. Allow the bones to soak in the plastic bins, changing the water and dish soap every other day.
2. Keep track of the tissue on the pelvic girdle, vertebrae, and ribs. Once the tissue has softened enough, gently disarticulate the bones.
3. Once disarticulated, gently scrape the bones to remove the tissue. Tweezers and a toothbrush are usually the best tools to apply to delicate elements such as ribs and vertebrae.
    a. *Ribs*: Attempt to remove the periosteum by applying gentle strokes with the toothbrush. Much of the tissue will fall off with periosteal removal.
        i. Do not grip ribs tightly between pinched fingers as they are susceptible to breakage. Lay the body of the rib across an open palm and apply the toothbrush to broadly supported areas of bone.
    b. *Vertebrae*: Do not pinch or clutch the centrum (body) of the vertebrae while cleaning as the structural integrity is often undermined by pathology (osteoporosis) or taphonomic change.
        i. Loosely hold the lateral edges and process using toothbrush and tweezers. A scoopula may be used on the costal facets and demi facts, but only do so with light pressure.
    c. *Pelvis*: The os coxae appear to be much more robust than they are. These bones contain important indicators of age and sex and must be handled with care.
        i. Do not grip/pinch the os coxa by the center of the iliac blade, the auricular surface, or use the iliopubic/ischiopubic ramus as a handle (Figure 16).
        ii. Many FIRS Donors present sacral fusion of one or both os coxae - do not ever attempt to force them apart.
        iii. If the os coxae are are subjected to high heat, while still articulated, there is a strong chance of breakage. Cold soak the pelvic girdle until tissue begins to loosen.

Figure 16: Left os coxa (medial aspect); areas to avoid gripping/pinching on the os coxa (indicated in red)

4. Again, if any tissue takes more than moderate effort to remove, move onto the next area. Some bones may be very delicate, so be careful when cleaning them and don't use force to remove tissue.
5. Once bones have successfully been disarticulated, transfer them to slow cookers (space permitting)
6. Place the individual bones into the slow cookers on low heat
    a. Note: *The lowest temperature rule* overrides all other temperature rules. If hands/feet are still being processed other elements may be added to the pot, but the temperature should never exceed the level appropriate for the most delicate bone in the pot.
7. Repeat daily/every other day until all the bones: sternum (manubrium, gladiolus, and xiphoid process), os coxae, vertebrae, ribs, and sacrum have been transferred into the slow cookers.
    a. **Be careful of smaller bones such as the xiphoid process, hyoid, and coccyx**, as well as any calcifications. Take care to not lose/dispose of them during maceration.

b. The large costal cartilage articulations at the ends of the ribs and along the sternum do not have to be retained unless they have begun to calcify (Figure 17). Do not remove the cartilage if it will damage the bone.

8. Clean out the plastic bins with soap and water.

Figure 17: Ossification of sternal rib ends (left) versus typical morphology (right)

Cranium and Mandible

1. Allow the bones to soak in a pot with 1 tablespoon of dish soap, changing the water and dish soap every other day.
2. Keep track of the tissue, removing it as it becomes softer.
3. When the tissue has become soft enough to disarticulate the mandible, separate it from the skull.
4. Gently scrape the mandible with a scoopula to remove the tissue, taking care to avoid damaging the bone or the teeth.
5. Transfer the detached mandible to a slow cooker.
6. While removing tissue from the skull, be careful of the more delicate bone around the nasal area and on the underside of the skull.
    a. Use tweezers and water to remove tissue from the bones of the base of the skull and the craniofacial region.
7. Be careful not to lose or damage any teeth in the skull.
    a. Teeth will often separate from the maxillae/mandible during maceration; search the discarded tissue within the colander before disposing of it in the biohazard bin.
    b. When dumping maceration water in the sink listen for a ‘clinking’ sound; the source of that noise is almost always tooth enamel on stainless steel.
8. Clean out the inside of the skull using a wood skewer to scoop out the brain tissue and wash out the inside cavity with water.
    a. If the skull contains a desiccated ‘brain ball,’ soak the skull until it loosens
    b. When sufficiently softened, use a wood skewer to gently break up the accretion.

c. Gently swirl a small amount of water (do not fill the cranium with water!) around inside the cranial cavity then dump it into the colander, again being mindful of loose teeth.

9. Place the cranium back into the pot with clean water and 1 tablespoon of dish soap.
10. Repeat until all tissue has been removed, then transfer it to an ammonia bath.

Slow Cookers and Pressure Cookers

1. Slow cookers and pressure cookers should be processed one at a time, all individuals working in the lab simultaneously should be sharing the contents of a single slow cooker/pressure cooker.
2. Place the colander over the sieve.
3. Carefully carry the inner pot of the slow cooker/pressure cooker to the sink (handles will be slippery!) and place in the base next to the colander (Figure 18).

Figure 18: Pan position prior to straining contents

4. Gently transfer the bones from the slow cooker into the colander.
5. Pour the water from the slow cooker over the bones in the colander (Figure 19).

Figure 19: Proper technique for straining water after placing bones in the colander

6. Rinse out the slow cooker with water and pour the water over the bones again. Remove all residual grease from the base and sides of the pot.
7. Fill the slow cooker 2/3 of the way full of water and add about 1 tablespoon of dish soap and ½ teaspoon of meat tenderizer.

Figure 20: Removing tissue and cartilage with scoopula; note the position of the tool relative to the bone.

8. Use a scoopula to gently scrape tissue away from the bones in the colander (Figure 20).
    a. Scissors can be used to remove large pieces of cartilage or tissue or to help disarticulate the fingers or toes.
    b. Again, if it takes more than moderate effort to remove the tissue, move onto the next area.
    c. During this time, be aware of small sesamoid bones that may be hidden in the tissue and cartilage, especially in the hands and feet.
        i. Feel pieces of tissue and cartilage to ensure that no hard pieces of bone are inside.
9. Place the bones that still have tissue on them back into the slow cooker.
    a. Place the bones with no tissue into an ammonia bath (see Ammonia baths for more instruction).
10. Once all of the bones have been worked on, place the slow cooker back into its stand, cover the pot (do not lock handles) with the lid and plug the pot in, keeping it on high heat if there is only a hand or foot, keeping it on low heat more delicate elements were added (e.g. ribs, vertebrae, mandible).
11. Move onto the next pot and repeat.
12. **Keep the contents of the slow cooker/pressure cooker, especially the hand and foot bones, separate from each other. Do not switch the contents of the pots.**
13. **Make sure to unplug and turn off all of the slow cookers at the end of the day.**

Incubator

1. Process pans in the incubator one at a time, following above instructions for slow cookers.
    a. All pans in the incubator will be hot. Handle with care.
    b. Keep the incubator closed as much as possible. The internal temperature cannot be maintained while the doors are open.
2. During the first week of a new maceration, change water, soap, and meat tenderizer in all pans in the incubator twice, then top off water levels and let all pans rest in the incubator for a few days.
3. Clean the contents of all the pans in the incubator at least twice a week until they are clean.
4. **Keep the contents of the pans, especially the hand and foot bones, separate from each other. Do not switch the contents of the pans.**
5. **Leave the incubator on.**

Ammonia Bath

Once a bone is clean of all cartilage and tissue, ammonia is used as a final degreasing agent

1. Place bones in a clean plastic bin or pot (Figure 21).
    a. Hand and foot bones from separate slow cookers should go into separate bins.
        i. Label the bins to show which slow cooker the bones came from.
2. Add enough water to cover the bones

Figure 21: Bones in labeled bin being prepared for ammonia bath

3. Add approximately 2-3 tablespoons of ammonia to the water (estimated amount is fine).
4. Swirl the mixture with gloved hand to ensure that the chemical is evenly distributed throughout the mixture.
5. Let the bones sit undisturbed for 24 hours

Stop Bath

1. The 24-hour ammonia bath should be followed by a stop bath. It is not sufficient to quickly rinse bones after several consecutive chemical baths; the microstructure of bones will trap and hold cleaner, resulting in destruction over time.
    a. A properly executed stop bath facilitates the permeation of microstructures with clean water, removing chemical products.
    b. Stop baths should be labeled according to contents (e.g., right/left hand/foot)
2. Stop baths should run for a minimum of 12-hours
    a. This does not need to be consecutive – water may be run unattended while someone is on-site but should be turned off before leaving.

3. Plan to begin a stop bath immediately upon entering the lab and stopping it just before leaving.
4. Water should be dumped and refilled at the start of each stop bath.
5. Discard the ammonia bath water through a colander in the sink.

Figure 22: Technician discarding the ammonia bath in preparation for the fresh water stop bath.

6. Position the bin or pot under one of the fixed taps located to the right or left of the sink.
    a. Fill the bin with fresh water until it is overflowing (Figure 23).
    b. When water overflow has been achieved, reduce the stream to a steady trickle so that water continues to overflow from the bin at a slow rate (Figure 24).

Figure 23: Correct level of water overflow in preparation for fresh water stop bath

7. While the stop bath is running, prepare the vented drying cabinet for the incoming bones (Figure 24).
8. The shelves should contain only elements from the current maceration.
9. Line all shelves with clean paper towel (Figure 24).
    a. Draw a grid on the paper towel of one shelf and label each quadrant right/ left, hand/foot (Figure 25).
10. Once the stop bath has run for the appropriate time, drain the bath and remove the bones.
    a. Place them on the drying rack in an organized manner, ensuring that elements are not touching or overlapping so that each has sufficient room for air circulation.

Figure 24: Line all shelves with clean paper towel prior to placing wet skeletal elements

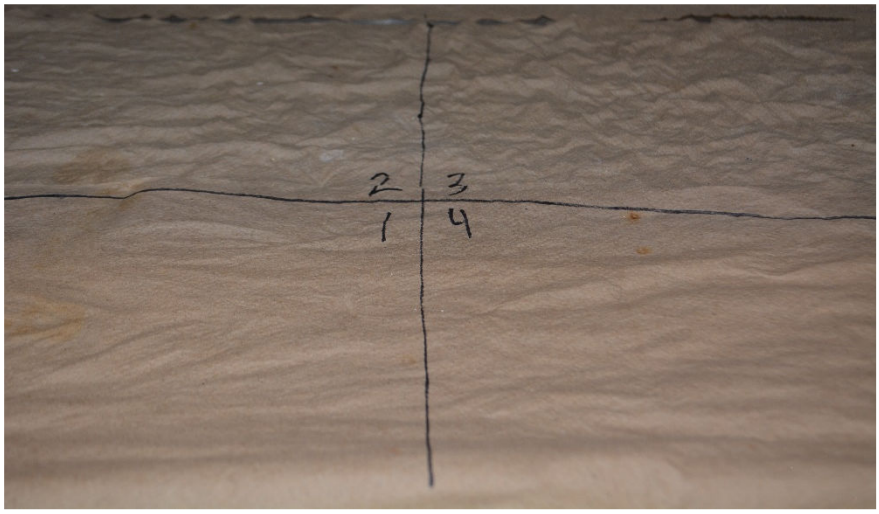


Figure 25: Draw a grid and place right/left hands/feet in each quadrant

Lab clean up: To be done at the end of every day.

1. Run gloved fingers through the debris at the bottom of the sink and colander to ensure that not bone particles have fallen through.
2. Gather cartilage and tissue pieces onto the sieve and dispose of them in a red biohazard bin (Figure 26).

Figure 26: Collection of cartilage and tissue into sieve and disposal into biohazard bin.

3. Thoroughly clean colander and sieve with soap and water. Put back into place on the side counter (Figure 27).

Figure 27: Scrub all maceration equipment after *every* use.

4. Thoroughly clean instruments with soap and water and let them air dry (Figure 28).

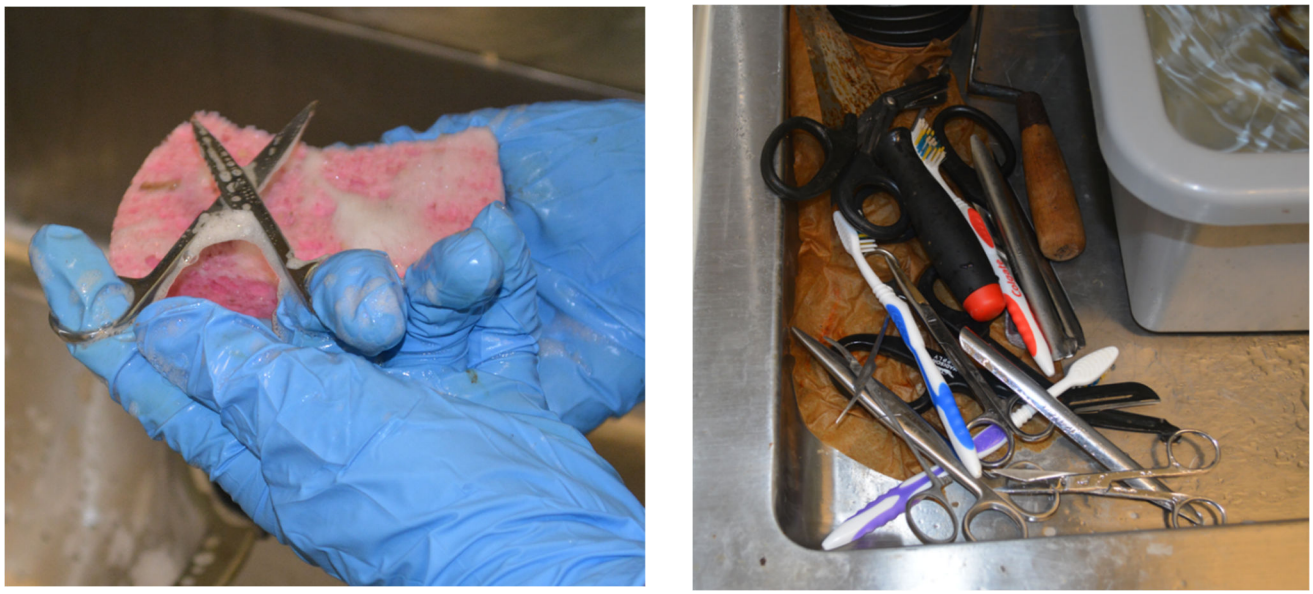


Figure 28: Scrub all maceration tools after *every* use.

5. Wash down the inside and back of the sink, the outer ledge, the side counters, the water hose, the water faucet, the tap handles, and anything else that might have come in contact with tissue with soap and water (Figure 29).

Figure 29: Detailed cleaning of all work surfaces following every maceration session

6. Rinse off all the soap.
7. Empty water from hose and wind the hose onto its hook.
8. Spray everything: sink, side counters, ledge, tools, colander, sieve, faucet, chairs, top of red bin with bleach and then Envirocide (Figure 30).

Figure 30: Spray all surfaces with bleach and Envirocide after scrubbing.

9. Dispose of gloves in a red biohazard bin.
10. Mop the floor throughout the entire lab.
11. **Turn off and unplug all slow cookers**.
12. Detach all hoses from the sink faucets
    a. **If this is in the midst of a maceration** (i.e., there are still bones being actively cleaned), uncoil hoses and drain all water from detached hoses then return to their respective position.
    b. If the maceration is finished (i.e., all bones are clean and in drying rack)
        i. Fill a bin with a 1:9 bleach solution
        ii. Soak hoses for five minutes
        iii. Remove from solution and lay out to dry

Figure 31: (a) All hoses detached; and (b) Hose soaking in 1:9 bleach solution

Figure 32: Drain hose of residual water before re-hanging

13. Fill out the daily maceration log, explaining the tasks completed so that the next person working on maceration knows exactly what was done.
14. Update the white board

Daily Maceration Log

To be completed when *any* maceration project is performed (regardless of scale) **Donor ID_____**

Special Notes:

Name	Date	Time In	Time Out	Stopbaths Off	Lab Clean	Notes

Daily Maceration Log **Donor ID _____**

To be completed after all daily maceration projects. Please include information regarding tasks performed, cleaner used, any challenges (i.e. excessive bone breakage, etc.) encountered while working.

Name: _____ **Date _____**

Notes:

What's next?:

Name: _____ **Date _____**

Notes:

What's next?:

Name: _____ **Date _____**

Notes:

What's next?: