

## Student Guide

### Fibers & Textiles Activity

#### Introduction:

Many objects are made from textiles, including tapestries (wall-hangings), upholstery, quilts, clothing, etc. These objects may be functional as well as decorative, and are often collected as works of art or historic artifacts. Textiles are woven from fibers. These fibers can be animal, plant or man-made. Common historical fibers used include cotton, wool, silk, and linen. Conservators need to identify fiber types in order to make treatment decisions. Different fibers will react differently to various chemicals. Categorizing fiber types also helps conservators identify the origin of a textile because different fibers are characteristic of different regions. Cotton and wool were often used in Ancient American art. Silk had numerous uses in art and trade in China, while linen was used extensively in Ancient Egypt.

#### Objectives:

- Learn the parts of a microscope
- Use high and low power to view specimens
- Make dry and wet mounts
- Compare and contrast different types of natural fibers using a burn test and microscopes views

#### Supplies:

Strand of human hair

Newspaper

Fabric A

Fabric B

Fabric C

Fabric D

Scissors

Compound microscope

Microscope slides

Cover slips

Distilled water

Matches

Bunsen burner

Tweezers

**Safety:** Students should be careful with an open flame and conduct burn tests in well-ventilated area to avoid setting off fire alarms!

**Procedures:****I. Microscope Exercises****A. Letter e**

1. Cut out a lower case "e" from a newspaper and put it on a slide.
2. Place a small drop of water to cover the "e".
3. Put a cover slip on top of the "e".
4. Draw what you see, before placing under the microscope.
5. Using the lowest power (4x), put the slide on the stage, center the "e" in the field of view.
6. Draw what you see.
7. Move the slide to the left, describe what happens.
8. Move the slide to the right, describe what happens.
9. Carefully view the "e" using high power (10x). Be sure to ONLY adjust the fine adjustment to focus. Draw what you see.

**B. Human Hair**

1. Obtain one strand of human hair and cut it into one-inch pieces. Put one piece on a slide.
2. Place a small drop of water on the hair.
3. Put a cover slip on the hair.
4. Using the lowest power (4x), put the slide on the stage, center the hair in the field of view.
5. Draw what you see.
6. Carefully view the hair using high power (10x). Be sure to only use the fine adjustment to focus. Draw what you see.

**C. Natural Fibers**

1. Remove a thread from fabric A. Gently encourage the thread to unravel and fray by rolling it between thumb and finger, separating the ply with straight pins, etc. Extract a single fiber or small group of fibers from the frayed thread with tweezers.
2. Place the fiber on a slide. View the dry mount using low (4x) and high (10x) power. Draw what you see.
3. Place a small drop of water on the fabric and cover with a cover slip.
4. Using low power (4x), put the slide on the stage, center the fabric in the field of view.
5. Label, describe and draw what you see.
6. Carefully view fabric "A" using high power (10x). Be sure to only use the fine adjustment to focus. Describe and draw what you see.
7. Use Tables 2 and 3 to try to identify the fibers.
8. Repeat steps 1-7 using fabrics "B", "C", and "D".  
*\*Students can also view fibers using 40x power if available.*

## II. Burn Tests

### A. Paper & Human Hair

1. Cut out a 10cm x 10cm piece of paper. Carefully set the paper on fire using matches or a Bunsen burner. Make detailed observations of the paper, including the smell.
2. Obtain a piece of human hair. Using tweezers carefully set the hair on fire. Make detailed observations of the hair, including the smell.

### B. Natural Fibers

1. Obtain a 1cm x 1cm piece of fabric "A".
2. Using tweezers, bring the fiber sample near the flame. Write observations of the fabric.
3. Now put the fabric directly in the flame. Write observations of the fabric, noting the smell.
4. Write observations of the ashes of fabric "A".
5. Use the Table 1 to give possible identifications of fabric "A".
6. Repeat steps 1-5 with fabrics "B", "C", and "D".

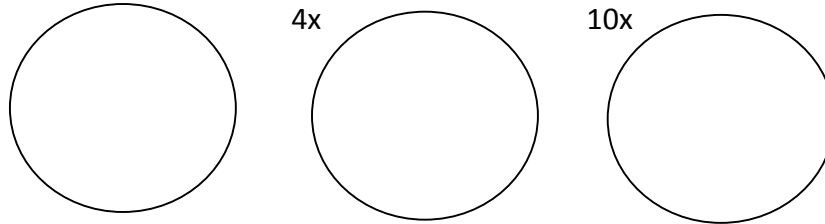
**Clean up:** Return supplies and dispose of waste in the trash can.

Student Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

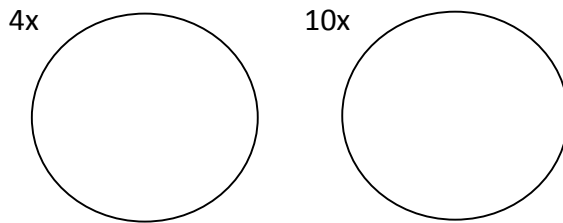
**Fiber Identification  
Answer Sheet**

**I. Microscope Exercises**

**A. Draw the letter e.**

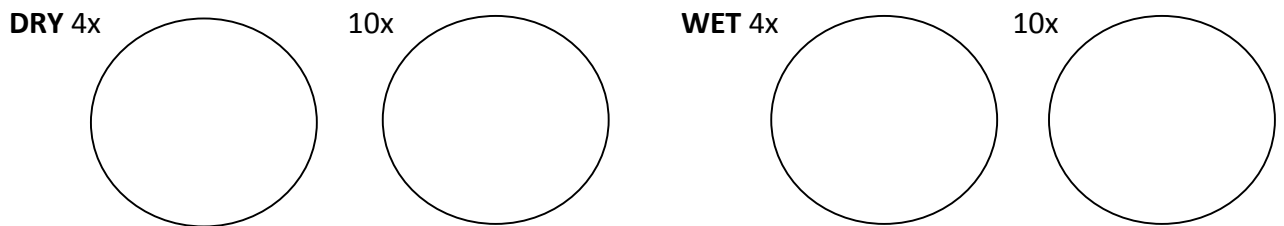


**B. Draw the Human Hair.**

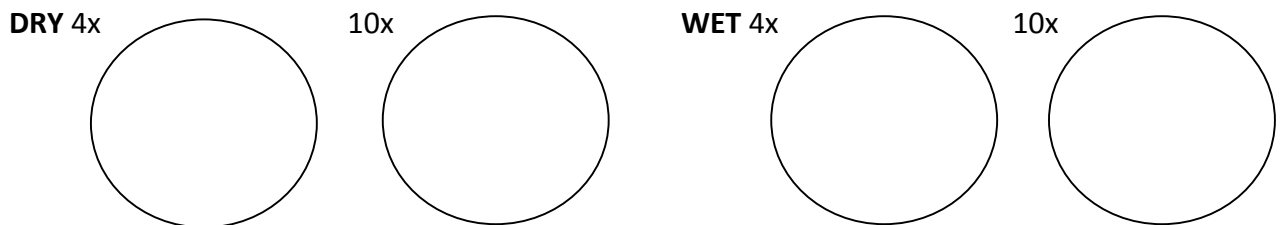


**C. Draw the Natural Fibers.**

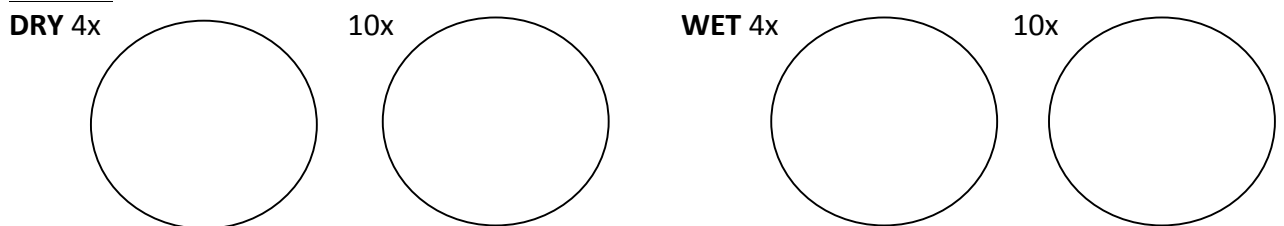
Fabric A



Fabric B

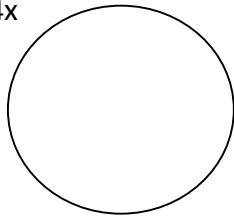


Fabric C

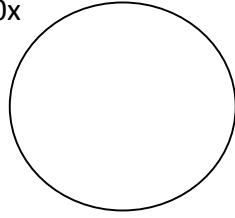


Fabric D

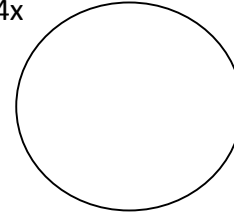
**DRY 4x**



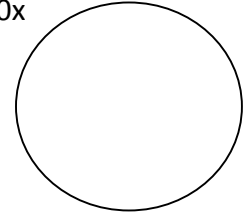
10x



**WET 4x**



10x



**II. Burn Tests**

**A. Paper – Observations after burning**

---



---



---

**Human Hair – Observations after burning**

---



---



---

**B. Natural Fibers – Observations**

| Fiber | Near Flame | In Flame | Out of Flame | Smell | Ashes | WHICH FIBER? |
|-------|------------|----------|--------------|-------|-------|--------------|
| A     |            |          |              |       |       |              |
| B     |            |          |              |       |       |              |
| C     |            |          |              |       |       |              |
| D     |            |          |              |       |       |              |

Analysis Questions

1. What was surprising about the letter e when viewed with the microscope?

---

---

---

---

---

2. Sometimes there are large empty circles with dark edges seen in wet mount slides. What are these circles?

---

---

---

---

---

3. Calculate the total magnification you used to observe silk fibers. The ocular lens magnification was 10x. Total magnification = ocular lens power x objective lens power

4. Referring to the introduction, how could the techniques used to identify the different fibers be used to prove that an art object is a fake?

---

---

---

---




---

**Table 1. Burn characteristics of cellulose and protein fibers in good condition**

| Type of Fiber                           | Burn Test  |                          |   |                              |  |
|---|--|--------------------------|---|------------------------------|--|
|   | Near Flame   | In Flame                 | Out of Flame  | Odor                         | Ash  |
| <b>Cellulose, e.g. cotton and linen</b> | - Does not shrive away from flame<br>- ignites immediately with contact to flame | - burns readily in flame | - continues to burn has an “afterglow” when removed from flame until fiber expended | - smells likes burning paper | - fluffy, small white to grey-colored                      |
| <b>Protein, e.g. silk and wool</b>      | - shrivels away from flame   | - burns slowly           | - self-extinguishes   | - smells like burning hair   | - very small, dark bead-like mass that breaks apart easily |

Modified from “The Identification of Natural Fibers”, Canadian Conservation Institute, CCI Notes 13/18. Canadian Heritage, Ottawa, Canada.





**Table 2. Longitudinal features of cellulose fibers in good condition**

| Cellulose Fibers         | Figure  | Longitudinal features   |
|--------------------------|---|---|
| <b>Cotton</b>            |  | <ul style="list-style-type: none"> <li>• looks like a ribbon with twists (convolutions) at intervals along length of fiber</li> <li>• interior central canal or lumen may look like a striation (a minute groove running the length of the fiber)</li> <li>• lumen is large, typically more than half the full width of the fiber</li> </ul>  |
| <b>Mercerized Cotton</b> |  | <ul style="list-style-type: none"> <li>• mercerized fibers have fewer convolutions</li> <li>• lumen may look like a striation</li> </ul>  |
| <b>Linen</b>             |  | <ul style="list-style-type: none"> <li>• single fibers or ultimates have nodes at intervals along fiber length in the form of I, V, or X, similar to the appearance of bamboo</li> <li>• irregular width</li> <li>• interior central lumen is quite small, typically less than half the full width of the fiber</li> <li>• often seen as a bundle of fibers tightly packed in the lengthwise direction, rather than as individual fibers</li> </ul> |

Modified from “The Identification of Natural Fibers”, Canadian Conservation Institute, CCI Notes 13/18. Canadian Heritage, Ottawa, Canada.



**Table 3. Longitudinal features of protein fibers in good condition**

| Protein Fibers         | Figure   | Longitudinal features   |
|------------------------|--|---|
| <b>Cultivated Silk</b> |   | <ul style="list-style-type: none"> <li>• looks like a cylindrical, smooth rod with periodic bulges</li> <li>• may sometimes have faint striations</li> </ul>  |
| <b>Wild Silk</b>       |   | <ul style="list-style-type: none"> <li>• flattened rod, like a ribbon, with irregularities in fiber diameter</li> <li>• may have more pronounced striations than cultivated silk</li> <li>• may have perpendicular cross-markings, similar to flax</li> </ul> |
| <b>Fine Wool</b>       |   | <ul style="list-style-type: none"> <li>• outer surface and edges rough, due to overlapping surface scales</li> <li>• no medulla (the dark central solid line or row of interrupted dots, depending on the animal)</li> </ul>                                  |
| <b>Coarse Wool</b>     |  | <ul style="list-style-type: none"> <li>• outer surface and edges rough, due to closely spaced, zigzag or jagged-edge surface scales</li> <li>• medulla visible</li> </ul>   |

Modified from “The Identification of Natural Fibers”, Canadian Conservation Institute, CCI Notes 13/18. Canadian Heritage, Ottawa, Canada