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# Using Paper Making and Fabric to Teach across Scales: From Microscopic Cells to Fabric and Paper

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Helping students understand the connection between microscopic observations and the macroscopic tangible world is challenging. We use a revised the "Fabric of Our Lives" lab from Estelle Levetin, Karen McMahon and Robert Reinsvold's "Laboratory Manual for Applied Botany" (2002) in order to teach students how to make connections between the microscope, cellular level and the macroscopic level of fabrics and papers. We also incorporate the historical importance of fabrics and paper. The goal of this mini-workshop was a presentation of an ordered method for teaching across scales using plant cells, tissues, fabric and paper.

**Keywords:** Teaching Across Scales

## Introduction

A challenging concept to learn and teach is the connection between microscopic observations and tangible macroscopic observations including historical context. During the Rock Valley College Plants and Society introductory biology course for non-majors, Dr. Megan Pease and Mrs. Lisa Strong use a revised version of the Levetin et al. "Fabric of Our Lives" lab from the "Laboratory Manual for Applied Biology" to help students make the connection between observations of plant cells, fabric, student made paper and the historical context of using plants for more than just food (2002). During this mini workshop participants will view prepared slides of plant cells, test samples of fabric to determine the lignin content and walk through the steps students go through to make the connection to fabric texture and the paper they have made from various plant organs. Participants will also be exposed to the brief historical context covered in more detail during the lecture of this portion. The goal of this workshop is to present an ordered method of teaching across scales, share our successes and failures with the techniques and invite feedback for improving weaknesses with the lab.

The students will have had a lecture about plant cells, tissues, organs and fabrics before beginning lab. The lab has specific readings with pictures the students will review before coming to class. During lab, the students begin with looking at the prepared slides of plants in order to identify the sclerenchyma, xylem and phloem cells being used to make fabric and paper. They will draw and label each sample to demonstrate their identification abilities, specifically focusing on the cell wall. Next they make slides of the different fabric samples and stain the fabric with phloroglucinol stain which turns red in the presence of lignin, a component of cell walls. They record the amount of lignin using a rating scale for a high, medium and low amount of lignin. They also categorize the fabric as being rough, medium textured or smooth. Using the lignin and texture rating data, they draw conclusions about the correlation between a fabric's feel and the amount of lignin in the cell walls. Ideally, their data will show a correlation between a high amount of lignin and a rough feeling fabric and a low amount of lignin correlating with a smooth feeling fabric. The tongue depressor is used as a positive control in this experiment because it will definitely show positive for lignin and nylon is a negative control because it is quite smooth and will not test positive for lignin. The students make their own paper using a mold and deckle set and different plant organs like cabbage leaves. A series of questions in the lab report ask students to make the connection between the plant organs they used and the paper making methods used to remove tissues from the plant organs in order to isolate the sclerenchyma, xylem and phloem cells to make their paper.

## Materials

Students work in pairs in a class with 24 total students. The instructor will need prepared slides of *Sambucus* stem, *Pyrus* sclerids, *Sedum* epidermis, etc., samples of white or cream colored fabric (ex. hemp, sisal, cotton, nylon) and a wooden tongue depressor, unused slides, cover slips, phloroglucinol stain, compound microscopes, several different types of plants (ex. cabbage, carrots, papyrus) mold and deckle sets for making paper and other paper making supplies.

## Notes for the Instructor

Phloroglucinol recipe: Yeung, E. 1998. A beginner's guide to the study of plant structure. Pages 125-142, in Tested studies for laboratory teaching, Volume 19 (S. J. Karcher, Editor). Proceedings of the 19th. Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 365 pages.

## Cited References

Estelle Levetin, Karen McMahon and Robert Reinsvold. "Laboratory Manual for Applied Botany", McGraw Hill, 2002.

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