



Plant

Morphology

BOT 125 Laboratory and Study Guide

by

Curtis Clark

Additional photomicrographs by Kevin J. Carpenter

Version 6.0, 2003

Copyright Information

Copyright © 2003 by Curtis Clark. The illustrations are also protected by individual copyright. Except as enumerated below or through written license, all rights are reserved, including right of republication in any form and right of derivative work, and any infringement will be vigorously contested by all available means.

- Licensed for use by students at California State Polytechnic University, Pomona.
- Licensed for use by instructors or students at other not-for-profit educational institutions, after approval (please email jcclark@csupomona.edu).
- Licensed for personal self-educational use by individuals.

For all other use, please contact Curtis Clark (jcclark@csupomona.edu).

Illustration Credits

All photographs and other illustrations are copyright © 1999-2003 by Curtis Clark unless noted below.

The following photographs are copyright © 1999 by Kevin J. Carpenter and Curtis Clark:

Lab 3	2, 4, 10, 12
Lab 4	2, 4, 7, 8, 9, 13
Lab 5	1, 2, 9, 11, 14, 15, 22
Lab 6	3, 4, 5, 8, 11
Lab 7	1, 2, 3, 5, 8
Lab 8	1, 3, 6
Lab 9	2, 6, 7, 8, 11, 12, 13, 15, 17, 19, 20, 21, 24, 25, 26, 27 (<i>lower</i>)
Lab 10	2, 4, 7, 13, 14
Lab 11	2, 3, 4, 6, 7, 9, 10, 11, 12, 14, 17
Lab 12	<i>none</i>
Lab 13	<i>none</i>
Lab 14	4, 6

Contents

ACKNOWLEDGMENTS	iii
HOW TO SUCCEED IN PLANT MORPHOLOGY	iv
LAB 1: LABORATORY ORIENTATION	i
LAB 2: PROPAGATION.....	5
LAB 3: CLONAL REPRODUCTION.....	8
LAB 4: SEXUAL REPRODUCTION	12
LAB 5: FUNGI.....	18
LAB 6: VARIOUS “PROTISTA”	23
LAB 7: HETEROKONTS.....	26
LAB 8: CHLOROPHYTA, LICHENS, SYMBIOSIS	29
LAB 9: BRYOPHYTES.....	33
LAB 10: LYCOPHYTA, PSILOTOPHYTA.....	37
LAB 11: SPHENOPHYTA, PTEROPHYTA	40
LAB 12: CYCADOPHYTA, GINKGOPHYTA	44
LAB 13: CONIFEROPHYTA, GNETOPHYTA	47
LAB 14: ANTHOPHYTA	50
APPENDIX A: CLASSIFICATION USED IN CLASS, WITH EXAMPLE GENERA.....	53
APPENDIX B: SPORES, TETRADS.....	56
APPENDIX C: WOODY STEMS OF SEED PLANTS	57
APPENDIX D: GEOLOGICAL TIME SCALE	59
COLOPHON.....	60

Acknowledgments

I owe a special debt of gratitude to Dr. Gery Allan, who was coauthor of the first edition of this manual when he was a graduate student at Cal Poly Pomona. Without his early efforts, the manual would not exist.

I also thank Anita Arias, Debbi Blunt, Carl L. Casey, Salvador Garfias, Anh Q. La, Donna Lee, Patty E. Peña, Oanh Kim Pham, Thao Tran, Linda Tsao, Vivianna Vuong, and Huey-Sheam Yen for providing material for the glossary, Eduardo Jovel, Emilie Clark, and Melissa Tulig for organizing the collection of microscope slides, and Judi Bogdanoff-Lord for additions to the manual.

Photomicrographs and their digitizations have been possible through the generosity of the Biological Sciences Department of California State Polytechnic University, Pomona, and Rancho Santa Ana Botanic Garden.

This course was first taught by Dr. Jack Erspamer, and after his retirement by the late Dr. Les Nyman. I team-taught with each of them, and their unique perspectives, styles, and enthusiasms have greatly influenced the course.

How to Succeed in Plant Morphology

When we think of biodiversity, we usually think of animals, and for good reason. Animals make up over 80% of the species on earth (and at least one out of four of the animals is a beetle!). But, despite the complexity that accompanies any course in invertebrate or vertebrate zoology, animals are surprisingly uniform in many significant ways. For example, all of them live by absorbing or ingesting food, none of them have cell walls, most of them store food as lipid and glycogen, and they all have the same sexual cycle.

When we shift our attention to plants, and to all the other organisms that were traditionally grouped with plants, we find a variety of nutritional lifestyles, morphological peculiarities, and sexual habits that make animals seem boring in comparison. Or perhaps they make animals seem comprehensible in comparison. The purpose of this course is to help you better understand the complexities of plants and other “non-animals”.

Most people find this course to be difficult. If you had trouble with invertebrate zoology, you will probably have trouble here. But there are certain things you can do to shift the odds in your favor:

- Focus on similarities and common features, rather than differences. There is more diversity to life than anyone can possibly comprehend, but there are key features that large groups of organisms share. Those features are an important component of the course.
- Learn the four general patterns of the sexual life cycle; study them until you can repeat them in your sleep. Pay special attention to ploidy level, syngamy, and meiosis. If you can do this, you will have learned just four life cycles, rather than separately memorizing the life cycles of the dozens of different organisms that you will study in this course. Remember: similarity.
- Pay attention to distinguishing between cells, structures, and organisms. You might never confuse a person with a kidney or a red blood cell, but most people don't have the same kind of familiarity with plants. And confusing a conceptacle with a sporophyte can cause the same sort of problems as confusing a kidney and a person.
- Don't be intimidated by technical terms and names of groups of organisms. To many people, scientific names seem like a foreign language, which of course they are—Latin. They

will seem hard to pronounce at first, but if you can break them into syllables you can usually sound them out, and if you learn the pronunciation of common endings like *-phyta* and *-opsida*, things will be that much easier.

- Look at everything that is set out for you in lab. You may not have the time or inclination to study every item carefully, but you should at least look, and try to make at least some sense of what you see. All of those little bits of information that you pick up will be useful to you, because they all tell parts of the same story.
- The lab exercises can usually be completed in less time than the three hour lab period. If you are having trouble, don't leave early. Use the time to review material from previous labs.
- Use the web page/CD-ROM effectively, but don't rely on it exclusively. It has a wealth of photographs and other information that will help you with both lecture and lab, but the lab tests still rely on actual slides and specimens.
- Look at plants in your world. All the kinds of plants you see in lab live somewhere; they are not just abstractions. If you pay attention to the plants around you, you will start to really look at plants, and that will pay off for understanding the equally real plants in the lab. Don't worry; the "looking at plants" syndrome is reversible after the end of the quarter in 90% of all cases (many of the rest become botany majors).

Lab 1: Laboratory Orientation

1. *Attendance*—You are not required to attend either the lab or the lecture. Of course it is a good idea, but no points are deducted for absences. There are also no penalties for arriving late or leaving early. If you know in advance that you will miss a lab, please ask about things you can do to see the material that will be presented in that lab.
2. *Cleanliness*—Plant morphology is not an inherently clean subject. Most of the organisms we study grow in soil, on decaying material, or in fresh or salt water. Sometimes the lab gets dirty. This is only a problem if it interferes with safety, the ability to culture organisms, or a coherent learning environment. Here are some guidelines to follow:
 - a. Clean up all water spills on the floor with paper towels so that the floor is not slippery.
 - b. Clean up your part of the lab table before you leave, and clean up your neighbors' parts if they didn't (make them clean yours next time). This means soil, water, plant parts, papers, and especially microscope slides and razor blades (see below).
 - c. Don't leave stuff on the side benches.
3. *Supply pans*—For each half of a lab table there is a pan containing microscope slides and cover slips, razor blades, inoculating loops, and possibly stains, forceps, and dissecting needles. Please let the lab instructor know if you run out of any of these supplies.
 - a. *Slides and cover slips*—Ordinarily you will use a single slide and cover slip through the course of one lab, cleaning them between uses. At the end of the lab period, place them both in the red plastic “sharps” container near the hood (not in the trash can). Please do not leave slides in the pans, on the benches, or by the sink. You may clean and dry them and return them to the boxes, but no one else will do that job for you.
 - b. *Razor blades*—These are potentially hazardous; treat them with care. Never leave razor blades in the pans or anywhere else loose with exposed edges. If the blade is too dull to be used effectively, put it in the red plastic “sharps” container near the hood (never in the trash can). If it can still be used, you can slide the sharp edge into the block of foam plastic in the pan. Make sure the entire edge is covered. If you cut yourself, inform the lab





- instructor immediately (see Blood below).
- c. *Tissue stains*—If you should spill one of these on your skin or clothing, you will understand why they are called “stains”. (Stains are not currently used in this course, but may be present from other labs.)
 - d. *Needles and loops*—Please return these to the pan when you are finished with them. The foam blocks are for razor blades; you may stick needles in them as long as they don’t interfere with that.
4. *Slide boxes and prepared slides*—There are six slide boxes for the lab, one assigned to each half-table. The boxes should be left in the designated drawers at the end of the lab. Please return each slide to its proper place in the box when you are finished with it. If a slide is missing, please let the lab instructor know, but please look through the box first to make sure it has not been misplaced. The slides are fragile, but a few simple precautions will keep them in good condition. Always return slides to the box when they are not in use. The practice of leaving several slides sitting out on your lab book is one you will regret when your neighbor drops a textbook on them. Dirt and fingerprints can often be removed with a dry Kim-Wipe; stubborn marks may need to be cleaned with alcohol, but be careful not to get alcohol on the label, and wipe carefully around the cover slip. If a slide breaks, please report it to the lab instructor. Also, don’t even think of “borrowing” a slide box from the lab; if a box turns up missing, lab exams will be changed to contain slides you’ve never seen before, and more non-slide material.
5. *Microscopes*—Carry scopes with two hands, and always return them to the proper cabinets. Always leave the low power objective (or no objective) in place when you return it to the cabinet, and never leave a slide on the stage. You probably knew this already. You may not know that you should dry the bottom of a wet mount slide before you put it on the stage (otherwise it will stick and not move easily), and you should never look at anything under the compound scope without a cover slip. Prepared microscope slides are ordinarily designed for viewing with a compound scope—the specimens are upside-down relative to the label, so that they will appear rightside-up when you look at them under the scope. Stereoscopes do not invert the image, so when you look at a prepared slide under a stereoscope, put

the label on the right side with its lettering reading upside-down.

6. *Living material*—Take only as much material as you need. Living organisms are currently the most expensive supply item for the course, and we order just enough. To avoid contaminating them, never return microscopic organisms to the tubes or dishes you got them from.
7. *Blood*—Because of the incidence of blood-borne diseases such as hepatitis and AIDS, human blood should always be regarded as a biohazard. Please avoid touching the blood of others. As a courtesy to others, if you have bled on a lab surface, please clean the blood up with the disinfectant provided on each bench.
8. *Food and drink* in lab is normally permitted, except when we are working with open fungal cultures.

Some Symbols Used in This Manual

Several symbols will indicate the type of material you will be viewing in lab:

-  Prepared microscope slide
-  Cultured, often microscopic living organism, usually in a tube or Petri dish
-  Macroscopic living organism, such as a branch from a plant or a mushroom
-  Demonstration; may be a microscope setup or a labeled organism.

Some more information about microscope slides

Prepared microscope slides (of the sort that are in your slide box) may be made from entire organisms or organs mounted on the slide (these are called whole mount slides) or of thin slices of plant material cut with a tool called a microtome (these are thin section slides). Whole mount slides traditionally have round cover slips and thin sections have square or rectangular cover slips. Some of the slides in your box don't follow this rule, but it is a good guide. Because whole mounts contain entire organisms or organs, they are usually thicker than thin sections, and

require care on the microscope—many of them cannot even be used at 40×, because the objective lens will hit the cover slip. If care is required in using a whole mount, it will be mentioned in the manual.