

Supplemental Material

CBE—Life Sciences Education

Wolkow et al.

Supplementary Figure 1. SUR training workshop agenda that all faculty at the two-year institution participated in prior to the first implementation.

UCCS-PPCC Soakin' Up the Rays Summer Workshop
Location: UCCS, Osborne Center - Room B305
May 25 to June 8, 2012

◀ Apr 2012		~ May 2012 ~					Jun 2012 ▶
Sun	Mon	Tue	Wed	Thu	Fri	Sat	
20	21	22	23	24	25 9am-12:30pm * UV mutagenesis * Review assessments	26	
27	28	29	30 Mutant Screen (select one) Session 1: 9:30-11am Session 2: 2-3:30pm	31	Notes: Monday is Memorial Day, so we will have two sessions on Wednesday (you only need to attend one).		

◀ May 2012		~ June 2012 ~					Jul 2012 ▶
Sun	Mon	Tue	Wed	Thu	Fri	Sat	
					1 9am-12:30pm *Select potential mutants *IRB training *Discuss assessments	2	
3	4 9am-12:30pm * Verification of mutants * Microscopy	5	6	7	8 9am-12:30pm * Fluorescence microscopy of created mutants * Discuss materials & implementation	9	

Supplementary Figure 2. The laboratory and assessment schedule for the four-year institution

Lab	Control Sections	Experimental Sections
	Safety, Scientific investigation IRB Consent form + knowledge assessments (pre)	Safety, Scientific investigation IRB Consent form + knowledge assessments (pre)
1	Cells and organelles	Cells and organelles
2	Biological Molecules	Biological Molecules
3	Osmosis and diffusion	Shortened Osmosis and diffusion Intro to SUR module
4	Enzymes	Lab 1: Mutagenesis of Yeast with Ultraviolet (UV) Light
5	Scientific Literature	Shortened Scientific Literature Lab 2: Replica Plate Survivors to Identify DDR Mutants
6	Respiration & fermentation	Shortened Respiration & fermentation Lab 3 Isolation of DDR Mutants
7	Photosynthesis	Shortened Photosynthesis Lab 4: Verification of DDR Pathway Mutants
8	Mitosis & meiosis	Lab 5: Characterize Mutants: Brightfield and Fluorescence Microscopy
9	No Classes: Spring Break Molecular biology	No Classes: Spring Break Molecular biology
10	Bacterial transformation	Bacterial transformation
11	Mendelian Genetics	Mendelian Genetics
	Lab Practical	Lab Practical
	Mendelian genetics, part 2 Post-knowledge assessments & lab evaluation	Mendelian Genetics, part 2 Post-knowledge assessments & lab evaluation

Supplementary Figure 3. Soakin' Up the Rays with *S. pombe* Pre/Post Knowledge Assessment

Question: 1

Single-celled model organisms are ideal for studying cancer for all the following reasons except

- A. they have a relatively short life cycle
- B. they share homologous genes with humans
- C. they are easy to breed or reproduce
- D. they get cancer
- E. they can exist as haploid

Question: 2

Starting with a fertilized egg (zygote), a series of three cell divisions would produce an early embryo with how many cells?

- A. 4
- B. 8
- C. 16
- D. 32
- E. 64

Question: 3

DNA is replicated during this phase of the cell cycle:

- A. G₀
- B. G₁
- C. S
- D. G₂
- E. M

Question: 4

How do the ultraviolet rays of sunlight promote the development of skin cancer?

- A. They directly cause skin cells to divide rapidly and uncontrollably.
- B. They randomly damage genes, sometimes damaging those required to repair damaged DNA.
- C. They cause increased osmosis across cellular membranes, damaging organelles required for cell division.
- D. They directly cause skin cells to migrate to other tissues.
- E. All of the above

Question: 5

Which of the following is an example of DNA damage:

- A. Thymine dimers
- B. Substrate-level phosphorylation
- C. Lysosome bulging
- D. Golgi migration
- E. Methionine truncation

Question: 6

The cell division cycle is a regulated process. One reason for cell cycle regulation is:

- A. to assist with the repair of DNA damage by delaying cell cycle progression.
- B. to monitor ATP production.
- C. to regulate osmosis of carcinogens.
- D. to mediate incorporation of radioactive atoms into proteins.
- E. All of the above

Question: 7

After comparing the DNA sequences of a gene in humans and a gene in yeast, you conclude that they are homologous (very similar). What does this suggest about the structure and function of the proteins created from these homologous genes?

- A. Similar structures and functions.
- B. Similar structures but dissimilar functions.
- C. Dissimilar structures but similar functions.
- D. Nothing in common.
- E. Nothing can be deduced based on DNA sequence alone.

Question: 8

Humans are diploid. Why might we use a haploid organism to study genetic factors that may contribute to disease development in humans?

- I. Haploid model organisms will develop human diseases at a faster rate.
- II. All haploid model organisms and humans share the same disease causing mutations.
- III. Gene mutations are readily observable in haploid model organisms.

- A. I only
- B. II only
- C. III only
- D. II and III
- E. I, II, and III

Question: 9

You are a physician researcher and have identified a condition in which affected children have extreme sensitivity to secondhand cigarette smoke and appear to develop lung cancer at an exceedingly high rate. What would be a likely explanation for their condition?

- A. They are deficient in a DNA repair mechanism.
- B. They are deficient in breaking down phenylalanine.
- C. They are deficient in melatonin.
- D. Their lung cells have defective plasma membranes.
- E. Their lung cells are defective in meiosis.

Question: 10

Researchers often attach GFP (green fluorescent protein) to a protein they want to study. GFP is useful because it:

- I. can help identify the location of a cellular protein
- II. can help determine the amino acid sequence of a protein
- III. emits UV light that damages DNA

- A. I only
- B. II only
- C. III only
- D. I and II
- E. I, II and III

Supplementary Figure 4. Perception Survey - Experimental Section followed by Conventional Section

Note: Questions with asterisk are only included in the Experimental Section Survey

The purpose of this survey is to provide us with feedback on the BIOL 111 laboratory in order to make improvements to the course. Using the provided scantron form, please select the choice that best describes how you feel about each of the following statements or questions. Unless indicated, mark only one answer per question using a #2 pencil. Your responses are completely anonymous. You do NOT need to write your name or student ID. Please provide additional feedback on the back of the scantron. Thank you for your valuable input!

Part I. Background questions

1. You are taking this course because:
 - A. It is a required course for your degree program
 - B. It is a recommended course for your degree program
 - C. It is an elective course for your degree program
 - D. It sounded interesting
 - E. Another reason
2. Which PPCC degree/certificate program are you currently pursuing?
 - A. Associate of Applied Science (AAS), such as nursing or allied health
 - B. Associate of Science (AS), such as biology, chemistry or pre-med
 - C. Associate of Arts (AA) or Associate of General Studies (AGS)
 - D. Certificate of Achievement (CER), such as nursing assistant or medical transcriptionist
 - E. I am not pursuing a degree/certificate from PPCC
3. Which of the following best describes your future career interest?
 - A. Nursing
 - B. Other Health professional (M.D. or D.O., Dental, Pharmacy, Public Health, etc.)
 - C. Biological Sciences
 - D. Other science
 - E. Other, non-science
4. Do you have any interest in pursuing a career in K-12 science education?
 - A. Yes
 - B. Possibly
 - C. No

5. Have you previously taken an introductory college level biology laboratory course?
- A. Yes, at PPCC
 - B. Yes, at another institution
 - C. No, this is my first college level introductory biology lab

Please evaluate each lab from the semester by responding to the following statements (6-27) using the scale provided below:

A	B	C	D	E
Strongly agree	Agree	Neutral	Disagree	Did not participate in this lab

Lab 1: Metric Measurements and Analysis (volume, mass, means, variance, etc.)

- 6. This lab helped me to understand the biological concepts discussed in lecture
- 7. This lab was enjoyable

Lab 2: Atoms, Molecules; Molecular weight (Periodic Table Exercise)

- 8. This lab helped me to understand the biological concepts discussed in lecture
- 9. This lab was enjoyable

Lab 3: Solutions; pH; Testing for Organic Molecules (Iodine, Benedict's, etc.)

- 10. This lab helped me to understand the biological concepts discussed in lecture
- 11. This lab was enjoyable

Lab 4: Microscopy, types of cells and cell structure (plant and animal cells under the microscope)

- 12. This lab helped me to understand the biological concepts discussed in lecture
- 13. This lab was enjoyable

A	B	C	D	E
Strongly agree	Agree	Neutral	Disagree	Did not participate in this lab

Lab 5: Cell membranes (effects of temperature and organic solvent stress on membranes)

- 14. This lab helped me to understand the biological concepts discussed in lecture
- 15. This lab was enjoyable

Lab 6: Diffusion & osmosis (movement of biological molecules through dialysis tubing, hypotonic, isotonic, hypertonic sucrose solutions)

- 16. This lab helped me to understand the biological concepts discussed in lecture
- 17. This lab was enjoyable

***Lab 7: Soakin' Up the Rays with *S. pombe* Part 1 (cell counting and dilution, plating cells, mutagenesis with UV light)**

- 18. This lab helped me to understand the biological concepts discussed in lecture
- 19. This lab was enjoyable

***Lab 8: Soakin' Up the Rays with *S. pombe* Part 2 (replica plating to identify DDR mutants)**

- 20. This lab helped me to understand the biological concepts discussed in lecture
- 21. This lab was enjoyable

***Lab 9: Soakin' Up the Rays with *S. pombe* Part 3 (selection and verification of DDR Mutants)**

- 22. This lab helped me to understand the biological concepts discussed in lecture
- 23. This lab was enjoyable

***Lab 10: Soakin' Up the Rays with *S. pombe* Part 4 (bioinformatics - use of computers in biological research)**

- 24. This lab helped me to understand the biological concepts discussed in lecture
- 25. This lab was enjoyable

***Labs 11-12: Soakin' Up the Rays with *S. pombe* Parts 5 & 6 (light and fluorescence microscopy of mutants)**

- 26. This lab helped me to understand the biological concepts discussed in lecture
- 27. This lab was enjoyable

Please respond to the following statements (28-49) regarding the laboratory component of this class overall using the scale provided below:

A	B	C	D	E
Strongly agree	Agree	Neutral	Disagree	Strongly disagree

- 28. The lab experiments helped me to understand how mutations in genes arise.
- 29. The lab experiments helped me to understand the ways that the molecules move through cell membranes.
- 30. The lab experiments helped me to understand how cells respond to environmental exposures that can cause cancer, such as tobacco or asbestos.
- 31. I have a better understanding of how computers can be used in biological research.
- 32. This laboratory class was interesting.
- 33. This laboratory class was enjoyable.
- 34. The laboratory classroom was appropriate for conducting the experiments.
- 35. The laboratory equipment was suitable for conducting the experiments.
- 36. I learned many laboratory techniques that I have not used prior to this lab course.
- 37. This laboratory class helped me to better understand the importance of microscopy (i.e. the use of microscopes) in biological research.
- 38. This laboratory class gave me a better understand basic laboratory skills utilized in biological research.
- 39. This laboratory class provided a good real-life example of biological research.
- 40. This laboratory class increased my interest in biology.
- 41. After taking this laboratory class, I feel more prepared for future coursework in biology.
- 42. After taking this laboratory class, I feel more prepared for reading and understanding the scientific literature.
- 43. I would prefer to have pre-lab reading material to prepare for lab class.

- 44. I think laboratory-related assignments are helpful to reinforce concepts that we cover in the laboratory.
- 45. I prefer to have more labs in which we design and perform our own experiments.
- 46. I prefer to have a lab structure in which a series of experiments are conducted from week-to-week, rather than the stand-alone (one day) experiment to demonstrate a concept.
- 47. Having a week-to-week format is more effective at encouraging participation and attendance in laboratory courses.
- 48. Writing a lab report is beneficial for understanding the scientific method.
- 49. Overall, I learned a lot from this laboratory experience.

*50. Overall, how would you rate the Soakin' Up the Rays lab manual (usefulness, clarity, etc.)?

- A. Excellent
- B. Good
- C. Satisfactory
- D. Below Average
- E. Poor

*51. Overall, what was your perception of the worksheets that accompanied the Soakin' Up the Rays lab manual?

- A. I did not complete any of them prior to class.
- B. I completed some of them prior to class.
- C. I completed all of them prior to class, and I found it to be very helpful with understanding the material.
- D. I completed all of them prior to class, and I found them to be somewhat helpful with understanding the material.
- E. I completed all of them prior to class, and I found them to be unhelpful with understanding the material.

52. Overall, how would you rate the Vodopich & Moore lab manual that was used for the first half of this lab class (usefulness, clarity, etc.)?

- A. Excellent
- B. Good
- C. Satisfactory
- D. Below Average
- E. Poor

53. How would you rate the overall challenge that the laboratory class?

- A. Very easy
- B. Easy
- C. Average

- D. Challenging
- E. Very challenging

54. What best describes the amount of time and effort that you put into this course (lecture and laboratory)?

- A. Minimal
- B. Less than average
- C. Average
- D. Above average
- E. Extraordinary

55. In general, how would you rate your interest in the biological sciences?

- A. Enthusiastically interested
- B. Very Interested
- C. Interested
- D. Somewhat interested
- E. Not interested

Conventional Section Only (questions that are different)

Note: This section contains only the lab evaluation questions that are different from the evaluation given to the Experimental sections.

A	B	C	D	E
Strongly agree	Agree	Neutral	Disagree	Did not participate in this lab

Lab 7: Enzymes (effect of temp and pH on enzyme activity)

- 18. This lab helped me to understand the biological concepts discussed in lecture
- 19. This lab was enjoyable

Lab 8: Cellular Respiration (yeast fermentation, aerobic respiration in Elodea and snails)

- 20. This lab helped me to understand the biological concepts discussed in lecture
- 21. This lab was enjoyable

Lab 9: Photosynthesis (Testing leaves with different colored filters for presence of starch)

- 22. This lab helped me to understand the biological concepts discussed in lecture
- 23. This lab was enjoyable

Lab 10: Mitosis and meiosis (demonstrate the stages using pop-bead models, look at plant and animal slides)

- 24. This lab helped me to understand the biological concepts discussed in lecture
- 25. This lab was enjoyable

Lab 11: Mendelian Genetics (evaluation of human traits such as attached earlobes, solving genetic problems)

- 26. This lab helped me to understand the biological concepts discussed in lecture
- 27. This lab was enjoyable

Lab 12: DNA and genetic transformation (Transformation of E. coli with ampicillin resistance and glow genes)

- 28. This lab helped me to understand the biological concepts discussed in lecture
- 29. This lab was enjoyable

Supplementary Table 1. Demographics of Four and Two-Year Campuses.

	<u>Two-Year Campus*</u> <u>1st Implementation</u>	<u>Two-Year Campus*</u> <u>2nd Implementation</u>	<u>Four-year**</u>
White Non-Hispanic	56%	70%	68%
Unknown/Not Reported	8%	8%	3%
Hispanic – Other	15%	10%	14%
Black Non-Hispanic	12%	4%	4%
Asian or Pacific Islander	6%	6%	3%
American Indian / Alaskan Native	3%	2%	1%
Male	47%	41%	47%
Female	53%	59%	53%
25 or older	45%	36%	24%
Part-time students***	56%	60%	29%

*Fall 2012 data from PPCC Data Book 2009-2013

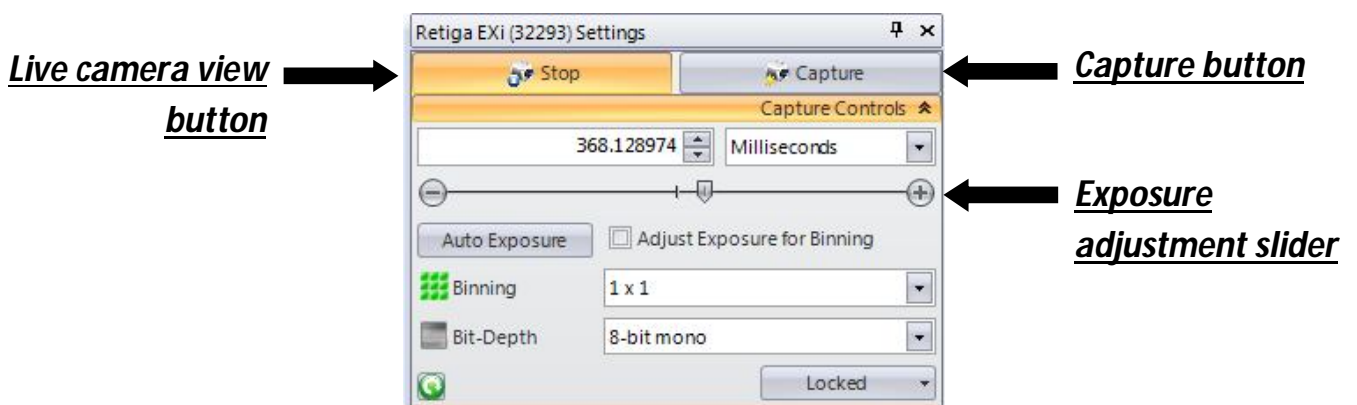
**Fall 2011 data from College Portrait www.uccs.edu/Documents/ir/VSA2011.PDF

***A student enrolled for less than 12 semester credit hours in a term.

Quick Reference: Fluorescence Microscopy

<u>Filter</u>	<u>Exposure (in milliseconds)</u>
5 = white light	~20
1= DAPI / DNA	~200
2 = GFP / Rad22	~1200

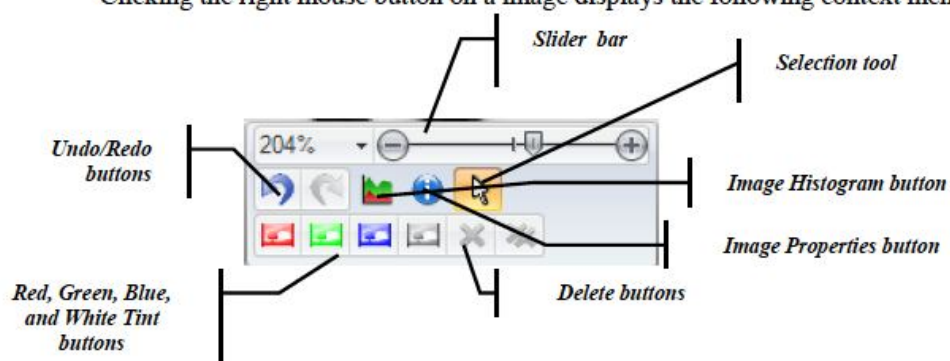
1. Make sure the fluorescence lamp box is turned on, lamp shutter is closed (button is OUT), shutter lever on the microscope is DOWN, and camera is live in QCapture.
2. On the microscope, rotate to filter #2 (GFP), turn on the white light, focus on a monolayer of cells with the 63X objective (with oil), and then turn the white light off.
3. In QCapture, adjust the exposure time according to table above, then open the fluorescence lamp shutter (push button IN), refocus, and click the Capture button.



4. Immediately close the fluorescence lamp shutter, rotate to filter #1 (DAPI), adjust the exposure time appropriately, open the shutter, refocus, and click the Capture button.
5. In QCapture, right-clicking on either of your pictures will access the image context menu, where you may apply tints and make other image adjustments.

The Image Context Menu

Clicking the right mouse button on a image displays the following context menu

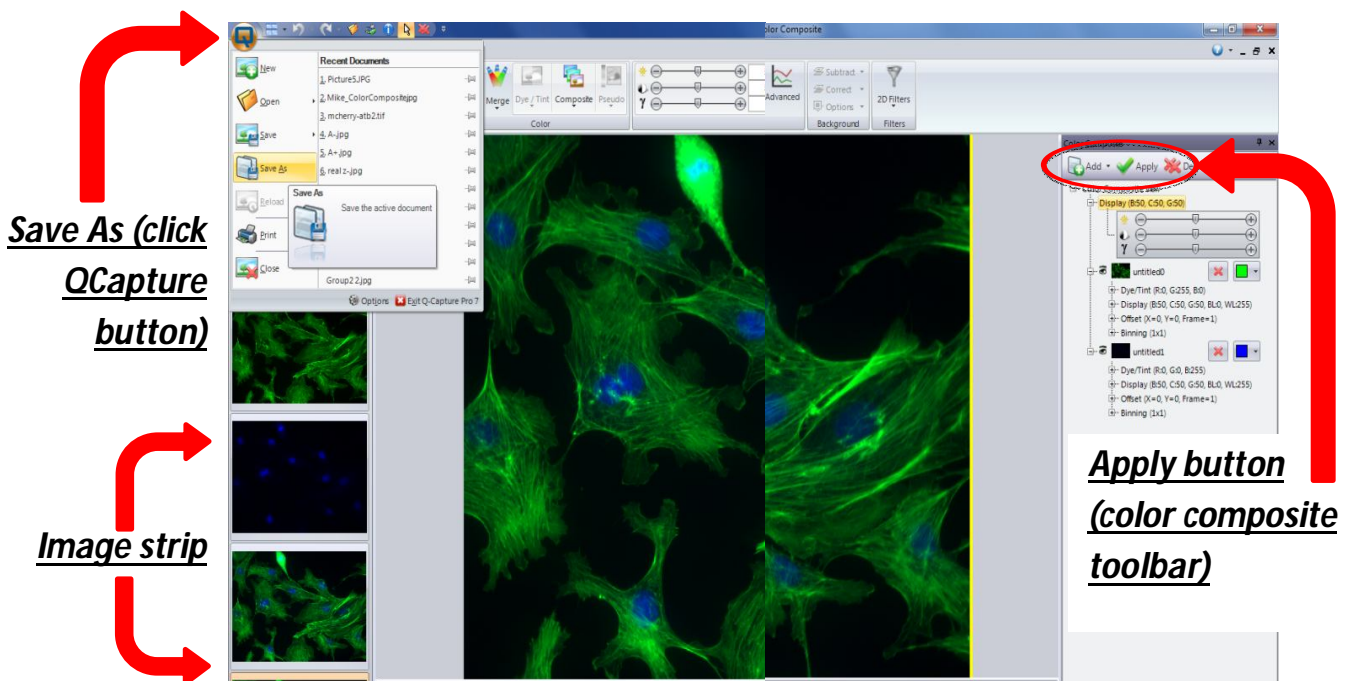


Saving and Printing Fluorescence Microscope Images

6. Once an image has been adjusted as desired, click on the Adjust tab in QCapture, then click the Apply button (a small green checkmark) to finalize your adjustments.



7. Once your adjustments have been applied, a color composite of your images will be generated. Use the Color Composite toolbar to make additional adjustments to your composite, then click its Apply button (another green checkmark) to generate a final composite image for saving and printing.



8. In the QCapture image strip, left-click on the new untitled color composite to select it, then click the large Q button in the upper left corner of the screen in order to access the Save As option.
9. Save your final image to a USB drive or other location of your choice.
10. Saved images viewed on a laptop or netbook may be printed in color by selecting the printer named "HP Officejet Pro K8600 Series". Alternatively, saved images may also be printed by attaching them to an email sent to uccsbiolab@hpeprint.com.