

Course Syllabus: BIOL 4450/6450: Spring 2014

Theory and Practice of Scanning Electron Microscopy CRN 21966 and 21990; MW 1:00 – 1:50 p.m. (BC 1202), MW 2:00 – 3:50 p.m. (BC 1075)

Instructor: Dr. Russ Goddard, BC 2090, 249-2642

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Office Hours: Tues. and Thurs.: 9:30 – 11:30 a.m.

Course Catalog Description: BIOL 4450/6450, Theory and practice of scanning electron microscopy, 2-2-4.

Prerequisite: BIOL 3200 and 3250 or consent of the instructor (for 6450: admission into the graduate program).

General principles of scanning electron microscopy operation and theory with comparison to light and TEM optics in a laboratory intensive environment. Topics include fixation and preparation of samples for standard, low voltage, low vacuum, and high resolution SEM.

Recommended Texts:

Goldstein et. al. 2003. Scanning electron microscopy and x-ray microanalysis, 3e. Kluwer Academic/ Plenum Publishers. New York.

Several text books will be placed in BC 1075 for use in BC 1075. These books may not be removed from the SEM lab or Dr. Goddard will remove the privilege of use!

Many links are also available through the internet for explanation of topics covered.

Grading: There are two parts to this course, the lecture and the laboratory, but students must understand that this course is a laboratory intensive course and that they will need to spend significant independent time in the laboratory.

Lecture Exams (300 pts): There will be 3 one-hour exams in this course. Each exam will mainly cover approximately 1/3 of the lecture material but each exam is comprehensive and can ask questions from any material covered since day one. Each of the three exams will be worth 100 pts.

Lab Image Portfolio (200 pts.): Throughout the course, students will be assigned comparative parameters that they will use to photograph specimens. Students will be required to make a high resolution electronic portfolio of the comparative images by Friday May 2nd, 2014 (Due by 3p.m.).

Check-out Exam (50 pts): After their first instruction on the SEM, students are required to use the microscope only during business hours following the rules outlined during lab. Students must work in pairs for their first 8 hours of logged use on the microscope. Once a student has logged eight hours of use and feels confident in their use of the microscope, you should schedule a basic check-out exam with Dr. Goddard. The requirements for this checkout are posted in the microscopy laboratory. Each student will be graded on their performance and on a fixed sample provided by Dr. Goddard that each student will process to preserve the best morphology possible (e.g. dehydration followed by CPD). All basic checkouts **must be completed before the end of February 21, 2014!** Significant late penalty point deductions will be applied after this date. After passing this check-out, students can operate the SEM independently, and they may work in the laboratory on nights and weekends provided this privilege is not abused.

Oral Proficiency Exams (100 pts): Each student will orally articulate and demonstrate any procedures with specimen preparation as well as basic and advanced microscope use during the week of April 21 – 25. After the basic check-out exam, students are expected to ask questions of the instructor based on the lab demonstrations and their independent use so that they are “expert” by the time they take this 100 point exam.

Research projects (Graduate Students): BIOL 6450 (100 pts). Since the SEM represents a tool for acquiring high quality research data, students must propose a research topic that could be studied using the equipment and procedures learned in the course. Students will research the literature and take preliminary photographs of any specimens that fit into a scientifically valid study. Graduate students will give a 10 min PowerPoint presentation, on their proposed research project during a lecture period TBA but near Feb. 24th. A final 20 min PowerPoint in the format of a scientific talk and containing images from the SEM, will be presented to

the class on April 30, 2014 during the lecture period. A paper copy containing a Title, Abstract, and References section will be required for hand-in at this time also.

Attendance: Students who miss class (lecture or laboratory) will lose points toward their final grade. Don't miss class.

Grading: The final grades will be based on a percentage of your cumulative points relative to the total points possible:

Guaranteed grade distribution is as follows (Max. pts = 650 for BIOL 4450; 750 for BIOL 6450):

A = 90-100%	<u>Points available: BIOL 4450:</u>	<u>Points available: BIOL 6450:</u>
B = 80-89%	Lecture Exams: 300 pts	Lecture Exams: 300 pts
C = 70-79%	Basic Check-Out: 50	Basic Check-Out: 50
D = 60-69%	Oral Proficiency Exam: 100	Oral Proficiency Exam: 100
F = ≤ 59%	<u>Lab Image Portfolio: 200</u>	Lab Image Portfolio: 200
	Total: 650 pts	Research Proposal 25
		<u>Research Presentation: 75 pts</u>
		Total: 750 pts

Tentative EXAM SCHEDULE:

Exam 1: Wednesday, 12 February 2014

Exam 2: Wednesday, 12 March 2014

Exam 3: Monday, 5 May 2014

Final Exam Period: Wednesday, May 7, 2014; 12:30 pm - 2:30 pm (Currently there is no final scheduled but this time may be used for the last exam, graduate student research presentations, etc. should any scheduling conflicts arise).

FERPA: The Family Educational Rights and Privacy Act (FERPA) prohibits the posting of grades by social security number or in any manner personally identifiable to the individual student. Grades will not be posted by social security number or by name. No grades can be given over the telephone, as positive identification cannot be made by this manner.

Students with Disabilities: Students requesting classroom accommodations or modifications because of a documented disability should contact the Access Office for Students with Disabilities located in room 1115 Nevins Hall. The phone numbers are 245-2498 (voice) and 219-1348 (tty).

It is expected that both the students and instructor will abide by the University policy on academic integrity found in the Student Code of Conduct on Page 60 of the student handbook:

(http://www.valdosta.edu/studentaffairs/documents/SAF_Student_Handbook_02122010revision.pdf)

General Course Objectives [Relevance to University General Education Outcomes listed as **VSU#**, for Biology undergraduate educational outcomes as **BIOL #**, and for Biology Masters educational outcomes as **MS #**]:

At the end of the course, each student will be able to:

1. Operate all instruments pertaining to SEM preparation (CPD, Sputter Coater, etc.) [VSU #3, BIOL #1, MS #1]
2. Operate the SEM proficiently and safely in all modes of operation. [VSU #3, BIOL #1, MS #1]
3. Analyze elemental characteristics of various samples [VSU #3, BIOL #1, MS #1]
4. Use image analysis software to make simple measurements of digital images. [VSU #7, BIOL #1, MS #1]
5. Understand what types of samples are amenable to SEM examination under different modes of operation. [VSU #5, BIOL #3, MS #1]
6. Identify the basic types of data that the SEM can produce and how that data can be interpreted and analyzed. [VSU #7, BIOL #1, MS #1]
7. Identify topical content standards that can be addressed with an SEM study. [VSU #5, BIOL #1& 3, MS #1]
8. Additional for Graduate Course 6450:
 - Develop a good scientific question that leads naturally to a good experimental design that is carried through to a written paper in the format of a scientific journal. [MS #2]
9. Present image data in a written portfolio of required images generated throughout the course. [VSU #7, BIOL #1, MS #2]
10. Present an oral PowerPoint presentation to the class of a research proposal to study a biological problem with SEM. [VSU #4&7, BIOL #1, MS #1&2]

Tentative Lecture and Laboratory Schedule:

Lecture:			Laboratory:	
Week	Date:	Topic :	Day	Exercise
1.	13 Jan.	Introduction and history of microscopy, Biological Specimen Preparation, Fixation	13 Jan.	Introduction to the Microscopy Laboratory; Safety in the Microscopy Laboratory; Fixation and preparation of specimens for SEM – Preparation of fixatives and samples
	15 Jan.		15 Jan.	Fixation and preparation of specimens for SEM
2.	20 Jan.	MLK Holiday: No Class	20 Jan.	MLK Holiday: No Class
	22 Jan.	Applications of LM, TEM, and SEM, Illumination sources (photons vs. accelerated electrons), Lens systems	22 Jan.	Critical Point Dryer principles and operation; Operation of the Denton Desk V sputter coater.
3.	27 Jan.	Magnification vs. resolution; Specimen-electron beam interactions; Factors affecting resolution and contrast	27 Jan.	Basic Operation of the SEM (Part 1): Cold vs. Warm start principles, Specimen exchange, turning on the microscope;
			29 Jan.	“ – second half of class.
4.	3 Feb.	Electron Guns, Lenses, vacuum systems, SEM Modes of Operation	3 Feb.	Basic Operation of the SEM (Part 2): Selection of Accelerating Voltage, Spot size, mechanical stage controls
			5 Feb.	“ – second half of class.
5.	10 Feb.	Illumination Systems and Aberrations, Magnification, Resolution, and Depth of Field	10 Feb.	Basic Operation of the SEM (Part 3): Optimization of resolution, depth of field, and signal to noise ratios.
	12 Feb.	Exam 1	12 Feb.	“ – second half of class.
6.	17 Feb.	SEM Imaging Processes SEM Signal Detectors	17 Feb.	Independent Use and Practice Basic Checkout Lab Exams
	21 Feb.	(Friday) Basic Checkout Complete!	19 Feb.	Independent Use and Practice
7.	24 Feb.	SEM Contrast Formation and Image Quality Other Contrast Mechanisms	24 Feb.	
			26 Feb.	Grad Student Research Proposals Due
8.	3 March	High Resolution Imaging and Signal Processing	3 March	Advanced Operation: Selection of Detectors for different sample composition
	6 March	MIDTERM Date: Last day to drop without penalty	5 March	“ – second half of class.
9.	10 March	Microscopy of Non-Conducting Specimens	10 March	Advanced Operation: Low Voltage SEM & Low Vacuum SEM
	12 March	Exam 2	12 March	“ – second half of class.
10.	17 March	Spring Break. No Classes	17	Spring Break. No Classes
			19	Spring Break. No Classes
11.	24 March	Low Voltage Microscopy	24 March	Advanced Operation: Energy Dispersive X-ray analysis
			26 March	“ – second half of class.
12.	31 March	Variable Pressure SEM and Environmental SEM.	31 March	Advanced Operation: Energy Dispersive X-ray analysis
			2 April	“ – second half of class.
13.	7 April	High-Resolution Microscopy methods	7 April	Independent Use and Practice
			9 April	Independent Use and Practice
14.	14 April	Final Check-out Exams – possibly no lecture...	14 April	Image Artifacts; Measuring Image data with ImageSys.; Photoshop and maintenance of image data
			16 April	
15.	21 April	Analytical SEM: Qualitative X-ray Analysis with EDS and WDS	21 April	Final Checkout / Oral exams
			23 April	Final Checkout / Oral exams
16.	28 April	Stereomicroscopy. Image Processing	28 April	Final Preparation of Portfolio's
	30 April	Graduate PPTs	30 April	
17.	5 May	Exam 3	5 May	No Lab
	7 May	Final Exam Period 12:30 – 2:30 pm		