

# Electron Microscopy

Program Number: 10-636-1

## Associate in Applied Science Degree

Biotechnology and Electron Microscopy Program Cluster

Center for Agriscience and Technologies

Program offered at Madison Campuses

For information call: (608) 246-6800 or  
(800) 322-6282 Ext. 6800

## About the Program

The Electron Microscopy program is a two-year program in which students learn to operate electron microscopes and related equipment, both scanning (SEM) and transmission (TEM). The preparation of biological and material samples for observation by TEM or SEM is an important part of the program. Interpretation of sample observations, including metallurgical structures and biological ultrastructure, is included.

Considerable emphasis is placed on communication skills, computer-image processing, X-ray microanalysis and maintenance of electron microscopes and related equipment. The entire program stresses a laboratory, hands-on approach to provide a graduating student with confident and proficient job-entry performance.

## Unique Requirements for Admission

It is strongly recommended that students take the math sequence of Algebra 1 and Algebra 2 to best prepare them for this program. In addition, one year each of biology and chemistry is highly recommended. Prior to registration, all students are required to consult with a faculty member. If high school chemistry has not been completed, it is recommended that 10-806-134 General Chemistry, be taken before beginning the program.

The Electron Microscopy Program participates in MAAP (Mandatory Assessment, Advising and Placement). This requires new students to complete the COMPASS or ASSET test. Advisement and course placement in English and math (and some science courses) are done based on test results. Testing should be completed prior to admission.

## Curriculum

The courses listed below outline the requirements for graduation for students entering this program in the 2011-2012 academic year. Requirements for graduation may vary depending on the semester in which a student is admitted to their program. Current/continuing students should consult their degree progress report available through their student center (myMadisonCollege) account for specific graduation requirements. Program requirements are subject to change.

FIRST YEAR		Credits	Hrs/week Lec-Lab
<b>First Semester</b>			
10-636-111	Scanning Electron Microscopy .....	3	2-3
10-636-112	Transmission Electron and Atomic Force Microscopy .....	4	3-3
10-636-113	EM Image Processing 1 .....	2	1-2
10-636-115	EM Photography & Lab Safety .....	2	2-0
10-804-118	Intermediate Algebra with Applications <b>OR</b> .....	3	2-2
20-804-201	Intermediate Algebra .....	(4)	(4-0)
10-806-134	General Chemistry <b>OR</b> .....	4	3-2
20-806-201	General Organic and Biological Chemistry .....	(5)	(4-2)
<b>Semester Total</b>		<b>18</b>	
<b>Second Semester</b>			
10-636-121	EM Biological Sample Preparation .....	3	2-2
10-636-122	EM Physical Preparation and FIB .....	4	3-3
10-636-123	EM Image Processing 2 .....	2	1-2
10-801-195	Written Communication .....	3	3-0
10-804-189	Introductory Statistics <b>OR</b> .....	3	3-0
20-804-240	Basic Statistics .....	(4)	(4-0)
10-806-182	Forces, Fields & Energy .....	3	2-2
<b>Semester Total</b>		<b>18</b>	
<b>SECOND YEAR</b>			
<b>First Semester</b>			
10-636-131	Advanced Biological Techniques and Ultrastructure Studies .....	3	2-2
10-636-132	Diffraction and Materials .....	4	3-3
10-636-133	Image Analysis .....	2	1-2
10-636-135	Laboratory and Microscope Maintenance .....	3	2-2
10-801-197	Technical Reporting .....	3	3-0
<b>Semester Total</b>		<b>15</b>	
<b>Second Semester</b>			
10-636-141	X-Ray Microanalysis .....	4	3-3
10-636-143	Special EM Techniques and Spectroscopy .....	3	2-3
10-636-147	Electron Microscopy Special Project .....	2	0-6
10-809-197	Contemporary American Society .....	3	3-0
10-809-199	Psychology of Human Relations .....	3	3-0
<b>Semester Total</b>		<b>15</b>	

*Note: Students are assessed for correct placement in English or mathematics courses based on their scores on the COMPASS test or on completion of the appropriate prerequisite(s). Additionally, there may be courses in other subject areas that may use COMPASS scores as prerequisites when reading, writing, math, or critical thinking competencies are required.*



## Program Courses

**10-636-111 Scanning Electron Microscopy 3 credits**  
Provides extensive laboratory work in which students become proficient in the operation of scanning electron microscopes (SEMs). Students learn electron-specimen interactions, image processing, effects of microscope variables on the image and the use of various microscope accessories and outputs. Microscope optics are also introduced.

**10-636-112 Transmission Electron and Atomic Force Microscopy 4 credits**  
Students become proficient in the alignment procedures, operation and theory of transmission electron microscopes (TEMs). Introduction to basic theory and operation of atomic force microscopes (AFMs). X-ray microanalysis will also be introduced.

**10-636-113 EM Image Processing 1 2 credits**  
This course studies the theory and application of digital image acquisition from microscopes. Students will learn how to import these images into a PC for incorporation into scientific documents. Additionally, the course will address issues of resolution, archiving, the differences between available image file formats and compression methods, and differences between various input and output sources.

**10-636-115 EM Photography Techniques and Lab Safety 2 credits**  
Students examine safety concerns and procedures encountered in an EM laboratory. The theory of optics and the practical application of light microscopy in science are studied. Film and principles of photography are also discussed.

**10-636-121 Biological Sample Prep EM 3 credits**  
Lecture-lab course covering biological sample preparation for both TEM and SEM. Includes chemical and cryo fixation, embedment, ultramicrotomy and staining methods. Solution preparation and laboratory techniques are also performed. Prerequisite: grade of C or better in both 10-636-111 and 10-636-112 or consent of the instructor.

**10-636-122 EM Physical Preparation and FIB 4 credits**  
Lecture-lab course covering specimen preparation for both SEM and TEM. Topics include replica preparation, ion milling, polishing and thinning methods. Material studies consider identification of metallurgical structures, fracture types, dislocation analysis and microstructures of geologic samples, plastics and ceramics. Prerequisite: grade of C or better in both 10-636-111 and 10-636-112 or consent of the instructor.

**10-636-123 EM Image Processing 2 2 credits**  
Advanced development of digital processing by enhancement and manipulation of EM images. Scientific filtering protocols, convolution masks, Fourier transforms, and Gaussian filters are applied in order to produce image for scientific and aesthetic purposes. Included are modules on scientific interpretation, analysis, and output media. This course explores in depth relationships between image quality at the microscope and output to various media. Scientific poster layout and design using Adobe InDesign and slide presentation using PowerPoint are covered. Prerequisite: grade of C or better in 10-636-113.

**10-636-131 Advanced Biological Techniques and Ultrastructure Studies 3 credits**  
Students prepare biological samples for both SEM and TEM using methods not previously presented, such as colloidal gold labeling. Includes ultrastructure studies enabling students to identify features encountered in micrographs for interpretation and analysis. Prerequisite: grade of C or better in both 10-636-121 and 10-636-122 or consent of instructor.

**10-636-132 Diffraction and Materials 4 credits**  
Interpretation and analysis is made for crystals using electron diffraction methods. Powder diffraction is introduced allowing compounds to be identified. Concepts of reciprocal lattice space and crystal structures are included. Prerequisite: grade of C or better in both 10-636-121 and 10-636-122 or consent of the instructor.

**10-636-133 Image Analysis 2 credits**  
Involves statistically measured and mathematical transformations of both analog and digital images. Topics include sampling techniques, stereology, three-dimensional reconstruction and analysis, cell or grain-size distribution and aspect-ratio-analysis, Fourier Transform analysis, and spatial filtering of images. Students will develop cross-platform computer skills with programs including: Adobe PhotoShop, NIH Image, ImagePro Plus, and VoxBlast. Prerequisite: grade of C or better in 10-636-123 or consent of instructor.

**10-636-135 Laboratory and Microscope Maintenance 3 credits**  
Students use oscilloscopes, vacuum leak checkers and other metrology equipment used for troubleshooting methods for the EM lab. Hands-on diagnostics, repairs and routine maintenance are made by students in EM lab setting.

**10-636-141 X-Ray Microanalysis 4 credits**  
Students perform elemental analysis with energy dispersive X-ray systems on both TEM and SEMs. The use of matrix corrections, qualitative and quantitative computer analysis routine will constitute a major part of this course. Prerequisite: grade of C or better in both 10-636-131 and 10-636-132 or consent of the instructor.

**10-636-143 Special EM Techniques and Spectroscopy 3 credits**  
Laboratory course in which students perform tasks including voltage contrast, electron beam induced current (EBIC) and electron channeling. Presents other microscopy methods, such as secondary ion mass spectroscopy (SIMS), focus ion beam (FIB) and Auger microscopes. Prerequisite: grade of C or better in both 10-636-131 and 10-636-132.

**10-636-147 Electron Microscopy Special Project 2 credits**  
Students choose an independent project resulting in a final report that will include micrographs from both TEMs and SEMs and x-ray analysis. Prerequisite: grade of C or better in Electron Microscopy Program sequence to date or consent of instructor.

## Career Potential:

- **Integrated Circuit Microscopic and Failure Analysts**  
Perform TEM, SEM, FIB, X-ray and AFM analysis to characterize micro-electronic components.
- **Biological Research Electron Microscopy Technicians**  
Prepare and examine plants and tissues for ultrastructural analysis.
- **Diagnostic Pathology Electron Microscopists**  
Produce micrographs for ultimate clinical diagnosis for a variety of diseases.
- **Materials Research Electron Microscopy Technicians**  
Evaluate metals, ceramics, plastics and geologic samples by Electron Microscopy and X-ray analysis.
- **Sales and/or Applications Representatives**  
Employment with microscope manufacturers, selling or demonstrating equipment, or instructing customers on equipment use.

*More detailed and updated information on this program may be available at: [madisoncollege.org](http://madisoncollege.org). The college reserves the right to make changes in the regulations and courses announced in this publication without notice.*

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