



MICROSCOPY SOCIETY OF AMERICA
Affiliate Society of American Institute of Physics - Affiliate Society of AAAS

Certification Program
Certified Electron Microscopy
Technologist
Biological Transmission Electron Microscopy

INFORMATION, REGULATIONS AND APPLICATION MATERIALS

IMPORTANT DATES

EXAMINATION CYCLE #66

Application Deadline	September 08, 2011
Written Examination Given	October 25, 2011
Practical Examination Deadline	December 14, 2011

MSA Certification Board

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GENERAL INFORMATION

The Microscopy Society of America (MSA)¹, the world's largest professional association of microscopists, provides the only certification of technologists in biological transmission electron microscopy available in the Americas. The program was initiated in 1978 to establish standards of technical skills. In addition to insuring employers that certified technologists are technically proficient, certification can be important in determining job classification, salary level, and potential for advancement or promotion. Many consider certification to be a key benchmark in their professional development.

The program is administered by the Certification Board which is appointed by the Council of the Society. The Board develops regulations, formulates and evaluates examinations, and interprets policies.

Individuals with the requisite educational and/or occupational qualifications can attain certification by completing and passing both written and practical examinations. Two examination cycles are offered each year. Complete regulations and an application form appear on the following pages.

The initial period of certification is one year, the calendar year indicated on the certificate furnished to all successful candidates. Certification may be renewed on a 5- year cycle by payment of the appropriate fee (\$75 for MSA members, \$150 for non -members²). At least every five years, a supervisor must write the Society to confirm the technologist's continuing employment in the field. Certified Technologists who allow their certification to lapse for one year may have it reinstated by paying the appropriate fees; if certification lapses for two or more years, the technologist must submit a new application and take both written and practical examinations again.

Communication with the Society, about certification or other matters, should be addressed to:

Microscopy Society of America
12100 Sunset Hills Road, Suite 130
Reston, VA 20190

Phone: (800) 538-3672
(703) 234-4115
FAX: (703) 435-4390

¹Before January 1, 1993, the Microscopy Society of America was the Electron Microscopy Society of America (EMSA). "Electron" was dropped from the name to reflect the Society's broadened scope that has come to include all kinds of microscopy and microanalysis. Nevertheless, most of the membership and scientific program still is concerned primarily with electron microscopy.

²The Society reserves the right to modify these and other fees from time to time to reflect changes in service, dues, etc.

APPLICATION AND REQUIREMENTS

An application for certification consists of:

1. A filled-out application form (included in this package).
2. An application fee of \$75.00 for MSA members or \$150.00 for non-members.^{1, 2}
3. Transcripts and/or documentation of **ONE** of the following:

Two years (60 credits) college or equivalent education, including at least two semesters of laboratory courses each in chemistry, physics, biology, and transmission electron microscopy (TEM), and one semester of mathematics

OR

One year (30 credits) college or equivalent education, including at least two semesters of laboratory courses each in chemistry and physics **AND** one year of recent³ full-time work experience doing biological TEM

OR

A high school diploma **AND** two years of recent³ full-time work experience doing biological TEM

OR

Three years of recent³ full-time work experience doing biological TEM

4. Letters of recommendation from two (2) experienced electron microscopists in supervisory positions having substantial records of research publication. At least one of them must be a member of MSA. The letters may either be enclosed with the application or sent separately, but the application will not be considered complete until the letters are received by the Society.

Applicants are responsible for seeing that all requirements are sent to the society in time and should check with the Society Office to make sure their applications are complete.

Applications completed after the deadline date automatically will be considered for the next examination cycle.

Completed applications are evaluated by the Certification Board to determine whether the applicant is qualified to take the examinations. Applicants not approved for examination will receive a written explanation and their certification application fee will be refunded (although MSA dues, if any, will not be refunded). Fees for applicants approved for examination are not refundable.

¹Application for membership in MSA is separate from application for certification. Candidates for certification may pay the lower member's fee by submitting an application for membership, along with one year's annual dues of \$60 (\$78 outside USA), at the same time they submit the application and fee for certification.

²Payment can be by check (US funds, drawn on a US bank) payable to MSA, or by credit card (Visa or Master Card only). If paying by credit card, supply the complete credit card number and expiration date.

³"recent" is interpreted to mean within the five years prior to application.

EXAMINATIONS: GENERAL

Candidates whose applications are approved must pass both a written and a practical examination in order to be certified. Both examinations usually are taken during the same cycle in which application was made; however, candidates may request deferring either or both examinations until the next cycle. Candidates who fail an examination in the cycle in which they applied may take it again in the next cycle without penalty.

All requirements for certification must be completed by the cycle after the one in which application is made. Otherwise the candidate must submit a new application, including the application fee and letters of recommendation (transcripts need not be re-submitted unless they have become outdated). Examinations taken prior to re-application must be taken again, even if previously passed.

Written Examination

The written examination is of the objective type (multiple choice, true-false, etc.); three hours are allotted for completion of the written examination. In most cases the examination is conducted in or near the candidate's home institution. A score of 70% is required to pass. The material covered includes:

- A. Instrumentation (approx. 25%)
- B. Tissue processing (approx. 25%)
- C. Sectioning and staining (approx. 25%)
- D. Special techniques and imaging (approx. 10%)
- E. General: chemistry, safety (approx. 15%)

Written Examination Study Syllabus

A. Instrumentation

Principles, components, alignment, routine maintenance of :

- Ultramicrotomes, both mechanical and thermal advance Knifemakers
- Light microscopes
- Transmission electron microscopes: fundamentals; operation, illumination; imaging systems; focusing; maintenance; test specimens; astigmatism; resolution, calibration, contamination
- Scanning electron microscopes: general principles; operation
- Vacuum systems: vacuum evaporator, sputter coaters, mechanical, diffusion, turbomolecular, ion pumps, vacuum gauges
- Incubators; ovens
- Balances
- pH meters
- Osmometers
- Centrifuges
- Photographic techniques

Written Examination Study Syllabus (continued)

B. Tissue Processing for TEM

Tissue procurement

Fixation: general principles and purpose; types, composition, preparation [glutaraldehyde, paraformaldehyde, OsO₄, KMnO₄]; buffers [phosphate, cacodylate, PIPES, HEPES, s-collidine, veronal- acetate]; factors affecting fixation [fixative concentration, time, temperature, pH, osmolarity, buffer, additives, penetration]; methods of fixation [immersion, perfusion, vapor]; criteria for good fixation

Washing: general principles and purpose; in block staining

Dehydration: general principles and purpose; dehydrating agents [ethanol, methanol, acetone, ethylene glycol]; factors affecting dehydration [concentration, time, temperature]

Infiltration: general principles and purpose

Embedding: general principles and purpose; types, composition and preparation of plastics [acrylics, polyesters, epoxies, catalysts, hardeners, plasticizers]; methods of embedding [capsules, flat, cell culture, vacuum]

Polymerization: general principles and purpose

Safety

C. Sectioning and Staining

Sectioning: general principles and purpose

Block Preparation: trimming; facing; re-mounting

Knife preparation: glass-breaking; inspection; troughs (boats); diamond knives; cleaning

Grid Preparation: types; cleaning; coating [Formvar, Butvar, collodion, carbon] "Thick" (semi-thin) sectioning; collection, mounting

Thin sectioning: orientation; flotation [liquid and meniscus]; flattening; collection; thickness [interference colors]; problems; factors

Staining: General principles and purpose

Thick sections: Toluidine blue-O, methylene blue, Paragon, azure II; Giemsa

Thin sections: factors affecting staining; preparation; methods; problems; specific stains [uranyl acetate, lead citrate, phosphotungstic acid, osmium, ruthenium, silver]

Safety

D. Special Techniques and Photography

General principles and purpose.

Processing: developers [types, factors]; preparation of negatives, prints, projection slides

Image processing, use of computers

Illustrations: labeling, magnifications

Negative staining

Shadow casting

Replication

Cytochemistry and immunolocalization

Autoradiography

Cryotechniques

E. General

Basic cytology, cell morphology, ultrastructure

Reagents: solvents, solutions, normality, molarity, percentage acids, bases, salts

Cleanliness: glassware, distilled and deionized water

Basic math: metric system, trigonometry, measurements

Safety: radiation, chemical, biological, fire

Written Examination: Sample Questions (from past examinations)

Multiple Choice

1. If a cell structure is 60 μm long on a micrograph at 20,000X, its actual length is:

- (a) 6 μm
- (b) 3 μm
- (c) 2 μm
- (d) 0.33 μm
- (e) 0.16 μm

2. Proper lab attire includes:

- (a) lab coat or jacket
- (b) open toed shoes or sandals
- (c) full length slacks
- (d) shorts
- (e) a and c above

3. Negative staining is often done with:

- (a) lead citrate
- (b) uranyl acetate
- (c) phosphotungstic Acid
- (d) Toluidine blue-O
- (e) b and c above

4. Astigmatism in a TEM can be caused by:

- (a) contamination of an aperture
- (b) improperly aligned filament
- (c) a vacuum leak in the camera chamber
- (d) a bent grid
- (e) b and c above

5. How much 25% glutaraldehyde is needed to make 50 ml of 3% glutaraldehyde?

- (a) 5 ml
- (b) 10 ml
- (c) 6 ml
- (d) 3 ml
- (e) 2.5 ml

Practical Examination

The practical examination consists of preparing blocks, sections, and micrographs from three **different tissues** and submitting them for evaluation by two (or sometimes three) members of the Certification Board having experience with specimens similar to those submitted. The examiners base their scoring on the usability of the specimens and grids in everyday practice. The relative weight given to various aspects of the submitted material is indicated on the *MSA Practical Exam Grading Sheet* included in this packet. An average (mean) score of 70 is required to pass.

All work must be done by the candidate except for obtaining the gross tissue specimens where a supervisor or other qualified individual may assist. A signed *Pledge of Independent Workmanship* (included in this package) must accompany the examination materials. Normal (**not pathological and not human**) tissue and common processing methods should be used. Detailed instructions follow:

1. Prepare three different tissues for transmission electron microscopy, from fixation through sectioning and uranyl acetate-lead staining, on uncoated 200 or 300 mesh copper grids. The tissues may be plant, animal or microorganism, as the candidate chooses, except that at least one tissue must be from a mammal or higher plant. *Be aware that the embedding resin you choose will affect the quality of your final images.*
2. Submit the following:
 - a. one trimmed tissue block from each tissue
 - b. four grids from each submitted block
 - c. one slide of “thick” (ca. 1 μ m) sections for light microscopy, appropriately stained, from each submitted block
 - d. a detailed description, no longer than one page for each tissue, of the preparation methods used . Be sure to indicate whether a glass or diamond knife was used.
 - e. one unmounted 8"x10" electron micrograph from each grid (a total of 12 micrographs) at a final magnification between 15,000X and 30,000X.
 - f. on a separate sheet, a complete figure legend for each micrograph. They should be one or two sentences long , journal style, (e.g. *Microscopy and Microanalysis*) and should describe any labeled structures and micron markers that appear on the micrographs.
 - g. the original negatives from which the submitted micrographs were printed. *If your laboratory does not have appropriate darkroom facilities, contact the Certification Board Chairman for instructions for submitting digital images.*
3. Identify these materials only with the **examination ID** number you were assigned when your application was approved. Do not label items with either your name or your lab’s name. Separate the grids into three groups of four and place them in a grid box (slide-type preferred) secured with a rubber band. We recommend packing all materials in a sturdy cardboard box such as a photographic paper box and putting the box in a padded mailing envelope.

4. Send all materials (do not forget the *Pledge of Independent Workmanship*) to the **Chair of the Certification Board to arrive by the deadline date.** [Sending the practical exam to the Business Office delays the grading of the exam and increases shipping costs.] The Certification Board Chairman will provide you with the appropriate shipping address when you are informed of passing the written examination. We recommend using a courier like UPS or Federal Express; if you use the U.S. Postal Service, send the exam by express, certified, or registered mail. MSA is not responsible for damage to examination materials in transit.
5. Submitted examination materials are held confidential, become the property of MSA, and are not returned to the applicant. If one or two grids per tissue are damaged or not usable, grades will be based on the remaining grids; if there are more than two damaged grids per sample or unlabeled or missing material, or other deficiencies, the examination may be returned for re-submission in a later cycle.

Reference Books on Transmission Electron Microscopy

- Bozzola, J. J. and Russell, L. D. *Electron Microscopy*, Jones and Bartlett, Boston, (1999)
- Dawes, C. J. *Biological Techniques in Electron Microscopy*, Barnes and Noble, New York (1979)
- Glauert, A. M., Ed., *Practical Methods in Electron Microscopy*, North Holland, Amsterdam:
- Vol. 2: Agar, A. W., Alderson, R. H., and Chescoe, D. *Principles and Practice of Electron Microscope Operation* (1974)
- Vol. 3, Part 1: Glauert, A. M. *Fixation, Dehydration, and Embedding of Biological Specimens* (1974)
- Vol. 5, Part 1: Lewis, P. R. and Knight, D. P. *Staining Methods for Sectioned Material* (1977)
- Glauert, A. M. and Lewis, P. R. *Biological Specimen Preparation for Electron Microscopy*, Princeton University Press, Princeton, NJ (1998)
- Griffiths, G. *Fine Structure Immunocytochemistry*, Springer-Verlag (1993)
- Hayat, M. A. *Basic Techniques for Transmission Electron Microscopy*, Academic Press, New York (1986)
- Hayat, M. A. *Correlative Microscopy in Biology. Instrumentation and Methods*, Academic Press, New York (1987)
- Hayat, M. A. *Principles and Techniques of Electron Microscopy. Biological Applications*, Cambridge University Press (2000)
- Maunsbach, A. B. and Afzelius, B. A. *Biomedical Electron Microscopy. Illustrated Methods and Interpretations*, Academic Press, New York (1999)

MICROSCOPY SOCIETY OF AMERICA

CERTIFICATION BOARD

Practical Examination

Pledge of Independent Workmanship

Applicant's Name: _____

Applicant's Examination Number: _____

I hereby state that all the procedures carried out in the preparation of the enclosed grids, microscope preparations and micrographs were performed exclusively by me and without any assistance.

Applicant's Signature: _____

Witness' Name (print): _____

Witness' Signature: _____

Date: _____

Location(s) where work was performed:

MSA PRACTICAL EXAM GRADING SHEET

ID# _____ Cycle# _____ For Certification as Technologist (Biological)
1st Submission _____ Retake _____

BIOLOGICAL SCIENCE TISSUES (NONPATHOLOGICAL)

	<u>POINTS</u>	<u>SCORE</u>	<u>TOTAL</u>
1. _____	BLOCK	3	_____
(Name of Specimen)	SLIDE	3	_____
	SECTION	7	_____
	FIXATION	6	_____
	STAIN	6	_____
	MICROGRAPH	6	_____
	LEGEND	2	_____
	(33)		_____
2. _____	BLOCK	3	_____
(Name of Specimen)	SLIDE	3	_____
	SECTION	7	_____
	FIXATION	6	_____
	STAIN	6	_____
	MICROGRAPH	6	_____
	LEGEND	2	_____
	(33)		_____
3. _____	BLOCK	3	_____
(Name of Specimen)	SLIDE	3	_____
	SECTION	7	_____
	FIXATION	6	_____
	STAIN	6	_____
	MICROGRAPH	6	_____
	LEGEND	2	_____
	(33)		_____
	TOTAL SCORE		_____

Date: _____ Signature: _____

MICROSCOPY SOCIETY OF AMERICA
Application for Certification
Electron Microscopy Technologist
Biological Transmission Electron Microscopy

Name: _____
Mailing Address: _____

Is this address your residence? _____ Work? _____
Company/University (only if not part of above address): _____
Daytime Phone: (____) _____ FAX: (____) _____
E-mail address: _____
I have read and understand the regulations pertaining to MSA Certification.
Your signature: _____ Date: _____

EDUCATION (Start with High School)
School/Location/Years Attended Credit Hours Major Field Degree

EMPLOYMENT (EM Related)

Current employer (name and address):

Position/Title: Years employed there: _____
Supervisor's name: _____

Previous employer (name and address):

Position/Title: _____ Years employed there: _____
Supervisor's name: _____