

The in-class lectures as well as lecture notes and PowerPoints posted on the Web provide a fairly complete introduction to the principles and practice of transmission electron microscopy and to image reconstruction, **BUT** they are **by no means** comprehensive. This “**REFERENCE LISTS**” document is a guide to books and articles from which you can obtain additional, more detailed descriptions of specific topics. To maximize the value derived from this course, the lectures and lecture notes ought to be supplemented by some outside reading. References identified with the ‘•’ symbol are recommended starting points. **Notes:** This list is far from complete and is a perpetual work in progress: when possible, updates will be posted at <http://cryoem.ucsd.edu>. Check the **BOOK LIST** document for complete citations for textbooks like Watt, Wischnitzer, Meek, Agar, and others, which provide a large number of the figures shown in class lecture and in the lecture notes.

INTRODUCTORY MATERIAL

- Watt (1985) Chap. 1, pp.1-19 (Chap. 1, pp.1-29 in 1997 edition)
 Wischnitzer (1981) Chap. 1-3, pp.1-37 (pp.1-37 in 1970 edition)
 •Meek (1976) Chap. 1-2, pp.1-59 (pp.1-65 in 1970 edition)
 Agar (1974) Chap. 1, pp.1-37
 Slayter (1970) Chap. 16, pp.341-350
 Sjostrand (1967) Chap. 2-3, pp.15-128
 Hall (1966) Chap. 1-2, pp.1-43

HISTORY OF THE ELECTRON MICROSCOPE

- Wischnitzer (1981) Chap. 2, pp.4-5 (4-5 in 1970 edition)
 •Meek (1976) Chap. 2, pp.55-59 (49-54 in 1970 edition)
 Hall (1966) Chap. 1, pp.1-6
- Burton, E. F. and W. H. Kohl, In The Electron Microscope. 1st ed. 1942, 2nd ed. (1946). Historical accounts of very early electron microscopy.
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- The Beginnings of Electron Microscopy. P. W. Hawkes (ed.). (1985). Contains many chapters devoted to the history of TEM and SEM. *Adv. Elec. Elec. Phys. Suppl. 16*
- Cosslett, V. E. (1987) Fifty years of instrumental development of the electron microscope. *Adv. Opt. Elec. Microsc. 10:215-267* (R. Barer and V. E. Cosslett, eds.).
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GENERAL OVERVIEW OF THE MICROSCOPE

- Slayter (1992) Chap. 1, pp.4-5
 Watt (1985) Chap. 2, pp.20-31 (Chap. 3, pp.59-89 in 1997 edition)
 Wischnitzer (1981) xvi-xix, Chap. 3, pp.36-37 (xiv-xv,36-37 in 1970 edition)
 •Meek (1976) Chap. 6, pp.107-111 (97-101 in 1970 edition)
 Agar (1974) Chap. 1, pp.8,14
 Slayter (1970) Chap. 18, pp.377-379
 Sjostrand (1967) Chap. 3, pp.63-66
 Hall (1966) Chap. 7, pp.136-138

ANALOGY BETWEEN ELECTRON AND LIGHT MICROSCOPY

- Slayter (1992) Chap. 1, pp.4-5
 Watt (1985) Chap. 2, pp.20-21 (Chap. 3, pp.59-61 in 1997 edition)
 Wischnitzer (1981) Chap. 3, pp.36-37; Chap. 4, pp.111-112 (36-37,108 in 1970 edition)
 •Meek (1976) Chap. 1, pp.1-38 (1-42 in 1970 edition)
 Agar (1974) Chap. 1, p.8
 Slayter (1970) Chap. 18, pp.377-379

PHOTONS/ELECTRONS: Diffraction/Interference/Coherence/Resolution

- Slayter (1992) Chap. 2, pp.7-22; Chap. 4, pp.39-49; Chap. 9, pp.118-130
 Watt (1985) Chap. 1, pp.6-10 (Chap. 1, pp.7-14 in 1997 edition)
 Wischnitzer (1981) Chap. 3, pp.6-15; Appendix A, pp.290-295; Appendix J, pp.316-321 (6-15,206-211,232-237 in 1970 edition)
 •Meek (1976) Chap. 1-2, pp.23-49 (20-45 in 1970 edition)
 Agar (1974) Chap. 1, pp.2-9; Chap. 3, pp.96-99
 Slayter (1970) Chap. 3, pp.65-71; Chap. 10, pp.233-248; Chap. 16, pp.341-346
 Sjostrand (1967) Chap. 2, pp.24-31; Chap. 4, pp.97-106,112-118
 Hall (1966) Chap. 1, pp.12-18; Chap. 3, pp.55-56; Chap. 7, pp.138-142,154-157; Chap. 9, pp.235-249

OPTICS (Lens Theory)

- Slayter (1992) Chap. 2, pp.10-13; Chap. 6, pp.65-73; Appendix, pp.298-301
 Watt (1985) Chap. 1, pp.1-5 (Chap. 1, pp.1-7 in 1997 edition)
 Wischnitzer (1981) Chap. 3, p.19 (19 in 1970 edition)
 •Meek (1976) Chap. 1, pp.1-23 (1-20 in 1970 edition)
 Agar (1974) Chap. 1, pp.4-9
 Slayter (1970) Chap. 8, pp.153-170,176-185; Chap. 17, pp.364-350
 Sjostrand (1967) Chap. 2, pp.15-24
 Hall (1966) Chap. 1, pp.6-12; Chap. 3, pp.44-57

Most physics textbooks have a chapter on geometrical optics

ELECTRON BEAMS/OPTICS AND MAGNETIC AND ELECTROSTATIC LENSES

- Slayter (1992) Chap. 6, pp.73-79
 Watt (1985) Chap. 1, pp.10-16 (Chap. 1, pp.14-24 in 1997 edition)
 Wischnitzer (1981) Chap. 3, pp.15-35 (15-35 in 1970 edition)
 •Meek (1976) Chap. 2, pp.49-54; Chap. 4, pp.75-80; Chap. 6, pp.103-107 (45-49,66-71,93-97 in 1970 ed.)
 Agar (1974) Chap. 3, pp.98-99; Chap. 8, pp.277
 Slayter (1970) Chap. 3, pp.70-71; Chap. 16-17, pp.349-363
 Sjostrand (1967) Chap. 2, pp.31-56
 Hall (1966) Chap. 2, pp.26-43; Chap. 4-5, pp.58-117; Chap. 7, pp.154-157

TRANSMISSION ELECTRON MICROSCOPE INSTRUMENTATION**General References**

- Slayter (1992) Chap. 14, pp.192-206
 Watt (1985) Chap. 2, pp.20-32 (Chap. 3, pp.59-85 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.38-81,102-103; Appendix E, pp.304-306; Appendix N, pp.335-342.
 Wischnitzer (1970) Chap. 4, pp.38-81,102-103; Appendix E, pp.220-222
 •Meek (1976) Chap. 5, pp.97-99; Chap. 6-8, pp.111-191; Chap. 15, pp.354-355.
 Meek (1970) Chap. 4, pp.87-88; Chap. 5-7, pp.101-176; Chap. 14, pp.372-373.
 Agar (1974) Chap. 1-2, pp.9-82; Chap. 6, pp.168-169,177,186
 Slayter (1970) Chap. 9, pp.187-219; Chap. 17-18, pp.363-397
 Sjostrand (1967) Chap. 2-3, pp.56-92
 Hall (1966) Chap. Chap. 1, pp.6-7; Chap. 6-7, pp. pp.118-166

TRANSMISSION ELECTRON MICROSCOPE INSTRUMENTATION (Cont'd)**A. Electron Gun**

- Slayter (1992) Chap. 14, pp.196-199
 Watt (1985) Appendix 4, pp.276-286 (Appendix 4, pp.432-447 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.38-46 (38-46 in 1970 edition)
 •Meek (1976) Chap. 6, pp.111-117 (101-106 in 1970 edition)
 Agar (1974) Chap. 1, pp.15-21; Chap. 2, pp.42-46
 Slayter (1970) Chap. 18, pp.379-383
 Sjostrand (1967) Chap. 3, pp.66-75
 Hall (1966) Chap. 7, pp.145-151

Field Emission Gun Technology

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 Otten, M. T. and W. M. J. Coene (1993) High-resolution imaging on a field emission TEM. *Ultramicrosc.* **48:77-91**.
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 •Zemlin, F. (1994) Expected contribution of the field-emission gun to high-resolution transmission electron microscopy. *Micron* **25:223-226**.
 Rathkey, D. (1995) Field emission basics: The water bucket analogy. *Microsc. Today* **95 10:20-21**.

B. Condenser Lens

- Slayter (1992) Chap. 14, pp.199-201
 Watt (1985) Chap. 2, pp.23-25 (Chap. 3, pp.63-65 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.46-50,102-103; Appendix E, pp.304-306 (46-50,102-103,220-222 in 1970)
 •Meek (1976) Chap. 6, pp.117-123 (107-113 in 1970 edition)
 Agar (1974) Chap. 1, pp.21-26; Chap. 2, pp.46-50
 Slayter (1970) Chap. 18, pp.388-391
 Sjostrand (1967) Chap. 3, pp.75-78
 Hall (1966) Chap. 7, pp.151-154

C. Lens Aberrations

- Slayter (1992) Chap. 6, pp.79-87
 Watt (1985) Chap. 1, pp.2-5,11-17 (Chap. 1, pp.1-6,18-24 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.53-59,64-65 (53-59,64-65 in 1970 edition)
 •Meek (1976) Chap. 4, pp.80-89 (71-80 in 1970 edition)
 Agar (1974) Chap. 1, pp.9-13
 Slayter (1970) Chap. 9, pp.187-219; Chap. 17, pp.363-372
 Sjostrand (1967) Chap. 2, pp.56-62
 Hall (1966) Chap. 6, pp.118-135

TRANSMISSION ELECTRON MICROSCOPE INSTRUMENTATION (Cont'd)**D. Objective Lens/Aperture and Specimen Stage**

- Slayter (1992) Chap. 14, pp.201-204
 Watt (1985) Chap. 2, pp.25-27 (Chap. 3, pp.66-68 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.50-52,72-75 (50-52,72-75 in 1970 edition)
 •Meek (1976) Chap. 5, pp.97-99; Chap. 6, pp.123-127 (87-88,113-117 in 1970 edition)
 Agar (1974) Chap. 1, pp.26-28; Chap. 2, pp.50-67; Chap. 6, pp.168-169
 Slayter (1970) Chap. 18, pp.391-394
 Sjostrand (1967) Chap. 3, pp.78-80
 Hall (1966) Chap. 7, pp.158-163

E. Projector Lens

- Slayter (1992) Chap. 14, p.204
 Watt (1985) Chap. 2, pp.27-28 (Chap. 3, pp.68-69 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.62-68 (62-68 in 1970 edition)
 •Meek (1976) Chap. 6, pp.127-133 (117-123 in 1970 edition)
 Agar (1974) Chap. 2, pp.28-37,69
 Slayter (1970) Chap. 18, pp.394-395
 Sjostrand (1967) Chap. 3, pp.80-81
 Hall (1966) Chap. 6-7, pp.132-135,163-166

F. Camera and Viewing System

- Slayter (1992) Chap. 14, pp.204-206
 Watt (1985) Chap. 2, pp.28-29 (Chap. 3, pp.69-72 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.68-71,75 (68-71,75 in 1970 edition)
 •Meek (1976) Chap. 15, pp.354-355 (372-373 in 1970 edition)
 Agar (1974) Chap. 2, pp.69-72; Chap. 6, p.177
 Slayter (1970) Chap. 18, pp.396-397
 Sjostrand (1967) Chap. 3, pp.82-83

G. Vacuum System

- Watt (1997) Chap. 3, pp.76-78; Appendix 1, pp.379-400
 Slayter (1992) Chap. 14, pp.192-196
 Watt (1985) Chap. 2, pp.29-31; Appendix 1, pp.228-241
 Wischnitzer (1981) Chap. 4, pp.76-79; Appendix N, pp.335-342 (76-79 in 1970 edition)
 •Meek (1976) Chap. 7, pp.139-166 (129-155 in 1970 edition)
 Agar (1974) Chap. 2, pp.73-77; Chap. 6, p.186
 Slayter (1970) Chap. 18, pp.383-387
 Sjostrand (1967) Chap. 3, pp.83-91

H. Electrical System

- Wischnitzer (1981) Chap. 4, pp.80-81 (80-81 in 1970 edition)
 •Meek (1976) Chap. 8, pp.167-191 (156-176 in 1970 edition)
 Agar (1974) Chap. 2, pp.78-82

CONTRAST AND IMAGE FORMATION**A. Depth of Field/Focus**

- Slayter (1992) Chap. 16, p.235
 Watt (1985) Chap. 1, pp.8-9 (Chap. 1, pp.10-11 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.61-64; Appendix F, pp.307-310 (61-64,223-226 in 1970 edition)
 •Meek (1976) Chap. 4, pp.89-91 (80-82 in 1970 edition)
 Agar (1974) Chap. 1, pp.13-14; Chap. 2, p.72
 Slayter (1970) Chap. 18, pp.413-415
 Sjostrand (1967) Chap. 4, pp.118-122
 Hall (1966) Chap. 7, pp.142-145

CONTRAST AND IMAGE FORMATION (Cont'd)**B. Elastic/Inelastic Scattering**

- Slayter (1992) Chap. 8, pp.102-109
- Watt (1985) Chap. 2, p. 74 (Chap. 2, pp.48-49 in 1997 edition)
- Wischnitzer (1981) Chap. 4, pp.59-61 (59-61 in 1970 edition)
- Meek (1976) Chap. 5, pp.94-97 (85-86 in 1970 edition)
- Agar (1974) Chap. 3, pp.83-87
- Slayter (1970) Chap. 19, pp.421-430
- Sjostrand (1967) Chap. 4, pp.93-97
- Hall (1966) Chap. 8, pp.200-216

C. Phase/Amplitude Contrast/Contrast Transfer Theory

- Slayter (1992) Chap. 7, pp.88-94; Chap. 8, pp.95-102,109-117
 - Watt (1985) Chap. 3, pp.88-91 (Chap. 5, pp.189-192 in 1997 edition)
 - Wischnitzer (1981) Chap. 4, pp.59-61; Appendix J, pp.317-321 (59-61,233-237 in 1970 edition)
 - Meek (1976) Chap. 5, pp.97-101 (88-90 in 1970 edition)
 - Agar (1974) Chap. 3, pp.87-96,99-110; Chap. 8, pp.277-285
 - Slayter (1970) Chap. 19, pp.421,431-441
 - Sjostrand (1967) Chap. 4, pp.106-110
 - Hall (1966) Chap. 9, pp.262-264
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CONTRAST AND IMAGE FORMATION (Cont'd)**C. Phase/Amplitude Contrast/Contrast Transfer Theory** (Cont'd)

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MICROSCOPE DISTURBANCES AND ALIGNMENT

- Slayter (1992) Chap. 16, pp.241-242
 Watt (1985) Chap. 2, pp.24-25 (Chap. 3, pp.65-66 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.81-95 (81-95 in 1970 edition)
 •Meek (1976) Chap. 6, pp.133-138; Chap. 11, pp.229-233,241-256,276-289
 (1970) 123-128,254-258,265-281,298-311
 Agar (1974) Chap. 3, pp.98-99; Chap. 8, pp.277
 Slayter (1970) Chap. 17, pp.370-372; Chap. 18, pp.387-388,399-402,409-413; Chap. 20, pp.453-459
 Sjostrand (1967) Chap. 10-11, pp.311-361
 Hall (1966) Chap. 7, pp.167-171

OPERATION OF THE TRANSMISSION ELECTRON MICROSCOPE**General References**

- Slayter (1992) Chap. 16, pp.238-246
 Wischnitzer (1981) Chap. 4, pp.100-102 (100-102 in 1970 edition)
 •Meek (1976) Chap. 11-12, pp.221-297 (246-319 in 1970 edition)
 Agar (1974) Chap. 6, pp.166-190
 Slayter (1970) Chap. 20, pp.458-459

A. Choice of Voltage

- Wischnitzer (1981) Chap. 4, pp.107-111 (none in 1970 edition)
 •Meek (1976) Chap. 11, p.228 (252-253 in 1970 edition)
 Agar (1974) Chap. 6, pp.166-167

B. Choice of Apertures

- Wischnitzer (1981) Chap. 4, pp.73-75 (73-75 in 1970 edition)
 Agar (1974) Chap. 6, pp.167-169

C. Specimen Stage

- Watt (1985) Chap. 2, pp.25-26 (Chap. 3, pp.66-67,74-75 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.72-73 (72-73 in 1970 edition)
 •Meek (1976) Chap. 11, pp.233-235 (258-261 in 1970 edition)
 Agar (1974) Chap. 6, pp.169-171
 Sjostrand (1967) Chap. 3, pp.81-82

D. Choice of Magnification

- Meek (1976) Chap. 11, pp.235-238 (260-262 in 1970 edition)
 Agar (1974) Chap. 1, pp.28-30
 Slayter (1970) Chap. 18, pp.395-396

E. Focusing

- Watt (1997) Chap. 3, pp.75-77; Chap. 5, pp.197-199
 Slayter (1992) Chap. 16, pp.238-240
 Watt (1985) Chap. 2, pp.29-30; Chap. 4, pp.169-172
 •Meek (1976) Chap. 11, pp.238-241; Chap. 12, pp.271-272,290-296 (263-265,293-294,311-318 in 1970 edition)
 Agar (1974) Chap. 3, pp.106-110; Chap. 6, pp.173-177
 Slayter (1970) Chap. 18, pp.402-409
 Sjostrand (1967) Chap. 4, pp.106-110

OPERATION OF THE TRANSMISSION ELECTRON MICROSCOPE (Cont'd)**F. Magnification Calibration**

- Slayter (1992) Chap. 16, pp.242-244
 Watt (1985) Chap. 3, pp.94-95 (Chap. 5, pp.195-197 in 1997 edition)
 Wischnitzer (1981) Chap. 4, pp.101-102 (101-102 in 1970 edition)
 •Meek (1976) Chap. 13, pp.317-321 (335-339 in 1970 edition)
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OPERATION OF THE TRANSMISSION ELECTRON MICROSCOPE (Cont'd)**H. Image Intensifier/TV Display**

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E. Field Emission/Emission/Ion/Shadow/Reflection/Mirror EM

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SPECIMEN PREPARATION TECHNIQUES**A. Specimen Support Grids for TEM**

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B. Specimen Support Films for TEM

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SPECIMEN PREPARATION TECHNIQUES (Continued)**C. Thin-sectioning (Fixation/Dehydration/Embedding/Staining)**

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 Watt (1985) Chap. 3, pp.87-88; Chap. 4, pp.149-154; Chap. 5, pp.216-218
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D. Negative Staining

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 Watt (1985) Chap. 4, pp.165,167; Chap. 5, pp.200-201
 Wischnitzer (1981) Chap. 12, pp.171-173; Chap. 13, pp.203-204 (167-169, 199-200 in 1970 edition)
 •Meek (1976) Chap. 15, pp.474-476 (465-467 in 1970 edition)
 Slayter (1970) Chap. 19, p.431
 Sjostrand (1967) Chap. 9, pp.303-308
 Hall (1966) Chap. 10, pp.333-337,356-360
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SPECIMEN PREPARATION TECHNIQUES (Cont'd)**E. Metal Shadowing**

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 •Meek (1976) Chap. 15, pp.476-482 (471-477 in 1970 edition)
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F. Unstained Specimens

To my knowledge, general textbooks have yet to include discussion about the preparation and microscopy of unstained specimens. Hence, to acquire any in-depth knowledge about preparation and imaging such specimens, it is important to read **at least one or two** of the articles listed below.

1. Unstained Specimens (Room Temperature)

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- Akey, C. W. and S. J. Edelstein (1983) Equivalence of the projected structure of thin catalase crystals preserved for electron microscopy by negative stain, glucose or embedding in the presence of tannic acid. *J. Mol. Biol.* **163:575-612.**
- Cohen, H. A., T. -W. Jeng, R. A. Grant and W. Chiu (1984) Specimen preparative methods for electron crystallography of soluble proteins. *Ultramicrosc.* **13:19-26.**

SPECIMEN PREPARATION TECHNIQUES (Cont'd)**2. Unstained Specimens (Frozen-Hydrated)**

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