BIO 595W 3D RECONSTRUCTION OF MACROMOLECULES

Most of the references listed here are in the Biosciences library in Lilly Hall of Life Sciences and several have been put on reserve (see list on page 7). Those marked '⇒' are good places to start. The Biosciences Library call numbers are given at the end of each reference. Unless otherwise specified, assume all citations are located in the Biosciences library. "TSB" means that T. S. Baker has a copy or copies that you may borrow temporarily if you can't find a copy in a Purdue library.

GENERAL TEXTBOOKS AND MONOGRAPHS

WHERE TO START:

⇒ **Three-Dimensional Electron Microscopy of Macromolecular Assemblies.** J. Frank. **1996**. Academic Press, San Diego, CA. The most recent, comprehensive text on issues relevant to image processing of biological macromolecules. Most emphasis is on processing of images of single particles without symmetry. (578.45 F851t & TSB)

⇒ **Biophysical Electron Microscopy: Basic Concepts and Modern Techniques**. P. W. Hawkes and U. Valdre (eds.). **1990**. Several chapters with one by M. F. Moody (140 pages) devoted to image analysis. (578.45 B524 & TSB)

⇒ **Image Analysis, Enhancement and Interpretation.** D. L. Misell. In Practical Methods in Electron Microscopy, Vol. 7, **1978**, A. M. Glauert (ed.). This was the first book to be written about the basics of image analysis discussed in this course. (502.8 P881 & TSB)

Electron Tomography: Three-Dimensional Imaging with the Transmission Electron Microscope. J. Frank (ed.). **1992**. Plenum Press, New York. Several contributed chapters relevant to image processing of biological macromolecules. (578.45 EL257 & TSB)

Computer Techniques for Image Processing in Electron Microscopy. W. O. Saxton. **1978**. Advances in Electronics and Electron Physics, Suppl. 10. Contains both theoretical and practical discussion of the use of computers to analyze electron micrographs. (621.38 Ad9s no.10 [normally in the Engineering Library] & TSB)

OTHER GENERAL TEXTS: (Alphabetical list)

Computer Assisted Microscopy: the Measurement and Analysis of Images. J. C. Russ. **1990**. Plenum Press, New York. Extensive, basic text of acquiring and processing microscopy images. This is the forerunner of Russ' text The Image Processing Handbook (see below) (502.820285 R91c & TSB)

Computer Image Processing and Recognition. E. L. Hall. **1979**. Volume from Computer Science and Applied Mathematics. This is an engineering view of computer analysis of pictures. (621.3819598 H141c c.2 [Engineering Library] & TSB)

Computer Processing of Electron Microscope Images. P. W. Hawkes (ed.). **1980**. Topics in Current Physics, Vol. 13. Contributed articles on various aspects of the use of computer analysis of electron micrographs. (535.332502854 C739 & TSB)

Digital Image Processing. R. C. Gonzalez and P. Wintz. **1987,** 2nd Ed.; **1992.** 3rd Ed. Addison-Wesley Pub. Co., Reading, MA. Electrical engineering perspective of digital image processing. (621.367 G588d [Engineering Library]; TSB has 1987 copy)

Electron Microscopy at Molecular Dimensions: State of the Art and Strategies for the Future. W. Baumeister and W. Vogell (eds.). **1980**. Proceedings of an international workshop "Regular 2-D Arrays of Biomacromolecules: Structure Determination and Assembly", Burg Gemen, Munsterland, June 1979. Contains several articles involving the use of image analysis techniques. (578.45 EL25 & TSB)

Image Analysis in Biology. D.-P. Häder (ed.). **1992.** CRC Press, Boca Raton, FL. Contains several contributed chapters relevant to image processing of biological macromolecules. (578.4 Im15 & TSB)

Image Analysis: Principles and Practice. 1985. A technical handbook produced by Joyce-Loebl. Short Run Press, Exeter, UK. A basic text on 'classical' image analysis techniques with emphasis on industrial applications. (TSB)

Image Restoration and Reconstruction. P. H. T. Bates and M. J. McDonnell. **1986**. Clarendon Press, Oxford. Mainly a theoretical treatment. From the Oxford Engineering Science Series. (621.367 B319i & TSB)

Signal and Image Processing in Microscopy and Microanalysis. P. W. Hawkes (ed.). **1992**. Scanning Microscopy International, Chicago. This has several useful articles, all from the Proceedings of the 10th Pfefferkorn Conference (U. Cambridge, U.K., Sept. 27-30, 1991) . (TSB)

The Image Processing Handbook. J. C. Russ. **1992**, **1995**, 2nd Ed. CRC Press, Boca Raton, FL. Extensive, basic text of materials science and engineering perspective of digital image processing. (1992 & 1995: 621.367 R91i Engineering Library & TSB)

PERIODICALS

Technical aspects of image processing and transmission electron microscopy are mainly covered in the following journals:

Journal	Call number (Library)	Vols. and Year(s)
Electron Microscopy Reviews	578.4505 EL25 (BIO)	v.1-5; 1988-1992
Journal of Electron Microscopy	578.1505 J826 (BIO)	v.1-; 1953-
Journal of Electron Microscopy Technique	578.4505 J8265 (BIO)	v.1-19; 1984-1991
Journal of Microscopy	578.06 R81 (BIO)	v.89-; 1969-
Journal of Structural Biology	610.5 J827 (BIO)	v.103-; 1990-
Micron (also Micron and Microscopia Acta)	578.4505 M583 (BIO)	v.10-; 1979-
Microscopy and Research Technique	578.4505 J8265 (BIO)	v.20-; 1992-
Optik	535.05 Op72 (PHYS)	v.10-; 1946-
Ultramicroscopy	578.405 U8 (BIO)	v.1-; 1975-

Journals that contain a significant number of articles of biological interest pertaining to results obtained by electron microscopy and image analysis include:

Biophysical Journal
Cell
Current Opinion in Structural Biology
EMBO Journal
Experimental Cell Research
FEBS Letters
Journal of Bacteriology
Journal of Cell Biology
Journal of Cell Science
Journal of General Microbiology
Journal of General Virology
Journal of Molecular Biology
Journal of Structural Biology
Journal of Virology
Molecular Cell
Nature
Nature Structural Biology
Proceedings of the Nat'l Academy of Sciences USA
Protoplasma
Science
Seminars in Virology
Structure
Virology

The above list is incomplete in the sense that virtually every discipline in biology has its own journal or journals that include a significant electron microscopy emphasis.

BOOKS ON RESERVE IN BIOSCIENCES LIBRARY (Spring 2000)

AUTHOR(S)	TITLE	CALL #	YEAR
Baumeister, W. & Vogell, W.	Electron Microscopy at Molecular Dimensions: State of the Art and Strategies for the Future. Proceedings of an international workshop *"Regular 2-D Arrays of Biomacromolecules: Structure Determination and Assembly"*.	578.45 EL25	1980
Frank, J.	Electron Tomography: Three-Dimensional Imaging with the Transmission Electron Microscope	578.45 EL257	1992
Frank, J.	Three-Dimensional Electron Microscopy of Macromolecular Assemblies	578.45 F851t	1996
Glauert, A. M.	Practical Methods in Electron Microscopy, Vol. 7	502.8 P881	1978
Häder, D.-P.	Image Analysis in Biology	578.4 Im15	1992
Hawkes, P. W.	Computer Processing of Electron Microscope Images	535.332502854 C739	1980
Hawkes, P. W. & U. Valdre	Biophysical Electron Microscopy: Basic Concepts and Modern Techniques	578.45 B524	1990
Meek, G. A.	Practical Electron Microscopy for Biologists, 2nd ed.	578.45 M471p	1976
Russ, J. C.	The Image Processing Handbook	621.367 R91i [Engin.]	1995
Saxton, W. O.	Computer Techniques for Image Processing in Electron Microscopy	621.38 Ad9s #10 (Engin.)	1978

Single-particle electron microscopy has now reached maturity, becoming a commonly used method in the examination of macromolecular structure. Using a small amount of purified protein, isolated molecules are observed under the electron microscope and the data collected can be averaged into a 3D reconstruction.Â This mini review describes a brief outline of the methods currently used in the 3D analysis of macromolecules using single-particle electron microscopy, intended for those first approaching this field. A summary of methods, techniques, software, and some recent work is presented. The spectacular improvements to the technique in recent years, its advantages and limitations compared to other structural methods, and its future developments are discussed. Basically, these macromolecules come from different combinations of smaller organic molecules.Â As youâ€™ve learned, biological macromolecules are large molecules, necessary for life, that are built from smaller organic molecules. In general, there are four major classes of biological macromolecules (carbohydrates, lipids, proteins, and nucleic acids). Each is an important cell component and performs a wide array of functions. Combined, these molecules make up the majority of a cellâ€™s dry mass (recall that water makes up the majority of its complete mass). Structural biology comprises a variety of tools to obtain atomic resolution data for the investigation of macromolecules. Conventional structural methodologies including crystallography, NMR and electron microscopy often do not provide sufficient details concerning flexibility and dynamics, even though these aspects are critical for the physiological functions of the systems under investigation.Â (2015). EMRinger: side chain-directed model and map validation for 3D cryo-electron microscopy. Nat. Methods 12, 943â€“946. doi: 10.1038/nmeth.3541.