

## 7 References

- Aalto, M. K., Ronne, H. & Keranen, S. (1993). Yeast syntaxins Sso1p and Sso2p belong to a family of related membrane proteins that function in vesicular transport. *Embo J* **12**, 4095-104.
- Adler, E. M., Augustine, G. J., Duffy, S. N. & Charlton, M. P. (1991). Alien intracellular calcium chelators attenuate neurotransmitter release at the squid giant synapse. *J Neurosci* **11**, 1496-507.
- Ambrose, W. P., Goodwin, P. M., Jett, J. H., Van Orden, A., Werner, J. H. & Keller, R. A. (1999). Single molecule fluorescence spectroscopy at ambient temperature. *Chem Rev*, 2929-2956.
- Annaert, W. G., Becker, B., Kistner, U., Reth, M. & Jahn, R. (1997). Export of cellubrevin from the endoplasmic reticulum is controlled by BAP31. *J Cell Biol* **139**, 1397-410.
- Antonin, W., Holroyd, C., Fasshauer, D., Pabst, S., Von Mollard, G. F. & Jahn, R. (2000). A SNARE complex mediating fusion of late endosomes defines conserved properties of SNARE structure and function. *Embo J* **19**, 6453-64.
- Aragon, S. R. & Pecora, R. (1976). Fluorescence correlation spectroscopy as a probe of molecular dynamics. *J Chem Phys* **64**, 1791-1803.
- Balch, W. E., Dunphy, W. G., Braell, W. A. & Rothman, J. E. (1984). Reconstitution of the transport of protein between successive compartments of the Golgi measured by the coupled incorporation of N-acetylglucosamine. *Cell* **39**, 405-16.
- Banfield, D. K., Lewis, M. J., Rabouille, C., Warren, G. & Pelham, H. R. (1994). Localization of Sed5, a putative vesicle targeting molecule, to the cis- Golgi network involves both its transmembrane and cytoplasmic domains. *J Cell Biol* **127**, 357-71.
- Barnstable, C. J., Hofstein, R. & Akagawa, K. (1985). A marker of early amacrine cell development in rat retina. *Brain Res* **352**, 286-90.
- Baumert, M., Maycox, P. R., Navone, F., De Camilli, P. & Jahn, R. (1989). Synaptobrevin: an integral membrane protein of 18,000 daltons present in small synaptic vesicles of rat brain. *Embo J* **8**, 379-84.
- Bennett, M. K., Calakos, N. & Scheller, R. H. (1992). Syntaxin: a synaptic protein implicated in docking of synaptic vesicles at presynaptic active zones. *Science* **257**, 255-9.
- Bennett, M. K. & Scheller, R. H. (1993). The molecular machinery for secretion is conserved from yeast to neurons. *Proc Natl Acad Sci USA* **90**, 2559-63.

- Berliner, L. J., Grunwald, J., Hankovszky, H. O. & Hideg, K. (1982). A novel reversible thiol-specific spin label: papain active site labeling and inhibition. *Anal Biochem* **119**, 450-5.
- Betz, A., Okamoto, M., Benseler, F. & Brose, N. (1997). Direct interaction of the rat unc-13 homologue Munc13-1 with the N terminus of syntaxin. *J Biol Chem* **272**, 2520-6.
- Binz, T., Blasi, J., Yamasaki, S., Baumeister, A., Link, E., Südhof, T. C., Jahn, R. & Niemann, H. (1994). Proteolysis of SNAP-25 by types E and A botulinal neurotoxins. *J Biol Chem* **269**, 1617-20.
- Blasi, J., Chapman, E. R., Link, E., Binz, T., Yamasaki, S., De Camilli, P., Südhof, T. C., Niemann, H. & Jahn, R. (1993a). Botulinum neurotoxin A selectively cleaves the synaptic protein SNAP-25 [see comments]. *Nature* **365**, 160-3.
- Blasi, J., Chapman, E. R., Yamasaki, S., Binz, T., Niemann, H. & Jahn, R. (1993b). Botulinum neurotoxin C1 blocks neurotransmitter release by means of cleaving HPC-1/syntaxin. *Embo J* **12**, 4821-8.
- Blumenthal, R., Sarkar, D. P., Durell, S., Howard, D. E. & Morris, S. J. (1996). Dilation of the influenza hemagglutinin fusion pore revealed by the kinetics of individual cell-cell fusion events. *J Cell Biol* **135**, 63-71.
- Bollmann, J. H., Sakmann, B. & Borst, J. G. (2000). Calcium sensitivity of glutamate release in a calyx-type terminal. *Science* **289**, 953-7.
- Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal Biochem* **72**, 248-54.
- Breckenridge, L. J. & Almers, W. (1987). Currents through the fusion pore that forms during exocytosis of a secretory vesicle. *Nature* **328**, 814-7.
- Brennwald, P., Kearns, B., Champion, K., Keranen, S., Bankaitis, V. & Novick, P. (1994). Sec9 is a SNAP-25-like component of a yeast SNARE complex that may be the effector of Sec4 function in exocytosis. *Cell* **79**, 245-58.
- Brunger, A. T. (2001). Structural insights into the molecular mechanism of calcium-dependent vesicle-membrane fusion. *Curr Opin Struct Biol* **11**, 163-73.
- Brunns, D., Engers, S., Yang, C., Ossig, R., Jeromin, A. & Jahn, R. (1997). Inhibition of transmitter release correlates with the proteolytic activity of tetanus toxin and botulinus toxin A in individual cultured synapses of Hirudo medicinalis. *J Neurosci* **17**, 1898-910.
- Calakos, N., Bennett, M. K., Peterson, K. E. & Scheller, R. H. (1994). Protein-protein interactions contributing to the specificity of intracellular vesicular trafficking. *Science* **263**, 1146-9.

- Callaghan, J., Simonsen, A., Gaullier, J. M., Toh, B. H. & Stenmark, H. (1999). The endosome fusion regulator early-endosomal autoantigen 1 (EEA1) is a dimer. *Biochem J* **338**, 539-43.
- Carr, C. M. (2001). The taming of the SNARE. *Nat Struct Biol* **8**, 186-8.
- Carr, C. M., Grote, E., Munson, M., Hughson, F. M. & Novick, P. J. (1999). Sec1p binds to SNARE complexes and concentrates at sites of secretion. *J Cell Biol* **146**, 333-44.
- Chandler, D. E. & Heuser, J. E. (1980). Arrest of membrane fusion events in mast cells by quick-freezing. *J Cell Biol* **86**, 666-74.
- Chapman, E. R., An, S., Barton, N. & Jahn, R. (1994). SNAP-25, a t-SNARE which binds to both syntaxin and synaptobrevin via domains that may form coiled coils. *J Biol Chem* **269**, 27427-32.
- Chen, Y. A. & Scheller, R. H. (2001). SNARE-mediated membrane fusion. *Nat Rev Mol Cell Biol* **2**, 98-106.
- Clary, D. O., Griff, I. C. & Rothman, J. E. (1990). SNAPS, a family of NSF attachment proteins involved in intracellular membrane fusion in animals and yeast. *Cell* **61**, 709-21.
- Clary, D. O. & Rothman, J. E. (1990). Purification of three related peripheral membrane proteins needed for vesicular transport. *J Biol Chem* **265**, 10109-17.
- Columbus, L., Kalai, T., Jeko, J., Hideg, K. & Hubbell, W. L. (2001). Molecular motion of spin labeled side chains in alpha-helices: analysis by variation of side chain structure. *Biochemistry* **40**, 3828-46.
- Dahan, M., Deniz, A. A., Ha, T., Chemla, D. S., Schultz, P. G. & Weiss, S. (1999). Ratiometric measurement and identification of single diffusing molecules. *Chemical Physics* **247**, 85-106.
- Del Castillo, J. & Katz, B. (1956). Biochemical aspects of neuromuscular transmission. *Prog Biophys Chem* **6**, 122-170.
- Deniz, A. A., Dahan, M., Grunwell, J. R., Ha, T., Faulhaber, A. E., Chemla, D. S., Weiss, S. & Schultz, P. G. (1999). Single-pair fluorescence resonance energy transfer on freely diffusing molecules: observation of Forster distance dependence and subpopulations. *Proc Natl Acad Sci U S A* **96**, 3670-5.
- Deniz, A. A., Laurence, T. A., Dahan, M., Chemla, D. S., Schultz, P. G. & Weiss, S. (2001). Ratiometric single-molecule studies of freely diffusing biomolecules. *Annu Rev Phys Chem* **52**, 233-53.

- Dulubova, I., Sugita, S., Hill, S., Hosaka, M., Fernandez, I., Südhof, T. C. & Rizo, J. (1999). A conformational switch in syntaxin during exocytosis: role of munc18. *Embo J* **18**, 4372-82.
- Dulubova, I., Yamaguchi, T., Wang, Y., Südhof, T. C. & Rizo, J. (2001). Vam3p structure reveals conserved and divergent properties of syntaxins. *Nat Struct Biol* **8**, 258-64.
- Edelmann, L., Hanson, P. I., Chapman, E. R. & Jahn, R. (1995). Synaptobrevin binding to synaptophysin: a potential mechanism for controlling the exocytic fusion machine. *Embo J* **14**, 224-31.
- Eggeling, C., Berger, S., Brand, L., Fries, J. R., Schaffer, J., Volkmer, A. & Seidel, C. A. (2001a). Data registration and selective single-molecule analysis using multi-parameter fluorescence detection. *J Biotechnol* **86**, 163-80.
- Eggeling, C., Fries, J. R., Brand, L., Gunther, R. & Seidel, C. A. (1998). Monitoring conformational dynamics of a single molecule by selective fluorescence spectroscopy. *Proc Natl Acad Sci U S A* **95**, 1556-61.
- Eggeling, C., Schaffer, J., Seidel, C. A. M., Korte, J., Brehm, G., Schneider, S. & Schrof, W. (2001b). Homogeneity, transport, and signal properties of single Ag particles studied by single-molecule surface-enhanced resonance raman scattering. *J Phys Chem A* **15**, 3673-3679.
- Fasshauer, D., Antonin, W., Margittai, M., Pabst, S. & Jahn, R. (1999). Mixed and non-cognate SNARE complexes. Characterization of assembly and biophysical properties. *J Biol Chem* **274**, 15440-6.
- Fasshauer, D., Bruns, D., Shen, B., Jahn, R. & Brunger, A. T. (1997a). A structural change occurs upon binding of syntaxin to SNAP-25. *J Biol Chem* **272**, 4582-90.
- Fasshauer, D., Eliason, W. K., Brunger, A. T. & Jahn, R. (1998a). Identification of a minimal core of the synaptic SNARE complex sufficient for reversible assembly and disassembly. *Biochemistry* **37**, 10354-62.
- Fasshauer, D., Otto, H., Eliason, W. K., Jahn, R. & Brunger, A. T. (1997b). Structural changes are associated with soluble N-ethylmaleimide-sensitive fusion protein attachment protein receptor complex formation. *J Biol Chem* **272**, 28036-41.
- Fasshauer, D., Sutton, R. B., Brunger, A. T. & Jahn, R. (1998b). Conserved structural features of the synaptic fusion complex: SNARE proteins reclassified as Q- and R-SNAREs. *Proc Natl Acad Sci U S A* **95**, 15781-6.
- Feix, J. B., and Klug, C.S. (1998). Spin Labeling: The Next Millenium (Berliner, L.J., Ed). *Biological Magnetic Resonance* **14**, 251-281.
- Fernandez, I., Ubach, J., Dulubova, I., Zhang, X., Südhof, T. C. & Rizo, J. (1998). Three-dimensional structure of an evolutionarily conserved N-terminal domain of syntaxin 1A. *Cell* **94**, 841-9.

- Ferro-Novick, S. & Jahn, R. (1994). Vesicle fusion from yeast to man. *Nature* **370**, 191-3.
- Fiebig, K. M., Rice, L. M., Pollock, E. & Brunger, A. T. (1999). Folding intermediates of SNARE complex assembly. *Nat Struct Biol* **6**, 117-23.
- Förster, T. (1948). Intermolecular energy migration and fluorescence. *Ann Phys* **2**, 55-75.
- Fries, J. R., Brand, L., Eggeling, C., Köllner, M. & Seidel, C. A. M. (1998). Quantitative identification of different single molecules by selective time-resolved confocal fluorescence spectroscopy. *Nature* **33**, 6601-6613.
- Furthmayr, H. & Marchesi, V. T. (1976). Subunit structure of human erythrocyte glycophorin A. *Biochemistry* **15**, 1137-44.
- Gaudin, Y., Raux, H., Flamand, A. & Ruigrok, R. W. (1996). Identification of amino acids controlling the low-pH-induced conformational change of rabies virus glycoprotein. *J Virol* **70**, 7371-8.
- Glick, B. S. & Rothman, J. E. (1987). Possible role for fatty acyl-coenzyme A in intracellular protein transport. *Nature* **326**, 309-12.
- Ha, T., Enderle, T., Ogletree, D. F., Chemla, D. S., Selvin, P. R. & Weiss, S. (1996). Probing the interaction between two single molecules: fluorescence resonance energy transfer between a single donor and a single acceptor. *Proc Natl Acad Sci U S A* **93**, 6264-8.
- Ha, T., Ting, A. Y., Liang, J., Caldwell, W. B., Deniz, A. A., Chemla, D. S., Schultz, P. G. & Weiss, S. (1999). Single-molecule fluorescence spectroscopy of enzyme conformational dynamics and cleavage mechanism. *Proc Natl Acad Sci U S A* **96**, 893-8.
- Haltia, T. & Freire, E. (1995). Forces and factors that contribute to the structural stability of membrane proteins. *Biochim Biophys Acta* **1241**, 295-322.
- Hanson, M. A. & Stevens, R. C. (2000). Cocrystal structure of synaptobrevin-II bound to botulinum neurotoxin type B at 2.0 Å resolution [In Process Citation]. *Nat Struct Biol* **7**, 687-92.
- Hanson, P. I., Heuser, J. E. & Jahn, R. (1997a). Neurotransmitter release - four years of SNARE complexes. *Curr Opin Neurobiol* **7**, 310-5.
- Hanson, P. I., Otto, H., Barton, N. & Jahn, R. (1995). The N-ethylmaleimide-sensitive fusion protein and alpha-SNAP induce a conformational change in syntaxin. *J Biol Chem* **270**, 16955-61.
- Hanson, P. I., Roth, R., Morisaki, H., Jahn, R. & Heuser, J. E. (1997b). Structure and conformational changes in NSF and its membrane receptor complexes visualized by quick-freeze/deep-etch electron microscopy. *Cell* **90**, 523-35.

- Hao, J. C., Salem, N., Peng, X. R., Kelly, R. B. & Bennett, M. K. (1997). Effect of mutations in vesicle-associated membrane protein (VAMP) on the assembly of multimeric protein complexes. *J Neurosci* **17**, 1596-603.
- Hata, Y., Slaughter, C. A. & Südhof, T. C. (1993). Synaptic vesicle fusion complex contains unc-18 homologue bound to syntaxin. *Nature* **366**, 347-51.
- Hayashi, T., McMahon, H., Yamasaki, S., Binz, T., Hata, Y., Südhof, T. C. & Niemann, H. (1994). Synaptic vesicle membrane fusion complex: action of clostridial neurotoxins on assembly. *Embo J* **13**, 5051-61.
- Hayashi, T., Yamasaki, S., Nauenburg, S., Binz, T. & Niemann, H. (1995). Disassembly of the reconstituted synaptic vesicle membrane fusion complex in vitro. *Embo J* **14**, 2317-25.
- Hazzard, J., Südhof, T. C. & Rizo, J. (1999). NMR analysis of the structure of synaptobrevin and of its interaction with syntaxin. *J Biomol NMR* **14**, 203-7.
- Hess, D. T., Slater, T. M., Wilson, M. C. & Skene, J. H. (1992). The 25 kDa synaptosomal-associated protein SNAP-25 is the major methionine-rich polypeptide in rapid axonal transport and a major substrate for palmitoylation in adult CNS. *J Neurosci* **12**, 4634-41.
- Higuchi, R. (1990). *PCR Protocols: A Guide to Methods and Applications*. (Innis, M.A., Gelfand, D. H., Sininsky, J. J., White, T. J., eds). pp. 177-183, Academic Press, New York.
- Hubbell, W. L., Cafiso, D. S. & Altenbach, C. (2000). Identifying conformational changes with site-directed spin labeling. *Nat Struct Biol* **7**, 735-9.
- Hubbell, W. L., Gross, A., Langen, R. & Lietzow, M. A. (1998). Recent advances in site-directed spin labeling of proteins. *Curr Opin Struct Biol* **8**, 649-56.
- Hubbell, W. L., McHaourab, H. S., Altenbach, C. & Lietzow, M. A. (1996). Watching proteins move using site-directed spin labeling. *Structure* **4**, 779-83.
- Hughson, F. M. (1999). Membrane fusion: structure snared at last. *Curr Biol* **9**, R49-52.
- Hunt, J. M., Bommert, K., Charlton, M. P., Kistner, A., Habermann, E., Augustine, G. J. & Betz, H. (1994). A post-docking role for synaptobrevin in synaptic vesicle fusion. *Neuron* **12**, 1269-79.
- Ishii, Y., Yoshida, T., Funatsu, T., Wazawa, T. & Yanagida, T. (1999). Fluorescence resonance energy transfer between single fluorophores attached to a coiled-coil protein in aqueous solution. *Chemical Physics* **247**, 163-173.
- Jahn, R. & Südhof, T. C. (1999). Membrane fusion and exocytosis. *Annu Rev Biochem* **68**, 863-911.

- Kandel, E. R., Schwartz, J. H. & Jessell, T. M. (2000). *Principles of Neural Science* (fourth edition). McGraw-Hill Companies.
- Katz, L. & Brennwald, P. (2000). Testing the 3Q:1R "rule": mutational analysis of the ionic "zero" layer in the yeast exocytic SNARE complex reveals no requirement for arginine. *Mol Biol Cell* **11**, 3849-58.
- Katz, L., Hanson, P. I., Heuser, J. E. & Brennwald, P. (1998). Genetic and morphological analyses reveal a critical interaction between the C-termini of two SNARE proteins and a parallel four helical arrangement for the exocytic SNARE complex. *Embo J* **17**, 6200-9.
- Kee, Y., Lin, R. C., Hsu, S. C. & Scheller, R. H. (1995). Distinct domains of syntaxin are required for synaptic vesicle fusion complex formation and dissociation. *Neuron* **14**, 991-8.
- Kemble, G. W., Danieli, T. & White, J. M. (1994). Lipid-anchored influenza hemagglutinin promotes hemifusion, not complete fusion. *Cell* **76**, 383-91.
- Klatt, A. R., Nitsche, D. P., Kobbe, B., Macht, M., Paulsson, M. & Wagener, R. (2001). Molecular structure, processing, and tissue distribution of matrilin-4. *J Biol Chem* **276**, 17267-75.
- Koebnik, R., Locher, K. P. & Van Gelder, P. (2000). Structure and function of bacterial outer membrane proteins: barrels in a nutshell. *Mol Microbiol* **37**, 239-53.
- Kyhse-Andersen, J. (1984). Electroblotting of multiple gels: a simple apparatus without buffer tank for rapid transfer of proteins from polyacrylamide to nitrocellulose. *J Biochem Biophys Methods* **10**, 203-9.
- Laage, R. & Langosch, D. (1997). Dimerization of the synaptic vesicle protein synaptobrevin (vesicle-associated membrane protein) II depends on specific residues within the transmembrane segment. *Eur J Biochem* **249**, 540-6.
- Laage, R., Rohde, J., Brosig, B. & Langosch, D. (2000). A conserved membrane-spanning amino acid motif drives homomeric and supports heteromeric assembly of presynaptic SNARE proteins. *J Biol Chem* **275**, 17481-7.
- Laemmli, U. K. (1970). Cleavage of structural proteins during the assembly of the head of bacteriophage T4. *Nature* **227**, 680-5.
- Lakowicz, J. R. (2000). *Principles of Fluorescence Spectroscopy* (second edition) pp. 291-319, Kluwer Academic, Plenum Publishers, New York.
- Lang, T., Bruns, D., Wenzel, D., Riedel, D., Holroyd, P., Thiele, C. & Jahn, R. (2001). SNAREs are concentrated in cholesterol-dependent clusters that define docking and fusion sites for exocytosis. *Embo J* **20**, 2202-13.

- Langen, R., Isas, J. M., Hubbell, W. L. & Haigler, H. T. (1998). A transmembrane form of annexin XII detected by site-directed spin labeling. *Proc Natl Acad Sci U S A* **95**, 14060-5.
- Langen, R., Oh, K. J., Cascio, D. & Hubbell, W. L. (2000). Crystal structures of spin labeled T4 lysozyme mutants: implications for the interpretation of EPR spectra in terms of structure. *Biochemistry* **39**, 8396-405.
- Langosch, D. & Heringa, J. (1998). Interaction of transmembrane helices by a knobs-into-holes packing characteristic of soluble coiled coils. *Proteins* **31**, 150-9.
- Lazaridis, T. & Karplus, M. (1997). "New view" of protein folding reconciled with the old through multiple unfolding simulations. *Science* **278**, 1928-31.
- Lemmon, M. A. & Engelman, D. M. (1994). Specificity and promiscuity in membrane helix interactions. *Q Rev Biophys* **27**, 157-218.
- Lemmon, M. A., Flanagan, J. M., Hunt, J. F., Adair, B. D., Bormann, B. J., Dempsey, C. E. & Engelman, D. M. (1992). Glycophorin A dimerization is driven by specific interactions between transmembrane alpha-helices. *J Biol Chem* **267**, 7683-9.
- Lerman, J. C., Robblee, J., Fairman, R. & Hughson, F. M. (2000). Structural analysis of the neuronal SNARE protein syntaxin-1A. *Biochemistry* **39**, 8470-9.
- Lin, R. C. & Scheller, R. H. (1997). Structural organization of the synaptic exocytosis core complex. *Neuron* **19**, 1087-94.
- Link, E., Edelmann, L., Chou, J. H., Binz, T., Yamasaki, S., Eissel, U., Baumert, M., Südhof, T. C., Niemann, H. & Jahn, R. (1992). Tetanus toxin action: inhibition of neurotransmitter release linked to synaptobrevin proteolysis. *Biochem Biophys Res Commun* **189**, 1017-23.
- Loewi, O. (1921). Über humorale Übertragbarkeit der Herznervenwirkung. *Pfluegers Arch* **189**, 201-213.
- Malhotra, V., Orci, L., Glick, B. S., Block, M. R. & Rothman, J. E. (1988). Role of an N-ethylmaleimide-sensitive transport component in promoting fusion of transport vesicles with cisternae of the Golgi stack. *Cell* **54**, 221-7.
- Mathies, R. A. & Peck, K. (1997). Optimization of high-sensitivity fluorescence detection. *Anal. Chem.* **62**, 1786-1791.
- Matveeva, E. & Whiteheart, S. W. (1998). The effects of SNAP/SNARE complexes on the ATPase of NSF. *FEBS Lett* **435**, 211-4.
- McHaourab, H. S., Lietzow, M. A., Hideg, K. & Hubbell, W. L. (1996). Motion of spin-labeled side chains in T4 lysozyme. Correlation with protein structure and dynamics. *Biochemistry* **35**, 7692-704.

- Misura, K. M., Scheller, R. H. & Weis, W. I. (2000). Three-dimensional structure of the neuronal-Sec1-syntaxin 1a complex [see comments]. *Nature* **404**, 355-62.
- Misura, K. M., Scheller, R. H. & Weis, W. I. (2001). Self-association of the h3 region of syntaxin 1a. implications for intermediates in snare complex assembly. *J Biol Chem* **276**, 13273-82.
- Munson, M., Chen, X., Cocina, A. E., Schultz, S. M. & Hughson, F. M. (2000). Interactions within the yeast t-SNARE Sso1p that control SNARE complex assembly. *Nat Struct Biol* **7**, 894-902.
- Nicholson, K. L., Munson, M., Miller, R. B., Filip, T. J., Fairman, R. & Hughson, F. M. (1998). Regulation of SNARE complex assembly by an N-terminal domain of the t-SNARE Sso1p. *Nat Struct Biol* **5**, 793-802.
- Novick, P., Ferro, S. & Schekman, R. (1981). Order of events in the yeast secretory pathway. *Cell* **25**, 461-9.
- Novick, P., Field, C. & Schekman, R. (1980). Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway. *Cell* **21**, 205-15.
- Oh, K. J., Zhan, H., Cui, C., Hideg, K., Collier, R. J. & Hubbell, W. L. (1996). Organization of diphtheria toxin T domain in bilayers: a site-directed spin labeling study. *Science* **273**, 810-2.
- Orci, L., Malhotra, V., Amherdt, M., Serafini, T. & Rothman, J. E. (1989). Dissection of a single round of vesicular transport: sequential intermediates for intercisternal movement in the Golgi stack. *Cell* **56**, 357-68.
- Ossig, R., Schmitt, H. D., de Groot, B., Riedel, D., Keranen, S., Ronne, H., Grubmuller, H. & Jahn, R. (2000). Exocytosis requires asymmetry in the central layer of the SNARE complex. *Embo J* **19**, 6000-10.
- Otto, H., Hanson, P. I. & Jahn, R. (1997). Assembly and disassembly of a ternary complex of synaptobrevin, syntaxin, and SNAP-25 in the membrane of synaptic vesicles. *Proc Natl Acad Sci U S A* **94**, 6197-201.
- Oyler, G. A., Higgins, G. A., Hart, R. A., Battenberg, E., Billingsley, M., Bloom, F. E. & Wilson, M. C. (1989). The identification of a novel synaptosomal-associated protein, SNAP-25, differentially expressed by neuronal subpopulations. *J Cell Biol* **109**, 3039-52.
- Palade, G. (1975). Intracellular aspects of the process of protein synthesis. *Science* **189**, 347-58.
- Parlati, F., Weber, T., McNew, J. A., Westermann, B., Söllner, T. H. & Rothman, J. E. (1999). Rapid and efficient fusion of phospholipid vesicles by the alpha-helical

- core of a SNARE complex in the absence of an N-terminal regulatory domain [see comments]. *Proc Natl Acad Sci U S A* **96**, 12565-70.
- Patel, S. K., Indig, F. E., Olivieri, N., Levine, N. D. & Latterich, M. (1998). Organelle membrane fusion: a novel function for the syntaxin homolog Ufe1p in ER membrane fusion. *Cell* **92**, 611-20.
- Pevsner, J., Hsu, S. C., Braun, J. E., Calakos, N., Ting, A. E., Bennett, M. K. & Scheller, R. H. (1994). Specificity and regulation of a synaptic vesicle docking complex. *Neuron* **13**, 353-61.
- Plonsky, I. & Zimmerberg, J. (1996). The initial fusion pore induced by baculovirus GP64 is large and forms quickly. *J Cell Biol* **135**, 1831-9.
- Poirier, M. A., Hao, J. C., Malkus, P. N., Chan, C., Moore, M. F., King, D. S. & Bennett, M. K. (1998a). Protease resistance of syntaxin.SNAP-25.VAMP complexes. Implications for assembly and structure. *J Biol Chem* **273**, 11370-7.
- Poirier, M. A., Xiao, W., Macosko, J. C., Chan, C., Shin, Y. K. & Bennett, M. K. (1998b). The synaptic SNARE complex is a parallel four-stranded helical bundle. *Nat Struct Biol* **5**, 765-9.
- Popot, J. L. & Engelman, D. M. (2000). Helical membrane protein folding, stability, and evolution. *Annu Rev Biochem* **69**, 881-922.
- Protopopov, V., Govindan, B., Novick, P. & Gerst, J. E. (1993). Homologs of the synaptobrevin/VAMP family of synaptic vesicle proteins function on the late secretory pathway in *S. cerevisiae*. *Cell* **74**, 855-61.
- Rice, L. M., Brennwald, P. & Brunger, A. T. (1997). Formation of a yeast SNARE complex is accompanied by significant structural changes. *FEBS Lett* **415**, 49-55.
- Rigaud, J. L., Pitard, B. & Levy, D. (1995). Reconstitution of membrane proteins into liposomes: application to energy-transducing membrane proteins. *Biochim Biophys Acta* **1231**, 223-46.
- Rossi, G., Salminen, A., Rice, L. M., Brunger, A. T. & Brennwald, P. (1997). Analysis of a yeast SNARE complex reveals remarkable similarity to the neuronal SNARE complex and a novel function for the C terminus of the SNAP-25 homolog, Sec9. *J Biol Chem* **272**, 16610-7.
- Rothman, J. E. (1994). Mechanisms of intracellular protein transport. *Nature* **372**, 55-63.
- Schiavo, G., Benfenati, F., Poulain, B., Rossetto, O., Polverino de Laureto, P., DasGupta, B. R. & Montecucco, C. (1992). Tetanus and botulinum-B neurotoxins block neurotransmitter release by proteolytic cleavage of synaptobrevin [see comments]. *Nature* **359**, 832-5.

- Schiavo, G., Malizio, C., Trimble, W. S., Polverino de Laureto, P., Milan, G., Sugiyama, H., Johnson, E. A. & Montecucco, C. (1994). Botulinum G neurotoxin cleaves VAMP/synaptobrevin at a single Ala-Ala peptide bond. *J Biol Chem* **269**, 20213-6.
- Schiavo, G., Matteoli, M. & Montecucco, C. (2000). Neurotoxins affecting neuroexocytosis. *Physiol Rev* **80**, 717-66.
- Schiavo, G., Shone, C. C., Bennett, M. K., Scheller, R. H. & Montecucco, C. (1995). Botulinum neurotoxin type C cleaves a single Lys-Ala bond within the carboxyl-terminal region of syntaxins. *J Biol Chem* **270**, 10566-70.
- Schneggenburger, R. & Neher, E. (2000). Intracellular calcium dependence of transmitter release rates at a fast central synapse. *Nature* **406**, 889-93.
- Schutz, G. J., Trabesinger, W. & Schmidt, T. (1998). Direct observation of ligand colocalization on individual receptor molecules. *Biophys J* **74**, 2223-6.
- Selvin, P. R. (1995). Fluorescence resonance energy transfer. *Methods Enzymol* **246**, 300-34.
- Selvin, P. R. (2000). The renaissance of fluorescence resonance energy transfer. *Nat Struct Biol* **7**, 730-4.
- Skehel, J. J. & Wiley, D. C. (1998). Coiled coils in both intracellular vesicle and viral membrane fusion. *Cell* **95**, 871-4.
- Skehel, J. J. & Wiley, D. C. (2000). Receptor binding and membrane fusion in virus entry: the influenza hemagglutinin. *Annu Rev Biochem* **69**, 531-69.
- Slichter, C. P. (1992). Springer-Verlag, Berlin. *Principles of Magnetic Resonance*, 72.
- Söllner, T., Whiteheart, S. W., Brunner, M., Erdjument-Bromage, H., Geromanos, S., Tempst, P. & Rothman, J. E. (1993). SNAP receptors implicated in vesicle targeting and fusion [see comments]. *Nature* **362**, 318-24.
- Stryer, L. & Haugland, R. P. (1967). Energy transfer: a spectroscopic ruler. *Proc Natl Acad Sci U S A* **58**, 719-26.
- Sutton, R. B., Fasshauer, D., Jahn, R. & Brunger, A. T. (1998). Crystal structure of a SNARE complex involved in synaptic exocytosis at 2.4 Å resolution [see comments]. *Nature* **395**, 347-53.
- Terrian, D. M. & White, M. K. (1997). Phylogenetic analysis of membrane trafficking proteins: a family reunion and secondary structure predictions. *Eur J Cell Biol* **73**, 198-204.
- Tishgarten, T., Yin, F. F., Faucher, K. M., Dluhy, R. A., Grant, T. R., Fischer von Mollard, G., Stevens, T. H. & Lipscomb, L. A. (1999). Structures of yeast vesicle trafficking proteins. *Protein Sci* **8**, 2465-73.

- Todd, A. P., Cong, J., Levinthal, F., Levinthal, C. & Hubbell, W. L. (1989). Site-directed mutagenesis of colicin E1 provides specific attachment sites for spin labels whose spectra are sensitive to local conformation. *Proteins* **6**, 294-305.
- Trimble, W. S., Cowan, D. M. & Scheller, R. H. (1988). VAMP-1: a synaptic vesicle-associated integral membrane protein. *Proc Natl Acad Sci U S A* **85**, 4538-42.
- Tsui, M. M. & Banfield, D. K. (2000). Yeast Golgi SNARE interactions are promiscuous. *J Cell Sci* **113**, 145-52.
- Veit, M., Söllner, T. H. & Rothman, J. E. (1996). Multiple palmitoylation of synaptotagmin and the t-SNARE SNAP-25. *FEBS Lett* **385**, 119-23.
- Weber, T., Zemelman, B. V., McNew, J. A., Westermann, B., Gmachl, M., Parlati, F., Söllner, T. H. & Rothman, J. E. (1998). SNAREpins: minimal machinery for membrane fusion. *Cell* **92**, 759-72.
- Weimbs, T., Low, S. H., Chapin, S. J., Mostov, K. E., Bucher, P. & Hofmann, K. (1997). A conserved domain is present in different families of vesicular fusion proteins: a new superfamily. *Proc Natl Acad Sci U S A* **94**, 3046-51.
- Weimbs, T., Mostov, K., Low, S. H. & Hofmann, K. (1998). A model for structural similarity between different SNARE complexes based on sequence relationships [letter; comment]. *Trends Cell Biol* **8**, 260-2.
- Weiss, S. (1999). Fluorescence spectroscopy of single biomolecules. *Science* **283**, 1676-83.
- Weiss, S. (2000). Measuring conformational dynamics of biomolecules by single molecule fluorescence spectroscopy. *Nat Struct Biol* **7**, 724-9.
- White, S. H. & Wimley, W. C. (1999). Membrane protein folding and stability: physical principles. *Annu Rev Biophys Biomol Struct* **28**, 319-65.
- Whiteheart, S. W., Griff, I. C., Brunner, M., Clary, D. O., Mayer, T., Buhrow, S. A. & Rothman, J. E. (1993). SNAP family of NSF attachment proteins includes a brain-specific isoform. *Nature* **362**, 353-5.
- Widengren, J., Mets, Ü. & Rigler, R. (1995). Fluorescence correlation spectroscopy of triplet states in solution: A theoretical and experimental study. *J Phys Chem* **99**, 13368-13379.
- Widengren, J., Rigler, R. & Mets, Ü. (1994). Triplet-state monitoring by fluorescence correlation spectroscopy. *J Fluoresc* **4**, 255-258.
- Wilson, D. W., Whiteheart, S. W., Wiedmann, M., Brunner, M. & Rothman, J. E. (1992). A multisubunit particle implicated in membrane fusion. *J Cell Biol* **117**, 531-8.

- Wilson, D. W., Wilcox, C. A., Flynn, G. C., Chen, E., Kuang, W. J., Henzel, W. J., Block, M. R., Ullrich, A. & Rothman, J. E. (1989). A fusion protein required for vesicle-mediated transport in both mammalian cells and yeast. *Nature* **339**, 355-9.
- Wyatt, P. J. (1993). Light scattering and the absolute characterization of macromolecules. *Analytica Chimica Acta* **272**, 1-40.
- Xiao, W., Poirier, M. A., Bennett, M. K. & Shin, Y. K. (2001). The neuronal t-SNARE complex is a parallel four-helix bundle. *Nat Struct Biol* **8**, 308-11.
- Xie, X. S. & Trautman, J. K. (1998). Optical studies of single molecules at room temperature. *Annu Rev Phys Chem* **49**, 441-480.
- Xu, T., Rammner, B., Margittai, M., Artalejo, A. R., Neher, E. & Jahn, R. (1999). Inhibition of SNARE complex assembly differentially affects kinetic components of exocytosis. *Cell* **99**, 713-22.
- Yang, B., Gonzalez, L., Jr., Prekeris, R., Steegmaier, M., Advani, R. J. & Scheller, R. H. (1999). SNARE interactions are not selective. Implications for membrane fusion specificity. *J Biol Chem* **274**, 5649-53.
- Yang, B., Steegmaier, M., Gonzalez, L. C., Jr. & Scheller, R. H. (2000). nSec1 binds a closed conformation of syntaxin1A. *J Cell Biol* **148**, 247-52.
- Zhong, P., Chen, Y. A., Tam, D., Chung, D., Scheller, R. H. & Miljanich, G. P. (1997). An alpha-helical minimal binding domain within the H3 domain of syntaxin is required for SNAP-25 binding. *Biochemistry* **36**, 4317-26.
- Zitzewitz, J. A., Bilsel, O., Luo, J., Jones, B. E. & Matthews, C. R. (1995). Probing the folding mechanism of a leucine zipper peptide by stopped-flow circular dichroism spectroscopy. *Biochemistry* **34**, 12812-9.
- Zucker, R. S. (1996). Exocytosis: a molecular and physiological perspective. *Neuron* **17**, 1049-55.