

5 References

1. R. K. Agrawal, Penczek P., Grassucci R. A., Li Y., Leith A., Nierhaus K. H., Frank J. (1996). Direct visualization of A-, P-, and E-site transfer RNAs in the Escherichia coli ribosome. *Science*. **271**, 1000-1002
2. R. K. Agrawal, Spahn C. M., Penczek P., Grassucci R. A., Nierhaus K. H., Frank J. (2000). Visualization of tRNA movements on the Escherichia coli 70S ribosome during the elongation cycle. *J Cell Biol.* **150**, 447-460
3. D. W. Andrews, Walter P., Ottensmeyer F. P. (1985). Structure of the signal recognition particle by electron microscopy. *Proc Natl Acad Sci U S A.* **82**, 785-789
4. G. Bacher, Lutcke H., Jungnickel B., Rapoport T. A., Dobberstein B. (1996). Regulation by the ribosome of the GTPase of the signal-recognition particle during protein targeting. *Nature*. **381**, 248-251
5. G. Bacher, Pool M., Dobberstein B. (1999). The ribosome regulates the GTPase of the beta-subunit of the signal recognition particle receptor. *J Cell Biol.* **146**, 723-730
6. N. Ban, Nissen P., Hansen J., Moore P. B., Steitz T. A. (2000). The complete atomic structure of the large ribosomal subunit at 2.4 Å resolution. *Science*. **289**, 905-920
7. R. Beckmann, Bubeck D., Grassucci R., Penczek P., Verschoor A., Blobel G., Frank J. (1997). Alignment of conduits for the nascent polypeptide chain in the ribosome-Sec61 complex. *Science*. **278**, 2123-2126
8. C. Bernabeu, Tobin E. M., Fowler A., Zabin I., Lake J. A. (1983). Nascent polypeptide chains exit the ribosome in the same relative position in both eucaryotes and prokaryotes. *J Cell Biol.* **96**, 1471-1474
9. H. D. Bernstein, Poritz M. A., Strub K., Hoben P. J., Brenner S., Walter P. (1989). Model for signal sequence recognition from amino-acid sequence of 54K subunit of signal recognition particle. *Nature*. **340**, 482-486
10. J. Berriman, Unwin N. (1994). Analysis of transient structures by cryo-microscopy combined with rapid mixing of spray droplets. *Ultramicroscopy*. **56**, 241-252

11. G. Blobel, Dobberstein B. (1975). Transfer of proteins across membranes. I. Presence of proteolytically processed and unprocessed nascent immunoglobulin light chains on membrane-bound ribosomes of murine myeloma. *J Cell Biol.* **67**, 835-851
12. G. Blobel, Sabatini D. D. (1970). Controlled proteolysis of nascent polypeptides in rat liver cell fractions. I. Location of the polypeptides within ribosomes. *J Cell Biol.* **45**, 130-145
13. G. Blobel, Sabatini D. D. (1971). Ribosome membrane interaction in eukaryotic cells. *Biomembranes. L.A. Manson (editor), Plenum Publishing Corporation, New York.* **2**, 193-195
14. S. Brenner, Horne R.W. (1959). A negative staining method for high resolution electron microscopy of viruses. *Biochim.Biophys.Acta.* **34**, 103- 110
15. W. J. Chirico, Waters M. G., Blobel G. (1988). 70K Heat Shock Related Proteins Stimulate Protein Translocation into Microsomes. *Nature.* **332**, 805-810
16. I. Collinson, Breyton C., Duong F., Tziatzios C., Schubert D., Or E., Rapoport T., Kuhlbrandt W. (2001). Projection structure and oligomeric properties of a bacterial core protein translocase. *EMBO J.* **20**, 2462-2471
17. T. Connolly, Gilmore R. (1989). The signal recognition particle receptor mediates the GTP-dependent displacement of SRP from the signal sequence of the nascent polypeptide. *Cell.* **57**, 599-610
18. T. Connolly, Rapiejko P. J., Gilmore R. (1991). Requirement of GTP hydrolysis for dissociation of the signal recognition particle from its receptor. *Science.* **252**, 1171-1173
19. J. F. Conway, Cheng N., Zlotnick A., Wingfield P. T., Stahl S. J., Steven A. C. (1997). Visualization of a 4-helix bundle in the hepatitis B virus capsid by cryo-electron microscopy. *Nature.* **386**, 91-94
20. K. S. Crowley, Liao S., Worrell V. E., Reinhart G. D., Johnson A. E. (1994). Secretory proteins move through the endoplasmic reticulum membrane via an aqueous, gated pore. *Cell.* **78**, 461-471

21. J. Dubochet, Adrian M., Chang J. J., Homo J. C., Lepault J., McDowall A. W., Schultz P. (1988). Cryo-electron microscopy of vitrified specimens. *Q Rev Biophys.* **21**, 129-228
22. K. Finke, Plath K., Panzner S., Prehn S., Rapoport T. A., Hartmann E., Sommer T. (1996). A second trimeric complex containing homologs of the Sec61p complex functions in protein transport across the ER membrane of *S. cerevisiae*. *EMBO J.* **15**, 1482-1494
23. J. Frank, Zhu J., Penczek P., Li Y., Srivastava S., Verschoor A., Radermacher M., Grassucci R., Lata R. K., Agrawal R. K. (1995). A model of protein synthesis based on cryo-electron microscopy of the *E. coli* ribosome. *Nature*. **376**, 441-444
24. J. Frank (1996). Three-Dimensional Electron Microscopy of Macromolecular Assemblies. Academic Press
25. D. M. Freymann, Keenan R. J., Stroud R. M., Walter P. (1997). Structure of the conserved GTPase domain of the signal recognition particle. *Nature*. **385**, 361-364
26. D. M. Freymann, Keenan R. J., Stroud R. M., Walter P. (1999). Functional changes in the structure of the SRP GTPase on binding GDP and Mg²⁺-GDP. *Nat Struct Biol.* **6**, 793-801
27. T. A. Fulga, Sinning I., Dobberstein B., Pool M. R. (2001). SRbeta coordinates signal sequence release from SRP with ribosome binding to the translocon. *EMBO J.* **20**, 2338-2347
28. I. S. Gabashvili, Agrawal R. K., Spahn C. M., Grassucci R. A., Svergun D. I., Frank J., Penczek P. (2000). Solution structure of the *E. coli* 70S ribosome at 11.5 Å resolution. *Cell*. **100**, 537-549
29. I. S. Gabashvili, Gregory S. T., Valle M., Grassucci R., Worbs M., Wahl M. C., Dahlberg A. E., Frank J. (2001). The polypeptide tunnel system in the ribosome and its gating in erythromycin resistance mutants of L4 and L22. *Mol Cell*. **8**, 181-188
30. R.H. Garrett, Grisham C.M. (1998). Biochemistry, 2nd Edition. Saunders College Publishing
31. S.A. Gerbi (1996). Expansion Segment: regions of variable size that interrupt the universal core secondary structure of ribosomal RNA, Structure, Evolution,

- Processing, and Function in Protein Synthesis. R.A. Zimmermann and A.E. Dahlberg (editors) (New York: CRC Press), 71-87
32. R. Gilmore, Blobel G., Walter P. (1982). Protein translocation across the endoplasmic reticulum. I. Detection in the microsomal membrane of a receptor for the signal recognition particle. *J Cell Biol.* **95**, 463-469
 33. R. Gilmore, Walter P., Blobel G. (1982). Protein translocation across the endoplasmic reticulum. II. Isolation and characterization of the signal recognition particle receptor. *J Cell Biol.* **95**, 470-477
 34. J. Goldberg (1998). Structural basis for activation of ARF GTPase: mechanisms of guanine nucleotide exchange and GTP-myristoyl switching. *Cell.* **95**, 237-248
 35. J. Goldberg (1998). Structural basis for activation of ARF GTPase: mechanisms of guanine nucleotide exchange and GTP-myristoyl switching. *Cell.* **95**, 237-248
 36. M. G. Gomez-Lorenzo, Spahn C. M., Agrawal R. K., Grassucci R. A., Penczek P., Chakraburty K., Ballesta J. P., Lavandera J. L., Garcia-Bustos J. F., Frank J. (2000). Three-dimensional cryo-electron microscopy localization of EF2 in the *Saccharomyces cerevisiae* 80S ribosome at 17.5 Å resolution. *EMBO J.* **19**, 2710-2718
 37. D. Görlich, Rapoport T. A. (1993). Protein translocation into proteoliposomes reconstituted from purified components of the endoplasmic reticulum membrane. *Cell.* **75**, 615-630
 38. D. Görlich, Prehn S., Hartmann E., Kalies K. U., Rapoport T. A. (1992). A mammalian homolog of SEC61p and SECYp is associated with ribosomes and nascent polypeptides during translocation. *Cell.* **71**, 489-503
 39. B. D. Hamman, Chen J. C., Johnson E. E., Johnson A. E. (1997). The aqueous pore through the translocon has a diameter of 40-60 Å during cotranslational protein translocation at the ER membrane. *Cell.* **89**, 535-544
 40. B. D. Hamman, Hendershot L. M., Johnson A. E. (1998). BiP maintains the permeability barrier of the ER membrane by sealing the luminal end of the translocon pore before and early in translocation. *Cell.* **92**, 747-758

41. D. Hanein, Matlack K. E., Jungnickel B., Plath K., Kalies K. U., Miller K. R., Rapoport T. A., Akey C. W. (1996). Oligomeric rings of the Sec61p complex induced by ligands required for protein translocation. *Cell.* **87**, 721-732
42. R. S. Hegde, Lingappa V. R. (1996). Sequence-specific alteration of the ribosome-membrane junction exposes nascent secretory proteins to the cytosol. *Cell.* **85**, 217-228
43. R. Henderson, Baldwin J. M., Ceska T. A., Zemlin F., Beckmann E., Downing K. H. (1990). Model for the structure of bacteriorhodopsin based on high-resolution electron cryo-microscopy. *J Mol Biol.* **213**, 899-929
44. S. High, Andersen S. S., Gorlich D., Hartmann E., Prehn S., Rapoport T. A., Dobberstein B. (1993). Sec61p is adjacent to nascent type I and type II signal-anchor proteins during their membrane insertion. *J Cell Biol.* **121**, 743-750
45. C. L. Casanova J. E. (2000). Turning on ARF: the Sec7 family of guanine-nucleotide-exchange factors. *Trends Cell Biol.* **10**, 60-67
46. A. E. Johnson, vanWaes M. A. (1999). The translocon: a dynamic gateway at the ER membrane. *Annu Rev Cell Dev Biol.* **15**, 799-842
47. A.E. Johnson, vanWaes M.A. (1999). The translocon: a dynamic gateway at the ER membrane. *Annu Rev Cell Dev Biol.* **15**, 799-842
48. B. Jungnickel, Rapoport T. A. (1995). A posttargeting signal sequence recognition event in the endoplasmic reticulum membrane. *Cell.* **82**, 261-270
49. B. Jungnickel, Rapoport T. A. (1995). A posttargeting signal sequence recognition event in the endoplasmic reticulum membrane. *Cell.* **82**, 261-270
50. K. U. Kalies, Rapoport T. A., Hartmann E. (1998). The beta subunit of the Sec61 complex facilitates cotranslational protein transport and interacts with the signal peptidase during translocation. *J Cell Biol.* **141**, 887-894
51. R. J. Keenan, Freymann D. M., Walter P., Stroud R. M. (1998). Crystal structure of the signal sequence binding subunit of the signal recognition particle. *Cell.* **94**, 181-191
52. R. J. Keenan, Freymann D. M., Stroud R. M., Walter P. (2001). The signal recognition particle. *Annu Rev Biochem.* **70**, 755-775

53. H. G. Koch, Moser M., Muller M. (2003). Signal recognition particle-dependent protein targeting, universal to all kingdoms of life. *Rev Physiol Biochem Pharmacol.* **146**, 55-94
54. W. Kuhlbrandt, Wang D. N., Fujiyoshi Y. (1994). Atomic model of plant light-harvesting complex by electron crystallography. *Nature.* **367**, 614-621
55. C. Lenzen, Cool R. H., Wittinghofer A. (1995). Analysis of intrinsic and CDC25-stimulated guanine nucleotide exchange of p21ras-nucleotide complexes by fluorescence measurements. *Methods Enzymol.* **255**, 95-109
56. S. Liao, Lin J., Do H., Johnson A. E. (1997). Both luminal and cytosolic gating of the aqueous ER translocon pore are regulated from inside the ribosome during membrane protein integration. *Cell.* **90**, 31-41
57. E. E. Marcantonio, Amar-Costepec A., Kreibich G. (1984). Segregation of the polypeptide translocation apparatus to regions of the endoplasmic reticulum containing ribophorins and ribosomes. II. Rat liver microsomal subfractions contain equimolar amounts of ribophorins and ribosomes. *J Cell Biol.* **99**, 2254-2259
58. K. E. Matlack, Plath K., Misselwitz B., Rapoport T. A. (1997). Protein transport by purified yeast Sec complex and Kar2p without membranes. *Science.* **277**, 938-941
59. J. F. Menetret, Neuhof A., Morgan D. G., Plath K., Radermacher M., Rapoport T. A., Akey C. W. (2000). The structure of ribosome-channel complexes engaged in protein translocation. *Mol Cell.* **6**, 1219-1232
60. D. I. Meyer, Dobberstein B. (1980). Identification and characterization of a membrane component essential for the translocation of nascent proteins across the membrane of the endoplasmic reticulum. *J Cell Biol.* **87**, 503-508
61. T. H. Meyer, Menetret J. F., Breitling R., Miller K. R., Akey C. W., Rapoport T. A. (1999). The bacterial SecY/E translocation complex forms channel-like structures similar to those of the eukaryotic Sec61p complex. *J Mol Biol.* **285**, 1789-1800
62. J. D. Miller, Wilhelm H., Giersch L., Gilmore R., Walter P. (1993). GTP binding and hydrolysis by the signal recognition particle during initiation of protein translocation. *Nature.* **366**, 351-354
63. J. D. Miller, Tajima S., Lauffer L., Walter P. (1995). The beta subunit of the signal recognition particle receptor is a transmembrane GTPase that anchors the alpha

- subunit, a peripheral membrane GTPase, to the endoplasmic reticulum membrane. *J Cell Biol.* **128**, 273-282
64. A. Miyazawa, Fujiyoshi Y., Stowell M., Unwin N. (1999). Nicotinic acetylcholine receptor at 4.6 Å resolution: transverse tunnels in the channel wall. *J Mol Biol.* **288**, 765-786
65. D. Moazed, Noller H. F. (1989). Intermediate states in the movement of transfer RNA in the ribosome. *Nature.* **342**, 142-148
66. G. Montoya, Svensson C., Luirink J., Sinning I. (1997). Crystal structure of the NG domain from the signal-recognition particle receptor FtsY. *Nature.* **385**, 365-368
67. D. G. Morgan, Menetret J. F., Radermacher M., Neuhof A., Akey I. V., Rapoport T. A., Akey C. W. (2000). A comparison of the yeast and rabbit 80 S ribosome reveals the topology of the nascent chain exit tunnel, inter-subunit bridges and mammalian rRNA expansion segments. *J Mol Biol.* **301**, 301-321
68. W. Mothes, Prehn S., Rapoport T. A. (1994). Systematic probing of the environment of a translocating secretory protein during translocation through the ER membrane. *EMBO J.* **13**, 3973-3982
69. W. Mothes, Jungnickel B., Brunner J., Rapoport T. A. (1998). Signal sequence recognition in cotranslational translocation by protein components of the endoplasmic reticulum membrane. *J Cell Biol.* **142**, 355-364
70. D. T. Ng, Brown J. D., Walter P. (1996). Signal sequences specify the targeting route to the endoplasmic reticulum membrane. *J Cell Biol.* **134**, 269-278
71. P. Nissen, Hansen J., Ban N., Moore P. B., Steitz T. A. (2000). The structural basis of ribosome activity in peptide bond synthesis. *Science.* **289**, 920-930
72. S. C. Ogg, Barz W. P., Walter P. (1998). A functional GTPase domain, but not its transmembrane domain, is required for function of the SRP receptor beta-subunit. *J Cell Biol.* **142**, 341-354
73. SL Palay GE Palade (1955). The Fine Structure of Neurons *Journal of Biophysical and Biochemical Cytology.* **1**, 69-88
74. S. Panzner, Dreier L., Hartmann E., Kostka S., Rapoport T. A. (1995). Posttranslational protein transport in yeast reconstituted with a purified complex of Sec proteins and Kar2p. *Cell.* **81**, 561-570

75. P. A. Penczek, Grassucci R. A., Frank J. (1994). The ribosome at improved resolution: new techniques for merging and orientation refinement in 3D cryo-electron microscopy of biological particles. *Ultramicroscopy*. **53**, 251-270
76. R. J. Planta, Mager W. H. (1998). The list of cytoplasmic ribosomal proteins of *Saccharomyces cerevisiae*. *Yeast*. **14**, 471-477
77. K. Plath, Mothes W., Wilkinson B. M., Stirling C. J., Rapoport T. A. (1998). Signal sequence recognition in posttranslational protein transport across the yeast ER membrane. *Cell*. **94**, 795-807
78. K. R. Porter, Claude A., Fullam E. (1945). A Study of Tissue Culture Cells by Electron Microscopy. *Journal of Experimental Medicine*. **81**, 233-246
79. W. A. Prinz, Grzyb L., Veenhuis M., Kahana J. A., Silver P. A., Rapoport T. A. (2000). Mutants affecting the structure of the cortical endoplasmic reticulum in *Saccharomyces cerevisiae*. *J Cell Biol*. **150**, 461-474
80. A. Prinz, Behrens C., Rapoport T. A., Hartmann E., Kalies K. U. (2000). Evolutionarily conserved binding of ribosomes to the translocation channel via the large ribosomal RNA. *EMBO J*. **19**, 1900-1906
81. P. J. Rapiejko, Gilmore R. (1997). Empty site forms of the SRP54 and SR alpha GTPases mediate targeting of ribosome-nascent chain complexes to the endoplasmic reticulum. *Cell*. **89**, 703-713
82. H. R. Saibil (2000). Macromolecular structure determination by cryo-electron microscopy. *Acta Crystallogr D Biol Crystallogr*. **56 (Pt 10)**, 1215-1222
83. F. Schluenzen, Tocilj A., Zarivach R., Harms J., Gluehmann M., Janell D., Bashan A., Bartels H., Agmon I., Franceschi F., Yonath A. (2000). Structure of functionally activated small ribosomal subunit at 3.3 angstroms resolution. *Cell*. **102**, 615-623
84. D. J. Schnell, Hebert D. N. (2003). Protein translocons: multifunctional mediators of protein translocation across membranes. *Cell*. **112**, 491-505
85. T. Schwartz, Blobel G. (2003). Structural basis for the function of the Beta subunit of the eukaryotic signal recognition particle receptor. *Cell*. **112**, 793-803
86. A. S. Shaw, Rottier P. J., Rose J. K. (1988). Evidence for the loop model of signal-sequence insertion into the endoplasmic reticulum. *Proc Natl Acad Sci U S A*. **85**, 7592-7596

87. W. Song, Raden D., Mandon E. C., Gilmore R. (2000). Role of Sec61alpha in the regulated transfer of the ribosome-nascent chain complex from the signal recognition particle to the translocation channel. *Cell.* **100**, 333-343
88. C. M. Spahn, Penczek P. A., Leith A., Frank J. (2000). A method for differentiating proteins from nucleic acids in intermediate-resolution density maps: cryo-electron microscopy defines the quaternary structure of the Escherichia coli 70S ribosome. *Structure Fold Des.* **8**, 937-948
89. C. M. Spahn, Beckmann R., Eswar N., Penczek P. A., Sali A., Blobel G., Frank J. (2001). Structure of the 80S ribosome from *Saccharomyces cerevisiae*--tRNA-ribosome and subunit-subunit interactions. *Cell.* **107**, 373-386
90. H. Stark, Orlova E. V., Rinke-Appel J., Junke N., Mueller F., Rodnina M., Wintermeyer W., Brimacombe R., Heel,van,M. (1997). Arrangement of tRNAs in pre- and posttranslocational ribosomes revealed by electron cryomicroscopy. *Cell.* **88**, 19-28
91. J. Toikkanen, Gatti E., Takei K., Saloheimo M., Olkkonen V. M., Soderlund H., De Camilli P., Keranen S. (1996). Yeast protein translocation complex: isolation of two genes SEB1 and SEB2 encoding proteins homologous to the Sec61 beta subunit. *Yeast.* **12**, 425-438
92. P. N. Unwin, Zampighi G. (1980). Structure of the junction between communicating cells. *Nature.* **283**, 545-549
93. I. R. Vetter, Wittinghofer A. (2001). The guanine nucleotide-binding switch in three dimensions. *Science.* **294**, 1299-1304
94. T. Wagenknecht, Grassucci R., Frank J. (1988). Electron microscopy and computer image averaging of ice-embedded large ribosomal subunits from *Escherichia coli*. *J Mol Biol.* **199**, 137-147
95. P. Walter, Blobel G. (1980). Purification of a membrane-associated protein complex required for protein translocation across the endoplasmic reticulum. *Proc. Natl. Acad. Sci. USA.* **77**, 7112-7116
96. P. Walter, Blobel G. (1981). Translocation of proteins across the endoplasmic reticulum. II. Signal recognition protein (SRP) mediates the selective binding to

- microsomal membranes of in-vitro-assembled polysomes synthesizing secretory protein. *J Cell Biol.* **91**, 551-556
97. P. Walter, Blobel G. (1981). Translocation of proteins across the endoplasmic reticulum III. Signal recognition protein (SRP) causes signal sequence-dependent and site-specific arrest of chain elongation that is released by microsomal membranes. *J Cell Biol.* **91**, 557-561
98. L. Wang, Dobberstein B. (1999). Oligomeric complexes involved in translocation of proteins across the membrane of the endoplasmic reticulum. *FEBS Lett.* **457**, 316-322
99. M. G. Waters, Blobel G. (1986). Secretory protein translocation in a yeast cell-free system can occur posttranslationally and requires ATP hydrolysis. *J Cell Biol.* **102**, 1543-1550
100. B. M. Wilkinson, Critchley A. J., Stirling C. J. (1996). Determination of the transmembrane topology of yeast Sec61p, an essential component of the endoplasmic reticulum translocation complex. *J Biol Chem.* **271**, 25590-25597
101. B. T. Wimberly, Brodersen D. E., Clemons W. M., Jr/Morgan-Warren R. J., Carter A. P., Vonrhein C., Hartsch T., Ramakrishnan V. (2000). Structure of the 30S ribosomal subunit. *Nature.* **407**, 327-339
102. B. Witmann-Liebold (1986). Ribosomal Proteins: Their Structure and Evolution *Structure, Function and genetics of Ribosomes, Hardesty and Kramer (editors)*, (New York: Springer Verlag). , 203-214
103. S. Wittke, Dunnwald M., Johnsson N. (2000). Sec62p, a component of the endoplasmic reticulum protein translocation machinery, contains multiple binding sites for the Sec-complex. *Mol Biol Cell.* **11**, 3859-3871
104. S. Wittke, Dunnwald M., Albertsen M., Johnsson N. (2002). Recognition of a subset of signal sequences by Ssh1p, a Sec61p-related protein in the membrane of endoplasmic reticulum of yeast *Saccharomyces cerevisiae*. *Mol Biol Cell.* **13**, 2223-2232
105. I.G. Wool, Endo Y., Chan Y.L., Glueck A. (1990). Structure, Function and Evolution of Mamalian Ribosomes. in the Ribosome: Structure, Function & Evolution. *Hill*,

- Dahlberg, Garrett, Schlesinger and Warner (editors) (Washington DC: ASM press). , 883-896
106. J. C. Young, Ursini J., Legate K. R., Miller J. D., Walter P., Andrews D. W. (1995). An amino-terminal domain containing hydrophobic and hydrophilic sequences binds the signal recognition particle receptor alpha subunit to the beta subunit on the endoplasmic reticulum membrane. *J Biol Chem.* **270**, 15650-7
107. Y. H. Yu, Sabatini D. D., Kreibich G. (1990). Antiribophorin antibodies inhibit the targeting to the ER membrane of ribosomes containing nascent secretory polypeptides. *J Cell Biol.* **111**, 1335-1342
108. D. Zopf, Bernstein H. D., Johnson A. E., Walter P. (1990). The methionine-rich domain of the 54 kd protein subunit of the signal recognition particle contains an RNA binding site and can be crosslinked to a signal sequence. *EMBO J.* **9**, 4511-4517