

8. LITERATURVERZEICHNIS

- Anderson, A. C., Earp, B. E. & Frederick, C. A. (1996) Sequence variation as a strategy for crystallizing RNA motifs. *J. Mol. Biol.* **259**, 696-703.
- Apirion, D. & Miczak, A. (1993) RNA processing in prokaryotic cells. *BioEssays* **15**, 113-120.
- Bald, R., Brumm, K., Buchholz, B., Fürste, J. P., Hartmann, R. K., Jäschke, A., Kretschmer-Kazemi Far, R., Lorenz, S., Raderschall, E., Schlegl, J., Specht, T., Zhang, M., Cech, D. & Erdmann, V. A. (1992) New possibilities in RNA research through RNA engineering. In: *Structural tools for the analysis of protein-nucleic acid complexes. Advances in life sciences.* Birkhäuser Verlag Basel.
- Ban, N., 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.
- Barciszewska, M. Z., Erdmann, V. A. & Barciszewski, J. (1996) Ribosomal 5S rRNA: tertiary structure and interactions with proteins. *Biol. Rev.* **71**, 1-25.
- Barciszewska, M. Z., Szymanski, M., Erdmann, V. A. & Barciszewski, J. (2000) 5S ribosomal RNA. *Biomacromolecules* **1**, 297-302.
- Berman, H. M., Gelbin, A. & Westbrook, J. (1996) Nucleic acid crystallography: a view from the nucleic acid database. *Prog. Biophys. Mol. Biol.* **66**, 255-288.
- Berger, I., Kang, C., Sinha, N., Wolters, M. & Rich, A. (1996) A highly efficient 24-condition matrix for the crystallization of nucleic acid fragments. *Acta Cryst.* **D52**, 465-468.
- Bessarab, D. A., Kaberdin, V. R., Wei, C. L., Liou, G. G. & Lin-Chao, S. (1998) RNA components of *Escherichia coli* degradosome: evidence for rRNA decay. *Proc. Natl. Acad. Sci. USA* **95**, 3157-3161.
- Betzl, C., Lorenz, S., Fürste, J. P., Bald, R., Zhang, M., Schneider, T. R., Wilson, K. S. & Erdmann, V. A. (1994) Crystal structure of domain A of *Thermus flavus* 5S rRNA and the contribution of water molecules to its structure. *FEBS Lett.* **351**, 159-164.
- Biswas, R., Wahl, M. C., Ban, C. & Sundaralingam, M. J. (1997) Crystal structure of an alternating octamer r(GUAUGUA)dC with adjacent G x U wobble pairs. *J. Mol. Biol.* **267**, 11449-11456.
- Bloemink, M. J. & Moore, P. B. (1999) Phosphorylation of ribosomal protein L18 is required for its folding and binding to 5S rRNA. *Biochemistry* **38**, 13385-13390.
- Brimacombe, R. (2000) The bacterial ribosome at atomic resolution. *Structure* **8**, 195-200.
- Bronstein, I. N. & Semendjajew, K. A. (1958) Taschenbuch der Mathematik. B. G. Teubner Verlagsgesellschaft, Leipzig.
- Brosius, J., Dull, T. J., Sleeter, D. D. & Noller, H. F. (1981) Gene organization and primary structure of a ribosomal RNA operon from *Escherichia coli*. *J. Mol. Biol.* **148**, 107-127.
- Brünger, A. T. (1992) X-PLOR. Version 3.1. A system for crystallography and NMR. Yale University Press, New Haven.
- Brunel, C., Romby, P., Westhof, E., Ehresmann, C. & Ehresmann, B. (1991) Three-dimensional model of *E. coli* ribosomal 5S RNA as deduced from structure probing in solution and computer modelling. *J. Mol. Biol.* **221**, 293-308.
- Butler, M., Stecker, K. & Bennett, C. F. (1997) Cellular distribution of Phosphothiodate oligonucleotides in normal rodent tissues. *Laboratory Investigations* **77**, 379-388.
- Cate, J. H., Gooding, A. R., Podell, E., Zhou, K., Golden, B. L., Kundrot, C. E., Cech, T. R. & Doudna, J. A. (1996) Crystal structure of a group I ribozyme domain: principles of RNA packing. *Science* **273**, 1678-1685.

- Chung, C. T., Niemela, S. L. & Miller, R. H. (1989) One-step preparation of competent *Escherichia coli*: transformation and storage of bacterial cells in the same solution. *Proc. Natl. Acad. Sci. USA* **86**, 2172-2175.
- Conn, G. L., Draper, D. E., Lattman, E. E. & Gittis, A. G. (1999) Crystal structure of a conserved ribosomal protein-RNA complex. *Science* **284**, 1171-1174.
- Correll, C. C., Freeborn, B., Moore, P. B. & Steitz, T. A. (1997a) Metals, motifs and recognition in the crystal structure of a 5S rRNA domain. *Cell* **91**, 705-712.
- Correll, C. C., Freeborn, B., Moore, P. B. & Steitz, T. A. (1997b) Use of chemically modified nucleotides to determine a 62-nucleotide RNA crystal structure: a survey of phosphorothioates, Br, Pt and Hg. *J. Biomol. Struct. Dyn.* **15**, 165-172.
- Cruse, W. B. T., Saludjian, P., Biala, E., Strazewski, P., Prangé, T. & Kennard, O. (1994) Structure of a mispaired RNA double helix at 1.6 Å resolution and implications for the prediction of RNA secondary structure. *Proc. Natl. Acad. Sci. USA* **91**, 4160-4164.
- Dallas, A. & Moore, P. B. (1997) The loop E-loop D region of *Escherichia coli* 5S rRNA: the solution structure reveals an unusual loop that may be important for binding ribosomal proteins. *Structure* **5**, 1639-1653.
- Dauter, Z., Dauter, M. & Rajashankar, K. R. (2000) Novel approach to phasing proteins: derivatization by short cryo-soaking with halides. *Acta Cryst.* **D56**, 1-5.
- Doudna, J. A., Grosshans, C., Gooding, A. & Kundrot, C. E. (1993) Crystallization of ribozymes and small RNA motifs by a sparse matrix approach. *Proc. Natl. Acad. Sci. USA* **90**, 7829-7833.
- Drenth, J. (1994) Principles of protein X-ray crystallography. Springer Verlag, New York.
- Egebjerg, J., Christiansen, J., Brown, R. S., Larsen, N. & Garrett, R. A. (1989) Protein L18 binds primarily at the junctions of helix II and internal loops A and B in *Escherichia coli* 5S RNA. *J. Mol. Biol.* **206**, 651-668.
- Erdmann, V. A., Fahnestock, S., Higo, K. & Nomura, M. (1971a) Role of 5S RNA in the function of ribosomal subunits. *Proc. Natl. Acad. Sci. USA* **68**, 2932-2936.
- Erdmann, V. A., Doberer, H. G. & Sprinzl, M. (1971b) Structure and function of 5S RNA: the role of the 3' terminus in 5S RNA function. *Mol. Gen. Genet.* **114**, 389-394.
- Erdmann, V. A., Lippmann, C., Betzel, C., Dauter, Z., Wilson, K., Hilgenfeld, R., Hoven, J., Liesum, A., Saenger, W., Müller-Fahrnow, A., Hinrichs, W., Düvel, M., Schulz, G. E., Müller, C. W., Wittmann, H. G., Yonath, A., Weber, G., Stegen, K., Plaas-Link, A. (1989) Crystallization of proteins under microgravity. *FEBS Letters* **259**, 194-198.
- Erdmann, V. A., Lorenz, S., Raderschall, E., Fürste, J. P., Bald, R., Zhang, M., Betzel, C. & Wilson, K. S. (1993) Crystallization and diffraction studies of *Thermus flavus* 5S rRNA and synthetic fragments of the 5S rRNA. In: K. H. Nierhaus *et al.* (eds.), *The Translational Apparatus*, Plenum Press, New York.
- Erdmann, V. A. (1995) Die Bedeutung der RNA-Technologien für die Biotechnologie und Medizin. In: *Berlin-Brandenburgische Akademie der Wissenschaften, Berichte und Abhandlungen*, Akademie Verlag Berlin, Band **1**, 41-53.
- Erdmann, V. A., Lorenz, S., Lippmann, C., Klussmann, S., Nolte, A., Fürste, J. P., Bald, R. & Betzel, C. (1996) The crystallization of ribonucleic acids and proteins under microgravity conditions. *Proceedings of China-Germany Workshop on Microgravity Science*, National Microgravity Laboratory, Beijing, 52-59.
- Erdmann, V. A. & Lorenz, S. (1998) Crystallization and X-ray analysis of 5S rRNA and the 5S rRNA domain A. Final science report of the experimental results from the LMS (Life and Microgravity Spacelab) space mission in 1996. In: *Advanced Protein Crystallization Facility (APCF)*, NASA / CP-1998-206960, J. P. Downey (Compiler), Marshall Space Flight Center, Alabama, 101-111.

- Fasman, G. D. (1975) Purines, pyrimidines, nucleosides and nucleotides: physical constants and spectral properties. In: *CRC Handbook of Biochemistry and Molecular Biology, Nucleic Acids - volume I*, 3rd edition, CRC Press, Cleveland, Ohio.
- Ferré-D'Amaré, A. R., Zhou, K. & Doudna, J. A. (1998) A general module for RNA crystallization. *J. Mol. Biol.* **279**, 621-631.
- Förster, C., Eickmann, A., Schubert, U., Hollmann, S., Müller, U., Heinemann, U. & Fürste, J. P. (1999) Crystallization and X-ray diffraction data of a tRNA^{Sec} acceptor-stem helix. *Acta Cryst.* **D55**, 664-666.
- Fuchs, U., Stiege, U. & Erdmann, V. A. (1997) Ribonucleolytic activities in the *Escherichia coli* *in vitro* translation system and in its separate components. *FEBS Lett.* **414**, 362-364.
- Funari, S. S., Rapp, G., Perbandt, M., Dierks, K., Vallazza, M., Betzel, C., Erdmann, V. A. & Svergun, D. I. (2000) Structure of free *Thermus flavus* 5S rRNA at 1.3 nm resolution from X-ray solution scattering. *J. Biol. Chem.* **275**, 31283-31288.
- George, A., Chiang, Y., Guo, B., Arabshahi, A., Cai, Z. & Wilson, W. W. (1997) Second virial coefficient as predictor in protein crystal growth. *Meth. Enzymol.* **276**, 100-110.
- Gilbert, W. (1986) The RNA world. *Nature* **319**, 618.
- Gongadse, G., Kashparov, I., Lorenz, S., Schröder, W., Erdmann, V. A., Liljas, A. & Garber, M. (1996) 5S rRNA binding ribosomal proteins from *Th. thermophilus*: identification and some structural properties. *FEBS Lett.* **386**, 260-262.
- Gongadze, G. M., Meshcheryakov, V. A., Serganov, A. A., Fomenkova, N. P., Mudrik, E. S., Jonsson, B.-H., Liljas, A., Nikonov, S. V. & Garber, M. (1999) N-terminal domain, residues 1-91, of ribosomal protein TL5 from *Thermus thermophilus* binds specifically and strongly to the region of 5S rRNA containing loop E. *FEBS Lett.* **451**, 51-55.
- Gross, B., Welfle, H. & Bielka, H. (1985) Protein-RNA interaction in the rat liver 5S rRNA-protein L5 complex studied by digestion with ribonucleases. *Nucl. Acids Res.* **1**, 2325-2335.
- Grüne, M., Fürste, J. P., Klußmann, S., Erdmann, V. A. & Brown, L. (1996a) Detection of multiple conformations of the E-domain of 5S rRNA from *Escherichia coli* in solution and in crystals by NMR spectroscopy. *Nucl. Acids Res.* **24**, 2592-2596.
- Grüne, M., Görlach, M., Soskic, V., Klussmann, S., Bald, R., Fürste, J. P., Erdmann, V. A. & Brown, L. R. (1996b) Initial analysis of 750 MHz NMR spectra of selectively ¹⁵N-G,U labelled *E. coli* 5S rRNA. *FEBS Letters* **385**, 114-118.
- Gryaznova, O. I., Davydova, N. L., Gongadze, G. M., Jonsson, B. H., Garber, M. B. & Liljas, A. (1996) A ribosomal protein from *Thermus thermophilus* is homologous to a general shock protein. *Biochimie* **78**, 915-919.
- Guerrier-Takada, C., Gardiner, K., Marsh, T., Pace, N. & Altman, S. (1983) The RNA moiety of Ribonuclease P is the catalytic subunit of the enzyme. *Cell* **35**, 849-857.
- Hartmann, R. K., Ulbrich, N. & Erdmann, V. A. (1987) An unusual rRNA operon constellation: in *Thermus thermophilus* HB8 the 23S/5S rRNA operon is a separate entity from the 16S rRNA operon. *Biochimie* **69**, 1097-1104.
- Hartmann, R. K., Vogel, D. W., Walker, R. T. & Erdmann, V. A. (1988) *In vitro* incorporation of eubacterial, archaeobacterial and eucaryotic 5S rRNAs into large ribosomal subunits of *Bacillus stearothermophilus*. *Nucl. Acids Res.* **16**, 3511-3524.
- Heinemann, U., Frevert, J., Hofmann, K.-P., Illing, G., Maurer, C., Oschkinat, H. & Saenger, W. (2000) An integrated approach to structural genomics. *Prog. Biophys. Mol. Biol.* **73**, 347-362.
- Helm, M., Brulé, H., Giegé, R. & Florentz, C. (1999) More mistakes by T7 RNA polymerase at the 5' ends of *in vitro*-transcribed RNAs. *RNA* **5**, 618-621.

- Herrlich, P. & Schweiger, M. (1974) DNA- and RNA-directed synthesis *in vitro* of phage enzymes. *Methods Enzymol.* **30**, 654-669.
- Holbrook, S. R. & Kim, S. H. (1997) RNA crystallography. *Biopolymers* **44**, 3-21.
- Horne, J. R. & Erdmann, V. A. (1972) Isolation and characterization of 5S RNA-protein complexes from *Bacillus stearothermophilus* and *Escherichia coli* ribosomes. *Mol. Gen. Genet.* **119**, 337-344.
- Huber, P. W. & Wool, I. G. (1984) Nuclease protection analysis of ribonucleoprotein complexes: use of the cytotoxic ribonuclease α -sarcin to determine the binding site for *Escherichia coli* ribosomal proteins L5, L18 and L25 on 5S rRNA. *Proc. Natl. Acad. Sci. USA* **81**, 322-326.
- Jahn, O., Hartmann, R. K.; Boeckh, T. & Erdmann, V. A. (1991) Comparative analysis of ribosomal protein L5 sequences from bacteria of the genus *Thermus*. *Biochimie* **73**, 669-678.
- Kalb, V. F. & Bernlohr, R. W. (1977) A new spectrophotometric assay for protein in cell extracts. *Anal. Biochem.* **82**, 362-371.
- Khaitovich, P. & Mankin, A. S. (1999) Effect of antibiotics on large ribosomal subunit assembly reveals possible function of 5S rRNA. *J. Mol. Biol.* **291**, 1025-1034.
- Kimura, J. & Kimura, M. (1987) The complete amino acid sequence of the 5S rRNA binding proteins L5 and L18 from the moderate thermophile *Bacillus stearothermophilus* ribosome. *FEBS Lett.* **210**, 85-90.
- Kirpekar, F., Douthwaite, S. & Roepstorff, P. (2000) Mapping posttranscriptional modifications in 5S ribosomal RNA by MALDI mass spectrometry. *RNA* **6**, 296-306.
- Kleber, W. (1961) Einführung in die Kristallographie. Verlag Technik, Berlin.
- Kruger, K., Grabowski, P. J., Zaug, A. J., Sands, J., Gottschling, D. E. & Cech, T. R. (1982) Self splicing RNA: autoexcision and autocatalyzation of the ribosomal RNA intervening sequence of *Tetrahymena*. *Cell* **31**, 147-157.
- Laemmli, U. K. (1970) Cleavage of structural proteins during the assembly of the head of bacteriophage T4. *Nature* **227**, 680-685.
- Leitner, D., Schröder, W. & Weisz, K. (1998) Direct monitoring of cytosine protonation in an intramolecular DNA triple helix. *J. Am. Chem. Soc.* **120**, 7123-7124.
- Leontis, N. B. & Westhof (1998) The 5S rRNA loop E: chemical probing and phylogenetic data versus crystal structure. *RNA* **4**, 1134-1153.
- Lilley, D. M. J. (1995) Kinking of DNA and RNA by base bulges. *Proc. Natl. Acad. Sci. USA* **92**, 7140-7142.
- Lima, W. F. & Crooke, S. T. (1997) Cleavage of single strand RNA adjacent to RNA-DNA duplex regions by *Escherichia coli* RNase H1. *J. Biol. Chem.* **272**, 27513-27516.
- Limmer, S., Hofmann, H.-P., Ott, G. & Sprinzl, M. (1993) The 3'-terminal end (NCCA) of tRNA determines the structure and stability of the aminoacyl acceptor stem. *Proc. Natl. Acad. Sci. USA* **90**, 6199-6202.
- Lorberboum, H., Digweed, M., Erdmann, V. A., Servadio, Y., Weinstein, D., De Groot, N. & Hochberg, A. (1986) Small cytoplasmic RNAs from human placental free mRNPs. *Eur. J. Biochem.* **155**, 279-287.
- Lorenz, S., Betzel, C., Raderschall, E., Dauter, Z., Wilson, K. S. & Erdmann, V. A. (1991) Crystallization and preliminary diffraction studies of 5S rRNA from the thermophilic bacterium *Thermus flavus*. *J. Mol. Biol.* **219**, 399-402.
- Lorenz, S., Fürste, J. P., Bald, R., Zhang, M., Raderschall, E., Betzel, C., Dauter, Z., Wilson, K. S. & Erdmann, V. A. (1993) Crystallization and preliminary diffraction studies of the chemically synthesized domain A of *Thermus flavus* 5S rRNA: a RNA dodecamer double helix. *Acta Cryst.* **D49**, 418-420.

- Lorenz, S., Perbandt, M., Lippmann, C., Moore, K., DeLucas, L. J., Betzel, C. & Erdmann, V. A. (2000) Crystallization of engineered *Thermus flavus* 5S rRNA under earth and microgravity conditions. *Acta Cryst.* **D56**, 498-500.
- Lu, M. & Steitz, T. A. (2000) Structure of *Escherichia coli* ribosomal protein L25 complexed with a 5S rRNA fragment at 1.8 Å resolution. *Proc. Natl. Acad. Sci. USA* **97**, 2023-2028.
- McMahon, M. E. & Erdmann, V. A. (1982) Binding of spermidine to transfer ribonucleic acid. *Biochemistry* **21**, 5280-5288.
- McPherson, A. (1990) Current approaches to macromolecular crystallization. *Eur. J. Biochem.* **189**, 1-23.
- Mikol, V., Rodeau, J.-L. & Giegé, R. (1990) Experimental determination of water equilibration rates in the hanging drop method of protein crystallization. *Anal. Biochem.* **186**, 332-339.
- Milligan, J. F., Groebe, D. R., Witherell, G. W. & Uhlenbeck, O. C. (1987) Oligoribonucleotide synthesis using T7 RNA polymerase and synthetic DNA templates. *Nucl. Acids Res.* **15**, 8783-8798.
- Morikawa, K., Kawakami, M. & Takemura, S. (1982) Crystallization and preliminary X-ray diffraction study of 5S rRNA from *Thermus thermophilus* HB8. *FEBS Lett.* **145**, 194-196.
- Müller, U., Schübel, H., Sprinzl, M. & Heinemann, U. (1999) Crystal structure of acceptor stem of tRNA^{Ala} from *Escherichia coli* shows unique G:U wobble base pair at 1.16 Å resolution. *RNA* **5**, 670-677.
- Musier-Forsyth, K., Shi, J. P., Henderson, B., Bald, R., Fürste, J. P., Erdmann, V. A. & Schimmel, P. (1995) Base-analog-induced aminoacylation of an RNA helix by a tRNA synthetase. *J. Am. Chem. Soc.* **117**, 7253-7254.
- Nakashima, T., Yao, M., Kawamura, S., Iwasaki, K., Kimura, M. & Tanaka, I. (2001) Ribosomal protein L5 has a highly twisted concave surface and flexible arms responsible for RNA binding. *RNA* **7**, 692-701.
- Navaza, J. (1994) AMoRe: an automated package for molecular replacement. *Acta Cryst.* **D50**, 157-163.
- Newberry, V., Brosius, J. & Garrett, R. (1978) Fragment of protein L18 from the *Escherichia coli* ribosome that contains the 5S RNA binding site. *Nucl. Acids Res.* **5**, 1753-1766.
- Nissen, P., 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.
- Nolte, A., Klußman, S., Lorenz, S., Bald, R., Betzel, C., Dauter, Z., Wilson, K., Fürste, J. P. & Erdmann, V. A. (1995) Crystallization and preliminary diffraction studies of the structural domain E of *Thermus flavus* 5S rRNA. *FEBS Lett.* **374**, 292-294.
- Nomura, M. & Erdmann, V. A. (1970) Reconstitution of 50S ribosomal subunits from dissociated molecular components. *Nature (London)* **228**, 744-748.
- Ogata, K., Ohno, R., Morioka, S. & Terao, K. (1996) Further study on association of 5S rRNA-L5 protein complex and methionyl-tRNA synthetase in macromolecular aminoacyl-tRNA synthetase complex. *J. Biochem.* **120**, 869-880.
- Ogle, J. M., Brodersen, D. E., Clemens Jr., W. M., Tarry, M. J., Carter, A. P. & Ramakrishnan, V. (2001) Recognition of cognate transfer RNA by the 30S ribosomal subunit. *Science* **292**, 897-902.
- Ott, G., Dörfler, S., Sprinzl, M., Müller, U. & Heinemann, U. (1996) Crystals of the chemically synthesized acceptor stem of tRNA^{Ala} from *Escherichia coli* diffracting to high resolution. *Acta Cryst.* **D52**, 871-873.
- Otwinowski, Z. (1993) DENZO, XDISP, SCALEPACK. An Oscillation Data Processing Program for Macromolecular Crystallography. Yale University, New Haven, CT, USA.

- Oubridge, C., Ito, N., Teo, C.-H., Fearnley, I. & Nagai, K. (1995) Crystallisation of RNA-protein complexes II: The application of protein engineering for crystallisation of the U1A protein-RNA complex. *J. Mol. Biol.* **249**, 409-423.
- Pace, B., Stahl, D. A. & Pace, N. R. (1984) The catalytic element of a ribosomal RNA-processing complex. *J. Biol. Chem.* **259**, 11454-11458.
- Pan, J., Thirumalai, D. & Woodson, S. A. (1999) Magnesium-dependent folding of self-splicing RNA: exploring the link between cooperativity, thermodynamics and kinetics. *Proc. Natl. Acad. Sci. USA* **96**, 6149-6154.
- Papworth, C., Bauer, J. C. & Braman, J. (1995) Site-directed mutagenesis in one day with > 80 % efficiency. *Strategies* **8**, 3-4.
- Perbandt, M., Nolte, A., Lorenz, S., Bald, R., Betzel, C. & Erdmann, V. A. (1998) Crystal structure of domain E of *Thermus flavus* 5S rRNA: a helical RNA structure including a hairpin loop. *FEBS Lett.* **429**, 211-215.
- Perbandt, M., Lorenz, S., Vallazza, M., Erdmann, V. A. & Betzel, C. (1999) Towards the 3D structure of 5S rRNA. In: J. Barciszewski and B.F.C. Clark (eds.) *RNA Biochemistry and Biotechnology*, Kluwer Academic Publishers, 63-71.
- Perbandt, M., Vallazza, M., Lippmann, C., Betzel, C. & Erdmann, V. A. (2001) Structure of an RNA duplex with an unusual G:C pair in wobble-like confirmation at 1.6 Å resolution. *Acta Cryst.* **D57**, 219-224.
- Perona, J. J., Rould, M. A., Steitz, T. A., Risler, J. L., Zelwer, C. & Brunie, S. (1991) Structural similarities in glutamyl- and methionyl-tRNA synthetases suggest a common overall orientation of tRNA binding. *Proc. Natl. Acad. Sci. USA* **88**, 2903-2907.
- Pieler, T. & Erdmann, V. A. (1982) Three-dimensional structural model of eubacterial 5S RNA that has functional implications. *Proc. Natl. Acad. Sci. USA* **79**, 4599-4603.
- Pleiss, J. A., Derrick, M. L. & Uhlenbeck, O. C. (1998) T7 RNA polymerase produces 5' end heterogeneity during *in vitro* transcription from certain templates. *RNA* **4**, 1313-1317.
- Pley, H. W., Flaherty, K. M., & McKay, D. B. (1994) Model for an RNA tertiary interaction from the structure of an intermolecular complex between a GAAA tetraloop and an RNA helix. *Nature* **372**, 111-113.
- Ramakrishnan, V. & Gerchman, S. E. (1991) Cloning, sequencing and overexpression of genes for ribosomal proteins from *Bacillus stearothermophilus*. *J. Biol. Chem.* **266**, 880-885.
- Ray, B. K., Singh, B. Roy, M. K. & Apirion, D. (1982) Ribonuclease E is involved in the processing of 5S rRNA from a number of rRNA transcription units. *Eur. J. Biochem.* **125**, 283-289.
- Richards, G. M., du Vair, G. & Laskowski, M. (1965) Comparison of the levels of phosphodiesterase, endonuclease and monophosphatases in several snake venoms. *Biochemistry* **4**, 501-503.
- Rife, J. P., Stallings, S. C., Correll, C. C., Dallas, A., Steitz, T. A. & Moore, P. B. (1999) Comparison of the crystal and solution structures of two RNA oligonucleotides. *Biophysical J.* **76**, 65-75.
- Rubinson, K. A., Ladner, J. E., Tordova, M. & Gilliland, G. L. (2000) Cryosalts: suppression of ice formation in macromolecular crystallography. *Acta Cryst.* **D56**, 996-1001.
- Saenger, W. (1987) Principles of Nucleic Acids. Springer Verlag, Berlin.
- Saiki, T., Kunura, R. & Arima, K. (1972) Isolation and characterization of extremely thermophilic bacteria from hot springs. *Agric. Biol. Chem.* **36**, 2357-2366.
- Sambrook, J., Fritsch, E. F. & Maniatis, T. (1989) Molecular Cloning. Cold Spring Harbor Lab Press.
- Sanger, F., Nicklen, S. & Coulson, A. R. (1977) DNA sequencing with chain-termination inhibitors. *Proc. Natl. Acad. Sci. USA* **74**, 5463-5467.

- Santoro, S. W. & Joyce, G. F. (1997) A general purpose RNA-cleaving DNA enzyme. *Proc. Natl. Acad. Sci. USA* **94**, 4262-4266.
- Schindelin, H., Zhang, M., Bald, R., Fürste, J. P., Erdmann, V. A. & Heinemann, U. (1995) Crystal structure of an RNA dodecamer containing the *Escherichia coli* Shine-Dalgarno sequence. *J. Mol. Biol.* **249**, 595-603.
- Schlesinger, G. & Miller, S. L. (1983) Prebiotic synthesis in atmospheres containing CH₄, CO and CO₂. II. Hydrogen cyanide, formaldehyde and ammonia. *J. Mol. Evol.* **19**, 383-390.
- Schwarz, R. M. & Dayhoff, M. O. (1978) Origins of procaryotes, eucaryotes, mitochondria and chloroplasts. *Science* **199**, 395-403.
- Scott, W. G., Finch, J. T., Grenfell, R., Fogg, J., Smith, T., Gait, J. & Klug, A. (1995) Rapid crystallization of chemically synthesized hammerhead RNAs using a double screening procedure. *J. Mol. Biol.* **250**, 327-332.
- Sergiev, P., Dokudovskaya, S., Romanova, E., Topin, A., Bogdanov, A., Bromacombe, R. & Dontsova, O. (1998) The environment of 5S rRNA in the ribosome: cross-links to the GTPase-associated area of 23S rRNA. *Nucl. Acids Res.* **26**, 2519-2525.
- Setterquist, R. A., Smith, G. K., Oakley, T. H., Lee, Y.-H. & Fox, G. E. (1996) Sequence, overproduction and purification of *Vibrio proteolyticus* ribosomal protein L18 for *in vitro* and *in vivo* studies. *Gene* **183**, 237-242.
- Sogin, M. L., Pace, B. & Pace, N. R. (1977) Partial purification and properties of a ribosomal RNA maturation endonuclease from *Bacillus subtilis*. *J. Biol. Chem.* **252**, 1350-1357.
- Specht, T., Wolters, J. & Erdmann, V. A. (1990) Compilation of 5S rRNA and 5S rRNA gene sequences. *Nucl. Acids Res.* **18** (Suppl.) 2215-2230.
- Steitz, J. A., Ber, C., Herdrick, J. P., La Branche-Chabot, M., Metspalu, A., Rinke, J. & Yario, T. (1988) A 5S rRNA/L5 complex is a precursor to ribosome assembly in mammalian cells. *J. Cell Biol.* **106**, 545-556.
- Stiege, W. & Erdmann, V. A. (1995) The potentials of the *in vitro* protein biosynthesis system. *J. Biotech.* **41**, 81-90.
- Stoldt, M., Wöhnert, J., Görlach, M. & Brown, L. (1998) The NMR structure of *Escherichia coli* ribosomal protein L25 shows homology to general stress proteins and glutaminyl-tRNA synthetases. *EMBO J.* **17**, 6377-6384.
- Stoldt, M., Wöhnert, J., Ohlenschläger, O., Görlach, M. & Brown, L. (1999) The NMR structure of the 5S rRNA E-domain-protein L25 complex shows preformed and induced recognition. *EMBO J.* **22**, 6508-6521.
- Stryer, L. (1994) Biochemie. Spektrum Akademischer Verlag, Heidelberg - Berlin - Oxford.
- Stura, E. & Chen, P. (1992) Crystallization of nucleic acids and proteins, a practical approach. A. Ducruix and R. Giege (eds.) Oxford University Press, 241-254.
- Svergun, D. I. & Nierhaus, K. H. (2000) A map of protein-rRNA distribution in the 70S *Escherichia coli* ribosome. *J. Biol. Chem.* **275**, 14432-14439.
- Szeberenyi, J., Roy, M. K., Vaidya, C. & Apirion, D. (1984) 7S RNA, containing 5S ribosomal RNA and the termination stem, is a specific substrate for the two RNA processing enzymes RNase III and RNase E. *Biochemistry* **23**, 2952-2957.
- Szymanski, M., Barciszewska, M. Z., Barciszewski, J. & Erdmann, V. A. (1999) 5S ribosomal RNA data bank. *Nucl. Acids Res.* **1**, 158-160.
- Tucker, C. E., Chen, L.-S., Judkins, M. B., Farmer, J. A., Gill, S. C. & Drolet, D. W. (1999) Detection and plasma pharmacokinetics of an anti-vascular endothelial growth factor oligonucleotide-aptamer (NX1838) in rhesus monkeys. *J. Chromatography* **B732**, 203-212.

- Vysotskaya, V. S., Shcherbakov, D. V. & Garber, M. B. (1997) Sequencing and analysis of the *Thermus thermophilus* ribosomal protein gene cluster equivalent to the spectinomycin operon. *Gene* **193**, 23-30.
- Weber, P. (1997) Overview of protein crystallization methods. *Meth. Enzymol.* **276**, 13-22.
- White, S. A., Nilges, M., Huang, A., Brünger, A. T. & Moore, P. B. (1992) NMR analysis of helix I from the 5S RNA of *Escherichia coli*. *Biochemistry* **31**, 1610-1621.
- Wolters, J. & Erdmann, V. A. (1986) Cladistic analysis of 5S rRNA and 16S rRNA secondary and primary structure – the evolution of eukaryotes and their relation to archaebacteria. *J. Mol. Biol.* **24**, 152-166.
- Wu, M., McDowell, J. A. & Turner, D. H. (1995) A periodic table of symmetric tandem mismatches in RNA. *Biochemistry* **32**, 3204-3211.
- Wyszko, E., Szymanski, M., Fürste, J. P., Giel-Pietraszuk, M., Barciszewska, M. Z., Mucha, P., Rekowski, P., Kupryszewski, G., Erdmann, V. A. & Barciszewski, J. (1999) Interaction of native RNAs with TAT peptides. In: J. Barciszewski and B.F.C. Clark (eds.) *RNA Biochemistry and Biotechnology*, Kluwer Academic Publishers.
- Young, R. A. (1979) Transcription termination in the *Escherichia coli* ribosomal RNA operon rrnC. *J. Biol. Chem.* **254**, 12725-12731.
- Yusupov, M. M., Yusupova, G. Z., Baucom, A., Lieberman, K., Earnest, T. N., Cate, J. H. D. & Noller, H. F. (2001) Crystal structure of the ribosome at 5.5 Å resolution. *Science* **292**, 883-896.
- Zhongwei, L., Pandit, S. & Deutscher, M. P. (1998) 3' exoribonucleolytic trimming is a common feature of the maturation of small, stable RNAs in *Escherichia coli*. *Proc. Natl. Acad. Sci. USA* **95**, 2856-2861.