

## 7 Literaturverzeichnis

Achsel, T., Brahms, H., Kastner, B., Bachi, A., Wilm, M. und Luhrmann, R. (1999) A doughnut-shaped heteromer of human Sm-like proteins binds to the 3'-end of U6 snRNA, thereby facilitating U4/U6 duplex formation in vitro. *EMBO J.*, **18**, 5789-5802.

Boelens, W.C., Palacios, I. und Mattaj, I.W. (1995) Nuclear retention of RNA as a mechanism for localization. *RNA*, **1**, 273-283.

Brahms, H., Raymackers, J., Union, A., de Keyser, F., Meheus, L. und Luhrmann, R. (2000) The C-terminal RG Dipeptide Repeats of the Spliceosomal Sm Proteins D1 and D3 Contain Symmetrical Dimethylarginines, Which Form a Major B-cell Epitope for Anti-Sm Autoantibodies. *J. Biol. Chem.*, **275**, 17122-17129.

Branlant, C., Krol, A., Ebel, J.P., Lazar, E., Haendler, B. und Jacob, M. (1982) U2 RNA shares a structural domain with U1, U4, and U5 RNAs. *EMBO J.*, **1**, 1259-1265.

Brzustowicz, L.M., Lehner, T., Castilla, L.H., Penchaszadeh, G.K., Wilhelmsen, K.C., Daniels, R., Davies, K.E., Leppert, M., Ziter, F., Wood, D. et al. (1990) Genetic mapping of chronic childhood-onset spinal muscular atrophy to chromosome 5q11.2-13.3. *Nature*, **344**, 540-541.

Buhler, D., Raker, V., Luhrmann, R. und Fischer, U. (1999) Essential role for the tudor domain of SMN in spliceosomal U snRNP assembly: implications for spinal muscular atrophy. *Hum. Mol. Genet.*, **8**, 2351-2357.

Camasses, A., Bragado-Nilsson, E., Martin, R., Seraphin, B. und Bordonne, R. (1997) Interactions within the yeast Sm core complex: from proteins to amino acids. *Mol. Cell. Biol.*, **18**, 1956-1965.

Campbell, L., Hunter, K.M., Mohaghegh, P., Tinsley, J.M., Brasch, M.A. und Davies, K.E. (2000) Direct interaction of Smn with dp103, a putative RNA helicase: a role for Smn in transcription regulation? *Hum. Mol. Genet.*, **9**, 1093-1100.

Carvalho, T., Almeida, F., Calapez, A., Lafarga, M., Berciano, M.T. und Carmo-Fonseca, M. (1999) The Spinal Muscular Atrophy Disease Gene Product, SMN. A link between snrnp biogenesis and the cajal (coiled) body. *J. Cell Biol.*, **147**, 715-728.

Charroux, B., Pellizzoni, L., Perkins, R.A., Shevchenko, A., Mann, M. und Dreyfuss, G. (1999) Gemin3: A novel DEAD box protein that interacts with SMN, the spinal muscular atrophy gene product, and is a component of gems. *J. Cell Biol.*, **147**, 1181-1194.

Charroux, B., Pellizzoni, L., Perkins, R.A., Yong, J., Shevchenko, A., Mann, M. und Dreyfuss, G. (2000) Gemin4. A novel component of the SMN complex that is found in both gems and nucleoli. *J. Cell Biol.*, **148**, 1177-1186.

Cifuentes-Diaz, C., Frugier, T., Tiziano, F.D., Lacene, E., Roblot, N., Joshi, V., Moreau, M.H. und Melki, J. (2001) Deletion of murine SMN exon 7 directed to skeletal muscle leads to severe muscular dystrophy. *J. Cell Biol.*, **152**, 1107-1114.

Clermont, O., Burlet, P., Lefebvre, S., Burglen, L., Munnich, A. und Melki, J. (1995) SMN gene deletions in adult-onset spinal muscular atrophy [letter; comment]. *Lancet*, **346**, 1712-1713.

Crawford, T.O. und Pardo, C.A. (1996) The neurobiology of childhood spinal muscular atrophy. *Neurobiol Dis*, **3**, 97-110.

Datta, P.K., Chytil, A., Gorska, A., E. und Moses, H.L. (1998) Identification of STRAP, a Novel WD Domain Protein Transforming Growth Factor- $\beta$  Signaling. *J. Biol. Chem.*, **273**, 34671-34674.

de la Cruz, J., Kressler, D. und Linder, P. (1999) Unwinding RNA in *Saccharomyces cerevisiae*: DEAD-box proteins and related families. *Trends Biochem. Sci.*, **24**, 192-198.

Dignam, J.D., Lebovitz, R.M. und Roeder, R.G. (1983) Accurate transcription initiation by RNA polymerase II in a soluble extract from isolated mammalian nuclei. *Nucleic Acids Res.*, **11**, 1475-1489.

Eckerskorn, C. und Lottspeich, F. (1989) Internal amino acid sequence analysis of proteins separated by gel electrophoresis after tryptic digestion in polyacrylamide matrix. *Chromatographia*, **28**, 92-94.

Fischer, U. und Luhrmann, R. (1990) An essential signaling role for the m3G cap in the transport of U1 snRNP to the nucleus. *Science*, **249**, 786-790.

Fischer, U., Sumpter, V., Sekine, M., Satoh, T. und Luhrmann, R. (1993) Nucleocytoplasmic transport of U snRNPs: definition of a nuclear location signal in the Sm

core domain that binds a transport receptor independently of the m3G cap. *EMBO J.*, **12**, 573-583.

Fischer, U., Liu, Q. und Dreyfuss, G. (1997) The SMN-SIP1 complex has an essential role in spliceosomal snRNP biogenesis. *Cell*, **90**, 1023-1029.

Fisher, D.E., Conner, G. E., Reeves, W. H., Wisniewolski, R. und Blobel, G. (1985) Small nuclear ribonucleoprotein particle assembly in vivo: demonstration of a 6S RNA-free core precursor and posttranslational modification. *Cell*, **42**, 751-758.

Friesen, W.J. und Dreyfuss, G. (2000) Specific sequences of the Sm and Sm-like (Lsm) proteins mediate their interaction with the spinal muscular atrophy disease gene product (SMN). *J. Biol. Chem.*, **275**, 26370-26375.

Friesen, W.J., Massenet, S., Paushkin, S., Wyce, A. und Dreyfuss, G. (2001) SMN, the Product of the Spinal Muscular Atrophy Gene, Binds Preferentially to Dimethylarginine-Containing Protein Targets. *Mol. Cell*, **7**, 1111-1117.

Frugier, T., Tiziano, F.D., Cifuentes-Diaz, C., Miniou, P., Roblot, N., Dierich, A., Le Meur, M. und Melki, J. (2000) Nuclear targeting defect of SMN lacking the C-terminus in a mouse model of spinal muscular atrophy. *Hum. Mol. Genet.*, **9**, 849-858.

Gangwani, L., Mikrut, M., Theroux, S., Sharma, M. und Davis, R.J. (2001) Spinal muscular atrophy disrupts the interaction of ZPR1 with the SMN protein. *Nat. Cell Biol.*, **3**, 376-383.

Giesemann, T., Rathke-Hartlieb, S., Rothkegel, M., Bartsch, J.W., Buchmeier, S., Jockusch, B.M. und Jockusch, H. (1999) A role for proline motifs in the spinal muscular atrophy protein SMN. Profilins bind to and colocalize with smn in nuclear gems. *J. Biol. Chem.*, **274**, 37908-37914.

Grundhoff, A.T., Kremmer, E., Türeci, Ö., Glieden, A., Gindorf, C., Atz, J., Müller-Lantzsch, N., Schubach, W.H. und Grässer, F.A. (1999) Characterisation of DP103, a novel DEAD box protein that binds to the Epstein-Barr virus nuclear proteins EBNA2 and EBNA3C. *J. Biol. Chem.*, **27**, 19136-19144.

Hamm, J., Darzynkiewicz, E., Tahara, S. M. und Mattaj, I. W. (1990) The trimethylguanosine cap structure of U1 snRNA is a component of a bipartite nuclear targeting signal. *Cell*, **62**, 569-577.

- Hannus, S., Buhler, D., Romano, M., Seraphin, B. und Fischer, U. (2000) The Schizosaccharomyces pombe protein Yab8p and a novel factor, Yip1p, share structural and functional similarity with the spinal muscular atrophy-associated proteins SMN and SIP1. *Hum. Mol. Genet.*, **9**, 663-674.
- Harlow, E. und Lane, D.P. (1988) *Antibodies. A Laboratory Manual*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N. Y.
- Hermann, H., Fabrizio, P., Raker, V.A., Foulaki, K., Hornig, H., Brahms, H. und Luhrmann, R. (1995) snRNP Sm proteins share two evolutionarily conserved sequence motifs which are involved in Sm protein-protein interactions. *EMBO J.*, **14**, 2076-2088.
- Hsieh-Li, H.M., Chang, J.G., Jong, Y.J., Wu, M.H., Wang, N.M., Tsai, C.H. und Li, H. (2000) A mouse model for spinal muscular atrophy. *Nat. Genet.*, **24**, 66-70.
- Hunt, S.L., Hsuan, J.J., Totty, N. und Jackson, R.J. (1998) unr, a cellular cytoplasmic RNA-binding protein with five cold-shock domains, is required for internal initiation of translation of human rhinovirus RNA. *Genes Dev.*, **13**, 347-448.
- Jablonka, S., Rossoll, W., Schrank, B. und Sendtner, M. (2000) The role of SMN in spinal muscular atrophy. *J. Neurol.*, **247**, Suppl. 1, I37-42.
- Jablonka, S., Bandilla, M., Wiese, S., Buhler, D., Wirth, B., Sendtner, M. und Fischer, U. (2001) Co-regulation of survival of motor neuron (SMN) protein and its interactor SIP1 during development and in spinal muscular atrophy. *Hum. Mol. Genet.*, **10**, 497-505.
- Jankowsky, E., Gross, C.H., Shuman, S. und Pyle, A.M. (2001) Active disruption of an RNA-protein interaction by a DExH/D RNA helicase. *Science*, **291**, 121-125.
- Jarmolowski, A. und Mattaj, I.W. (1993) The determinants for Sm protein binding to Xenopus U1 and U5 snRNAs are complex and non-identical. *EMBO J.*, **12**, 223-232.
- Johnson, J.L. und Craig, E.A. (1997) Protein Folding In Vivo: Unraveling Complex Pathways. *Cell*, **90**, 201-204.
- Jones, K.W., Gorzynski, K., Hales, C.M., Fischer, U., Terns, R.M. und Terns, M.P. (2001) Direct interaction of the spinal muscular atrophy disease protein SMN with the core snoRNP protein fibrillarin. *submitted*.

- Kambach, C., Walke, S., Young, R., Avis, J.M., de la Fortelle, E., Raker, V.A., Luhrmann, R., Li, J. und Nagai, K. (1999) Crystal Structures of Two Sm Protein Complexes and Their Implications for the Assembly of the Spliceosomal snRNPs. *Cell*, **96**, 375-387.
- Kastner, B., Bach, M. und Luhrmann, R. (1990) Electron microscopy of small nuclear ribonucleoprotein (snRNP) particles U2 and U5: evidence for a common structure-determining principle in the major U snRNP family. *Proc. Natl. Acad. Sci. USA*, **87**, 1710-1714.
- Kramer, A. (1996) The structure and function of proteins involved in mammalian pre-mRNA splicing. *Annu. Rev. Biochem.*, **65**, 367-409.
- Lefebvre, S., Burglen, L., Reboullet, S., Clermont, O., Burlet, P., Viollet, L., Benichou, B., Cruaud, C., Millasseau, P., Zeviani, M. et al. (1995) Identification and characterization of a spinal muscular atrophy- determining gene. *Cell*, **80**, 155-165.
- Lefebvre, S., Burlet, P., Liu, Q., Bertrand, S., Clermont, O., Munnich, A., Dreyfuss, G. und Melki, J. (1997) Correlation between severity and SMN protein level in spinal muscular atrophy. *Nat. Genet.*, **16**, 265-269.
- Lefebvre, S., Bürglen, L., Frezal, J., Munnich, A. und Melki, J. (1998) The role of the SMN gene in proximal spinal muscular atrophy. *Hum. Molec. Genet.*, **7**, 1531-1536.
- Lerner, E.A., Lerner, M.R., Hardin, J.A., Janeway, C.A. und Steitz, J.A. (1981) Monoclonal antibodies to nucleic acid-containing cellular constituents: probes for molecular biology and autoimmune disease. *Proc. Natl. Acad. Sci. USA*, **78**, 2737-2741.
- Liu, Q. und Dreyfuss, G. (1996) A novel nuclear structure containing the survival of motor neurons protein. *EMBO J.*, **15**, 3555-3565.
- Liu, Q., Fischer, U., Wang, F. und Dreyfuss, G. (1997) The spinal muscular atrophy disease gene product, SMN, and its associated protein SIP1 are in a complex with spliceosomal snRNP proteins. *Cell*, **90**, 1013-1021.
- Lorson, C.L., Strasswimmer, J., Yao, J.M., Baleja, J.D., Hahnen, E., Wirth, B., Le, T., Burghes, A.H. und Androphy, E.J. (1998a) SMN oligomerization defect correlates with spinal muscular atrophy severity. *Nat. Genet.*, **19**, 63-66.

Lorson, C.L. und Androphy, E.J. (1998b) The domain encoded by exon 2 of the survival motor neuron protein mediates nucleic acid binding. *Hum. Mol. Genet.*, **7**, 1269-1275.

Lorson, C.L., Hahnen, E., Androphy, E.J. und Wirth, B. (1999) A single nucleotide in the SMN gene regulates splicing and is responsible for spinal muscular atrophy. *Proc. Natl. Acad. Sci. USA*, **96**, 6307-6311.

Lorson, C.L. und Androphy, E.J. (2000) An exonic enhancer is required for inclusion of an essential exon in the SMA-determining gene SMN. *Hum. Mol. Genet.*, **9**, 259-265.

Mattaj, I.W. (1986) Cap trimethylation of U snRNA is cytoplasmic and dependent on U snRNP protein binding. *Cell*, **46**, 905-911.

Mattaj, I.W. (1988) U snRNP assembly und transport. In Birnstiel, M. (ed.) *Structure and function of major and minor small nuclear ribonucleoprotein particles*. Springer Verlag, Berlin/New York, pp. 100-114.

McAllister, G., Amara, S.G. und Lerner, M.R. (1988) Tissue-specific expression and cDNA cloning of small nuclear ribonucleoprotein-associated polypeptide N. *Proc. Natl. Acad. Sci. USA*, **85**, 5296-5300.

Meister, G., Buhler, D., Laggerbauer, B., Zobawa, M., Lottspeich, F. und Fischer, U. (2000) Characterization of a nuclear 20S complex containing the survival of motor neurons (SMN) protein and a specific subset of spliceosomal Sm proteins. *Hum. Mol. Genet.*, **9**, 1977-1986.

Melki, J., Abdelhak, S., Sheth, P., Bachet, M.F., Burlet, P., Marcadet, A., Aicardi, J., Barois, A., Carriere, J.P., Fardeau, M. et al. (1990) Gene for chronic proximal spinal muscular atrophies maps to chromosome 5q. *Nature*, **344**, 767-768.

Miguel-Aliaga, I., Culetto, E., Walker, D.S., Baylis, H.A., Sattelle, D.B. und Davies, K.E. (1999) The *Caenorhabditis elegans* orthologue of the human gene responsible for spinal muscular atrophy is a maternal product critical for germline maturation and embryonic viability. *Hum. Mol. Genet.*, **8**, 2133-2143.

Monani, U.R., Lorson, C.L., Parsons, D.W., Prior, T.W., Androphy, E.J., Burghes, A.H. und McPherson, J.D. (1999) A single nucleotide difference that alters splicing patterns distinguishes the SMA gene SMN1 from the copy gene SMN2. *Hum. Mol. Genet.*, **8**, 1177-1183.

- Monani, U.R., Sendtner, M., Covert, D.D., Parsons, D.W., Andreassi, C., Le, T.T., Jablonka, S., Schrank, B., Rossol, W., Prior, T.W., Morris, G.E. und Burghes, A.H. (2000) The human centromeric survival motor neuron gene (SMN2) rescues embryonic lethality in Smn(-/-) mice and results in a mouse with spinal muscular atrophy. *Hum. Mol. Genet.*, **9**, 333-339.
- Murray, A.W. (1991) Cell cycle extracts. In Kay, B.K. and Peng, H.B. (eds.), *Methods in Cell Biology*. Academic Press, Inc., New York, Vol. 36, pp. 581-604.
- Nelissen, R.L., Will, C.L., van Venrooij, W.J. und Luhrmann, R. (1994) The association of the U1-specific 70K and C proteins with U1 snRNPs is mediated in part by common U snRNP proteins. *EMBO J.*, **13**, 4113-4125.
- Owen, N., Doe, C.L., Mellor, J. und Davies, K.E. (2000) Characterization of the *Schizosaccharomyces pombe* orthologue of the human survival motor neuron (SMN) protein. *Hum. Mol. Genet.*, **9**, 675-684.
- Paushkin, S., Charroux, B., Abel, L., Perkins, R.A., Pellizzoni, L. und Dreyfuss, G. (2000) The survival motor neuron protein of *Schizosaccharomyces pombe*. Conservation of survival motor neuron interaction domains in divergent organisms. *J. Biol. Chem.*, **275**, 23841-23846.
- Pearn, J. (1978) Incidence, prevalence and gene frequency studies of chronic childhood spinal muscular atrophy. *J. Med. Genet.*, **10**, 260-265.
- Pellizzoni, L., Kataoka, N., Charroux, B. und Dreyfuss, G. (1998) A novel function for SMN, the spinal muscular atrophy disease gene product, in pre-mRNA splicing. *Cell*, **95**, 615-624.
- Pellizzoni, L., Charroux, B. und Dreyfuss, G. (1999) SMN mutants of spinal muscular atrophy patients are defective in binding to snRNP proteins. *Proc. Natl. Acad. Sci. USA*, **96**, 11167-11172.
- Pellizzoni, L., Charroux, B., Rappaport, J., Mann, M. und Dreyfuss, G. (2001) A Functional Interaction between the Survival Motor Neuron Complex and RNA Polymerase II. *J. Cell Biol.*, **152**, 75-86.
- Plessel, G., Fischer, U. und Lurmann, R. (1994) m3G cap hypermethylation of U1 small nuclear ribonucleoprotein (snRNP) in vitro: evidence that the U1 small nuclear RNA-(guanosine-N2)-methyltransferase is a non snRNP cytoplasmic protein that requires a binding site on the Sm core domain. *Mol. Cell. Biol.*, **14**, 4160-4172.

- Ponting, C.P. (1997) Tudor domains in proteins that interact with RNA. *Trends Biochem. Sci.*, **22**, 51-52.
- Raker, V.A., Plessel, G. und Luhrmann, R. (1996) The snRNP core assembly pathway: identification of stable core protein heteromeric complexes and an snRNP subcore particle in vitro. *EMBO J.*, **15**, 2256-2269.
- Raker, V.A., Hartmuth, K., Kastner, B. und R, L. (1999) Spliceosomal U snRNP Core Assembly: Sm Proteins Assemble onto an Sm Site RNA Nonanucleotide in a Specific and Thermodynamically Stable Manner. *Mol. Cell. Biol.*, **19**, 6554-6565.
- Roberts, D.G., Chavez, J. und Court, S.D.M. (1970) The genetic component in child mortality. *Arch. Dis. Child.*, **45**, 33-38.
- Roy, N., Mahadevan, M.S., McLean, M., Shutler, G., Yaraghi, Z., Farahani, R., Baird, S., Besner-Johnston, A., Lefebvre, C., Kang, X. et al. (1995) The gene for neuronal apoptosis inhibitory protein is partially deleted in individuals with spinal muscular atrophy. *Cell*, **80**, 167-178.
- Sambrook, J., Fritsch, E.F. und Maniatis, T. (1989) *Molecular Cloning: A Laboratory Manual*. Cold Spring Laboratory Press, Cold Spring Harbor, N. Y.
- Schrank, B., Gotz, R., Gunnersen, J.M., Ure, J.M., Toyka, K.V., Smith, A.G. und Sendtner, M. (1997) Inactivation of the survival motor neuron gene, a candidate gene for human spinal muscular atrophy, leads to massive cell death in early mouse embryos. *Proc. Natl. Acad. Sci. USA*, **94**, 9920-9925.
- Seraphin, B. (1995) Sm and Sm-like proteins belong to a large family: identification of proteins of the U6 as well as the U1, U2, U4 and U5 snRNPs. *EMBO J.*, **14**, 2089-2098.
- Singh, R. und Reddy, R. (1989) Gamma-monomethyl phosphate: a cap structure in spliceosomal U6 small nuclear RNA. *Proc. Natl. Acad. Sci. USA*, **86**, 8280-8283.
- Smith, T.F., Gaitatzes, C., Saxena, K. und Neer, E.J. (1999) The WD repeat: a common architecture for diverse functions. *Trends Biochem. Sci.*, **24**, 181-185.
- Staley, J.P. und Guthrie, C. (1998) Mechanical devices of the spliceosome: motors, clocks, springs, and things. *Cell*, **92**, 315-326.

- Stark, H., Dube, P., Luhrmann, R. und Kastner, B. (2001) Arrangement of RNA and proteins in the spliceosomal U1 small nuclear ribonucleoprotein particle. *Nature*, **409**, 539-542.
- Strasswimmer, J., Lorson, C.L., Breiding, D.E., Chen, J.J., Le, T., Burghes, A.H. und Androphy, E.J. (1999) Identification of survival motor neuron as a transcriptional activator- binding protein. *Hum. Mol. Genet.*, **8**, 1219-1226.
- Sumpter, V., Kahrs, A., Fischer, U., Kornstadt, U. und Luhrmann, R. (1992) In vitro reconstitution of U1 and U2 snRNPs from isolated proteins and snRNA. *Mol. Biol. Rep.*, **16**, 229-240.
- Terns, M.P., Dahlberg, J.E. und Lund, E. (1993) Multiple cis-acting signals for export of pre-U1 snRNA from the nucleus. *Genes Dev.*, **7**, 1898-1908.
- Urlaub, H., Raker, V.A., Kostka, S. und Luhrmann, R. (2001) Sm protein-Sm site RNA interactions within the inner ring of the spliceosomal snRNP core structure. *EMBO J.*, **20**, 187-196.
- Will, C.L. und Luhrmann, R. (1997) Protein functions in pre-mRNA splicing. *Curr. Opin. Cell Biol.*, **9**, 320-328.
- Will, C.L. und Luhrmann, R. (2001) Spliceosomal UsnRNP biogenesis, structure and function. *Curr. Opin. Cell Biol.*, **13**, 290-301.
- Wirth, B. (2000) An update of the mutation spectrum of the survival motor neuron gene (SMN1) in autosomal recessive spinal muscular atrophy (SMA). *Hum. Mutat.*, **15**, 228-237.
- Yang, H., Moss, M.L., Lund, E. und Dahlberg, J.E. (1992) Nuclear processing of the 3'-terminal nucleotides of pre U1 snRNA in *Xenopus laevis* Oocytes. *Mol Cell Biol.*, **12**, 1553-1560.
- Young, P.J., Man, N., Lorson, C.L., Le, T.T., Androphy, E.J., Burghes, A.H. und Morris, G.E. (2000) The exon 2b region of the spinal muscular atrophy protein, SMN, is involved in self-association and SIP1 binding. *Hum. Mol. Genet.*, **9**, 2869-2877.
- Zeller, R., Nyffenegger, T. und De Robertis, E.M. (1983) Nucleocytoplasmic distribution of snRNPs and stockpiled snRNA-binding proteins during oogenesis and early development in *Xenopus laevis*. *Cell*, **32**, 425-434.

Zhang, D., Abovich, N. und Rosbash, M. (2001) A Biochemical Function for the Sm Complex. *Mol. Cell*, **7**, 319-329.