

## **ALAN R. REIN, PH.D.**

### PUBLICATIONS

- Baker, W.K., and A. Rein. 1962. The dichotomous action on Y chromosomes on the expression of position-free variegation. *Genetics* 47: 1399-1407.
- Rubin, H., and A. Rein. 1967. Proximity effects in the growth of animal cells. In: *Wistar Symposium Monograph No. 7: Growth Regulation Substances for Animal Cells in Culture* (V. Defendi and M. Stoker, eds.), Wistar Institute Press, Philadelphia.
- Rein, A., and H. Rubin. 1968. Effects of local cell concentrations upon the growth of chick embryo cells in tissue culture. *Exp. Cell Res.* 49: 666-678.
- Rein, A., and S. Penman. 1969. Species specificity of the low molecular weight nuclear RNAs. *Biochim. Biophys. Acta* 190: 1-9.
- Rein, A., and H. Rubin. 1971. On the survival of chick embryo cells at low concentration in culture. *Exp. Cell Res.* 65: 209-214.
- Rein, A. 1971. The small molecular weight monodisperse nuclear RNAs in mitotic cells. *Biochim. Biophys. Acta* 232: 306-313.
- Rein, A., and S. Penman. 1972. Synthesis of the small molecular weight monodisperse nuclear RNAs in contact-inhibited cell cultures. *J. Cell. Physiol.* 79: 453-456.
- Rein, A., R.A. Carchman, G.S. Johnson, and I. Pastan. 1973. Simian virus 40 rapidly lowers cAMP levels in mouse cells. *Biochem. Biophys. Res. Commun.* 52: 899-904.
- Rubinstein, L., and A. Rein. 1974. A rapid method for collecting and assaying gradient fractions for radioactive macromolecules. *Biochem. J.* 137: 131-133.
- Rubinstein, L., and A. Rein. 1974. Effect of camptothecin on simian virus 40 DNA. *Nature* 248: 226-228.
- Gisselbrecht, S., R.H. Bassin, B.I. Gerwin, and A. Rein. 1974. Dual susceptibility of a 3T3 mouse cell line to infection by N- and B-tropic murine leukemia virus: Apparent lack of expression of the Fv-1 gene. *Int. J. Cancer* 14: 106-113.
- Bassin, R.H., G. Duran-Troise, B.I. Gerwin, S. Gisselbrecht, and A. Rein. 1975. Murine sarcoma virus pseudotypes acquire a determinant specifying N- or B-tropism from leukemia virus during rescue. *Nature* 256: 223-225.
- Rein, A., S.V.S. Kashmiri, R.H. Bassin, B.I. Gerwin, and G. Duran-Troise. 1976. Phenotypic mixing between N- and B-tropic murine leukemia viruses: Infectious particles with dual sensitivity to Fv-1 restriction. *Cell* 7: 373-379.

- Rein, A., S.V.S. Kashmiri, R.H. Bassin, B.I. Gerwin, and G. Duran-Troise. 1976. Studies on the mechanism of Fv-1 restriction: Properties of determinants specifying viral tropism. In: *Animal Virology: ICN-UCLA Symposium on Molecular Biology IV* (D. Baltimore, A.S. Huang, and C.F. Fox, eds.), Academic Press, New York, pp. 269-282.
- Duran-Troise, G., R.H. Bassin, A. Rein, and B.I. Gerwin. 1977. Loss of Fv-1 restriction in BALB/3T3 cells following infection with a single N-tropic murine leukemia virus particle. *Cell* 10: 479-488.
- Kashmiri, S.V.S., A. Rein, R.H. Bassin, B.I. Gerwin, and S. Gisselbrecht. 1977. Donation of N- or B-tropic phenotype to NB-tropic murine leukemia virus during mixed infections. *J. Virol.* 22: 626-633.
- Bassin, R.H., G. Duran-Troise, B.I. Gerwin, A. Rein, and B. Barlow. 1977. Studies on the mechanism of Fv-1 restriction in BALB/3T3 cells. *Proceedings, Oji International Seminar on Genetic Aspects of Friend Virus and Friend Cells.*
- Rein, A., B.I. Gerwin, R.H. Bassin, L. Schwarm, and G. Schidlovsky. 1978. A replication-defective variant of Moloney murine leukemia virus. I. Biological characterization. *J. Virol.* 25: 146-156.
- Bassin, R.H., G. Duran-Troise, B.I. Gerwin, and A. Rein. 1978. Abrogation of Fv-1b restriction with murine leukemia viruses inactivated by heat or by gamma irradiation. *J. Virol.* 26: 306-315.
- Rein, A., and R.H. Bassin. 1978. Replication-defective ecotropic murine leukemia viruses: Detection and quantitation of infectivity using helper-dependent XC plaque formation. *J. Virol.* 28: 656-660.
- Rein, A., B.M. Benjers, B.I. Gerwin, R.H. Bassin, and D.R. Slocum. 1979. Rescue and transmission of a replication-defective variant of Moloney murine leukemia virus. *J. Virol.* 29: 494-500.
- Rein, A., E. Athan, B.M. Benjers, R.H. Bassin, B.I. Gerwin, and D.R. Slocum. 1979. Isolation of a replication-defective murine leukaemia virus from cultured AKR leukaemia cells. *Nature* 282: 753-754.
- Gerwin, B.I., A. Rein, J.G. Levin, R.H. Bassin, B.M. Benjers, S.V.S. Kashmiri, D. Hopkins, and B.J. O'Neill. 1979. A mutant of B-tropic murine leukemia virus synthesizing an altered polymerase molecule. *J. Virol.* 31: 741-751.
- Benjers, B.M., R.H. Bassin, A. Rein, B.I. Gerwin, and G. Duran-Troise. 1979. The mechanism of restriction of murine leukemia viruses varies among different strains of Fv-1<sup>n</sup> mice. *Int. J. Cancer* 24: 600-607.
- Benade, L.E., R.H. Bassin, J.N. Ihle, J.C. Lee, and A. Rein. 1980. Isolation and characterization of a unique C57BL B-tropic virus. *Virology* 100: 199-203.

- Bassin, R.H., B.I. Gerwin, J.G. Levin, G. Duran-Troise, B.M. Benjers, and A. Rein. 1980. Macromolecular requirements for abrogation of Fv-1 restriction by murine leukemia viruses. *J. Virol.* 35: 287-297.
- Gilden, R.V., S. Oroszlan, H.A. Young, N.R. Rice, M.A. Gonda, M. Cohen, and A. Rein. 1981. Genetics of retrovirus-host interactions. In: *Frontiers in Immunogenetics* (W.H. Hildemann, ed.), Elsevier North-Holland, New York, pp. 191-223.
- Duran-Troise, G., R.H. Bassin, B.F. Wallace, and A. Rein. 1981. BALB/3T3 cells chronically infected with N-tropic murine leukemia virus continue to express Fv-1<sup>b</sup> restriction. *Virology* 112: 795-799.
- Cohen, M., A. Rein, R.M. Stephens, C. O'Connell, R.V. Gilden, M. Shure, M.O. Nicolson, and N. Davidson. 1981. Baboon endogenous virus genome. III. Molecular cloning and structural characterization of nondefective viral genomes from the DNA of a baboon cell strain. *Proc. Natl. Acad. Sci. USA* 78: 5207-5211.
- Ihle, J.N., A. Hapel, J. Greenberger, J.C. Lee, and A. Rein. 1981. Possible roles of interleukin 3 in the regulation of lymphocyte differentiation. In: *The Potential Role of T-Cell Subpopulations in Cancer Therapy*, Vol. 20 (A. Fefer and A.L. Goldstein, eds.), Raven Press, New York, pp. 70-93.
- Rein, A., D.R. Lowy, B.I. Gerwin, S. Ruscetti, and R.H. Bassin. 1982. Molecular properties of a *gag<sup>B</sup> pol<sup>B</sup> env<sup>+</sup>* murine leukemia virus from cultured AKR lymphoma cells. *J. Virol.* 41: 626-634.
- Rein, A., A.M. Schultz, J.P. Bader, and R.H. Bassin. 1982. Inhibitors of glycosylation reverse retroviral interference. *Virology* 119: 185-192.
- Rein, A. 1982. Interference grouping of murine leukemia viruses: A distinct receptor for the MCF-recombinant viruses on mouse cells. *Virology* 120: 251-257.
- Rein, A., N. Rice, S. Simek, M. Cohen, and R.J. Mural. 1982. *In situ* hybridization: A general infectivity assay for retroviruses. *J. Virol.* 43: 1055-1060.
- Levin, J.G., B.G. Hughes, J.S. Graeter, A. Rein, E. Rands, and A.B. Mukherjee. 1982. Transfer of murine leukaemia and murine sarcoma virus genetic information by transfection with isolated metaphase chromosomes. *J. Gen. Virol.* 62: 227-237.
- Bassin, R.H., S. Ruscetti, I. Ali, D.K. Haapala, and A. Rein. 1982. Normal DBA/2 mouse cells synthesize a glycoprotein which interferes with MCF virus infection. *Virology* 123: 139-151.
- Schultz, A.M., A. Rein, L.E. Henderson, and S. Oroszlan. 1983. Biological, chemical, and immunological studies of Rauscher ecotropic and mink cell focus-forming viruses from JLS-V9 cells. *J. Virol.* 45: 995-1003.

- Rein, A., and A. Oliff. 1983. Interference between murine leukemia viruses: Detection of new cell-surface receptor and localization of the receptor-specific region within gp70. In: *Leukemia Reviews International I* (M.A. Rich, ed.), Marcel Dekker, Inc., New York, pp. 42-43.
- Ihle, J.N., A. Rein, and R. Mural. 1984. Immunological and virological mechanisms in retrovirus induced murine leukemogenesis. In: *Advances in Viral Oncology*, Vol. 4 (G. Klein, ed.), Raven Press, New York, pp. 95-137.
- Rein, A., and A. Schultz. 1984. Different recombinant murine leukemia viruses use different cell surface receptors. *Virology* 136: 144-152.
- Levin, J.G., S.C. Hu, A. Rein, L.I. Messer, and B.I. Gerwin. 1984. Murine leukemia virus mutant with a frameshift in the reverse transcriptase coding region: Implications for *pol* gene structure. *J. Virol.* 51: 470-478.
- Rein, A., J. Keller, A.M. Schultz, K.L. Holmes, R. Medicus, and J.N. Ihle. 1985. Infection of immune mast cells by Harvey sarcoma virus: Immortalization without loss of requirement for interleukin-3. *Mol. Cell. Biol.* 5: 2257-2264.
- Katoh, I., Y. Yoshinaka, A. Rein, M. Shibuya, T. Odaka, and S. Oroszlan. 1985. Murine leukemia virus maturation: Protease region required for conversion from "immature" to "mature" core form and for virus infectivity. *Virology* 145: 280-292.
- Schultz, A.M., and A. Rein. 1985. Maturation of murine leukemia virus *env* proteins in the absence of other viral proteins. *Virology* 145: 335-339.
- Ihle, J.N., J. Keller, A. Rein, J. Cleveland, and U. Rapp. 1985. Interleukin 3 regulation of the growth of normal and transformed hematopoietic cells. In: *Cancer Cells 3/Growth Factors and Transformation* (J. Feramisco, B. Ozanne, and C. Stiles, eds.), Cold Spring Harbor Laboratory, Cold Spring Harbor, pp. 211-219.
- Ihle, J.N., J. Keller, A. Rein, J. Pierce, and U. Rapp. 1986. The effects of transforming retroviruses on mast cell growth and IL-3 dependence. In: *Mast Cell Differentiation and Heterogeneity* (A.D. Befus et al., eds.), Raven Press, New York, pp. 45-53.
- Rein, A., M.R. McClure, N.R. Rice, R.B. Luftig, and A.M. Schultz. 1986. Myristylation site in Pr65<sup>gag</sup> is essential for virus particle formation by Moloney murine leukemia virus. *Proc. Natl. Acad. Sci. USA* 83: 7246-7250.
- Rein, A., M.R. McClure, N.R. Rice, R.B. Luftig, and A.M. Schultz. 1987. Assembly of Moloney murine leukemia virus: Requirement for myristylation site in Pr65<sup>gag</sup>. In: *Positive Strand RNA Viruses* (M.A. Brinton and R.R. Rueckert, eds.), Alan R. Liss, Inc., New York, pp. 227-237.

- Copeland, N.G., N.A. Jenkins, B. Nexø, A.M. Schultz, A. Rein, T. Mikkelsen, and P. Jorgensen. 1988. Poorly expressed endogenous ecotropic provirus of DBA/2 mice encodes a mutant Pr65<sup>gag</sup> protein that is not myristylated. *J. Virol.* 62: 479-487.
- Silverman, T., A. Rein, B. Orrison, J. Langloss, G. Bratthauer, J.-I. Miyazaki, and K. Ozato. 1988. Establishment of cell lines from somite stage mouse embryos and expression of major histocompatibility class I genes in these cells. *J. Immunol.* 140: 4378-4387.
- Gorelick, R.J., L.E. Henderson, J.P. Hanser, and A. Rein. 1988. Point mutants of Moloney murine leukemia virus that fail to package viral RNA: Evidence for specific RNA recognition by a "zinc finger-like" protein sequence. *Proc. Natl. Acad. Sci. USA* 85: 8420-8424.
- Schultz, A., and A. Rein. 1989. Unmyristylated Moloney murine leukemia virus Pr65<sup>gag</sup> is excluded from virus assembly and maturation events. *J. Virol.* 63: 2370-2373.
- Feng, Y.-X., D.L. Hatfield, A. Rein, and J.G. Levin. 1989. Translational readthrough of the murine leukemia virus *gag* gene amber codon does not require virus-induced alteration of tRNA. *J. Virol.* 63: 2405-2410.
- Feng, Y.-X., J.G. Levin, D.L. Hatfield, T.S. Schaefer, R.J. Gorelick, and A. Rein. 1989. Suppression of UAA and UGA termination codons in mutant murine leukemia viruses. *J. Virol.* 63: 2870-2873.
- Hatfield, D., Y.-X. Feng, B.J. Lee, A. Rein, J.G. Levin, and S. Oroszlan. 1989. Chromatographic analysis of the aminoacyl-tRNAs which are required for translation of codons at and around the ribosomal frameshift sites of HIV, HTLV-1 and BLV. *Virology* 173: 736-742.
- Hatfield, D.L., B.J. Lee, Y.X. Feng, J.G. Levin, A. Rein, and S. Oroszlan. 1989. Mechanisms of ribosomal frameshifting for synthesis of the protease in HIV and other retroviruses and the possible use of hypomodified tRNAs in the frameshift event. *Proceedings of the Colloquium C52 of the 14th International Congress of Biochemistry* (V. Kostka, ed.), Walter de Gruyter and Co., Berlin and New York, pp. 25-33.
- Feng, Y.-X., J.G. Levin, D.L. Hatfield, T.S. Schaefer, R.J. Gorelick, and A. Rein. 1990. Readthrough suppression in Moloney murine leukemia virus. In: *New Aspects of Positive-Strand RNA Viruses* (M.A. Brinton and F.X. Heinz, eds.), American Society for Microbiology Press, Washington, DC, pp. 188-191.
- Feng, Y.-X., T.D. Copeland, S. Oroszlan, A. Rein, and J.G. Levin. 1990. Identification of amino acids inserted during suppression of UAA and UGA termination codons at the *gag-pol* junction of Moloney murine leukemia virus. *Proc. Natl. Acad. Sci. USA* 87: 8860-8863.

- Ott, D.E., R. Friedrich, and A. Rein. 1990. Sequence analysis of amphotropic and 10A1 murine leukemia viruses: Close relationship to mink cell focus-inducing viruses. *J. Virol.* 64: 757-766.
- Gorelick, R.J., S.M. Nigida, Jr., J.W. Bess, Jr., L.O. Arthur, L.E. Henderson, and A. Rein. 1990. Non-infectious HIV-1 mutants deficient in genomic RNA. *J. Virol.* 64: 3207-3211.
- Gorelick, R.J., S.M. Nigida, Jr., L.O. Arthur, L.E. Henderson, and A. Rein. 1991. Roles of nucleocapsid cysteine arrays in retroviral assembly and replication: Possible mechanisms in RNA encapsidation. In: *Advances in Molecular Biology and Targeted Treatment for AIDS* (A. Kumar, ed.), Plenum Press, New York, pp. 257-272.
- Brightman, B., A. Rein, D. Trepp, and H. Fan. 1991. An enhancer variant of Moloney murine leukemia virus defective in leukemogenesis does not generate detectable mink cell focus-inducing virus in vivo. *Proc. Natl. Acad. Sci. USA* 88: 2264-2268.
- Hatfield, D.L., J.G. Levin, A. Rein, and S. Oroszlan. 1992. Translational suppression in retroviral gene expression. In: *Advances in Virus Research*, Vol. 41 (K. Maramorosch, F. Murphy, and A. Shatkin, eds.), Academic Press, Orlando, pp. 193-239.
- Feng, Y.-X., H. Yuan, A. Rein, and J.G. Levin. 1992. A bipartite signal for read-through suppression in murine leukemia virus mRNA: An eight-nucleotide purine-rich sequence immediately downstream of the *gag* termination codon followed by an RNA pseudoknot. *J. Virol.* 66: 5127-5132.
- Ott, D., and A. Rein. 1992. Basis for receptor specificity for non-ecotropic murine leukemia viral gp70<sup>SU</sup>. *J. Virol.* 66: 4632-4638.
- Ott, D.E., J. Keller, K. Sill, and A. Rein. 1992. Phenotypes of murine leukemia virus-induced tumors: Influence of 3' viral coding sequences. *J. Virol.* 66: 6107-6116.
- Rein, A., and J.G. Levin. 1992. Readthrough suppression in the mammalian type C retroviruses and what it has taught us. *New Biol.* 4: 283-289.
- Levin, J.G., D.L. Hatfield, S. Oroszlan, and A. Rein. 1993. Biosynthesis of reverse transcriptase. In: *Reverse Transcriptase* (S. Goff and A.M. Skalka, eds.), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, pp. 5-31.
- Gorelick, R.J., D.J. Chabot, A. Rein, L.E. Henderson, and L.O. Arthur. 1993. The two zinc fingers in the human immunodeficiency virus type 1 nucleocapsid protein are not functionally equivalent. *J. Virol.* 67: 4027-4036.
- Fu, W., and A. Rein. 1993. Maturation of dimeric viral RNA of Moloney murine leukemia virus. *J. Virol.* 67: 5443-5449.
- Rein, A. 1994. Retroviral RNA packaging: A review. *Arch. Virol.* 9 (suppl.): 513-522.

- Rein, A., J. Mirro, J.A. Gordon-Haynes, S.M. Ernst, and K. Nagashima. 1994. Function of the cytoplasmic domain of a retroviral transmembrane protein: p15E-p2E cleavage activates the membrane-fusion capability of the murine leukemia virus Env protein. *J. Virol.* 68: 1773-1781.
- Fu, W.W., R.J. Gorelick, and A. Rein. 1994. Characterization of human immunodeficiency virus-1 (HIV-1) viral dimeric RNA from wild-type and protease-defective mutant virions. *J. Virol.* 68: 5013-5018.
- Ott, D.E., J. Keller, and A. Rein. 1994. 10A1 MuLV induces a murine leukemia that expresses hematopoietic stem cell markers by a mechanism that includes *fli-1* integration. *Virology* 205: 563-568.
- Rein, A., D.P. Harvin, J. Mirro, S.M. Ernst, and R.J. Gorelick. 1994. Evidence that a central domain of nucleocapsid protein is required for RNA packaging in murine leukemia virus. *J. Virol.* 68: 6124-6129.
- Natsoulis, G., P. Seshaiiah, M.J. Federspiel, A. Rein, S.H. Hughes, and J.D. Boeke. 1995. Targeting of a nuclease to murine leukemia virus capsids inhibits viral multiplication. *Proc. Natl. Acad. Sci. USA* 92: 364-368.
- Feng, Y.-X., W. Fu, A.J. Winter, J.G. Levin, and A. Rein. 1995. Multiple regions of Harvey sarcoma virus RNA can dimerize in vitro. *J. Virol.* 69: 2486-2490.
- Gorelick, R.J., D.J. Chabot, D.E. Ott, T.D. Gagliardi, A. Rein, L.E. Henderson, and L.O. Arthur. 1996. Genetic analysis of the zinc finger in the Moloney murine leukemia virus nucleocapsid domain: Replacement of zinc-coordinating residues with other zinc-coordinating residues yields noninfectious particles containing genomic RNA. *J. Virol.* 70: 2593-2597.
- Feng, Y.-X., T.D. Copeland, L.E. Henderson, R.J. Gorelick, W.J. Bosche, J.G. Levin, and A. Rein. 1996. HIV-1 nucleocapsid protein induces "maturation" of dimeric retroviral RNA in vitro. *Proc. Natl. Acad. Sci. USA* 93: 7577-7581.
- Rein, A., D.E. Ott, J. Mirro, L.O. Arthur, W. Rice, and L.E. Henderson. 1996. Inactivation of murine leukemia virus by compounds that react with the zinc finger in the viral nucleocapsid protein. *J. Virol.* 70: 4966-4972.
- Schumann, G., L. Qin, A. Rein, G. Natsoulis, and J.D. Boeke. 1996. Therapeutic effect of Gag-nuclease fusion protein on retrovirus-infected cell cultures. *J. Virol.* 70: 4329-4337.
- Wu, W., L.E. Henderson, T.D. Copeland, R.J. Gorelick, W.J. Bosche, A. Rein, and J.G. Levin. 1996. Human immunodeficiency virus type 1 nucleocapsid protein reduces reverse transcriptase pausing at a secondary structure near the murine leukemia virus polypurine tract. *J. Virol.* 70: 7132-7142.

- Robinson, H.L., A. Rein, and N.A. Speck. 1997. Avian and murine retroviruses. In: *Viral Pathogenesis* (N. Nathanson, ed.), Lippincott-Raven Press, pp. 629-656.
- Fu, W., B.A. Ortiz-Conde, R.J. Gorelick, S.H. Hughes, and A. Rein. 1997. Placement of tRNA primer on the primer-binding site requires *pol* gene expression in avian but not murine retroviruses. *J. Virol.* 71: 6940-6946.
- Fisher R.J., A. Rein, M. Fivash, M.A. Urbaneja, J.R. Casas-Finet, M. Medaglia, and L.E. Henderson. 1998. Sequence-specific binding of HIV-1 nucleocapsid protein to short oligonucleotides. *J. Virol.* 72: 1902-1909.
- von Laer, D., S. Thomsen, B. Vogt, M. Donath, J. Kruppa, A. Rein, W. Ostertag, and C. Stocking. 1998. Entry of amphotropic and 10A1 pseudotyped murine retroviruses is restricted in hematopoietic stem cell lines. *J. Virol.* 72: 1424-1430.
- Rein, A., C. Yang, J.A. Haynes, J. Mirro, and R.W. Compans. 1998. Evidence for cooperation between murine leukemia virus Env molecules in mixed oligomers. *J. Virol.* 72: 3432-3435.
- Yeager, M., E.M. Wilson-Kubalek, S.G. Weiner, P.O. Brown, and A. Rein. 1998. Supramolecular organization of immature and mature murine leukemia virus revealed by electron cryo-microscopy: Implications for retroviral assembly mechanisms. *Proc. Natl. Acad. Sci. USA* 95: 7299-7304.
- Rein, A., L.E. Henderson and J.G. Levin. 1998. Nucleic acid chaperone activity of retroviral nucleocapsid proteins: Significance for viral replication. *Trends Biochem. Sci.* 23: 297-301.
- Bowzard, J.B., R.P. Bennett, N.K. Krishna, S.M. Ernst, A. Rein and J.W. Wills. 1998. Importance of basic residues in the nucleocapsid sequence for retrovirus Gag assembly and complementation rescue. *J. Virol.* 72: 9034-9044.
- Campbell, S., and A. Rein. 1999. In vitro assembly properties of HIV-1 gag protein lacking the p6 domain. *J. Virol.* 73: 2270-2279.
- Feng, Y.-X., S. Campbell, D. Harvin, B. Ehresmann, C. Ehresmann, and A. Rein. 1999. The human immunodeficiency virus type-1 *gag* polyprotein has nucleic acid chaperone activity: Possible role in dimerization of genomic RNA and placement of tRNA on the primer binding site. *J. Virol.* 73: 4251-4256.
- Gorelick, R.J., W. Fu, T.D. Gagliardi, W.J. Bosche, A. Rein, L.E. Henderson, and L.O. Arthur. 1999. Characterization of the block in replication of nucleocapsid protein zinc finger mutants from Moloney murine leukemia virus. *J. Virol.* 73: 8185-8195.



- Yuan, B., S. Campbell, E. Bacharach, A. Rein, and S.P. Goff. 2000. Infectivity of Moloney murine leukemia virus defective in late assembly events is restored by late assembly domains of other retroviruses. *J. Virol.* 74: 7250-7260.
- Feng, Y.-X., S.P. Moore, D.J. Garfinkel, and A. Rein. 2000. The genomic RNA in Ty1 virus-like particles is dimeric. *J. Virol.* 74: 10819-10821.
- Muriaux, D., J. Mirro, D. Harvin, and A. Rein. 2001. RNA is a structural element in retrovirus particles. *Proc. Natl. Acad. Sci. USA* 98: 5246-5251.
- Campbell, S., R.J. Fisher, E.M. Towler, S. Fox, H.J. Issaq, T. Wolfe, L.R. Phillips, and A. Rein. 2001. Modulation of HIV-like particle assembly *in vitro* by inositol phosphates. *Proc. Natl. Acad. Sci. USA* 98: 10875-10879.
- Muriaux, D., J. Mirro, D. Harvin, and A. Rein. 2001. Structural role of RNA in retrovirus particles. *Virus Res.* 77: 114-117.
- Muriaux, D., and A. Rein. 2003. Encapsidation and transduction of cellular genes by retroviruses. In: *Frontiers in Bioscience* 8:d135-142.
- Stephen, A.G., K.M. Worthy, E.S. Towler, J.A. Mikovits, S. Sei, P. Roberts, Q. Yang, R.K. Akee, P. Klausmeyer, T.G. McCloud, L. Henderson, A. Rein, D.G. Covell, M. Currens, R.H. Shoemaker, and R.J. Fisher. 2002. Identification of HIV-1 nucleocapsid protein: Nucleic acid antagonists with cellular anti-HIV activity. *Biochem. Biophys. Res. Commun.* 296: 1228-1237.
- Campbell, S., M. Oshima, J. Mirro, K. Nagashima, and A. Rein. 2002. Reversal by dithiothreitol of the block in murine leukemia virus maturation induced by disulfide crosslinking. *J. Virol.* 76: 10050-10055.
- Muriaux, D., J. Mirro, K. Nagashima, D. Harvin, and A. Rein. 2002. Murine leukemia virus nucleocapsid mutants lacking viral RNA encapsidate ribosomes. *J. Virol.* 76: 11405-11413.
- Feng, Y.-X., T. Li, S. Campbell, and A. Rein. 2002. Reversible binding of recombinant HIV-1 Gag protein to nucleic acids in virus-like particle assembly *in vitro*. *J. Virol.* 76: 11757-11762.
- Cen, S., H. Jaavanbakht, S. Kim, K. Shiba, R. Craven, A. Rein, K. Ewalt, P. Schimmel, K. Musier-Forsyth, and L. Kleiman. 2002. Retrovirus-specific packaging of aminoacyl-tRNA synthetases with cognate primer tRNAs. *J. Virol.* 76: 13111-13115.
- Kominsky, S.L., P. Argani, D. Korz, E. Evron, V. Raman, E. Garrett, A. Rein, G. Sauter, O.-P. Kallioniemi, and S. Sukumar. 2003. Loss of the tight junction protein claudin-7 correlates with histological grade in both ductal carcinoma in situ and invasive ductal carcinoma of the breast. *Oncogene* 22: 2021.

- Rawat, S.S., M. Viard, S.A. Gallo, A. Rein, R. Blumenthal, and A. Puri. 2003. Modulation of entry of enveloped viruses by cholesterol and sphingolipids (Review). *Mol. Membr. Biol.* 20: 243-254.
- Bouamr, F., J.A. Melillo, M.Q. Wang, K. Nagashima, M.de Los Santos, A. Rein, and S. Goff. 2003. PPPYEPTAP motif is the late domain of human T-cell leukemia virus type 1 Gag and mediates its functional interaction with cellular proteins Nedd4 and Tsg101. *J. Virol.* 77: 11882-11895.
- Rein, A. 2003. Genetic footprinting of a retroviral Gag gene suggests an important role in virus replication (Commentary). *Proc. Natl. Acad. Sci. USA* 100: 11929-11930.
- Oshima, M., D. Muriaux, J. Mirro, K. Nagashima, K. Dryden, M. Yeager, and A. Rein. 2004. Effects of blocking individual maturation cleavages in murine leukemia virus Gag. *J. Virol.* 78: 1411-1420.
- Hibbert, C.S., J. Mirro, and A. Rein. 2004. mRNA molecules containing MLV packaging signals are encapsidated as dimers. *J. Virol.* 78: 10927-10938.
- Mura, M., P. Murcia, M. Caporale, T. S. Spencer, K. Nagashima, A. Rein, and M. Palmarini. 2004. A novel mechanism of viral interference induced by transdominant Gag of an endogenous retrovirus. *Proc. Natl. Acad. Sci. USA* 101: 11117-11122.
- Muriaux, D., S. Costes, K. Nagashima, J. Mirro, E. Cho, S. Lockett, and A. Rein. 2004. Role of murine leukemia virus nucleocapsid protein in virus assembly. *J. Virol.* 78: 12378-12385.
- Baumann J. G., D. Unutmaz, M.D. Miller, S. K.J. Breun, S. M. Grill, J. Mirro, D.R. Littman, A. Rein, and V.N. KewalRamani. 2004. Murine T cells potently restrict human immunodeficiency virus infection. *J. Virol.* 78: 12537-12547.
- Rein, A. 2004. Take two. *Nat. Struct. Mol. Biol.* 11: 1034-1035.
- Yang, Q., A.G. Stephen, J.W. Adelsberger, P.E. Roberts, W. Zhu, M.J. Currens, Y. Feng, B.J. Crise, R.J. Gorelick, A.R. Rein, R.J. Fisher, R.H. Shoemaker, and S. Sei. 2005. Discovery of small-molecule HIV-1 entry inhibitors that target the gp120-binding domain of CD4. *J. Virol.* 79: 6122-6133.
- Hibbert, C.S., and A. Rein. 2005. Preliminary physical mapping of RNA-RNA linkages in the genomic RNA of Moloney murine leukemia virus. *J. Virol.* 79: 8142-8148.
- Rulli, S.J., Jr., D. Muriaux, K. Nagashima, J. Mirro, M. Oshima, J.G. Baumann, and A. Rein. 2006. Mutant murine leukemia virus Gag proteins lacking proline at the N-terminus of the capsid domain block infectivity in virions containing wild-type Gag. *Virology* 347: 364-371.

- Fisher, R.J., M.J. Fivash, A.G. Stephen, ...and A. Rein. 2006. Complex interactions of HIV-1 nucleocapsid protein with oligonucleotides. *Nucleic Acids Res.* 34: 472-484.
- Cruceanu, M., M.A. Urbaneja, ...A. Rein, I. Rouzina, and M.C. Williams. 2006. Nucleic acid binding and chaperone properties of HIV-1 Gag and nucleocapsid proteins. *Nucleic Acids Res.* 34: 593-605.
- Shkriabai, N., S.A.K. Datta, Z. Zhao, S. Hess, A. Rein, and M. Kvaratskhelia. 2006. HIV-1 Gag interactions with assembly cofactors. *Biochemistry* 45: 4077-4083.
- Kol, N., M. Gladnikoff, D. Barlam, R.Z. Schneck, A. Rein, and I. Rousso. 2006. Mechanical properties of murine leukemia virus particles: Effect of maturation. *Biophys. J.* 91:767-774.
- Kovaleski, B.J., R. Kenedy, M.K. Hong, S.A. Datta, L. Kleiman, A. Rein, and K. Musier-Forsyth. 2006. In vitro characterization of the interaction between HIV-1 Gag and human lysyl-tRNA synthetase. *J. Biol. Chem.* 281: 19449-19456.
- Datta, S.A.K., Z. Zhao, P.K. Clark, S. Tarasov, J.N. Alexandratos, S.J. Campbell, M. Kvaratskhelia, J. Lebowitz, and A. Rein. 2007. Interactions between HIV-1 Gag molecules in solution: An inositol phosphate-mediated switch. *J. Mol. Biol.* 365: 799-811.
- Datta, S.A.K., J.E. Curtis, W. Ratcliff, P.K. Clark, R.M. Crist, J. Lebowitz, S. Krueger, and A. Rein. 2007. Conformation of the HIV-1 Gag protein in solution. *J. Mol. Biol.* 365: 812-824.
- Rulli, S.J., Jr., C.S. Hibbert, J. Mirro, T. Pederson, S. Biswal, and A. Rein. 2007. Selective and non-selective packaging of cellular RNAs in retrovirus particles. *J. Virol.* 81: 6623-6631.
- Stephen, A.G., S.A.K. Datta, K.M. Worthy, L. Bindu, M.J. Fivash, K.B. Turner, D. Fabris, A. Rein, and R.J. Fisher. 2007. Measuring the binding stoichiometry of HIV-1 Gag to very-low-density oligonucleotide surfaces using surface plasmon resonance spectroscopy. *J. Biomol. Tech.* 18: 259-266.
- Ricci, E.P., C.H. Herbreteau, D. Decimo, A. Schaupp, S.A.K. Datta, A. Rein, J.-L. Darlix, and T. Ohlmann. 2008. In vitro expression of the HIV-2 genomic RNA is controlled by three distinct internal ribosome entry segments that are regulated by the HIV protease and the Gag polyprotein. *RNA* 14: 1443-1455.
- Rulli, S.J., Jr., J. Mirro, S.A. Hill, P. Lloyd, R.J. Gorelick, J.M. Coffin, D. Derse, and A. Rein. 2008. Interactions of murine APOBEC3 and human APOBEC3G with murine leukemia viruses. *J. Virol.* 82: 6566-6575.
- Wilkinson, K.A., R.J. Gorelick, S.M. Vasa, N. Guex, A. Rein, D.H. Mathews, M.C. Giddings, and K.M. Weeks. 2008. High-throughput SHAPE analysis reveals structures in HIV-1 genomic RNA strongly conserved across distinct biological states. *PLoS Biol.* 6: e96.

- Chen, H., J.S. Lee, ...A. Rein, and S. Sukumar. 2008. Hoxb7 inhibits transgenic HER-2/neu-induced mouse mammary tumor onset but promotes progression and lung metastasis. *Cancer Res.* 68: 3637-3644.
- Datta, S.A.K., and A. Rein. 2009. Preparation of recombinant HIV-1 Gag protein and assembly of virus-like particles *in vitro*. *Methods Mol. Biol.* 485: 197-208.
- Crist, R.M., S.A.K. Datta, A.G. Stephen, F. Soheilian, J. Mirro, R.J. Fisher, K. Nagashima, and A. Rein. 2009. Assembly properties of human immunodeficiency virus type 1 Gag-leucine zipper chimeras: Implications for retrovirus assembly. *J. Virol.* 83: 2216-2225.
- Wu, T., S.A.K. Datta, M. Mitra, R.J. Gorelick, A. Rein, and J.G. Levin. 2010. Fundamental differences between the nucleic acid chaperone activities of HIV-1 nucleocapsid protein and Gag or Gag-derived proteins: Biological implications. *Virology* 405: 556-567.
- Nanda, H., S.A.K. Datta, F. Heinrich, M. Lösche, A. Rein, S. Krueger, and J.E. Curtis. 2010. Electrostatic interactions and binding orientation of HIV-1 matrix studied by neutron reflectivity. *Biophys. J.* 99: 2516-2524.
- Gherghe, C., T. Lombo, C.W. Leonard, S.A.K. Datta, J.W. Bess, Jr., R.J. Gorelick, A. Rein, and K.M. Weeks. 2010. Definition of a high-affinity Gag recognition structure mediating packaging of a retroviral RNA genome. *Proc. Natl. Acad. Sci. USA* 107: 19248-19253.
- Rein, A. 2010. Nucleic acid chaperone activity of retroviral Gag proteins. *RNA Biol.* 7: 700-705.
- Aloia, A.L., K.S. Sfanos, W.B. Isaacs, Q. Zheng, F. Maldarelli, A.M. De Marzo, and A. Rein. 2010. XMRV: A new virus in prostate cancer? *Cancer Res.* 70: 10028-10033.
- Jones, C.P., S.A.K. Datta, A. Rein, I. Rouzina, and K. Musier-Forsyth. 2011. Matrix domain modulates HIV-1 Gag's chaperone activity via a conformational switch triggered by plasma membrane binding. *J. Virol.* 85: 1594-1603.
- Datta, S.A.K., L.G. Temeselew, R.M. Crist, F. Soheilian, A. Kamata, J. Mirro, D. Harvin, K. Nagashima, R.E. Cachau, and A. Rein. 2011. On the role of SP1 in HIV-1 virus particle assembly: A molecular switch? *J. Virol.* 85: 4111-4121.
- Ramalingam, D., S. Duclair, S.A.K. Datta, A. Ellington, A. Rein, and V.R. Prasad. 2011. RNA aptamers directed to human immunodeficiency virus type 1 Gag polyprotein bind to the matrix and nucleocapsid domains and inhibit virus release. *J. Virol.* 85: 305-314.
- Datta, S.A.K., F. Heinrich, S. Raghunandan, S. Krueger, J.E. Curtis, A. Rein, and H. Nanda. 2011. HIV-1 Gag extension: Conformational changes require simultaneous interaction with membrane and nucleic acid. *J. Mol. Biol.* 406: 205-214.
- Goicochea, N.L., S.A.K. Datta, M. Ayaluru, C. Kao, A. Rein, and B. Dragnea. 2011. Structure and stoichiometry of template-directed recombinant HIV-1 Gag particles. *J. Mol. Biol.* 410: 667-680.

- Rein, A., S.A.K. Datta, C.P. Jones, and K. Musier-Forsyth. 2011. Diverse interactions of retroviral Gag proteins with RNAs. *Trends Biochem. Sci.* 36: 373-380.
- Sfanos, K.S., A.L. Aloia, ...A. Rein, and A. deMarzo. 2011. Identification of replication competent murine gammaretroviruses in commonly used prostate cancer cell lines. *PLoS One* 6: e20874.
- Rein, A. 2011. Murine leukemia viruses: Objects and Organisms. *Advances in Virology*, Article 403419.
- Datta, S.A.K., X. Zuo, P.K. Clark, S.J. Campbell, Y.-X. Wang, and A. Rein. 2011. Solution properties of murine leukemia virus Gag protein: Differences from HIV-1 Gag. *J. Virol.* 85: 12733-12741.
- O'Carroll, I.P., R.M. Crist, J. Mirro, D. Harvin, F. Soheilian, A. Kamata, K. Nagashima, and A. Rein. 2012. Functional redundancy in HIV-1 particle assembly. *J. Virol.* 86: 12991-12996.
- Sfanos, K.S., A.L. Aloia, A.M. De Marzo, and A. Rein. 2012. XMRV and prostate cancer: A "final" perspective. *Nature Rev. Urol.* 9: 111-118.
- Sanchez-Martinez, S., A.L. Aloia, D. Harvin, J. Mirro, R.J. Gorelick, P. Jern, J.M. Coffin, and A. Rein. 2012. Studies on the restriction of murine leukemia viruses by mouse APOBEC3. *PLoS One* 7:e38190.
- Aloia, A.L., L. Duffy, V. Pak, K. Lee, S. Sanchez-Martinez, D. Derse, G. Heidecker, K. Cornetta, and A. Rein. 2013. A reporter system for replication-competent gammaretroviruses: The in*GLuc*-MLV-DERSE assay. *Gene Ther.* 20: 169-176.
- O'Carroll, I., F. Soheilian, A. Kamata, K. Nagashima, and A. Rein. 2013. Elements in HIV-1 Gag contributing to virus particle assembly. *Virus Res.* 171: 341-345.
- Stavrou, S., T. Nitta, S. Kotla, D. Ha, K. Nagashima, A. Rein, H. Fan, and S.R. Ross. 2013. Murine leukemia virus glycosylated Gag blocks apolipoprotein B editing complex 3 and cytosolic sensor access to the reverse transcription complex. *Proc. Natl. Acad. Sci. USA* 110: 9078-9083.
- Rein, A. 2013. Murine leukemia virus p12 functions include hitch-hiking into the nucleus. *Proc. Natl. Acad. Sci. USA* 110: 9195-9196 (Commentary).
- Fang, X., Wang, J., O'Carroll, I.P., Mitchell, M., Zuo, X., Wang, Y., Yu, P., Liu, Y., Rausch, J.W., Dyba, M.A., Kjemis, J., Schwieters, C.D., Seifert, S., Winans, R.E., Watts, N.R., Stahl, S.J., Wingfield, P.T., Byrd, R.A., Le Grice, S.F.J., Rein, A.\*, and Wang, Y.-X. 2013. An unusual topological structure of the HIV-1 Rev response element. *Cell* 155: 594-605. (\*Co-corresponding author)

- Jensen, S.M., F.W. Ruscetti, A. Rein, D.C. Bertolette, C.J. Saucedo, B.R. O'Keefe, and K.S. Jones. 2014. Differential inhibitory effects of cyanovirin-N, griffithsin and scytovirin on entry mediated by envelopes of gammaretroviruses and deltaretroviruses. *J. Virol.* 88: 2327-2332.
- Munro, J.B., A. Nath, M. Farber, S.A.K. Datta, A. Rein, E. Rhoades, and W. Mothes. 2014. A conformational transition observed in single HIV-1 Gag molecules during in vitro assembly of virus like particles. *J. Virol.* 88: 3577-3585.
- Nair, S., S. Sanchez-Martinez, S. Ji, and A. Rein. 2014. Biochemical and biological studies on mouse APOBEC3. *J. Virol.* 88: 3850-3860.
- Grohman, J.K., R.J. Gorelick, S. Kottegoda, N.L. Allbritton, A. Rein, and K. Weeks. 2014. An immature retroviral RNA genome represents a kinetically trapped intermediate state. *J. Virol.* 88: 6061-6068.
- Nair, S., and A. Rein. 2014. Antiretroviral restriction factors in mice. *Virus Res.* 193: 130-134.
- Han, L., A. Diehl, N.K. Nguyen, P. Korangath, W. Teo, S. Cho, S. Kominsky, D.L. Huso, L. Feigenbaum, A. Rein, P. Argani, G. Landberg, M. Gessler, and S. Sukumar. 2014. The Notch pathway inhibits TGF $\beta$  signaling in breast cancer through HEYL-mediated crosstalk. *Cancer Res.* 74: 6509-6518.
- Nair, S., and A. Rein. 2014. In vitro assay for cytidine deaminase activity of APOBEC3 protein. *bio-protocol* 4(20): e1266.
- Dick, R.A., S.A.K. Datta, H. Nanda, X. Fang, Y. Wen, M. Barros, Y.-X. Wang, A. Rein, and V.M. Vogt. 2015. Hydrodynamic and membrane binding properties of purified Rous sarcoma virus Gag protein. *J. Virol.* 89: 10371-10382.
- O'Carroll, I.P., and A. Rein. 2016. Viral nucleic acids. In: *Encyclopedia of Cell Biology*, Vol. 1 (R.A. Bradshaw and P.D. Stahl, eds.), Academic Press, Waltham, MA, pp. 517-524.
- Datta, S.A.K., P.K. Clark, L. Fan, B. Ma, D.P. Harvin, R.C. Sowder II, R. Nussinov, Y.-X. Wang, and A. Rein. 2016. Dimerization of the SP-1 region of HIV-1 Gag induces a helical conformation and association into helical bundles: Implications for particle assembly. *J. Virol.* 90: 1773-1787.
- Barros, M., F. Heinrich, S.A.K. Datta, A. Rein, I. Karageorgos, H. Nanda, and M. Lösche. 2016. Membrane binding of HIV-1 matrix protein: Dependence on bilayer composition and protein lipidation. *J. Virol.* 90: 4544-4555.
- Comas-Garcia, M., S.R. Davis, and A. Rein. 2016. On the selective packaging of genomic RNA by HIV-1. *Viruses* 8(9): 246.

Saxena, P., L. He, A. Malyutin, S.A.K. Datta, A. Rein, K.M. Bond, M.F. Jarrold, A. Spilotros, D. Svergun, T. Douglas, and B. Dragnea. 2016. Virus matryoshka: A bacteriophage particle-guided molecular assembly approach to a monodisperse model of the immature human immunodeficiency virus. *Small* doi:10.1002/sml.201601712.

Ahi, Y.S., S. Zhang, Y. Thappeta, A. Denman, A. Feizpour, S. Gummuluru, B. Reinhard, D. Muriaux, M.J. Fivash, and A. Rein. 2016. Functional interplay between murine leukemia virus glycoprotein, Serinc5, and surface glycoprotein governs virus entry: Opposite effects on gammaretroviral and Ebolavirus glycoproteins. *mBio* 7(6): e01985-16.

## PATENTS

Gorelick RJ, Arthur LO, Rein A, Henderson LE, and Oroszlan S: Design and Construction of Noninfectious Human Retroviral Mutants Deficient in Genomic RNA. Patent Number 5,674,720, Issued October 7, 1997.

Henderson LE, Arthur LO, Rice WG, and Rein AR: Method for identifying and using compounds that inactivate HIV-1 and other retroviruses by attacking highly conserved zinc fingers in the viral nucleocapsid protein. Patent Number 6,001,555, Issued December 14, 1999.

Rein A, Casas-Finet J, Fisher R, Fivash M, and Henderson LE: Oligonucleotides which specifically bind retroviral nucleocapsid proteins. Patent Number 6,316,190, Issued November 13, 2001.

Shoemaker R, Currens M, Rein A, Feng YX, Fisher R, Stephen A, Sei S, Crise B, Henderson L, and Worthy K: Identification of anti-HIV compounds inhibiting virus assembly and binding of nucleocapsid protein to nucleic acid. Patent Number 7,572,828, Issued August 11, 2009.