

## REFERENCES

- Albright AV, Shieh JT, Itoh T, Lee B, Pleasure D, O'Connor MJ, et al. Microglia express CCR5, CXCR4, and CCR3, but of these, CCR5 is the principal coreceptor for human immunodeficiency virus type 1 dementia isolates. *J Virol* 1999;73(1):205-13.
- Alkhatib G, Combadiere C, Broder CC, Feng Y, Kennedy PE, Murphy PM, et al. CC CKR5: a RANTES, MIP-1alpha, MIP-1beta receptor as a fusion cofactor for macrophage-tropic HIV-1. *Science* 1996;272(5270):1955-8.
- An P, Martin MP, Nelson GW, Carrington M, Smith MW, Gong K, et al. Influence of CCR5 promoter haplotypes on AIDS progression in African-Americans. *Aids* 2000;14(14):2117-22.
- Ansari-Lari MA, Liu XM, Metzker ML, Rut AR, Gibbs RA. The extent of genetic variation in the CCR5 gene. *Nat Genet* 1997;16(3):221-2.
- Barre-Sinoussi F, Chermann JC, Rey F, Nugeyre MT, Chamaret S, Gruest J, et al. Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS). *Science* 1983;220(4599):868-71.
- Benkirane M, Jin DY, Chun RF, Koup RA, Jeang KT. Mechanism of transdominant inhibition of CCR5-mediated HIV-1 infection by ccr5delta32. *J Biol Chem* 1997;272(49):30603-6.
- Berger EA, Doms RW, Fenyo EM, Korber BT, Littman DR, Moore JP, et al. A new classification for HIV-1. *Nature* 1998;391(6664):240.
- Berger EA, Murphy PM, Farber JM. Chemokine receptors as HIV-1 coreceptors: roles in viral entry, tropism, and disease. *Annu Rev Immunol* 1999;17:657-700.
- Berson JF, Doms RW. Structure-function studies of the HIV-1 coreceptors. *Semin Immunol* 1998;10(3):237-48.
- Beyrer C, Artenstein AW, Rugpao S, Stephens H, VanCott TC, Robb ML, et al. Epidemiologic and biologic characterization of a cohort of human immunodeficiency virus type 1 highly

- exposed, persistently seronegative female sex workers in northern Thailand. Chiang Mai HEPS Working Group. *J Infect Dis* 1999;179(1):59-67.
- Biti R, Ffrench R, Young J, Bennetts B, Stewart G, Liang T. HIV-1 infection in an individual homozygous for the CCR5 deletion allele. *Nat Med* 1997;3(3):252-3.
- Bleul CC, Farzan M, Choe H, Parolin C, Clark-Lewis I, Sodroski J, et al. The lymphocyte chemoattractant SDF-1 is a ligand for LESTR/fusin and blocks HIV-1 entry. *Nature* 1996;382(6594):829-33.
- Boyer V, Desgranges C, Trabaud MA, Fischer E, Kazatchkine MD. Complement mediates human immunodeficiency virus type 1 infection of a human T cell line in a CD4- and antibody-independent fashion. *J Exp Med* 1991;173(5):1151-8.
- Broliden K, Hinkula J, Devito C, Kiama P, Kimani J, Trabattoni D, et al. Functional HIV-1 specific IgA antibodies in HIV-1 exposed, persistently IgG seronegative female sex workers. *Immunol Lett* 2001;79(1-2):29-36.
- Carrington M, Kissner T, Gerrard B, Ivanov S, O'Brien SJ, Dean M. Novel alleles of the chemokine-receptor gene CCR5. *Am J Hum Genet* 1997;61(6):1261-7.
- Carrington M, Dean M, Martin MP, O'Brien SJ. Genetics of HIV-1 infection: chemokine receptor CCR5 polymorphism and its consequences. *Hum Mol Genet* 1999;8(10):1939-45.
- Carrington M, Nelson G, O'Brien SJ. Considering genetic profiles in functional studies of immune responsiveness to HIV-1. *Immunol Lett* 2001;79(1-2):131-40.
- Choe H, Farzan M, Sun Y, Sullivan N, Rollins B, Ponath PD, et al. The beta-chemokine receptors CCR3 and CCR5 facilitate infection by primary HIV-1 isolates. *Cell* 1996;85(7):1135-48.
- Cocchi F, DeVico AL, Garzino-Demo A, Arya SK, Gallo RC, Lusso P. Identification of RANTES, MIP-1 alpha, and MIP-1 beta as the major HIV-suppressive factors produced by CD8+ T cells. *Science* 1995;270(5243):1811-5.
- Connor RI, Paxton WA, Sheridan KE, Koup RA. Macrophages and CD4+ T lymphocytes from two multiply exposed, uninfected individuals resist infection with primary non-syncytium-inducing isolates of human immunodeficiency virus type 1. *J Virol* 1996;70(12):8758-64.

- Dean M, Carrington M, Winkler C, Huttley GA, Smith MW, Allikmets R, et al. Genetic restriction of HIV-1 infection and progression to AIDS by a deletion allele of the CKR5 structural gene. Hemophilia Growth and Development Study, Multicenter AIDS Cohort Study, Multicenter Hemophilia Cohort Study, San Francisco City Cohort, ALIVE Study. *Science* 1996;273(5283):1856-62.
- Deng H, Liu R, Ellmeier W, Choe S, Unutmaz D, Burkhardt M, et al. Identification of a major coreceptor for primary isolates of HIV-1. *Nature* 1996;381(6584):661-6.
- Devito C, Hinkula J, Kaul R, Lopalco L, Bwayo JJ, Plummer F, et al. Mucosal and plasma IgA from HIV-exposed seronegative individuals neutralize a primary HIV-1 isolate. *Aids* 2000;14(13):1917-20.
- Devito C, Brolden K, Kaul R, Svensson L, Johansen K, Kiama P, et al. Mucosal and plasma IgA from HIV-1-exposed uninfected individuals inhibit HIV-1 transcytosis across human epithelial cells. *J Immunol* 2000;165(9):5170-6.
- Doranz BJ, Rucker J, Yi Y, Smyth RJ, Samson M, Peiper SC, et al. A dual-tropic primary HIV-1 isolate that uses fusin and the beta-chemokine receptors CKR-5, CKR-3, and CKR-2b as fusion cofactors. *Cell* 1996;85(7):1149-58.
- Dragic T, Litwin V, Allaway GP, Martin SR, Huang Y, Nagashima KA, et al. HIV-1 entry into CD4+ cells is mediated by the chemokine receptor CC-CKR-5. *Nature* 1996;381(6584):667-73.
- D'Souza MP, Fauci AS. Immunopathogenesis. In: *Textbook of AIDS medicine*. 2nd ed. Maryland: Williams & Wilkins; 1999.
- Eugen-Olsen J, Iversen AK, Garred P, Koppelhus U, Pedersen C, Benfield TL, et al. Heterozygosity for a deletion in the CKR-5 gene leads to prolonged AIDS-free survival and slower CD4 T-cell decline in a cohort of HIV-seropositive individuals. *Aids* 1997;11(3):305-10.
- Farzan M, Choe H, Vaca L, Martin K, Sun Y, Desjardins E, et al. A tyrosine-rich region in the N terminus of CCR5 is important for human immunodeficiency virus type 1 entry and mediates an association between gp120 and CCR5. *J Virol* 1998;72(2):1160-4.
- Fauci AS. Host factors and the pathogenesis of HIV-induced disease. *Nature* 1996;384(6609):529-34.

- Faure S, Meyer L, Costagliola D, Vaneensbergh C, Genin E, Autran B, et al. Rapid progression to AIDS in HIV+ individuals with a structural variant of the chemokine receptor CX3CR1. *Science* 2000;287(5461):2274-7.
- Feng Y, Broder CC, Kennedy PE, Berger EA. HIV-1 entry cofactor: functional cDNA cloning of a seven-transmembrane, G protein-coupled receptor. *Science* 1996;272(5263):872-7.
- Folks TM, Hart CE. The life cycle of human immunodeficiency virus type 1. in AIDS: etiology, diagnosis, treatment, and prevention. 4th ed. Philadelphia: Lippincott-Raven Publishers; 1997.
- Fowke KR, Kaul R, Rosenthal KL, Oyugi J, Kimani J, Rutherford WJ, et al. HIV-1-specific cellular immune responses among HIV-1-resistant sex workers. *Immunol Cell Biol* 2000;78(6):586-95.
- Gallo RC, Salahuddin SZ, Popovic M, Shearer GM, Kaplan M, Haynes BF, et al. Frequent detection and isolation of cytopathic retroviruses (HTLV-III) from patients with AIDS and at risk for AIDS. *Science* 1984;224(4648):500-3.
- Grosskurth H, Mosha F, Todd J, Mwijarubi E, Klokke A, Senkoro K, et al. Impact of improved treatment of sexually transmitted diseases on HIV infection in rural Tanzania: randomised controlled trial. *Lancet* 1995;346(8974):530-6.
- Guignard F, Combadiere C, Tiffany HL, Murphy PM. Gene organization and promoter function for CC chemokine receptor 5 (CCR5). *J Immunol* 1998;160(2):985-92.
- Hall T. BioEdit Sequence Alignment Editor. Computer Software. Department of Microbiology North Corolina State University, 1999. version 5.0.9, 245,232 KB, disk.
- Harouse JM, Bhat S, Spitalnik SL, Laughlin M, Stefano K, Silberberg DH, et al. Inhibition of entry of HIV-1 in neural cell lines by antibodies against galactosyl ceramide. *Science* 1991;253(5017):320-3.
- Hogan CM, Hammer SM. Host determinants in HIV infection and disease. Part 1: cellular and humoral immune responses. *Ann Intern Med* 2001;134(9 Pt 1):761-76.
- Homsy J, Meyer M, Tateno M, Clarkson S, Levy JA. The Fc and not CD4 receptor mediates antibody enhancement of HIV infection in human cells. *Science* 1989;244(4910):1357-60.

- Howard OM, Shirakawa AK, Turpin JA, Maynard A, Tobin GJ, Carrington M, et al. Naturally occurring CCR5 extracellular and transmembrane domain variants affect HIV-1 Co-receptor and ligand binding function. *J Biol Chem* 1999;274(23):16228-34.
- Huang Y, Paxton WA, Wolinsky SM, Neumann AU, Zhang L, He T, et al. The role of a mutant CCR5 allele in HIV-1 transmission and disease progression. *Nat Med* 1996;2(11):1240-3.
- Kaul R, Rowland-Jones SL, Gillespie G, Kimani J, Dong T, Kiama P, et al. Gonococcal cervicitis is associated with reduced systemic CD8+ T cell responses in human immunodeficiency virus type 1-infected and exposed, uninfected sex workers. *J Infect Dis* 2002;185(10):1525-9.
- Kirchhoff F, Greenough TC, Brettler DB, Sullivan JL, Desrosiers RC. Brief report: absence of intact nef sequences in a long-term survivor with nonprogressive HIV-1 infection. *N Engl J Med* 1995;332(4):228-32.
- Kostrikis LG, Neumann AU, Thomson B, Korber BT, McHardy P, Karanicolas R, et al. A polymorphism in the regulatory region of the CC-chemokine receptor 5 gene influences perinatal transmission of human immunodeficiency virus type 1 to African-American infants. *J Virol* 1999;73(12):10264-71.
- Laga M, Schwartländer B. Epidemiology of AIDS in the developing world. in *Textbook of AIDS medicine*. 2nd ed. Maryland: Williams & Wilkins; 1999.
- Liu R, Paxton WA, Choe S, Ceradini D, Martin SR, Horuk R, et al. Homozygous defect in HIV-1 coreceptor accounts for resistance of some multiply-exposed individuals to HIV-1 infection. *Cell* 1996;86(3):367-77.
- Liu R, Zhao X, Gurney TA, Landau NR. Functional analysis of the proximal CCR5 promoter. *AIDS Res Hum Retroviruses* 1998;14(17):1509-19.
- Liu H, Chao D, Nakayama EE, Taguchi H, Goto M, Xin X, et al. Polymorphism in RANTES chemokine promoter affects HIV-1 disease progression. *Proc Natl Acad Sci U S A* 1999;96(8):4581-5.
- Louisinrotchanakul S, Roongpisuthipong A, Poonarkngeng R, Chaiyakool P, Sangswang S, Wasi C. Virological, immunological and host factors in HIV-1 discordant couples in Thailand. *Asian Pac J Allergy Immunol* 2001;19(4):259-65.

- Louisirirotchanakul S, Liu H, Roongpisuthipong A, Nakayama EE, Takebe Y, Shiota T, et al. Genetic analysis of HIV-1 discordant couples in Thailand: association of CCR2 64I homozygosity with HIV-1-negative status. *J Acquir Immune Defic Syndr* 2002;29(3):314-5.
- Magierowska M, Lepage V, Lien TX, Lan NT, Guillotel M, Issafraas H, et al. Novel variant of the CCR5 gene in a Vietnamese population. *Microbes Infect* 1999;1(2):123-4.
- Martin MP, Dean M, Smith MW, Winkler C, Gerrard B, Michael NL, et al. Genetic acceleration of AIDS progression by a promoter variant of CCR5. *Science* 1998;282(5395):1907-11.
- Martinson JJ, Chapman NH, Rees DC, Liu YT, Clegg JB. Global distribution of the CCR5 gene 32-basepair deletion. *Nat Genet* 1997;16(1):100-3.
- Mascola JR, Frankel SS, Brodalen K. HIV-1 entry at the mucosal surface: role of antibodies in protection. *Aids* 2000;14 Suppl 3:S167-74.
- McDermott DH, Zimmerman PA, Guignard F, Kleeberger CA, Leitman SF, Murphy PM. CCR5 promoter polymorphism and HIV-1 disease progression. Multicenter AIDS Cohort Study (MACS). *Lancet* 1998;352(9131):866-70.
- McDermott DH, Beecroft MJ, Kleeberger CA, Al-Sharif FM, Ollier WE, Zimmerman PA, et al. Chemokine RANTES promoter polymorphism affects risk of both HIV infection and disease progression in the Multicenter AIDS Cohort Study. *Aids* 2000;14(17):2671-8.
- McElrath MJ, Pruett JE, Cohn ZA. Mononuclear phagocytes of blood and bone marrow: comparative roles as viral reservoirs in human immunodeficiency virus type 1 infections. *Proc Natl Acad Sci U S A* 1989;86(2):675-9.
- Mertens T, Piot P. Global aspects of human immunodeficiency virus epidemiology: general considerations. 4th ed. Philadelphia: Lippincott-Raven Publishers; 1997.
- McNicholl JM, Smith DK, Qari SH, Hodge T. Host genes and HIV: the role of the chemokine receptor gene CCR5 and its allele. *Emerg Infect Dis* 1997;3(3):261-71.
- Michael NL, Chang G, Louie LG, Mascola JR, Dondero D, Birx DL, et al. The role of viral phenotype and CCR-5 gene defects in HIV-1 transmission and disease progression. *Nat Med* 1997;3(3):338-40.

- Michael NL, Nelson JA, KewalRamani VN, Chang G, O'Brien SJ, Mascola JR, et al. Exclusive and persistent use of the entry coreceptor CXCR4 by human immunodeficiency virus type 1 from a subject homozygous for CCR5 delta32. *J Virol* 1998;72(7):6040-7.
- Michael NL. Host genetic influences on HIV-1 pathogenesis. *Curr Opin Immunol* 1999;11(4):466-74.
- Moriuchi H, Moriuchi M, Fauci AS. Cloning and analysis of the promoter region of CCR5, a coreceptor for HIV-1 entry. *J Immunol* 1997;159(11):5441-9.
- Mummidi S, Ahuja SS, McDaniel BL, Ahuja SK. The human CC chemokine receptor 5 (CCR5) gene. Multiple transcripts with 5'-end heterogeneity, dual promoter usage, and evidence for polymorphisms within the regulatory regions and noncoding exons. *J Biol Chem* 1997;272(49):30662-71.
- Nakayama EE, Hoshino Y, Xin X, Liu H, Goto M, Watanabe N, et al. Polymorphism in the interleukin-4 promoter affects acquisition of human immunodeficiency virus type 1 syncytium-inducing phenotype. *J Virol* 2000;74(12):5452-9.
- Nakayama EE, Meyer L, Iwamoto A, Persoz A, Nagai Y, Rouzioux C, et al. Protective effect of interleukin-4 -589T polymorphism on human immunodeficiency virus type 1 disease progression: relationship with virus load. *J Infect Dis* 2002;185(8):1183-6.
- Oberlin E, Amara A, Bachelerie F, Bessia C, Virelizier JL, Arenzana-Seisdedos F, et al. The CXC chemokine SDF-1 is the ligand for LESTR/fusin and prevents infection by T-cell-line-adapted HIV-1. *Nature* 1996;382(6594):833-5.
- Ostrowski MA, Justement SJ, Catanzaro A, Hallahan CA, Ehler LA, Mizell SB, et al. Expression of chemokine receptors CXCR4 and CCR5 in HIV-1-infected and uninfected individuals. *J Immunol* 1998;161(6):3195-201.
- Paxton WA, Dragic T, Koup RA, Moore JP. The beta-chemokines, HIV type 1 second receptors, and exposed uninfected persons. *AIDS Res Hum Retroviruses* 1996;12(13):1203-7.
- Paxton WA, Liu R, Kang S, Wu L, Gingras TR, Landau NR, et al. Reduced HIV-1 infectability of CD4+ lymphocytes from exposed-uninfected individuals: association with low expression of CCR5 and high production of beta-chemokines. *Virology* 1998;244(1):66-73.

- Pease JE, Murphy PM. Microbial corruption of the chemokine system: an expanding paradigm. *Semin Immunol* 1998;10(3):169-78.
- Quillent C, Oberlin E, Braun J, Rousset D, Gonzalez-Canali G, Metais P, et al. HIV-1-resistance phenotype conferred by combination of two separate inherited mutations of CCR5 gene. *Lancet* 1998;351(9095):14-8.
- Raport CJ, Gosling J, Schweickart VL, Gray PW, Charo IF. Molecular cloning and functional characterization of a novel human CC chemokine receptor (CCR5) for RANTES, MIP-1 $\beta$ , and MIP-1 $\alpha$ . *J Biol Chem* 1996;271(29):17161-6.
- Rottman JB, Ganley KP, Williams K, Wu L, Mackay CR, Ringler DJ. Cellular localization of the chemokine receptor CCR5. Correlation to cellular targets of HIV-1 infection. *Am J Pathol* 1997;151(5):1341-51.
- Rowland-Jones SL, Nixon DF, Aldhous MC, Gotch F, Ariyoshi K, Hallam N, et al. HIV-specific cytotoxic T-cell activity in an HIV-exposed but uninfected infant. *Lancet* 1993;341(8849):860-1.
- Rowland-Jones S, Sutton J, Ariyoshi K, Dong T, Gotch F, McAdam S, et al. HIV-specific cytotoxic T-cells in HIV-exposed but uninfected Gambian women. *Nat Med* 1995;1(1):59-64.
- Samson M, Labbe O, Mollereau C, Vassart G, Parmentier M. Molecular cloning and functional expression of a new human CC-chemokine receptor gene. *Biochemistry* 1996;35(11):3362-7.
- Samson M, Libert F, Doranz BJ, Rucker J, Liesnard C, Farber CM, et al. Resistance to HIV-1 infection in caucasian individuals bearing mutant alleles of the CCR-5 chemokine receptor gene. *Nature* 1996;382(6593):722-5.
- Shieh B, Liau YE, Hsieh PS, Yan YP, Wang ST, Li C. Influence of nucleotide polymorphisms in the CCR2 gene and the CCR5 promoter on the expression of cell surface CCR5 and CXCR4. *Int Immunol* 2000;12(9):1311-8.
- Shioda T, Nakayama EE, Tanaka Y, Xin X, Liu H, Kawana-Tachikawa A, et al. Naturally occurring deletional mutation in the C-terminal cytoplasmic tail of CCR5 affects surface trafficking of CCR5. *J Virol* 2001;75(7):3462-8.

- Simon F, Mauclere P, Roques P, Loussert-Ajaka I, Muller-Trutwin MC, Saragosti S, et al. Identification of a new human immunodeficiency virus type 1 distinct from group M and group O. *Nat Med* 1998;4(9):1032-7.
- Simonsen JN, Plummer FA, Ngugi EN, Black C, Kreiss JK, Gakinya MN, et al. HIV infection among lower socioeconomic strata prostitutes in Nairobi. *Aids* 1990;4(2):139-44.
- Simonsen JN, Fowke KR, MacDonald KS, Plummer FA. HIV pathogenesis: mechanisms of susceptibility and disease progression. *Curr Opin Microbiol* 1998;1(4):423-9.
- Smith MW, Dean M, Carrington M, Winkler C, Huttley GA, Lomb DA, et al. Contrasting genetic influence of CCR2 and CCR5 variants on HIV-1 infection and disease progression. Hemophilia Growth and Development Study (HGDS), Multicenter AIDS Cohort Study (MACS), Multicenter Hemophilia Cohort Study (MHCS), San Francisco City Cohort (SFCC), ALIVE Study. *Science* 1997;277(5328):959-65.
- Smith BA, Gartner S, Liu Y, Perelson AS, Stilianakis NI, Keele BF, et al. Persistence of infectious HIV on follicular dendritic cells. *J Immunol* 2001;166(1):690-6.
- Sriwanthana B, Hodge T, Mastro TD, Dezzutti CS, Bond K, Stephens HA, et al. HIV-specific cytotoxic T lymphocytes, HLA-A11, and chemokine-related factors may act synergistically to determine HIV resistance in CCR5 delta32-negative female sex workers in Chiang Rai, northern Thailand. *AIDS Res Hum Retroviruses* 2001;17(8):719-34.
- Theodorou I, Meyer L, Magierowska M, Katlama C, Rouzioux C. HIV-1 infection in an individual homozygous for CCR5 delta 32. Seroco Study Group. *Lancet* 1997;349(9060):1219-20.
- Wasserheit JN. Epidemiological synergy. Interrelationships between human immunodeficiency virus infection and other sexually transmitted diseases. *Sex Transm Dis* 1992;19(2):61-77.
- Winkler C, Modi W, Smith MW, Nelson GW, Wu X, Carrington M, et al. Genetic restriction of AIDS pathogenesis by an SDF-1 chemokine gene variant. ALIVE Study, Hemophilia Growth and Development Study (HGDS), Multicenter AIDS Cohort Study (MACS), Multicenter Hemophilia Cohort Study (MHCS), San Francisco City Cohort (SFCC). *Science* 1998;279(5349):389-93.

Wong LM, Myers SJ, Tsou CL, Gosling J, Arai H, Charo IF. Organization and differential expression of the human monocyte chemoattractant protein 1 receptor gene. Evidence for the role of the carboxyl-terminal tail in receptor trafficking. *J Biol Chem* 1997;272(2):1038-45.

Wu L, Paxton WA, Kassam N, Ruffing N, Rottman JB, Sullivan N, et al. CCR5 levels and expression pattern correlate with infectability by macrophage-tropic HIV-1, in vitro. *J Exp Med* 1997;185(9):1681-91.

Yang OO, Garcia-Zepeda EA, Walker BD, Luster AD. Monocyte chemoattractant protein-2 (CC chemokine ligand 8) inhibits replication of human immunodeficiency virus type 1 via CC chemokine receptor 5. *J Infect Dis* 2002;185(8):1174-8.