

7. References

Abbas, A. K., Murphy, K. M., and Sher, A. (1996). Functional diversity of helper T lymphocytes. *Nature* **383**, 787-793.

Aicher, A., Hayden-Ledbetter, M., Brady, W. A., Pezzutto, A., Richter, G., Magaletti, D., Buckwalter, S., Ledbetter, J. A., and Clark, E. A. (2000). Characterization of human inducible costimulator ligand expression and function. *J Immunol* **164**, 4689-4696.

Alexander, W. S. (2002). Suppressors of cytokine signalling (SOCS) in the immune system. *Nat Rev Immunol* **2**, 410-416.

Allen, C. D., Ansel, K. M., Low, C., Lesley, R., Tamamura, H., Fujii, N., and Cyster, J. G. (2004). Germinal center dark and light zone organization is mediated by CXCR4 and CXCR5. *Nat Immunol* **5**, 943-952.

Andersson, E., Dahlenborg, K., Ohlin, M., Borrebaeck, C. A., and Carlsson, R. (1996). Immunoglobulin production induced by CD57+ GC-derived helper T cells in vitro requires addition of exogenous IL-2. *Cell Immunol* **169**, 166-173.

Ansel, K. M., McHeyzer-Williams, L. J., Ngo, V. N., McHeyzer-Williams, M. G., and Cyster, J. G. (1999). In vivo-activated CD4 T cells upregulate CXC chemokine receptor 5 and reprogram their response to lymphoid chemokines. *J Exp Med* **190**, 1123-1134.

Ansel, K. M., Ngo, V. N., Hyman, P. L., Luther, S. A., Forster, R., Sedgwick, J. D., Browning, J. L., Lipp, M., and Cyster, J. G. (2000). A chemokine-driven positive feedback loop organizes lymphoid follicles. *Nature* **406**, 309-314.

Arimura, Y., Kato, H., Dianzani, U., Okamoto, T., Kamekura, S., Buonfiglio, D., Miyoshi-Akiyama, T., Uchiyama, T., and Yagi, J. (2002). A co-stimulatory molecule on activated T cells, H4/ICOS, delivers specific signals in T(h) cells and regulates their responses. *Int Immunol* **14**, 555-566.

Artavanis-Tsakonas, S., Rand, M. D., and Lake, R. J. (1999). Notch signaling: cell fate control and signal integration in development. *Science* **284**, 770-776.

Baggiolini, M., Dewald, B., and Moser, B. (1997). Human chemokines: an update. *Annu Rev Immunol* **15**, 675-705.

Berlin, C., Bargatze, R. F., Campbell, J. J., von Andrian, U. H., Szabo, M. C., Hasslen, S. R., Nelson, R. D., Berg, E. L., Erlandsen, S. L., and Butcher, E. C. (1995). alpha 4 integrins mediate lymphocyte attachment and rolling under physiologic flow. *Cell* **80**, 413-422.

Berlin, C., Berg, E. L., Briskin, M. J., Andrew, D. P., Kilshaw, P. J., Holzmann, B., Weissman, I. L., Hamann, A., and Butcher, E. C. (1993). Alpha 4 beta 7 integrin mediates lymphocyte binding to the mucosal vascular addressin MAdCAM-1. *Cell* **74**, 185-195.

Bowen, M. B., Butch, A. W., Parvin, C. A., Levine, A., and Nahm, M. H. (1991). Germinal center T cells are distinct helper-inducer T cells. *Hum Immunol* **31**, 67-75.

Bradley, L. M., Watson, S. R., and Swain, S. L. (1994). Entry of naive CD4 T cells into peripheral lymph nodes requires L-selectin. *J Exp Med* **180**, 2401-2406.

REFERENCES

- Breitfeld, D., Ohl, L., Kremmer, E., Ellwart, J., Sallusto, F., Lipp, M., and Forster, R. (2000). Follicular B helper T cells express CXC chemokine receptor 5, localize to B cell follicles, and support immunoglobulin production. *J Exp Med* *192*, 1545-1552.
- Bretscher, P., and Cohn, M. (1970). A theory of self-nonself discrimination. *Science* *169*, 1042-1049.
- Brown, J. A., Dorfman, D. M., Ma, F. R., Sullivan, E. L., Munoz, O., Wood, C. R., Greenfield, E. A., and Freeman, G. J. (2003). Blockade of programmed death-1 ligands on dendritic cells enhances T cell activation and cytokine production. *J Immunol* *170*, 1257-1266.
- Brunner-Weinzierl, M. C., Hoff, H., and Burmester, G. R. (2004). Multiple functions for CD28 and cytotoxic T lymphocyte antigen-4 during different phases of T cell responses: implications for arthritis and autoimmune diseases. *Arthritis Res Ther* *6*, 45-54.
- Butch, A. W., Chung, G. H., Hoffmann, J. W., and Nahm, M. H. (1993). Cytokine expression by germinal center cells. *J Immunol* *150*, 39-47.
- Carreno, B. M., and Collins, M. (2002). The B7 family of ligands and its receptors: new pathways for costimulation and inhibition of immune responses. *Annu Rev Immunol* *20*, 29-53.
- Chan, V. W., Kothakota, S., Rohan, M. C., Panganiban-Lustan, L., Gardner, J. P., Wachowicz, M. S., Winter, J. A., and Williams, L. T. (1999). Secondary lymphoid-tissue chemokine (SLC) is chemotactic for mature dendritic cells. *Blood* *93*, 3610-3616.
- Chtanova, T., Tangye, S. G., Newton, R., Frank, N., Hodge, M. R., Rolph, M. S., and Mackay, C. R. (2004). T follicular helper cells express a distinctive transcriptional profile, reflecting their role as non-Th1/Th2 effector cells that provide help for B cells. *J Immunol* *173*, 68-78.
- Claman, H. N., Chaperon, E. A., and Triplett, R. F. (1966) Thymus-marrow cell combinations. Synergism in antibody production.
- Collins, A. V., Brodie, D. W., Gilbert, R. J., Iaboni, A., Manso-Sancho, R., Walse, B., Stuart, D. I., van der Merwe, P. A., and Davis, S. J. (2002). The interaction properties of costimulatory molecules revisited. *Immunity* *17*, 201-210.
- Coyle, A. J., Lehar, S., Lloyd, C., Tian, J., Delaney, T., Manning, S., Nguyen, T., Burwell, T., Schneider, H., Gonzalo, J. A., *et al.* (2000). The CD28-related molecule ICOS is required for effective T cell-dependent immune responses. *Immunity* *13*, 95-105.
- Cozine, C. L., Wolniak, K. L., and Waldschmidt, T. J. (2005). The primary germinal center response in mice. *Curr Opin Immunol* *17*, 298-302.
- Cyster, J. G. (1999a). Chemokines and cell migration in secondary lymphoid organs. *Science* *286*, 2098-2102.
- Cyster, J. G. (1999b). Chemokines and the homing of dendritic cells to the T cell areas of lymphoid organs. *J Exp Med* *189*, 447-450.

REFERENCES

Dong, C., Juedes, A. E., Temann, U. A., Shresta, S., Allison, J. P., Ruddle, N. H., and Flavell, R. A. (2001a). ICOS co-stimulatory receptor is essential for T-cell activation and function. *Nature* **409**, 97-101.

Dong, C., Temann, U. A., and Flavell, R. A. (2001b). Cutting edge: critical role of inducible costimulator in germinal center reactions. *J Immunol* **166**, 3659-3662.

Dutton, R. W., Bradley, L. M., and Swain, S. L. (1998). T cell memory. *Annu Rev Immunol* **16**, 201-223.

Flynn, S., Toellner, K. M., Raykundalia, C., Goodall, M., and Lane, P. (1998). CD4 T cell cytokine differentiation: the B cell activation molecule, OX40 ligand, instructs CD4 T cells to express interleukin 4 and upregulates expression of the chemokine receptor, Blr-1. *J Exp Med* **188**, 297-304.

Forster, R., Mattis, A. E., Kremmer, E., Wolf, E., Brem, G., and Lipp, M. (1996). A putative chemokine receptor, BLR1, directs B cell migration to defined lymphoid organs and specific anatomic compartments of the spleen. *Cell* **87**, 1037-1047.

Forster, R., Schubel, A., Breitfeld, D., Kremmer, E., Renner-Muller, I., Wolf, E., and Lipp, M. (1999). CCR7 coordinates the primary immune response by establishing functional microenvironments in secondary lymphoid organs. *Cell* **99**, 23-33.

Geginat, J., Sallusto, F., and Lanzavecchia, A. (2001). Cytokine-driven proliferation and differentiation of human naive, central memory, and effector memory CD4(+) T cells. *J Exp Med* **194**, 1711-1719.

Gonzalo, J. A., Delaney, T., Corcoran, J., Goodearl, A., Gutierrez-Ramos, J. C., and Coyle, A. J. (2001). Cutting edge: the related molecules CD28 and inducible costimulator deliver both unique and complementary signals required for optimal T cell activation. *J Immunol* **166**, 1-5.

Grakoui, A., Bromley, S. K., Sumen, C., Davis, M. M., Shaw, A. S., Allen, P. M., and Dustin, M. L. (1999). The immunological synapse: a molecular machine controlling T cell activation. *Science* **285**, 221-227.

Green, D. R. (2005). Apoptotic pathways: ten minutes to dead. *Cell* **121**, 671-674.

Greenwald, R. J., Freeman, G. J., and Sharpe, A. H. (2005). The B7 family revisited. *Annu Rev Immunol* **23**, 515-548.

Grimbacher, B., Hutloff, A., Schlesier, M., Glocker, E., Warnatz, K., Drager, R., Eibel, H., Fischer, B., Schaffer, A. A., Mages, H. W., *et al.* (2003). Homozygous loss of ICOS is associated with adult-onset common variable immunodeficiency. *Nat Immunol* **4**, 261-268.

Gunn, M. D. (2003). Chemokine mediated control of dendritic cell migration and function. *Semin Immunol* **15**, 271-276.

Guo, J., Stolina, M., Bready, J. V., Yin, S., Horan, T., Yoshinaga, S. K., and Senaldi, G. (2001). Stimulatory effects of B7-related protein-1 on cellular and humoral immune responses in mice. *J Immunol* **166**, 5578-5584.

Harada, Y., Ohgai, D., Watanabe, R., Okano, K., Koiwai, O., Tanabe, K., Toma, H., Altman, A., and Abe, R. (2003). A single amino acid alteration in cytoplasmic

domain determines IL-2 promoter activation by ligation of CD28 but not inducible costimulator (ICOS). *J Exp Med* 197, 257-262.

Hardtke, S., Ohl, L., and Forster, R. (2005). Balanced expression of CXCR5 and CCR7 on follicular T helper cells determines their transient positioning to lymph node follicles and is essential for efficient B-cell help. *Blood* 106, 1924-1931.

Hoyne, G. F., Dallman, M. J., Champion, B. R., and Lamb, J. R. (2001). Notch signalling in the regulation of peripheral immunity. *Immunol Rev* 182, 215-227.

Hozumi, K., Negishi, N., Suzuki, D., Abe, N., Sotomaru, Y., Tamaoki, N., Mailhos, C., Ish-Horowitz, D., Habu, S., and Owen, M. J. (2004). Delta-like 1 is necessary for the generation of marginal zone B cells but not T cells in vivo. *Nat Immunol* 5, 638-644.

Hurchla, M. A., Sedy, J. R., Gavrieli, M., Drake, C. G., Murphy, T. L., and Murphy, K. M. (2005). B and T lymphocyte attenuator exhibits structural and expression polymorphisms and is highly induced in anergic CD4+ T cells. *J Immunol* 174, 3377-3385.

Hutloff, A., Buchner, K., Reiter, K., Baelde, H. J., Odendahl, M., Jacobi, A., Dorner, T., and Kroczeck, R. A. (2004). Involvement of inducible costimulator in the exaggerated memory B cell and plasma cell generation in systemic lupus erythematosus. *Arthritis Rheum* 50, 3211-3220.

Hutloff, A., Dittrich, A. M., Beier, K. C., Eljaschewitsch, B., Kraft, R., Anagnostopoulos, I., and Kroczeck, R. A. (1999). ICOS is an inducible T-cell costimulator structurally and functionally related to CD28. *Nature* 397, 263-266.

Ilangumaran, S., and Rottapel, R. (2003). Regulation of cytokine receptor signaling by SOCS1. *Immunol Rev* 192, 196-211.

Iwai, Y., Okazaki, T., Nishimura, H., Kawasaki, A., Yagita, H., and Honjo, T. (2002). Microanatomical localization of PD-1 in human tonsils. *Immunol Lett* 83, 215-220.

Johansson-Lindbom, B., Ingvarsson, S., and Borrebaeck, C. A. (2003). Germinal centers regulate human Th2 development. *J Immunol* 171, 1657-1666.

Kaech, S. M., Wherry, E. J., and Ahmed, R. (2002). Effector and memory T-cell differentiation: implications for vaccine development. *Nat Rev Immunol* 2, 251-262.

Kellermann, S. A., Hudak, S., Oldham, E. R., Liu, Y. J., and McEvoy, L. M. (1999). The CC chemokine receptor-7 ligands 6Ckine and macrophage inflammatory protein-3 beta are potent chemoattractants for in vitro- and in vivo-derived dendritic cells. *J Immunol* 162, 3859-3864.

Kim, C. H., Lim, H. W., Kim, J. R., Rott, L., Hillsamer, P., and Butcher, E. C. (2004). Unique gene expression program of human germinal center T helper cells. *Blood* 104, 1952-1960.

Kim, C. H., Nagata, K., and Butcher, E. C. (2003). Dendritic cells support sequential reprogramming of chemoattractant receptor profiles during naive to effector T cell differentiation. *J Immunol* 171, 152-158.

- Kim, C. H., Rott, L. S., Clark-Lewis, I., Campbell, D. J., Wu, L., and Butcher, E. C. (2001). Subspecialization of CXCR5+ T cells: B helper activity is focused in a germinal center-localized subset of CXCR5+ T cells. *J Exp Med* 193, 1373-1381.
- Kim, J. R., Lim, H. W., Kang, S. G., Hillsamer, P., and Kim, C. H. (2005). Human CD57+ germinal center-T cells are the major helpers for GC-B cells and induce class switch recombination. *BMC Immunol* 6, 3.
- Kondrack, R. M., Harbertson, J., Tan, J. T., McBreen, M. E., Surh, C. D., and Bradley, L. M. (2003). Interleukin 7 regulates the survival and generation of memory CD4 cells. *J Exp Med* 198, 1797-1806.
- Kopf, M., Coyle, A. J., Schmitz, N., Barner, M., Oxenius, A., Gallimore, A., Gutierrez-Ramos, J. C., and Bachmann, M. F. (2000). Inducible costimulator protein (ICOS) controls T helper cell subset polarization after virus and parasite infection. *J Exp Med* 192, 53-61.
- Kunemund, V., Jungalwala, F. B., Fischer, G., Chou, D. K., Keilhauer, G., and Schachner, M. (1988). The L2/HNK-1 carbohydrate of neural cell adhesion molecules is involved in cell interactions. *J Cell Biol* 106, 213-223.
- Lange, R., Peng, X., Wimmer, E., Lipp, M., and Bernhardt, G. (2001). The poliovirus receptor CD155 mediates cell-to-matrix contacts by specifically binding to vitronectin. *Virology* 285, 218-227.
- Lanzavecchia, A., and Sallusto, F. (2000). Dynamics of T lymphocyte responses: intermediates, effectors, and memory cells. *Science* 290, 92-97.
- Larsson, E. L., Iscove, N. N., and Coutinho, A. (1980). Two distinct factors are required for induction of T-cell growth. *Nature* 283, 664-666.
- Lenschow, D. J., Walunas, T. L., and Bluestone, J. A. (1996). CD28/B7 system of T cell costimulation. *Annu Rev Immunol* 14, 233-258.
- Li, J., Huston, G., and Swain, S. L. (2003). IL-7 promotes the transition of CD4 effectors to persistent memory cells. *J Exp Med* 198, 1807-1815.
- Liang, S. C., Latchman, Y. E., Buhlmann, J. E., Tomczak, M. F., Horwitz, B. H., Freeman, G. J., and Sharpe, A. H. (2003). Regulation of PD-1, PD-L1, and PD-L2 expression during normal and autoimmune responses. *Eur J Immunol* 33, 2706-2716.
- Loetscher, P., Moser, B., and Baggiolini, M. (2000). Chemokines and their receptors in lymphocyte traffic and HIV infection. *Adv Immunol* 74, 127-180.
- Luster, A. D., Alon, R., and von Andrian, U. H. (2005). Immune cell migration in inflammation: present and future therapeutic targets. *Nat Immunol* 6, 1182-1190.
- Luther, S. A., Tang, H. L., Hyman, P. L., Farr, A. G., and Cyster, J. G. (2000). Coexpression of the chemokines ELC and SLC by T zone stromal cells and deletion of the ELC gene in the plt/plt mouse. *Proc Natl Acad Sci U S A* 97, 12694-12699.
- MacLennan, I. C. (1994). Germinal centers. *Annu Rev Immunol* 12, 117-139.
- Maillard, I., Adler, S. H., and Pear, W. S. (2003). Notch and the immune system. *Immunity* 19, 781-791.

REFERENCES

- Mak, T. W., Shahinian, A., Yoshinaga, S. K., Wakeham, A., Boucher, L. M., Pintiie, M., Duncan, G., Gajewska, B. U., Gronski, M., Eriksson, U., *et al.* (2003). Costimulation through the inducible costimulator ligand is essential for both T helper and B cell functions in T cell-dependent B cell responses. *Nat Immunol* 4, 765-772.
- Manjunath, N., Shankar, P., Wan, J., Weninger, W., Crowley, M. A., Hieshima, K., Springer, T. A., Fan, X., Shen, H., Lieberman, J., and von Andrian, U. H. (2001). Effector differentiation is not prerequisite for generation of memory cytotoxic T lymphocytes. *J Clin Invest* 108, 871-878.
- Martin-Fontecha, A., Sebastiani, S., Hopken, U. E., Ugucioni, M., Lipp, M., Lanzavecchia, A., and Sallusto, F. (2003). Regulation of dendritic cell migration to the draining lymph node: impact on T lymphocyte traffic and priming. *J Exp Med* 198, 615-621.
- Matloubian, M., Lo, C. G., Cinamon, G., Lesneski, M. J., Xu, Y., Brinkmann, V., Allende, M. L., Proia, R. L., and Cyster, J. G. (2004). Lymphocyte egress from thymus and peripheral lymphoid organs is dependent on S1P receptor 1. *Nature* 427, 355-360.
- McAdam, A. J., Chang, T. T., Lumelsky, A. E., Greenfield, E. A., Boussiotis, V. A., Duke-Cohan, J. S., Chernova, T., Malenkovich, N., Jabs, C., Kuchroo, V. K., *et al.* (2000). Mouse inducible costimulatory molecule (ICOS) expression is enhanced by CD28 costimulation and regulates differentiation of CD4+ T cells. *J Immunol* 165, 5035-5040.
- McAdam, A. J., Greenwald, R. J., Levin, M. A., Chernova, T., Malenkovich, N., Ling, V., Freeman, G. J., and Sharpe, A. H. (2001). ICOS is critical for CD40-mediated antibody class switching. *Nature* 409, 102-105.
- McGarry, R. C., Helfand, S. L., Quarles, R. H., and Roder, J. C. (1983). Recognition of myelin-associated glycoprotein by the monoclonal antibody HNK-1. *Nature* 306, 376-378.
- Mitchell, G. F., and Miller, J. F. (1968). Immunological activity of thymus and thoracic-duct lymphocytes. *Proc Natl Acad Sci U S A* 59, 296-303.
- Moser, B., and Loetscher, P. (2001). Lymphocyte traffic control by chemokines. *Nat Immunol* 2, 123-128.
- Moser, B., Wolf, M., Walz, A., and Loetscher, P. (2004). Chemokines: multiple levels of leukocyte migration control. *Trends Immunol* 25, 75-84.
- Mosmann, T. R., Cherwinski, H., Bond, M. W., Giedlin, M. A., and Coffman, R. L. (1986). Two types of murine helper T cell clone. I. Definition according to profiles of lymphokine activities and secreted proteins. *J Immunol* 136, 2348-2357.
- Muller, G., Hopken, U. E., Stein, H., and Lipp, M. (2002). Systemic immunoregulatory and pathogenic functions of homeostatic chemokine receptors. *J Leukoc Biol* 72, 1-8.
- Muller, G., and Lipp, M. (2003). Shaping up adaptive immunity: the impact of CCR7 and CXCR5 on lymphocyte trafficking. *Microcirculation* 10, 325-334.
- Murali-Krishna, K., Altman, J. D., Suresh, M., Sourdive, D. J., Zajac, A. J., Miller, J. D., Slansky, J., and Ahmed, R. (1998). Counting antigen-specific CD8 T

cells: a reevaluation of bystander activation during viral infection. *Immunity* **8**, 177-187.

Murphy, P. M. (1994). The molecular biology of leukocyte chemoattractant receptors. *Annu Rev Immunol* **12**, 593-633.

Murphy, P. M., Baggiolini, M., Charo, I. F., Hebert, C. A., Horuk, R., Matsushima, K., Miller, L. H., Oppenheim, J. J., and Power, C. A. (2000). International union of pharmacology. XXII. Nomenclature for chemokine receptors. *Pharmacol Rev* **52**, 145-176.

Nakano, H., Mori, S., Yonekawa, H., Nariuchi, H., Matsuzawa, A., and Kakiuchi, T. (1998). A novel mutant gene involved in T-lymphocyte-specific homing into peripheral lymphoid organs on mouse chromosome 4. *Blood* **91**, 2886-2895.

Nakano, H., Tamura, T., Yoshimoto, T., Yagita, H., Miyasaka, M., Butcher, E. C., Nariuchi, H., Kakiuchi, T., and Matsuzawa, A. (1997). Genetic defect in T lymphocyte-specific homing into peripheral lymph nodes. *Eur J Immunol* **27**, 215-221.

Ng, L. G., Mackay, C. R., and Mackay, F. (2005). The BAFF/APRIL system: life beyond B lymphocytes. *Mol Immunol* **42**, 763-772.

Ngo, V. N., Tang, H. L., and Cyster, J. G. (1998). Epstein-Barr virus-induced molecule 1 ligand chemokine is expressed by dendritic cells in lymphoid tissues and strongly attracts naive T cells and activated B cells. *J Exp Med* **188**, 181-191.

Nurieva, R. I. (2005). Regulation of immune and autoimmune responses by ICOS-B7h interaction. *Clin Immunol* **115**, 19-25.

Ogawa, S., Nagamatsu, G., Watanabe, M., Watanabe, S., Hayashi, T., Horita, S., Nitta, K., Nihei, H., Tezuka, K., and Abe, R. (2001). Opposing effects of anti-activation-inducible lymphocyte-immunomodulatory molecule/inducible costimulator antibody on the development of acute versus chronic graft-versus-host disease. *J Immunol* **167**, 5741-5748.

Ohl, L., Henning, G., Krautwald, S., Lipp, M., Hardtke, S., Bernhardt, G., Pabst, O., and Forster, R. (2003). Cooperating mechanisms of CXCR5 and CCR7 in development and organization of secondary lymphoid organs. *J Exp Med* **197**, 1199-1204.

Okada, T., Miller, M. J., Parker, I., Krummel, M. F., Neighbors, M., Hartley, S. B., O'Garra, A., Cahalan, M. D., and Cyster, J. G. (2005). Antigen-engaged B cells undergo chemotaxis toward the T zone and form motile conjugates with helper T cells. *PLoS Biol* **3**, e150.

Okada, T., Ngo, V. N., Ekland, E. H., Forster, R., Lipp, M., Littman, D. R., and Cyster, J. G. (2002). Chemokine requirements for B cell entry to lymph nodes and Peyer's patches. *J Exp Med* **196**, 65-75.

Parry, R. V., Rumbley, C. A., Vandenberghe, L. H., June, C. H., and Riley, J. L. (2003). CD28 and inducible costimulatory protein Src homology 2 binding domains show distinct regulation of phosphatidylinositol 3-kinase, Bcl-xL, and IL-2 expression in primary human CD4 T lymphocytes. *J Immunol* **171**, 166-174.

Prasad, K. V., Cai, Y. C., Raab, M., Duckworth, B., Cantley, L., Shoelson, S. E., and Rudd, C. E. (1994). T-cell antigen CD28 interacts with the lipid kinase

phosphatidylinositol 3-kinase by a cytoplasmic Tyr(P)-Met-Xaa-Met motif. *Proc Natl Acad Sci U S A* *91*, 2834-2838.

Rabin, R. L., Alston, M. A., Sircus, J. C., Knollmann-Ritschel, B., Moratz, C., Ngo, D., and Farber, J. M. (2003). CXCR3 is induced early on the pathway of CD4+ T cell differentiation and bridges central and peripheral functions. *J Immunol* *171*, 2812-2824.

Radtke, F., Wilson, A., and MacDonald, H. R. (2004). Notch signaling in T- and B-cell development. *Curr Opin Immunol* *16*, 174-179.

Randolph, D. A., Huang, G., Carruthers, C. J., Bromley, L. E., and Chaplin, D. D. (1999). The role of CCR7 in TH1 and TH2 cell localization and delivery of B cell help in vivo. *Science* *286*, 2159-2162.

Reif, K., Ekland, E. H., Ohl, L., Nakano, H., Lipp, M., Forster, R., and Cyster, J. G. (2002). Balanced responsiveness to chemoattractants from adjacent zones determines B-cell position. *Nature* *416*, 94-99.

Riley, J. L., Blair, P. J., Musser, J. T., Abe, R., Tezuka, K., Tsuji, T., and June, C. H. (2001). ICOS costimulation requires IL-2 and can be prevented by CTLA-4 engagement. *J Immunol* *166*, 4943-4948.

Riley, J. L., Mao, M., Kobayashi, S., Biery, M., Burchard, J., Cavet, G., Gregson, B. P., June, C. H., and Linsley, P. S. (2002). Modulation of TCR-induced transcriptional profiles by ligation of CD28, ICOS, and CTLA-4 receptors. *Proc Natl Acad Sci U S A* *99*, 11790-11795.

Rivino, L., Messi, M., Jarrossay, D., Lanzavecchia, A., Sallusto, F., and Geginat, J. (2004). Chemokine receptor expression identifies Pre-T helper (Th)1, Pre-Th2, and nonpolarized cells among human CD4+ central memory T cells. *J Exp Med* *200*, 725-735.

Roitt, I. M., Greaves, M. F., Torrigiani, G., Brostoff, J., and Playfair, J. H. (1969). The cellular basis of immunological responses. A synthesis of some current views. *Lancet* *2*, 367-371.

Rossi, D., and Zlotnik, A. (2000). The biology of chemokines and their receptors. *Annu Rev Immunol* *18*, 217-242.

Rot, A., and von Andrian, U. H. (2004). Chemokines in innate and adaptive host defense: basic chemokines grammar for immune cells. *Annu Rev Immunol* *22*, 891-928.

Rottman, J. B., Smith, T., Tonra, J. R., Ganley, K., Bloom, T., Silva, R., Pierce, B., Gutierrez-Ramos, J. C., Ozkaynak, E., and Coyle, A. J. (2001). The costimulatory molecule ICOS plays an important role in the immunopathogenesis of EAE. *Nat Immunol* *2*, 605-611.

Rudd, C. E., and Schneider, H. (2003). Unifying concepts in CD28, ICOS and CTLA4 co-receptor signalling. *Nat Rev Immunol* *3*, 544-556.

Sallusto, F., Lanzavecchia, A., and Mackay, C. R. (1998a). Chemokines and chemokine receptors in T-cell priming and Th1/Th2-mediated responses. *Immunol Today* *19*, 568-574.

REFERENCES

- Sallusto, F., Lenig, D., Forster, R., Lipp, M., and Lanzavecchia, A. (1999). Two subsets of memory T lymphocytes with distinct homing potentials and effector functions. *Nature* *401*, 708-712.
- Sallusto, F., Lenig, D., Mackay, C. R., and Lanzavecchia, A. (1998b). Flexible programs of chemokine receptor expression on human polarized T helper 1 and 2 lymphocytes. *J Exp Med* *187*, 875-883.
- Sallusto, F., Mackay, C. R., and Lanzavecchia, A. (1997). Selective expression of the eotaxin receptor CCR3 by human T helper 2 cells. *Science* *277*, 2005-2007.
- Sallusto, F., Mackay, C. R., and Lanzavecchia, A. (2000). The role of chemokine receptors in primary, effector, and memory immune responses. *Annu Rev Immunol* *18*, 593-620.
- Sato, T., Kanai, T., Watanabe, M., Sakuraba, A., Okamoto, S., Nakai, T., Okazawa, A., Inoue, N., Totsuka, T., Yamazaki, M., *et al.* (2004). Hyperexpression of inducible costimulator and its contribution on lamina propria T cells in inflammatory bowel disease. *Gastroenterology* *126*, 829-839.
- Schaerli, P., Loetscher, P., and Moser, B. (2001). Cutting edge: induction of follicular homing precedes effector Th cell development. *J Immunol* *167*, 6082-6086.
- Schaerli, P., Willimann, K., Lang, A. B., Lipp, M., Loetscher, P., and Moser, B. (2000). CXC chemokine receptor 5 expression defines follicular homing T cells with B cell helper function. *J Exp Med* *192*, 1553-1562.
- Schneider, H., Cai, Y. C., Prasad, K. V., Shoelson, S. E., and Rudd, C. E. (1995). T cell antigen CD28 binds to the GRB-2/SOS complex, regulators of p21ras. *Eur J Immunol* *25*, 1044-1050.
- Schneider, P., MacKay, F., Steiner, V., Hofmann, K., Bodmer, J. L., Holler, N., Ambrose, C., Lawton, P., Bixler, S., Acha-Orbea, H., *et al.* (1999). BAFF, a novel ligand of the tumor necrosis factor family, stimulates B cell growth. *J Exp Med* *189*, 1747-1756.
- Schwartz, G. A., Jungalwala, F. B., Chou, D. K., Boyer, A. M., and Yamamoto, M. (1987). Sulfated glucuronic acid-containing glycoconjugates are temporally and spatially regulated antigens in the developing mammalian nervous system. *Dev Biol* *120*, 65-76.
- Smith, K. A., Lachman, L. B., Oppenheim, J. J., and Favata, M. F. (1980). The functional relationship of the interleukins. *J Exp Med* *151*, 1551-1556.
- Song, K., Rabin, R. L., Hill, B. J., De Rosa, S. C., Perfetto, S. P., Zhang, H. H., Foley, J. F., Reiner, J. S., Liu, J., Mattapallil, J. J., *et al.* (2005). Characterization of subsets of CD4+ memory T cells reveals early branched pathways of T cell differentiation in humans. *Proc Natl Acad Sci U S A* *102*, 7916-7921.
- Sporici, R. A., and Perrin, P. J. (2001). Costimulation of memory T-cells by ICOS: a potential therapeutic target for autoimmunity? *Clin Immunol* *100*, 263-269.
- Steinman, R. M., Pack, M., and Inaba, K. (1997). Dendritic cells in the T-cell areas of lymphoid organs. *Immunol Rev* *156*, 25-37.

- Stevens, T. L., Bossie, A., Sanders, V. M., Fernandez-Botran, R., Coffman, R. L., Mosmann, T. R., and Vitetta, E. S. (1988). Regulation of antibody isotype secretion by subsets of antigen-specific helper T cells. *Nature* 334, 255-258.
- Tanigaki, K., Han, H., Yamamoto, N., Tashiro, K., Ikegawa, M., Kuroda, K., Suzuki, A., Nakano, T., and Honjo, T. (2002). Notch-RBP-J signaling is involved in cell fate determination of marginal zone B cells. *Nat Immunol* 3, 443-450.
- They, C., and Amigorena, S. (2001). The cell biology of antigen presentation in dendritic cells. *Curr Opin Immunol* 13, 45-51.
- Tibbetts, M. D., Zheng, L., and Lenardo, M. J. (2003). The death effector domain protein family: regulators of cellular homeostasis. *Nat Immunol* 4, 404-409.
- Toellner, K. M., Scheel-Toellner, D., Sprenger, R., Duchrow, M., Trumper, L. H., Ernst, M., Flad, H. D., and Gerdes, J. (1995). The human germinal centre cells, follicular dendritic cells and germinal centre T cells produce B cell-stimulating cytokines. *Cytokine* 7, 344-354.
- Truitt, K. E., Hicks, C. M., and Imboden, J. B. (1994). Stimulation of CD28 triggers an association between CD28 and phosphatidylinositol 3-kinase in Jurkat T cells. *J Exp Med* 179, 1071-1076.
- van Kooten, C., and Banchereau, J. (2000). CD40-CD40 ligand. *J Leukoc Biol* 67, 2-17.
- Walker, L. S., Gulbranson-Judge, A., Flynn, S., Brocker, T., Raykundalia, C., Goodall, M., Forster, R., Lipp, M., and Lane, P. (1999). Compromised OX40 function in CD28-deficient mice is linked with failure to develop CXC chemokine receptor 5-positive CD4 cells and germinal centers. *J Exp Med* 190, 1115-1122.
- Wang, S., Zhu, G., Chapoval, A. I., Dong, H., Tamada, K., Ni, J., and Chen, L. (2000). Costimulation of T cells by B7-H2, a B7-like molecule that binds ICOS. *Blood* 96, 2808-2813.
- Wherry, E. J., Teichgraber, V., Becker, T. C., Masopust, D., Kaech, S. M., Antia, R., von Andrian, U. H., and Ahmed, R. (2003). Lineage relationship and protective immunity of memory CD8 T cell subsets. *Nat Immunol* 4, 225-234.
- Wong, S. C., Oh, E., Ng, C. H., and Lam, K. P. (2003). Impaired germinal center formation and recall T-cell-dependent immune responses in mice lacking the costimulatory ligand B7-H2. *Blood* 102, 1381-1388.
- Yamamoto, S., Oka, S., Inoue, M., Shimuta, M., Manabe, T., Takahashi, H., Miyamoto, M., Asano, M., Sakagami, J., Sudo, K., *et al.* (2002). Mice deficient in nervous system-specific carbohydrate epitope HNK-1 exhibit impaired synaptic plasticity and spatial learning. *J Biol Chem* 277, 27227-27231.
- Ye, Q., Wang, L., Wells, A. D., Tao, R., Han, R., Davidson, A., Scott, M. L., and Hancock, W. W. (2004). BAFF binding to T cell-expressed BAFF-R costimulates T cell proliferation and alloresponses. *Eur J Immunol* 34, 2750-2759.
- Yoshihara, Y., Oka, S., Watanabe, Y., and Mori, K. (1991). Developmentally and spatially regulated expression of HNK-1 carbohydrate antigen on a novel phosphatidylinositol-anchored glycoprotein in rat brain. *J Cell Biol* 115, 731-744.
- Zhang, M., Ko, K. H., Lam, Q. L., Lo, C. K., Srivastava, G., Zheng, B., Lau, Y. L., and Lu, L. (2005). Expression and function of TNF family member B cell-

REFERENCES

activating factor in the development of autoimmune arthritis. *Int Immunol* 17, 1081-1092.