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# Molecular Immunology

## Contents

- C. D. Partidos and C. Kanse** 1105 Specificity of the T-cell responses in covalently linked peptides each comprising of a T helper epitope
- I. Dalum, M. R. Jensen, K. Gregorius, C. M. Thomasen, H. I. Elsner and S. Mouritsen** 1113 Induction of cross-reactive antibodies against a self protein by immunization with a modified self protein containing a foreign T helper epitope
- K. B. Vu, M. A. Ghahroudi, L. Wyns and S. Muyldermans** 1121 Comparison of llama V<sub>H</sub> sequences from conventional and heavy chain antibodies
- N. G. Saito and Y. Paterson** 1133 Contribution of peptide backbone atoms to binding of an antigenic peptide to class I major histocompatibility complex molecule
- K. Tominaga, T. Kirikae and M. Nakano** 1147 Lipopolysaccharide (LPS)-induced IL-6 production by embryonic fibroblasts isolated and cloned from LPS-responsive and LPS-hyporesponsive mice
- I. C. Nicholson, K. A. Lenton, D. J. Little, T. Decorso, F. T. Lee, A. M. Scott, H. Zola and A. W. Hohmann** 1157 Construction and characterisation of a functional CD19 specific single chain Fv fragment for immunotherapy of B lineage leukaemia and lymphoma
- E. Lunde, B. Bogen and I. Sandlie** 1167 Immunoglobulin as a vehicle for foreign antigenic peptides immunogenic to T cells
- B. B. Jrad and E. Bahraoui** 1177 Linear and cyclic peptides mimicking the disulfide loops in HIV-2 envelope glycoprotein induced antibodies with different specificity
- E. Virts, D. Barritt, E. Siden and W. C. Raschke** 1191 Murine mast cells and monocytes express distinctive sets of CD45 isoforms
- J. C. Almagro, I. Hernandez, M. del Carmen Ramirez and E. Vargas-Madrado** 1199 The differences between the structural repertoires of V<sub>H</sub> germ-line gene segments of mice and humans: implication for the molecular mechanism of the immune response

—continued on inside back cover

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253



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# Molecular Immunology

**Contents** — *continued from outside back cover*

- U. Lamminmäki, B. O. Villoutreix,  
P. Jauria, P. Saviranta, M. Vihinen,  
L. Nilsson, O. Teleman and T. Lövgren** 1215 Structural analysis of an anti-estradiol antibody
- M. Salmi, D. J. Smith, P. Bono,  
T. Leu, J. Hellman, M.-T. Matikainen  
and S. Jalkanen** 1227 A mouse molecular mimic of human vascular adhesion  
protein-1
- I Forthcoming papers



**Pergamon**

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## CONSTRUCTION AND CHARACTERISATION OF A FUNCTIONAL CD19 SPECIFIC SINGLE CHAIN Fv FRAGMENT FOR IMMUNOTHERAPY OF B LINEAGE LEUKAEMIA AND LYMPHOMA

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(First received 20 July 1997; accepted in revised form 7 November 1997)

**Abstract**—The B cell specific antigen CD19 is a target for the immunotherapy of B lineage leukaemias and lymphomas. We have engineered a single chain Fv (scFv) fragment from the mouse hybridoma cell line FMC63 which produces monoclonal antibody specific for CD19. The genes encoding the FMC63 heavy and light chain variable regions were amplified from cDNA and a scFv was constructed by splice overlap extension PCR. Analysis of staining of lymphoblastoid cell lines, peripheral blood lymphocytes and tonsil sections demonstrated that the monovalent scFv fragment has the same cellular specificity as the parent hybridoma antibody. Kinetic studies with radiolabelled material showed that the scFv binds target cells with a  $K_a$  of  $2.3 \times 10^{-9}$ , compared with  $4.2 \times 10^{-9}$  for the parent antibody. This CD19 scFv will be used in experimental models to test its therapeutic efficacy and immunogenicity, with a view to application in the diagnosis and treatment of human B cell cancers. © 1997 Elsevier Science Ltd. All rights reserved.

**Key words:** scFv, CD19, antibody therapy, leukaemia, lymphoma.

### INTRODUCTION

Antibody directed imaging and immunotherapy of tumours relies on targeting tumour-associated antigens. CD19 is expressed on most B lineage malignancies, including acute lymphoblastic leukaemia, chronic lymphocytic leukaemia and non-Hodgkin's lymphoma. Because CD19 is absent from bone marrow progenitor cells it is a potential target for immunotherapy of these malignancies (Uckun *et al.*, 1988). Antibodies against CD19 inhibit the growth of tumour cells (Ghetie *et al.*, 1994). CD19 is not readily shed from cells (Uckun *et al.*, 1988) and is internalised with bound antibody, allowing delivery of anti-CD19-linked toxins (Uckun *et al.*, 1988). Animal models have indicated the potential value of antibodies to CD19 (Jansen *et al.*, 1992; Pietersz *et al.*, 1995). Antibody alone (Hekman *et al.*, 1991), with IL-2 (Vlas-

veld *et al.*, 1995), or conjugated to toxin (Grossbard *et al.*, 1993; Stone *et al.*, 1996) have been used in clinical trials for therapy of leukaemia and lymphoma and CD19 scFv have been described (Bejcek *et al.*, 1995).

Some of the limitations of therapeutic monoclonal antibodies can be overcome by engineering smaller and more effective antibody fragments (Winter *et al.*, 1994). scFv are single gene fusions of the antibody heavy and light chain variable regions joined by a peptide linker. Because they are smaller than whole antibodies, scFv show improved penetration into poorly vascularised tumours (Yokota *et al.*, 1992) and in clinical trials have shown negligible immunogenicity (Begent *et al.*, 1996). Functional moieties such as toxins, enzymes, or sites for binding drugs or radioisotopes can be incorporated (Ghetie and Vitetta 1994; Pietersz *et al.*, 1992). Engineered antibody fragments can be produced on a large scale in bacterial or mammalian expression systems (Pack *et al.*, 1993; Bebbington, 1995).

We describe the production and characterisation of a CD19 scFv, CHRI-19Fv1. Staining of lymphoblastoid cell lines, peripheral blood lymphocytes and tonsil sections indicates that CHRI-19Fv1 has the same cellular specificity as the parent antibody and has retained a high level of binding albeit with a 2-fold reduction in affinity

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