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(54) Titre : ZCYTOR14 SOLUBLES, ANTI-ZCYTOR14 ET PARTENAIRES DE LIAISON ET LEURS PROCEDES
D'UTILISATION DANS L'INFLAMMATION

(54) Title: SOLUBLE ZCYTOR14, ANTI-ZCYTOR14 ANTIBODIES AND BINDING PARTNERS AND METHODS OF
USING IN INFLAMMATION

(57) **Abrégé/Abstract:**

The present invention relates to blocking, inhibiting, reducing, antagonizing or neutralizing the activity of IL-17F, IL-17A, or both IL-17A and IL-17F polypeptide molecules. IL-17A and IL-17F are cytokines that are involved in inflammatory processes and human disease. ZcytoR14 is a common receptor for IL-17A and IL-17F. The present invention includes soluble ZcytoR14, anti-ZcytoR14 antibodies and binding partners, as well as methods for antagonizing IL-17F, IL-17A or both IL-17A and IL-17F using such soluble receptors, antibodies and binding partners.



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**SOLUBLE ZCYTOR14, ANTI-ZCYTOR14 ANTIBODIES AND BINDING PARTNERS AND
METHODS OF USING IN INFLAMMATION**

REFERENCE TO RELATED INVENTIONS

This application claims the benefit of U.S. Provisional Application Serial No. 60/578,805, filed June 10, 2004, which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Cytokines are soluble, small proteins that mediate a variety of biological effects, including the regulation of the growth and differentiation of many cell types (see, for example, Arai *et al.*, *Annu. Rev. Biochem.* 59:783 (1990); Mosmann, *Curr. Opin. Immunol.* 3:311 (1991); Paul and Seder, *Cell* 76:241 (1994)). Proteins that constitute the cytokine group include interleukins, interferons, colony stimulating factors, tumor necrosis factors, and other regulatory molecules. For example, human interleukin-17 is a cytokine which stimulates the expression of interleukin-6, intracellular adhesion molecule 1, interleukin-8, granulocyte macrophage colony-stimulating factor, and prostaglandin E2 expression, and plays a role in the preferential maturation of CD34+ hematopoietic precursors into neutrophils (Yao *et al.*, *J. Immunol.* 155:5483 (1995); Fossiez *et al.*, *J. Exp. Med.* 183:2593 (1996)).

Receptors that bind cytokines are typically composed of one or more integral membrane proteins that bind the cytokine with high affinity and transduce this binding event to the cell through the cytoplasmic portions of the certain receptor subunits. Cytokine receptors have been grouped into several classes on the basis of similarities in their extracellular ligand binding domains.

The demonstrated *in vivo* activities of cytokines and their receptors illustrate the clinical potential of, and need for, other cytokines, cytokine receptors, cytokine agonists, and cytokine antagonists. For example, demonstrated *in vivo* activities of the pro-inflammatory cytokine family illustrates the enormous clinical potential of, and need for antagonists of pro-inflammatory molecules.

DETAILED DESCRIPTION OF THE INVENTION

The present invention addresses these needs by providing antagonists to pro-inflammatory cytokines IL-17A and IL-17F. Specifically, the pro-inflammatory cytokines IL-17A and IL-17F have a high degree of sequence similarity, share many biological properties, and are both produced by activated T cells. They have both been implicated as factors that contribute to the progression of various autoimmune and inflammatory diseases including rheumatoid arthritis and asthma. In fact, reagents that negate IL-17A function significantly ameliorate disease incidence and severity in several mouse models of human disease. IL-17A mediates its effects through interaction with its cognate receptor, the IL-17 receptor (IL-17R), but the receptor for IL-17F has not yet been identified. We now report that we have identified the IL-17R-related molecule, ZcytoR14 as the receptor for IL-17F. However, we have also noted that this receptor binds to both IL-17A and IL-17F with a similar high affinity. IL-17R on the other hand, binds IL-17A with high affinity, but binds IL-17F with very low affinity. Consistent with this, we have shown that a soluble form of IL-17R blocks IL-17A binding and signaling in cells expressing either receptor, but does not interfere with binding or function of IL-17F to ZcytoR14. In contrast, a soluble form of ZcytoR14 antagonizes both IL-17A and IL-17F, either singly or together, in cells expressing either receptor. Since IL-17A intervention has been proposed as an effective therapy for several auto-immune diseases, using antagonists of the present invention, which may block, inhibit, reduce, antagonize or neutralize the activity of IL-17A, IL-17F, or both IL-17A and IL-17F, which include soluble ZcytoR14 receptors and neutralizing anti-ZcytoR14 antibodies, will have advantages over therapies that target only one of these two cytokines. The invention further provides uses therefor in inflammatory disease, as well as related compositions and methods.

A) Overview

Immune related and inflammatory diseases are the manifestation or consequence of fairly complex, often multiple interconnected biological pathways which in normal physiology are critical to respond to insult or injury, initiate repair from insult or injury, and mount innate and acquired defense against foreign organisms. Disease or pathology occurs when these normal physiological pathways cause additional insult or injury either as directly related to the intensity of the response, as a consequence of abnormal regulation or excessive stimulation, as a reaction to self, or as a combination of these.

Though the genesis of these diseases often involves multi-step pathways and often multiple different biological systems/pathways, intervention at critical points in one or more of these pathways can have an ameliorative or therapeutic effect. Therapeutic

intervention can occur by either antagonism of a detrimental process/pathway or stimulation of a beneficial process/pathway.

Many immune related diseases are known and have been extensively studied. Such diseases include immune-mediated inflammatory diseases (such as rheumatoid arthritis, immune mediated renal disease, hepatobiliary diseases, inflammatory bowel disease (IBD),
5 psoriasis, and asthma), non-immune-mediated inflammatory diseases, infectious diseases, immunodeficiency diseases, neoplasia, etc.

T lymphocytes (T cells) are an important component of a mammalian immune response. T cells recognize antigens which are associated with a self-molecule encoded by genes within the major histocompatibility complex (MHC). The antigen may be displayed
10 together with MHC molecules on the surface of antigen presenting cells, virus infected cells, cancer cells, grafts, etc. The T cell system eliminates these altered cells which pose a health threat to the host mammal. T cells include helper T cells and cytotoxic T cells. Helper T cells proliferate extensively following recognition of an antigen-MHC complex on an antigen
15 presenting cell. Helper T cells also secrete a variety of cytokines, i.e., lymphokines, which play a central role in the activation of B cells, cytotoxic T cells and a variety of other cells which participate in the immune response.

A central event in both humoral and cell mediated immune responses is the activation and clonal expansion of helper T cells. Helper T cell activation is initiated by the
20 interaction of the T cell receptor (TCR)--CD3 complex with an antigen-MHC on the surface of an antigen presenting cell. This interaction mediates a cascade of biochemical events that induce the resting helper T cell to enter a cell cycle (the G0 to G1 transition) and results in the expression of a high affinity receptor for IL-2 and sometimes IL-4. The activated T cell progresses through the cycle proliferating and differentiating into memory cells or effector
25 cells.

In addition to the signals mediated through the TCR, activation of T cells involves additional costimulation induced by cytokines released by the antigen presenting cell or through interactions with membrane bound molecules on the antigen presenting cell and the T cell. The cytokines IL-1 and IL-6 have been shown to provide a costimulatory signal. Also,
30 the interaction between the B7 molecule expressed on the surface of an antigen presenting cell and CD28 and CTLA-4 molecules expressed on the T cell surface effect T cell activation. Activated T cells express an increased number of cellular adhesion molecules, such as ICAM-1, integrins, VLA-4, LFA-1, CD56, etc.

T-cell proliferation in a mixed lymphocyte culture or mixed lymphocyte reaction (MLR) is an established indication of the ability of a compound to stimulate the immune system. In many immune responses, inflammatory cells infiltrate the site of injury or infection. The migrating cells may be neutrophilic, eosinophilic, monocytic or lymphocytic as
5 can be determined by histologic examination of the affected tissues. Current Protocols in Immunology, ed. John E. Coligan, 1994, John Wiley & Sons, Inc.

Immune related diseases could be treated by suppressing the immune response. Using soluble receptors and/or neutralizing antibodies that inhibit molecules having immune stimulatory activity would be beneficial in the treatment of immune-mediated and
10 inflammatory diseases. Molecules which inhibit the immune response can be utilized (proteins directly or via the use of antibody agonists) to inhibit the immune response and thus ameliorate immune related disease.

Interleukin-17 (IL-17A) has been identified as a cellular ortholog of a protein encoded by the T lymphotropic Herpes virus Saimiri (HSV) [see, Rouvier et al., J. Immunol.,
15 150(12): 5445-5456 (19993); Yao et al., J. Immunol., 122(12):5483-5486 (1995) and Yao et al., Immunity, 3(6):811-821 (1995)]. Subsequent characterization has shown that this protein is a potent cytokine that acts to induce proinflammatory responses in a wide variety of peripheral tissues. IL-17A is a disulfide-linked homodimeric cytokine of about 32 kDa which is synthesized and secreted only by CD4+activated memory T cells (reviewed in Fossiez et al.,
20 Int. Rev. Immunol., 16: 541-551 [1998]). Specifically, IL-17 is synthesized as a precursor polypeptide of 155 amino acids with an N-terminal signal sequence of 19-23 residues and is secreted as a disulfide-linked homodimeric glycoprotein. IL-17A is disclosed in WO9518826 (1995), WO9715320 (1997) and WO9704097 (1997), as well as US Patent No. 6,063,372.

Despite its restricted tissue distribution, IL-17A exhibits pleiotropic biological
25 activities on various types of cells. IL-17A has been found to stimulate the production of many cytokines. It induces the secretion of IL-6, IL-8, IL-12, leukemia inhibitory factor (LIF), prostaglandin E2, MCP-1 and G-CSF by adherent cells like fibroblasts, keratinocytes, epithelial and endothelial cells. IL-17A also has the ability to induce ICAM-1 surface expression, proliferation of T cells, and growth and differentiation of CD34.sup.+ human
30 progenitors into neutrophils. IL-17A has also been implicated in bone metabolism, and has been suggested to play an important role in pathological conditions characterized by the presence of activated T cells and TNF-.alpha. production such as rheumatoid arthritis and loosening of bone implants (Van Bezooijen et al., J. Bone Miner. Res. 14: 1513-1521 [1999]). Activated T cells of synovial tissue derived from rheumatoid arthritis patients were found to

secrete higher amounts of IL-17A than those derived from normal individuals or osteoarthritis patients (Chabaud et al., *Arthritis Rheum.* 42: 963-970 [1999]). It was suggested that this proinflammatory cytokine actively contributes to synovial inflammation in rheumatoid arthritis. Apart from its proinflammatory role, IL-17A seems to contribute to the pathology of
5 rheumatoid arthritis by yet another mechanism. For example, IL-17A has been shown to induce the expression of osteoclast differentiation factor (ODF) mRNA in osteoblasts (Kotake et al., *J. Clin. Invest.*, 103: 1345-1352 [1999]). ODF stimulates differentiation of progenitor cells into osteoclasts, the cells involved in bone resorption.

Since the level of IL-17A is significantly increased in synovial fluid of
10 rheumatoid arthritis patients, it appears that IL-17A induced osteoclast formation plays a crucial role in bone resorption in rheumatoid arthritis. IL-17A is also believed to play a key role in certain other autoimmune disorders such as multiple sclerosis (Matusevicius et al., *Mult. Scler.*, 5: 101-104 [1999]). IL-17A has further been shown, by intracellular signalling, to stimulate $\text{Ca}_{\text{sup.2+}}$ influx and a reduction in [cAMP], in human macrophages (Jovanovic et
15 al., *J. Immunol.*, 160:3513 [1998]). Fibroblasts treated with IL-17A induce the activation of NF- κ B, [Yao et al., *Immunity*, 3:811 (1995), Jovanovic et al., *supra*], while macrophages treated with it activate NF- κ B and mitogen-activated protein kinases (Shalom-Barek et al., *J. Biol. Chem.*, 273:27467 [1998]).

Additionally, IL-17A also shares sequence similarity with mammalian
20 cytokine-like factor 7 that is involved in bone and cartilage growth. Other proteins with which IL-17A polypeptides share sequence similarity are human embryo-derived interleukin-related factor (EDIRF) and interleukin-20.

Consistent with IL-17A's wide-range of effects, the cell surface receptor for IL-17A has been found to be widely expressed in many tissues and cell types (Yao et al.,
25 *Cytokine*, 9:794 [1997]). While the amino acid sequence of the human IL-17A receptor (IL-17R) (866 amino acids) predicts a protein with a single transmembrane domain and a long, 525 amino acid intracellular domain, the receptor sequence is unique and is not similar to that of any of the receptors from the cytokine/growth factor receptor family. This coupled with the lack of similarity of IL-17A itself to other known proteins indicates that IL-17A and its
30 receptor may be part of a novel family of signalling proteins and receptors. It has been demonstrated that IL-17A activity is mediated through binding to its unique cell surface receptor, wherein previous studies have shown that contacting T cells with a soluble form of the IL-17A receptor polypeptide inhibited T cell proliferation and IL-2 production induced by PHA, concanavalin A and anti-TCR monoclonal antibody (Yao et al., *J. Immunol.*, 155:5483-

5486 [1995]). As such, there is significant interest in identifying and characterizing novel polypeptides having homology to the known cytokine receptors, specifically IL-17A receptors.

The expression pattern of IL-17F appears to be similar to that of IL-17A, such that it includes only activated CD4+ T cells and monocytes (Starnes et al. J. Immunol. 167: 4137-4140 [2001]). IL-17F has been demonstrated to induce G-CSF, IL-6, and IL-8 in fibroblasts (Hymowitz et al, EMBO J. 20:5322-5341 [2001]) and TGF- β in endothelial cells (Starnes et al. J. Immunol. 167: 4137-4140 [2001]). It has recently been reported that IL-23, a cytokine produced by dendritic cell, can mediate the production of both IL-17A and IL-17F, primarily in memory T cells (Aggarwal et al. J. Biol. Chem. 278:1910-1914 [2003]).

Moreover, over expression or upregulation of both IL-17A and IL-17F have been shown in arthritic and asthmatic individuals (reviewed in Moseley et al. Cytokine Growth Factor Rev 14:155-174 [2003]). With regards to arthritis, these cytokines act in a manner characteristic to the cartilage and joint destruction that is associated with rheumatoid- and osteo-arthritis. For example, IL-17A and IL-17F have been demonstrated to enhance matrix degradation in articular cartilage explants via release of cartilage proteoglycan glycosaminoglycans and collagen fragments, while inhibiting the synthesis of new proteoglycans and collagens (Cai et al. Cytokine 16:10-21 [2001]; Attur et al Arthritis Rheum 44:2078-2083 [2001]).

Similar to IL-17A, overexpression of IL-17F in mice has also been shown to increase lung neutrophil recruitment and result in increased expression of Th1-associated cytokines in the lung, including IL-6, IFN- γ , IP-10 and MIG (Starnes et al. J. Immunol. 167: 4137-4140 [2001]). IL-17F was also upregulated in T cells from allergen-challenged asthmatics (Kawaguchi et al J. Immunol 167:4430-4435 [2001]), and found to induce IL-6 and IL-8 production in NHBE. In contrast to IL-17A, IL-17F appears to inhibit angiogenesis in vitro (Starnes et al. J. Immunol. 167: 4137-4140 [2001]).

IL-17F mRNA was not detected by northern blot in various human tissues but was dramatically induced upon activation of CD4+ T cells and monocytes. Id. In mice, Th2 cells and mast cells were found to express IL-17F upon activation. See Dumont, Expert Opin. Ther. Patents 13(3) (2003). Like IL-17A, the expression of IL-17F was also found to be upregulated by IL-23 in mouse.

The IL-17 cytokine/receptor families appear to represent a unique signaling system within the cytokine network that will offer innovative approaches to the manipulation of immune and inflammatory responses. Accordingly, the present invention is based on the

discovery of a new IL-17 family receptor, ZcytoR14 and its ability to bind both IL-17A and IL-17F.

As such, antagonists to IL-17F and IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention, are useful in therapeutic treatment of inflammatory diseases, particularly as antagonists to both IL-17F and IL-17A singly or together in the treatment of psoriasis. Moreover, antagonists to IL-17F activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention, are useful in therapeutic treatment of other inflammatory diseases for example as bind, block, inhibit, reduce, antagonize or neutralize IL-17F and IL-17A (either individually or together) in the treatment of atopic and contact dermatitis, IBD, colitis, Endotoxemia, arthritis, rheumatoid arthritis, psoriatic arthritis, adult respiratory disease (ARD), septic shock, multiple organ failure, inflammatory lung injury such as asthma, chronic obstructive pulmonary disease (COPD), airway hyper-responsiveness, chronic bronchitis, allergic asthma, bacterial pneumonia, psoriasis, eczema, , and inflammatory bowel disease such as ulcerative colitis and Crohn's disease, *helicobacter pylori* infection. intraabdominal adhesions and/or abscesses as results of peritoneal inflammation (i.e. from infection, injury, etc.), systemic lupus erythematosus (SLE), multiple sclerosis, systemic sclerosis, nephrotic syndrome, organ allograft rejection, graft vs. host disease (GVHD), kidney, lung, heart, etc. transplant rejection, streptococcal cell wall (SCW)-induced arthritis, osteoarthritis, gingivitis/periodontitis, herpetic stromal keratitis, cancers including prostate, renal, colon, ovarian, cervical, leukemia, angiogenesis, restenosis and kawasaki disease.

Cytokine receptors subunits are characterized by a multi-domain structure comprising a ligand-binding domain and an effector domain that is typically involved in signal transduction. Multimeric cytokine receptors include monomers, homodimers (e.g., PDGF receptor $\alpha\alpha$ and $\beta\beta$ isoforms, erythropoietin receptor, MPL [thrombopoietin receptor], and G-CSF receptor), heterodimers whose subunits each have ligand-binding and effector domains (e.g., PDGF receptor $\alpha\beta$ isoform), and multimers having component subunits with disparate functions (e.g., IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, and GM-CSF receptors). Some receptor subunits are common to a plurality of receptors. For example, the AIC2B subunit, which cannot bind ligand on its own but includes an intracellular signal transduction domain, is a component of IL-3 and GM-CSF receptors. Many cytokine receptors can be placed into one of four related families on the basis of their structures and functions. Class I hematopoietic receptors, for example, are characterized by the presence of a domain containing conserved

cysteine residues and the WSXWS motif (SEQ ID NO:10). Additional domains, including protein kinase domains; fibronectin type III domains; and immunoglobulin domains, which are characterized by disulfide-bonded loops, are present in certain hematopoietic receptors. Cytokine receptor structure has been reviewed by Urdal, Ann. Reports Med. Chem. 26:221-
5 228, 1991 and Cosman, Cytokine 5:95-106, 1993. It is generally believed that under selective pressure for organisms to acquire new biological functions, new receptor family members arose from duplication of existing receptor genes leading to the existence of multi-gene families. Family members thus contain vestiges of the ancestral gene, and these characteristic features can be exploited in the isolation and identification of additional family members.

10 Amongst other inventions, the present invention provides novel uses for a soluble receptor, designated "ZcytoR14" or "soluble ZcytoR14" or "sZcytoR14", all of which may be used herein interchangeably, or and neutralizing antibodies to ZcytoR14 cytokine receptors. The present invention also provides soluble ZcytoR14 polypeptide fragments and fusion proteins, for use in human inflammatory and autoimmune diseases. The anti- ZcytoR14
15 antibodies, and soluble ZcytoR14 receptors of the present invention, including the neutralizing anti-ZcytoR14 antibodies of the present invention, can be used to block, inhibit, reduce, antagonize or neutralize the activity of either IL-17F or IL-17A, or both IL-17A and IL-17F in the treatment of inflammation and inflammatory diseases such as psoriasis, psoriatic arthritis, rheumatoid arthritis, endotoxemia, inflammatory bowel disease (IBD), colitis, asthma, allograft
20 rejection, immune mediated renal diseases, hepatobiliary diseases, multiple sclerosis, atherosclerosis, promotion of tumor growth, or degenerative joint disease and other inflammatory conditions disclosed herein.

 An illustrative nucleotide sequence that encodes human ZcytoR14 is provided by SEQ ID NO:1; the encoded polypeptide is shown in SEQ ID NO:2. ZcytoR14 functions as
25 a receptor for both IL-17A (SEQ ID NOS:13 & 14) and IL-17F (SEQ ID NOS:15 & 16). ZcytoR14 can act as a monomer, a homodimer or a heterodimer. Preferably, ZcytoR14 acts as a homodimeric receptor for both IL-17A and/or IL-17F. ZcytoR14 can also act as a heterodimeric receptor subunit for a IL-17-related cytokine. ZcytoR14 is disclosed in commonly owned US Patent Application No. 10/458,647, and commonly owned WIPO
30 publication WO 01/04304, both of which are incorporated herein in their entirety by reference. Analysis of a human cDNA clone encoding ZcytoR14 (SEQ ID NO:1) revealed an open reading frame encoding 692 amino acids (SEQ ID NO:2) comprising a putative signal sequence of approximately 20 amino acid residues (amino acid residues 1 to 20 of SEQ ID NO:2), an extracellular ligand-binding domain of approximately 431 amino acid residues

(amino acid residues 21-452 of SEQ ID NO:2; SEQ ID NO:3), a transmembrane domain of approximately 20 amino acid residues (amino acid residues 453-473 of SEQ ID NO:2), and an intracellular domain of approximately 203 amino acid residues (amino acid residues 474 to 677 of SEQ ID NO:2). Furthermore, a ligand binding domain is represented by SEQ ID NO:22.

5 Yet another illustrative nucleotide sequence that encodes a variant human ZcytoR14, designated as "ZcytoR14-1" is provided by SEQ ID NO:4, the encoded polypeptide is shown in SEQ ID NO:5. ZcytoR14-1 is disclosed in commonly owned US Patent Application No. 10/458,647, and commonly owned WIPO publication WO 01/04304, both of which are incorporated herein in their entirety by reference. Sequence analysis revealed that
10 ZcytoR14-1 is a truncated form of receptor polypeptide. That is, ZcytoR14-1 lacks amino acid residues 1-113 of SEQ ID NO:2. SEQ ID NO:10 presents an amino acid sequence of a ZcytoR14-1 polypeptide that includes the N-terminal portion of ZcytoR14.

A comparison of the ZcytoR14 and ZcytoR14-1 amino acid sequences also indicated that the two polypeptides represent alternatively spliced variants. The amino acid
15 sequence of ZcytoR14 includes a 17 amino acid segment (amino acid residues 339 to 355 of SEQ ID NO:2), which ZcytoR14-1 lacks, while ZcytoR14 lacks, following amino acid 479, a 13 amino acid segment found in ZcytoR14-1 (amino acid residues 350 to 362 of SEQ ID NO:5). A polypeptide that contains both amino acid segments is provided by SEQ ID NO:11, whereas SEQ ID NO:12 presents the amino acid sequence of a polypeptide that lacks both 13 and 17
20 amino acid segments.

Yet another illustrative nucleotide sequence that encodes a variant human ZcytoR14, designated as "ZcytoR14-6" is provided by SEQ ID NO:23, the encoded polypeptide is shown in SEQ ID NO:24. ZcytoR14-6 contains a 25 amino acid residue deletion as compared to ZcytoR14 as embodied in SEQ ID NO:2. Specifically, ZcytoR14-6
25 does not contain amino acid residue 94 to amino acid residue 118 of SEQ ID NO:2. Analysis of a human cDNA clone encoding ZcytoR14-6 (SEQ ID NO:23) revealed an extracellular ligand-binding domain of approximately 427 amino acid residues (amino acid residues 1-427 of SEQ ID NO:24), a transmembrane domain of approximately 20 amino acid residues (amino acid residues 428-448 of SEQ ID NO:24), and an intracellular domain of approximately 218
30 amino acid residues (amino acid residues 449 to 667 of SEQ ID NO:24).

An illustrative nucleotide sequence that encodes a variant murine ZcytoR14 is provided by SEQ ID NO:25; the encoded polypeptide is shown in SEQ ID NO:26. Murine ZcytoR14 functions as a receptor for both murine IL-17A (SEQ ID NOS:17 & 18) and murine IL-17F (SEQ ID NOS:19 & 20). Analysis of a murine cDNA clone encoding ZcytoR14 (SEQ

ID NO:1) revealed an extracellular ligand-binding domain of approximately 449 amino acid residues SEQ ID NO:27). Furthermore, a ligand binding domain is represented by SEQ ID NO:28.

Yet another illustrative nucleotide sequence that encodes a variant murine
5 ZcytoR14 is provided by SEQ ID NO:29; the encoded polypeptide is shown in SEQ ID NO:30.

The Zcytor14 gene resides in chromosome 3p25 – 3p24. As discussed below, this region is associated with various disorders and diseases.

Northern analyses indicate that there is strong expression of the *Zcytor14* gene in thyroid, adrenal gland, prostate, and liver tissues, and less expression in heart, small
10 intestine, stomach, and trachea tissues. In contrast, there is little or no expression in brain, placenta, lung, skeletal muscle, kidney, pancreas, spleen, thymus, testis, ovary, colon, peripheral blood leukocytes, spinal cord, lymph node, and bone marrow. These observations show that Zcytor14 sequences can be used differentiate between various tissues.

As described below, the present invention provides isolated polypeptides
15 comprising an amino acid sequence that is at least 70%, at least 80%, or at least 90%, or greater than 95%, such as 96%, 97%, 98%, or greater than 99% or more identical to a reference amino acid sequence of 21-692 of SEQ ID NO:2, wherein the isolated polypeptide specifically binds with an antibody that specifically binds with a polypeptide comprising the amino acid sequence of SEQ ID NO:2. The present invention also provides isolated polypeptides
20 comprising an amino acid sequence that is at least 70%, at least 80%, or at least 90% identical to a reference amino acid sequence selected from the group consisting of: (a) amino acid residues 21 to 452 of SEQ ID NO:2, (b) amino acid residues 21 to 435 of SEQ ID NO:10, (c) amino acid residues 21 to 677 of SEQ ID NO:2, and (d) amino acid residues 1 to 692 of SEQ ID NO:2, wherein the isolated polypeptide specifically binds with an antibody that specifically
25 binds with a polypeptide consisting of either the amino acid sequence of SEQ ID NO:2, or the amino acid sequence of SEQ ID NO:10. Illustrative polypeptides include a polypeptide comprising the amino acid sequence of SEQ ID NO:2, SEQ ID NO:10, SEQ ID NO:11, or SEQ ID NO:12.

The present invention also provides isolated polypeptides comprising an
30 extracellular domain, wherein the extracellular domain comprises either amino acid residues 21 to 452 of the amino acid sequence of SEQ ID NO:2 or amino acid residues 21 to 435 of the amino acid sequence of SEQ ID NO:10. Such polypeptides may further comprise a transmembrane domain that resides in a carboxyl-terminal position relative to the extracellular domain, wherein the transmembrane domain comprises amino acid residues 453 to 473 of SEQ

ID NO:2. These polypeptides may also comprise an intracellular domain that resides in a carboxyl-terminal position relative to the transmembrane domain, wherein the intracellular domain comprises either amino acid residues 474 to 677 of SEQ ID NO:2, or amino acid residues 457 to 673 of SEQ ID NO:10, and optionally, a signal secretory sequence that resides
5 in an amino-terminal position relative to the extracellular domain, wherein the signal secretory sequence comprises amino acid residues 1 to 20 of the amino acid sequence of SEQ ID NO:2.

The present invention also includes variant Zcytor14 polypeptides, wherein the amino acid sequence of the variant polypeptide shares an identity with the amino acid sequence of SEQ ID NO:2 selected from the group consisting of at least 70% identity, at least 80%
10 identity, at least 90% identity, at least 95% identity, or greater than 95% identity, and wherein any difference between the amino acid sequence of the variant polypeptide and the amino acid sequence of SEQ ID NO:2 is due to one or more conservative amino acid substitutions.

Moreover, the present invention also provides isolated polypeptides as disclosed above that bind IL-17F (e.g., human IL-17F polypeptide sequence as shown in SEQ
15 ID NO:16). The human IL-17F polynucleotide sequence is shown in SEQ ID NO:15. The mouse IL-17F polynucleotide sequence is shown in SEQ ID NO:19, and corresponding polypeptide is shown in SEQ ID NO:20. The present invention also provides isolated polypeptides as disclosed above that bind IL-17A (e.g., human IL-17A polypeptide sequence as shown in SEQ ID NO:14). The human IL-17A polynucleotide sequence is shown in SEQ ID
20 NO:13. The mouse IL-17A polynucleotide sequence is shown in SEQ ID NO:17, and corresponding polypeptide is shown in SEQ ID NO:18.

The present invention also provides isolated polypeptides and epitopes comprising at least 15 contiguous amino acid residues of an amino acid sequence of SEQ ID NO:2 or 3. Illustrative polypeptides include polypeptides that either comprise, or consist of
25 SEQ ID NO:2 or 3, an antigenic epitope thereof, or a functional IL-17A or IL-17F binding fragment thereof. Moreover, the present invention also provides isolated polypeptides as disclosed above that bind to, block, inhibit, reduce, antagonize or neutralize the activity of IL-17F or IL-17A.

The present invention also includes variant ZcytoR14 polypeptides, wherein
30 the amino acid sequence of the variant polypeptide shares an identity with the amino acid residues of SEQ ID NO:2 selected from the group consisting of at least 70% identity, at least 80% identity, at least 90% identity, at least 95% identity, or greater than 95% identity, such as 96%, 97%, 98%, or greater than 99% or more identity, and wherein any difference between the amino acid sequence of the variant polypeptide and the corresponding amino acid sequence of

SEQ ID NO:2 is due to one or more conservative amino acid substitutions. Such conservative amino acid substitutions are described herein. Moreover, the present invention also provides isolated polypeptides as disclosed above that bind to, block, inhibit, reduce, antagonize or neutralize the activity of IL-17F or IL-17A.

5 The present invention further provides antibodies and antibody fragments that specifically bind with such polypeptides. Exemplary antibodies include neutralizing antibodies, polyclonal antibodies, murine monoclonal antibodies, humanized antibodies derived from murine monoclonal antibodies, and human monoclonal antibodies. Illustrative antibody fragments include F(ab')₂, F(ab)₂, Fab', Fab, Fv, scFv, and minimal recognition units.

10 Neutralizing antibodies preferably bind ZcytoR14 such that the interaction of IL-17A and IL-17F with ZcytoR14 is blocked, inhibited, reduced, antagonized or neutralized; anti-ZcytoR14 neutralizing antibodies such that the binding of either IL-17A or IL-17F to ZcytoR14 is blocked, inhibited, reduced, antagonized or neutralized are also encompassed by the present invention. That is, the neutralizing anti-ZcytoR14 antibodies of the present invention can

15 either either bind, block, inhibit, reduce, antagonize or neutralize each of IL-17A or IL-17F singly, or bind, block, inhibit, reduce, antagonize or neutralize IL-17A and IL-17F together. The present invention further includes compositions comprising a carrier and a peptide, polypeptide, or antibody described herein.

 In addition, the present invention provides pharmaceutical compositions

20 comprising a pharmaceutically acceptable carrier and at least one of such an expression vector or recombinant virus comprising such expression vectors. The present invention further includes pharmaceutical compositions, comprising a pharmaceutically acceptable carrier and a polypeptide or antibody described herein.

 The present invention also contemplates anti-idiotypic antibodies, or anti-

25 idiotype antibody fragments, that specifically bind an antibody or antibody fragment that specifically binds a polypeptide comprising the amino acid sequence of SEQ ID NO:2 or a fragment thereof. An exemplary anti-idiotypic antibody binds with an antibody that specifically binds a polypeptide consisting of SEQ ID NO:2.

 The present invention also provides fusion proteins, comprising a ZcytoR14

30 polypeptide and an immunoglobulin moiety. In such fusion proteins, the immunoglobulin moiety may be an immunoglobulin heavy chain constant region, such as a human F_C fragment. The present invention further includes isolated nucleic acid molecules that encode such fusion proteins.

The present invention also provides polyclonal and monoclonal antibodies that bind to polypeptides comprising an ZcytoR14 extracellular domain such as monomeric, homodimeric, heterodimeric and multimeric receptors, including soluble receptors. Moreover, such antibodies can be used antagonize the binding of ZcytoR14 ligands, IL-17F (SEQ ID NO:16), and IL-17A (SEQ ID NO:14), individually or together to the ZcytoR14 receptor.

These and other aspects of the invention will become evident upon reference to the following detailed description. In addition, various references are identified below and are incorporated by reference in their entirety.

10 B) Definitions

In the description that follows, a number of terms are used extensively. The following definitions are provided to facilitate understanding of the invention.

As used herein, “nucleic acid” or “nucleic acid molecule” refers to polynucleotides, such as deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), oligonucleotides, fragments generated by the polymerase chain reaction (PCR), and fragments generated by any of ligation, scission, endonuclease action, and exonuclease action. Nucleic acid molecules can be composed of monomers that are naturally-occurring nucleotides (such as DNA and RNA), or analogs of naturally-occurring nucleotides (*e.g.*, α -enantiomeric forms of naturally-occurring nucleotides), or a combination of both. Modified nucleotides can have alterations in sugar moieties and/or in pyrimidine or purine base moieties. Sugar modifications include, for example, replacement of one or more hydroxyl groups with halogens, alkyl groups, amines, and azido groups, or sugars can be functionalized as ethers or esters. Moreover, the entire sugar moiety can be replaced with sterically and electronically similar structures, such as aza-sugars and carbocyclic sugar analogs. Examples of modifications in a base moiety include alkylated purines and pyrimidines, acylated purines or pyrimidines, or other well-known heterocyclic substitutes. Nucleic acid monomers can be linked by phosphodiester bonds or analogs of such linkages. Analogs of phosphodiester linkages include phosphorothioate, phosphorodithioate, phosphoroselenoate, phosphorodiselenoate, phosphoroanilothioate, phosphoranilidate, phosphoramidate, and the like. The term “nucleic acid molecule” also includes so-called “peptide nucleic acids,” which comprise naturally-occurring or modified nucleic acid bases attached to a polyamide backbone. Nucleic acids can be either single stranded or double stranded.

The term “complement of a nucleic acid molecule” refers to a nucleic acid molecule having a complementary nucleotide sequence and reverse orientation as compared to

a reference nucleotide sequence. For example, the sequence 5' ATGCACGGG 3' is complementary to 5' CCCGTGCAT 3'.

The term “degenerate nucleotide sequence” denotes a sequence of nucleotides that includes one or more degenerate codons as compared to a reference nucleic acid molecule that encodes a polypeptide. Degenerate codons contain different triplets of nucleotides, but encode the same amino acid residue (*i.e.*, GAU and GAC triplets each encode Asp).

The term “structural gene” refers to a nucleic acid molecule that is transcribed into messenger RNA (mRNA), which is then translated into a sequence of amino acids characteristic of a specific polypeptide.

10 An “isolated nucleic acid molecule” is a nucleic acid molecule that is not integrated in the genomic DNA of an organism. For example, a DNA molecule that encodes a growth factor that has been separated from the genomic DNA of a cell is an isolated DNA molecule. Another example of an isolated nucleic acid molecule is a chemically-synthesized nucleic acid molecule that is not integrated in the genome of an organism. A nucleic acid molecule that has been isolated from a particular species is smaller than the complete DNA molecule of a chromosome from that species.

A “nucleic acid molecule construct” is a nucleic acid molecule, either single- or double-stranded, that has been modified through human intervention to contain segments of nucleic acid combined and juxtaposed in an arrangement not existing in nature.

20 “Linear DNA” denotes non-circular DNA molecules having free 5' and 3' ends. Linear DNA can be prepared from closed circular DNA molecules, such as plasmids, by enzymatic digestion or physical disruption.

“Complementary DNA (cDNA)” is a single-stranded DNA molecule that is formed from an mRNA template by the enzyme reverse transcriptase. Typically, a primer complementary to portions of mRNA is employed for the initiation of reverse transcription. Those skilled in the art also use the term “cDNA” to refer to a double-stranded DNA molecule consisting of such a single-stranded DNA molecule and its complementary DNA strand. The term “cDNA” also refers to a clone of a cDNA molecule synthesized from an RNA template.

30 A “promoter” is a nucleotide sequence that directs the transcription of a structural gene. Typically, a promoter is located in the 5' non-coding region of a gene, proximal to the transcriptional start site of a structural gene. Sequence elements within promoters that function in the initiation of transcription are often characterized by consensus nucleotide sequences. These promoter elements include RNA polymerase binding sites, TATA sequences, CAAT sequences, differentiation-specific elements (DSEs; McGehee *et al.*, *Mol.*

Endocrinol. 7:551 (1993)), cyclic AMP response elements (CREs), serum response elements (SREs; Treisman, *Seminars in Cancer Biol.* 1:47 (1990)), glucocorticoid response elements (GREs), and binding sites for other transcription factors, such as CRE/ATF (O'Reilly *et al.*, *J. Biol. Chem.* 267:19938 (1992)), AP2 (Ye *et al.*, *J. Biol. Chem.* 269:25728 (1994)), SP1, cAMP
5 response element binding protein (CREB; Loeken, *Gene Expr.* 3:253 (1993)) and octamer factors (see, in general, Watson *et al.*, eds., *Molecular Biology of the Gene*, 4th ed. (The Benjamin/Cummings Publishing Company, Inc. 1987), and Lemaigre and Rousseau, *Biochem. J.* 303:1 (1994)). If a promoter is an inducible promoter, then the rate of transcription increases in response to an inducing agent. In contrast, the rate of transcription is not regulated by an
10 inducing agent if the promoter is a constitutive promoter. Repressible promoters are also known.

A "core promoter" contains essential nucleotide sequences for promoter function, including the TATA box and start of transcription. By this definition, a core promoter may or may not have detectable activity in the absence of specific sequences that may enhance the activity or confer tissue specific activity.

15 A "regulatory element" is a nucleotide sequence that modulates the activity of a core promoter. For example, a regulatory element may contain a nucleotide sequence that binds with cellular factors enabling transcription exclusively or preferentially in particular cells, tissues, or organelles. These types of regulatory elements are normally associated with genes that are expressed in a "cell-specific," "tissue-specific," or "organelle-specific" manner.

20 An "enhancer" is a type of regulatory element that can increase the efficiency of transcription, regardless of the distance or orientation of the enhancer relative to the start site of transcription.

"Heterologous DNA" refers to a DNA molecule, or a population of DNA molecules, that does not exist naturally within a given host cell. DNA molecules heterologous
25 to a particular host cell may contain DNA derived from the host cell species (*i.e.*, endogenous DNA) so long as that host DNA is combined with non-host DNA (*i.e.*, exogenous DNA). For example, a DNA molecule containing a non-host DNA segment encoding a polypeptide operably linked to a host DNA segment comprising a transcription promoter is considered to be a heterologous DNA molecule. Conversely, a heterologous DNA molecule can comprise an
30 endogenous gene operably linked with an exogenous promoter. As another illustration, a DNA molecule comprising a gene derived from a wild-type cell is considered to be heterologous DNA if that DNA molecule is introduced into a mutant cell that lacks the wild-type gene.

A “polypeptide” is a polymer of amino acid residues joined by peptide bonds, whether produced naturally or synthetically. Polypeptides of less than about 10 amino acid residues are commonly referred to as “peptides.”

A “protein” is a macromolecule comprising one or more polypeptide chains.
5 A protein may also comprise non-peptidic components, such as carbohydrate groups. Carbohydrates and other non-peptidic substituents may be added to a protein by the cell in which the protein is produced, and will vary with the type of cell. Proteins are defined herein in terms of their amino acid backbone structures; substituents such as carbohydrate groups are generally not specified, but may be present nonetheless.

10 A peptide or polypeptide encoded by a non-host DNA molecule is a “heterologous” peptide or polypeptide.

A “cloning vector” is a nucleic acid molecule, such as a plasmid, cosmid, or bacteriophage, that has the capability of replicating autonomously in a host cell. Cloning vectors typically contain one or a small number of restriction endonuclease recognition sites that allow
15 insertion of a nucleic acid molecule in a determinable fashion without loss of an essential biological function of the vector, as well as nucleotide sequences encoding a marker gene that is suitable for use in the identification and selection of cells transformed with the cloning vector. Marker genes typically include genes that provide tetracycline resistance or ampicillin resistance.

An “expression vector” is a nucleic acid molecule encoding a gene that is
20 expressed in a host cell. Typically, an expression vector comprises a transcription promoter, a gene, and a transcription terminator. Gene expression is usually placed under the control of a promoter, and such a gene is said to be “operably linked to” the promoter. Similarly, a regulatory element and a core promoter are operably linked if the regulatory element modulates the activity of the core promoter.

25 A “recombinant host” is a cell that contains a heterologous nucleic acid molecule, such as a cloning vector or expression vector. In the present context, an example of a recombinant host is a cell that produces ZcytoR14 from an expression vector. In contrast, ZcytoR14 can be produced by a cell that is a “natural source” of ZcytoR14, and that lacks an expression vector.

30 “Integrative transformants” are recombinant host cells, in which heterologous DNA has become integrated into the genomic DNA of the cells.

A “fusion protein” is a hybrid protein expressed by a nucleic acid molecule comprising nucleotide sequences of at least two genes. For example, a fusion protein can comprise at least part of a ZcytoR14 polypeptide fused with a polypeptide that binds an affinity

matrix. Such a fusion protein provides a means to isolate large quantities of ZcytoR14 using affinity chromatography.

The term "receptor" denotes a cell-associated protein that binds to a bioactive molecule termed a "ligand." This interaction mediates the effect of the ligand on the cell. Receptors can be membrane bound, cytosolic or nuclear; monomeric (*e.g.*, thyroid stimulating hormone receptor, beta-adrenergic receptor) or multimeric (*e.g.*, PDGF receptor, growth hormone receptor, IL-3 receptor, GM-CSF receptor, G-CSF receptor, erythropoietin receptor and IL-6 receptor). Membrane-bound receptors are characterized by a multi-domain structure comprising an extracellular ligand-binding domain and an intracellular effector domain that is typically involved in signal transduction. In certain membrane-bound receptors, the extracellular ligand-binding domain and the intracellular effector domain are located in separate polypeptides that comprise the complete functional receptor.

In general, the binding of ligand to receptor results in a conformational change in the receptor that causes an interaction between the effector domain and other molecule(s) in the cell, which in turn leads to an alteration in the metabolism of the cell. Metabolic events that are often linked to receptor-ligand interactions include gene transcription, phosphorylation, dephosphorylation, increases in cyclic AMP production, mobilization of cellular calcium, mobilization of membrane lipids, cell adhesion, hydrolysis of inositol lipids and hydrolysis of phospholipids.

A "soluble receptor" is a receptor polypeptide that is not bound to a cell membrane. Soluble receptors are most commonly ligand-binding receptor polypeptides that lack transmembrane and cytoplasmic domains, and other linkage to the cell membrane such as via glycosylphosphatidylinositol (gpi). Soluble receptors can comprise additional amino acid residues, such as affinity tags that provide for purification of the polypeptide or provide sites for attachment of the polypeptide to a substrate, or immunoglobulin constant region sequences. Many cell-surface receptors have naturally occurring, soluble counterparts that are produced by proteolysis or translated from alternatively spliced mRNAs. Soluble receptors can be monomeric, homodimeric, heterodimeric, or multimeric, with multimeric receptors generally not comprising more than 9 subunits, preferably not comprising more than 6 subunits, and most preferably not comprising more than 3 subunits. Receptor polypeptides are said to be substantially free of transmembrane and intracellular polypeptide segments when they lack sufficient portions of these segments to provide membrane anchoring or signal transduction, respectively. Soluble receptors of cytokine receptors generally comprise the extracellular cytokine binding domain free of a transmembrane domain and intracellular domain. For

example, representative soluble receptors include soluble receptors for IL-17R as shown in SEQ ID NO:21. It is well within the level of one of skill in the art to delineate what sequences of a known cytokine receptor sequence comprise the extracellular cytokine binding domain free of a transmembrane domain and intracellular domain. Moreover, one of skill in the art
5 using the genetic code can readily determine polynucleotides that encode such soluble receptor polypeptides.

The term “secretory signal sequence” denotes a DNA sequence that encodes a peptide (a “secretory peptide”) that, as a component of a larger polypeptide, directs the larger polypeptide through a secretory pathway of a cell in which it is synthesized. The larger
10 polypeptide is commonly cleaved to remove the secretory peptide during transit through the secretory pathway.

An “isolated polypeptide” is a polypeptide that is essentially free from contaminating cellular components, such as carbohydrate, lipid, or other proteinaceous impurities associated with the polypeptide in nature. Typically, a preparation of isolated
15 polypeptide contains the polypeptide in a highly purified form, *i.e.*, at least about 80% pure, at least about 90% pure, at least about 95% pure, greater than 95% pure, such as 96%, 97%, or 98% or more pure, or greater than 99% pure. One way to show that a particular protein preparation contains an isolated polypeptide is by the appearance of a single band following sodium dodecyl sulfate (SDS)-polyacrylamide gel electrophoresis of the protein preparation
20 and Coomassie Brilliant Blue staining of the gel. However, the term “isolated” does not exclude the presence of the same polypeptide in alternative physical forms, such as dimers or alternatively glycosylated or derivatized forms.

The terms “amino-terminal” and “carboxyl-terminal” are used herein to denote positions within polypeptides. Where the context allows, these terms are used with reference
25 to a particular sequence or portion of a polypeptide to denote proximity or relative position. For example, a certain sequence positioned carboxyl-terminal to a reference sequence within a polypeptide is located proximal to the carboxyl terminus of the reference sequence, but is not necessarily at the carboxyl terminus of the complete polypeptide.

The term “expression” refers to the biosynthesis of a gene product. For example,
30 in the case of a structural gene, expression involves transcription of the structural gene into mRNA and the translation of mRNA into one or more polypeptides.

The term “splice variant” is used herein to denote alternative forms of RNA transcribed from a gene. Splice variation arises naturally through use of alternative splicing sites within a transcribed RNA molecule, or less commonly between separately transcribed

RNA molecules, and may result in several mRNAs transcribed from the same gene. Splice variants may encode polypeptides having altered amino acid sequence. The term splice variant is also used herein to denote a polypeptide encoded by a splice variant of an mRNA transcribed from a gene.

5 As used herein, the term “immunomodulator” includes cytokines, stem cell growth factors, lymphotoxins, co-stimulatory molecules, hematopoietic factors, and the like, and synthetic analogs of these molecules.

The term “complement/anti-complement pair” denotes non-identical moieties that form a non-covalently associated, stable pair under appropriate conditions. For instance,
10 biotin and avidin (or streptavidin) are prototypical members of a complement/anti-complement pair. Other exemplary complement/anti-complement pairs include receptor/ligand pairs, antibody/antigen (or hapten or epitope) pairs, sense/antisense polynucleotide pairs, and the like. Where subsequent dissociation of the complement/anti-complement pair is desirable, the complement/anti-complement pair preferably has a binding affinity of less than 10^9 M^{-1} .

15 An “anti-idiotypic antibody” is an antibody that binds with the variable region domain of an immunoglobulin. In the present context, an anti-idiotypic antibody binds with the variable region of an anti-ZcytoR14 antibody, and thus, an anti-idiotypic antibody mimics an epitope of ZcytoR14.

An “antibody fragment” is a portion of an antibody such as F(ab')_2 , F(ab)_2 , Fab' ,
20 Fab , and the like. Regardless of structure, an antibody fragment binds with the same antigen that is recognized by the intact antibody. For example, an anti-ZcytoR14 monoclonal antibody fragment binds with an epitope of ZcytoR14.

The term “antibody fragment” also includes a synthetic or a genetically engineered polypeptide that binds to a specific antigen, such as polypeptides consisting of the
25 light chain variable region, “Fv” fragments consisting of the variable regions of the heavy and light chains, recombinant single chain polypeptide molecules in which light and heavy variable regions are connected by a peptide linker (“scFv proteins”), and minimal recognition units consisting of the amino acid residues that mimic the hypervariable region.

A “chimeric antibody” is a recombinant protein that contains the variable
30 domains and complementary determining regions derived from a rodent antibody, while the remainder of the antibody molecule is derived from a human antibody.

“Humanized antibodies” are recombinant proteins in which murine complementarity determining regions of a monoclonal antibody have been transferred from heavy and light variable chains of the murine immunoglobulin into a human variable domain.

Construction of humanized antibodies for therapeutic use in humans that are derived from murine antibodies, such as those that bind to or neutralize a human protein, is within the skill of one in the art.

As used herein, a “therapeutic agent” is a molecule or atom which is
5 conjugated to an antibody moiety to produce a conjugate which is useful for therapy. Examples of therapeutic agents include drugs, toxins, immunomodulators, chelators, boron compounds, photoactive agents or dyes, and radioisotopes.

A “detectable label” is a molecule or atom which can be conjugated to an antibody moiety to produce a molecule useful for diagnosis. Examples of detectable labels
10 include chelators, photoactive agents, radioisotopes, fluorescent agents, paramagnetic ions, or other marker moieties.

The term “affinity tag” is used herein to denote a polypeptide segment that can be attached to a second polypeptide to provide for purification or detection of the second polypeptide or provide sites for attachment of the second polypeptide to a substrate. In
15 principal, any peptide or protein for which an antibody or other specific binding agent is available can be used as an affinity tag. Affinity tags include a poly-histidine tract, protein A (Nilsson *et al.*, *EMBO J.* 4:1075 (1985); Nilsson *et al.*, *Methods Enzymol.* 198:3 (1991)), glutathione S transferase (Smith and Johnson, *Gene* 67:31 (1988)), Glu-Glu affinity tag (Grussenmeyer *et al.*, *Proc. Natl. Acad. Sci. USA* 82:7952 (1985)), substance P, FLAG peptide
20 (Hopp *et al.*, *Biotechnology* 6:1204 (1988)), streptavidin binding peptide, or other antigenic epitope or binding domain. See, in general, Ford *et al.*, *Protein Expression and Purification* 2:95 (1991). DNA molecules encoding affinity tags are available from commercial suppliers (*e.g.*, Pharmacia Biotech, Piscataway, NJ).

A “naked antibody” is an entire antibody, as opposed to an antibody fragment,
25 which is not conjugated with a therapeutic agent. Naked antibodies include both polyclonal and monoclonal antibodies, as well as certain recombinant antibodies, such as chimeric and humanized antibodies.

As used herein, the term “antibody component” includes both an entire antibody and an antibody fragment.

30 An “immunoconjugate” is a conjugate of an antibody component with a therapeutic agent or a detectable label.

As used herein, the term “antibody fusion protein” refers to a recombinant molecule that comprises an antibody component and a ZcytoR14 polypeptide component.

Examples of an antibody fusion protein include a protein that comprises a ZcytoR14 extracellular domain, and either an Fc domain or an antigen-binding region.

A “target polypeptide” or a “target peptide” is an amino acid sequence that comprises at least one epitope, and that is expressed on a target cell, such as a tumor cell, or a cell that carries an infectious agent antigen. T cells recognize peptide epitopes presented by a major histocompatibility complex molecule to a target polypeptide or target peptide and typically lyse the target cell or recruit other immune cells to the site of the target cell, thereby killing the target cell.

An “antigenic peptide” is a peptide which will bind a major histocompatibility complex molecule to form an MHC-peptide complex which is recognized by a T cell, thereby inducing a cytotoxic lymphocyte response upon presentation to the T cell. Thus, antigenic peptides are capable of binding to an appropriate major histocompatibility complex molecule and inducing a cytotoxic T cells response, such as cell lysis or specific cytokine release against the target cell which binds or expresses the antigen. The antigenic peptide can be bound in the context of a class I or class II major histocompatibility complex molecule, on an antigen presenting cell or on a target cell.

In eukaryotes, RNA polymerase II catalyzes the transcription of a structural gene to produce mRNA. A nucleic acid molecule can be designed to contain an RNA polymerase II template in which the RNA transcript has a sequence that is complementary to that of a specific mRNA. The RNA transcript is termed an “anti-sense RNA” and a nucleic acid molecule that encodes the anti-sense RNA is termed an “anti-sense gene.” Anti-sense RNA molecules are capable of binding to mRNA molecules, resulting in an inhibition of mRNA translation.

An “anti-sense oligonucleotide specific for ZcytoR14” or a “ZcytoR14 anti-sense oligonucleotide” is an oligonucleotide having a sequence (a) capable of forming a stable triplex with a portion of the *ZcytoR14* gene, or (b) capable of forming a stable duplex with a portion of an mRNA transcript of the *ZcytoR14* gene.

A “ribozyme” is a nucleic acid molecule that contains a catalytic center. The term includes RNA enzymes, self-splicing RNAs, self-cleaving RNAs, and nucleic acid molecules that perform these catalytic functions. A nucleic acid molecule that encodes a ribozyme is termed a “ribozyme gene.”

An “external guide sequence” is a nucleic acid molecule that directs the endogenous ribozyme, RNase P, to a particular species of intracellular mRNA, resulting in the

cleavage of the mRNA by RNase P. A nucleic acid molecule that encodes an external guide sequence is termed an “external guide sequence gene.”

The term “variant *ZcytoR14* gene” refers to nucleic acid molecules that encode a polypeptide having an amino acid sequence that is a modification of SEQ ID NO:2. Such variants include naturally-occurring polymorphisms of *ZcytoR14* genes, as well as synthetic genes that contain conservative amino acid substitutions of the amino acid sequence of SEQ ID NO:2. Additional variant forms of *ZcytoR14* genes are nucleic acid molecules that contain insertions or deletions of the nucleotide sequences described herein. A variant *ZcytoR14* gene can be identified, for example, by determining whether the gene hybridizes with a nucleic acid molecule having the nucleotide sequence of SEQ ID NO:1 OR SEQ ID NO:4, or its complement, under stringent conditions.

Alternatively, variant *ZcytoR14* genes can be identified by sequence comparison. Two amino acid sequences have “100% amino acid sequence identity” if the amino acid residues of the two amino acid sequences are the same when aligned for maximal correspondence. Similarly, two nucleotide sequences have “100% nucleotide sequence identity” if the nucleotide residues of the two nucleotide sequences are the same when aligned for maximal correspondence. Sequence comparisons can be performed using standard software programs such as those included in the LASERGENE bioinformatics computing suite, which is produced by DNASTAR (Madison, Wisconsin). Other methods for comparing two nucleotide or amino acid sequences by determining optimal alignment are well-known to those of skill in the art (see, for example, Peruski and Peruski, *The Internet and the New Biology: Tools for Genomic and Molecular Research* (ASM Press, Inc. 1997), Wu *et al.* (eds.), “Information Superhighway and Computer Databases of Nucleic Acids and Proteins,” in *Methods in Gene Biotechnology*, pages 123-151 (CRC Press, Inc. 1997), and Bishop (ed.), *Guide to Human Genome Computing*, 2nd Edition (Academic Press, Inc. 1998)). Particular methods for determining sequence identity are described below.

Regardless of the particular method used to identify a variant *ZcytoR14* gene or variant *ZcytoR14* polypeptide, a variant gene or polypeptide encoded by a variant gene may be functionally characterized the ability to bind specifically to an anti-*ZcytoR14* antibody. A variant *ZcytoR14* gene or variant *ZcytoR14* polypeptide may also be functionally characterized the ability to bind to its ligand, for example, IL-17A and/or IL-17F, using a biological or biochemical assay described herein.

The term “allelic variant” is used herein to denote any of two or more alternative forms of a gene occupying the same chromosomal locus. Allelic variation arises

naturally through mutation, and may result in phenotypic polymorphism within populations. Gene mutations can be silent (no change in the encoded polypeptide) or may encode polypeptides having altered amino acid sequence. The term allelic variant is also used herein to denote a protein encoded by an allelic variant of a gene.

5 The term “ortholog” denotes a polypeptide or protein obtained from one species that is the functional counterpart of a polypeptide or protein from a different species. Sequence differences among orthologs are the result of speciation.

 “Paralogs” are distinct but structurally related proteins made by an organism. Paralogs are believed to arise through gene duplication. For example, α -globin, β -globin, and
10 myoglobin are paralogs of each other.

 The present invention includes functional fragments of *ZcytoR14* genes. Within the context of this invention, a “functional fragment” of a *ZcytoR14* gene refers to a nucleic acid molecule that encodes a portion of a *ZcytoR14* polypeptide which is a domain described herein or at least specifically binds with an anti-*ZcytoR14* antibody.

15 Due to the imprecision of standard analytical methods, molecular weights and lengths of polymers are understood to be approximate values. When such a value is expressed as “about” X or “approximately” X, the stated value of X will be understood to be accurate to $\pm 10\%$.

20 C) Production of *ZcytoR14* Polynucleotides or Genes

 Nucleic acid molecules encoding a human *ZcytoR14* gene can be obtained by screening a human cDNA or genomic library using polynucleotide probes based upon SEQ ID NO:1 OR SEQ ID NO:4. These techniques are standard and well-established, and may be accomplished using cloning kits available by commercial suppliers. See, for example, Ausubel
25 *et al.* (eds.), *Short Protocols in Molecular Biology*, 3rd Edition, John Wiley & Sons 1995; Wu *et al.*, *Methods in Gene Biotechnology*, CRC Press, Inc. 1997; Aviv and Leder, *Proc. Nat'l Acad. Sci. USA* 69:1408 (1972); Huynh *et al.*, “Constructing and Screening cDNA Libraries in λ gt10 and λ gt11,” in *DNA Cloning: A Practical Approach Vol. I*, Glover (ed.), page 49 (IRL Press, 1985); Wu (1997) at pages 47-52.

30 Nucleic acid molecules that encode a human *ZcytoR14* gene can also be obtained using the polymerase chain reaction (PCR) with oligonucleotide primers having nucleotide sequences that are based upon the nucleotide sequences of the *ZcytoR14* gene or cDNA. General methods for screening libraries with PCR are provided by, for example, Yu *et al.*, “Use of the Polymerase Chain Reaction to Screen Phage Libraries,” in *Methods in*

Molecular Biology, Vol. 15: PCR Protocols: Current Methods and Applications, White (ed.), Humana Press, Inc., 1993. Moreover, techniques for using PCR to isolate related genes are described by, for example, Preston, "Use of Degenerate Oligonucleotide Primers and the Polymerase Chain Reaction to Clone Gene Family Members," in *Methods in Molecular Biology, Vol. 15: PCR Protocols: Current Methods and Applications*, White (ed.), Humana Press, Inc. 1993. As an alternative, a *ZcytoR14* gene can be obtained by synthesizing nucleic acid molecules using mutually priming long oligonucleotides and the nucleotide sequences described herein (see, for example, Ausubel (1995)). Established techniques using the polymerase chain reaction provide the ability to synthesize DNA molecules at least two kilobases in length (Adang *et al.*, *Plant Molec. Biol.* 21:1131 (1993), Bambot *et al.*, *PCR Methods and Applications* 2:266 (1993), Dillon *et al.*, "Use of the Polymerase Chain Reaction for the Rapid Construction of Synthetic Genes," in *Methods in Molecular Biology, Vol. 15: PCR Protocols: Current Methods and Applications*, White (ed.), pages 263-268, (Humana Press, Inc. 1993), and Holowachuk *et al.*, *PCR Methods Appl.* 4:299 (1995)). For reviews on polynucleotide synthesis, see, for example, Glick and Pasternak, *Molecular Biotechnology, Principles and Applications of Recombinant DNA* (ASM Press 1994), Itakura *et al.*, *Annu. Rev. Biochem.* 53:323 (1984), and Climie *et al.*, *Proc. Nat'l Acad. Sci. USA* 87:633 (1990).

D) Production of ZcytoR14 Gene Variants

The present invention provides a variety of nucleic acid molecules, including DNA and RNA molecules, that encode the ZcytoR14 polypeptides disclosed herein. Those skilled in the art will readily recognize that, in view of the degeneracy of the genetic code, considerable sequence variation is possible among these polynucleotide molecules. Moreover, the present invention also provides isolated soluble monomeric, homodimeric, heterodimeric and multimeric receptor polypeptides that comprise at least one ZcytoR14 receptor subunit that is substantially homologous to the receptor polypeptide of SEQ ID NO:2. Thus, the present invention contemplates ZcytoR14 polypeptide-encoding nucleic acid molecules comprising degenerate nucleotides of SEQ ID NO:1 or SEQ ID NO:4, and their RNA equivalents.

Those skilled in the art will readily recognize that, in view of the degeneracy of the genetic code, considerable sequence variation is possible among these polynucleotide molecules. SEQ ID NO:7 is a degenerate nucleotide sequence that encompasses all nucleic acid molecules that encode the ZcytoR14 polypeptide of SEQ ID NO:2. Those skilled in the art will recognize that the degenerate sequence of SEQ ID NO:7 also provides all RNA sequences encoding SEQ ID NO:2, by substituting U for T. Thus, the present invention contemplates

Zcytor14 polypeptide-encoding nucleic acid molecules comprising nucleotide 154 to nucleotide 2229 of SEQ ID NO:1, and their RNA equivalents. Similarly, the Zcytor14-1 degenerate sequence of SEQ ID NO:6 also provides all RNA sequences encoding SEQ ID NO:5, by substituting U for T.

- 5 Table 1 sets forth the one-letter codes to denote degenerate nucleotide positions. "Resolutions" are the nucleotides denoted by a code letter. "Complement" indicates the code for the complementary nucleotide(s). For example, the code Y denotes either C or T, and its complement R denotes A or G, A being complementary to T, and G being complementary to C.

Table 1

Nucleotide	Resolution	Complement	Resolution
A	A	T	T
C	C	G	G
G	G	C	C
T	T	A	A
R	A G	Y	C T
Y	C T	R	A G
M	A C	K	G T
K	G T	M	A C
S	C G	S	C G
W	A T	W	A T
H	A C T	D	A G T
B	C G T	V	A C G
V	A C G	B	C G T
D	A G T	H	A C T
N	A C G T	N	A C G T

The degenerate codons, encompassing all possible codons for a given amino
5 acid, are set forth in Table 2.

Table 2

Amino Acid	One Letter Code	Codons	Degenerate Codon
Cys	C	TGC TGT	TGY
Ser	S	AGC AGT TCA TCC TCG TCT	WSN
Thr	T	ACA ACC ACG ACT	ACN
Pro	P	CCA CCC CCG CCT	CCN
Ala	A	GCA GCC GCG GCT	GCN
Gly	G	GGA GGC GGG GGT	GGN
Asn	N	AAC AAT	AAY
Asp	D	GAC GAT	GAY
Glu	E	GAA GAG	GAR
Gln	Q	CAA CAG	CAR
His	H	CAC CAT	CAY
Arg	R	AGA AGG CGA CGC CGG CGT	MGN
Lys	K	AAA AAG	AAR
Met	M	ATG	ATG
Ile	I	ATA ATC ATT	ATH
Leu	L	CTA CTC CTG CTT TTA TTG	YTN
Val	V	GTA GTC GTG GTT	GTN
Phe	F	TTC TTT	TTY
Tyr	Y	TAC TAT	TAY
Trp	W	TGG	TGG
Ter	.	TAA TAG TGA	TRR
Asn Asp	B		RAY
Glu Gln	Z		SAR
Any	X		NNN

One of ordinary skill in the art will appreciate that some ambiguity is introduced in determining a degenerate codon, representative of all possible codons encoding an amino acid. For example, the degenerate codon for serine (WSN) can, in some circumstances, encode arginine (AGR), and the degenerate codon for arginine (MGN) can, in some circumstances, encode serine (AGY). A similar relationship exists between codons encoding phenylalanine and leucine. Thus, some polynucleotides encompassed by the

degenerate sequence may encode variant amino acid sequences, but one of ordinary skill in the art can easily identify such variant sequences by reference to the amino acid sequences of SEQ ID NO:3. Variant sequences can be readily tested for functionality as described herein.

Different species can exhibit "preferential codon usage." In general, see, 5 Grantham *et al.*, *Nucl. Acids Res.* 8:1893 (1980), Haas *et al.* *Curr. Biol.* 6:315 (1996), Wain-Hobson *et al.*, *Gene* 13:355 (1981), Grosjean and Fiers, *Gene* 18:199 (1982), Holm, *Nuc. Acids Res.* 14:3075 (1986), Ikemura, *J. Mol. Biol.* 158:573 (1982), Sharp and Matassi, *Curr. Opin. Genet. Dev.* 4:851 (1994), Kane, *Curr. Opin. Biotechnol.* 6:494 (1995), and Makrides, *Microbiol. Rev.* 60:512 (1996). As used herein, the term "preferential codon usage" or 10 "preferential codons" is a term of art referring to protein translation codons that are most frequently used in cells of a certain species, thus favoring one or a few representatives of the possible codons encoding each amino acid (See Table 2). For example, the amino acid threonine (Thr) may be encoded by ACA, ACC, ACG, or ACT, but in mammalian cells ACC is the most commonly used codon; in other species, for example, insect cells, yeast, viruses or 15 bacteria, different Thr codons may be preferential. Preferential codons for a particular species can be introduced into the polynucleotides of the present invention by a variety of methods known in the art. Introduction of preferential codon sequences into recombinant DNA can, for example, enhance production of the protein by making protein translation more efficient within a particular cell type or species. Therefore, the degenerate codon sequences disclosed herein 20 serve as a template for optimizing expression of polynucleotides in various cell types and species commonly used in the art and disclosed herein. Sequences containing preferential codons can be tested and optimized for expression in various species, and tested for functionality as disclosed herein.

A ZcytoR14-encoding cDNA can be isolated by a variety of methods, such as 25 by probing with a complete or partial human cDNA or with one or more sets of degenerate probes based on the disclosed sequences. A cDNA can also be cloned using the polymerase chain reaction with primers designed from the representative human *ZcytoR14* sequences disclosed herein. In addition, a cDNA library can be used to transform or transfect host cells, and expression of the cDNA of interest can be detected with an antibody to ZcytoR14 30 polypeptide.

Those skilled in the art will recognize that the sequence disclosed in SEQ ID NO:1 represents a single allele of human ZcytoR14, and that allelic variation and alternative splicing are expected to occur. Allelic variants of this sequence can be cloned by probing cDNA or genomic libraries from different individuals according to standard procedures.

Allelic variants of the nucleotide sequences disclosed herein, including those containing silent mutations and those in which mutations result in amino acid sequence changes, are within the scope of the present invention, as are proteins which are allelic variants of the amino acid sequences disclosed herein. cDNA molecules generated from alternatively spliced mRNAs, which retain the properties of the ZcytoR14 polypeptide are included within the scope of the present invention, as are polypeptides encoded by such cDNAs and mRNAs. Allelic variants and splice variants of these sequences can be cloned by probing cDNA or genomic libraries from different individuals or tissues according to standard procedures known in the art.

Using the methods discussed above, one of ordinary skill in the art can prepare a variety of polypeptides that comprise a soluble ZcytoR14 receptor subunit that is substantially homologous to either SEQ ID NO:1 or SEQ ID NO:4, or that encodes amino acids of either SEQ ID NO:2 or SEQ ID NO:5, or allelic variants thereof and retain the ligand-binding properties of the wild-type ZcytoR14 receptor. Such polypeptides may also include additional polypeptide segments as generally disclosed herein.

Within certain embodiments of the invention, the isolated nucleic acid molecules can hybridize under stringent conditions to nucleic acid molecules comprising nucleotide sequences disclosed herein. For example, such nucleic acid molecules can hybridize under stringent conditions to nucleic acid molecules comprising the nucleotide sequence of SEQ ID NO:1 OR SEQ ID NO:4, or to nucleic acid molecules comprising a nucleotide sequence complementary to SEQ ID NO:1 OR SEQ ID NO:4, or fragments thereof.

In general, stringent conditions are selected to be about 5°C lower than the thermal melting point (T_m) for the specific sequence at a defined ionic strength and pH. The T_m is the temperature (under defined ionic strength and pH) at which 50% of the target sequence hybridizes to a perfectly matched probe. Following hybridization, the nucleic acid molecules can be washed to remove non-hybridized nucleic acid molecules under stringent conditions, or under highly stringent conditions. See, for example, Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, Second Edition (Cold Spring Harbor Press 1989); Ausubel *et al.*, (eds.), *Current Protocols in Molecular Biology* (John Wiley and Sons, Inc. 1987); Berger and Kimmel (eds.), *Guide to Molecular Cloning Techniques*, (Academic Press, Inc. 1987); and Wetmur, *Crit. Rev. Biochem. Mol. Biol.* 26:227 (1990)). Sequence analysis software such as OLIGO 6.0 (LSR; Long Lake, MN) and *Primer Premier 4.0* (Premier Biosoft International; Palo Alto, CA), as well as sites on the Internet, are available tools for analyzing a given sequence and calculating T_m based on user-defined criteria. It is well within the abilities of

one skilled in the art to adapt hybridization and wash conditions for use with a particular polynucleotide hybrid.

The present invention also provides isolated ZcytoR14 polypeptides that have a substantially similar sequence identity to the polypeptides of SEQ ID NO:2, or their orthologs. The term “substantially similar sequence identity” is used herein to denote polypeptides having at least 70%, at least 80%, at least 90%, at least 95%, such as 96%, 97%, 98%, or greater than 95% sequence identity to the sequences shown in SEQ ID NO:2, or their orthologs. For example, variant and orthologous ZcytoR14 receptors can be used to generate an immune response and raise cross-reactive antibodies to human ZcytoR14. Such antibodies can be humanized, and modified as described herein, and used therapeutically to treat psoriasis, psoriatic arthritis, IBD, colitis, endotoxemia as well as in other therapeutic applications described herein.

The present invention also contemplates ZcytoR14 variant nucleic acid molecules that can be identified using two criteria: a determination of the similarity between the encoded polypeptide with the amino acid sequence of SEQ ID NO:2, and a hybridization assay. Such ZcytoR14 variants include nucleic acid molecules (1) that remain hybridized with a nucleic acid molecule having the nucleotide sequence of SEQ ID NO:1 OR SEQ ID NO:4 (or its complement) under stringent washing conditions, in which the wash stringency is equivalent to 0.5x - 2x SSC with 0.1% SDS at 55 - 65°C, and (2) that encode a polypeptide having at least 70%, at least 80%, at least 90%, at least 95%, or greater than 95% such as 96%, 97%, 98%, or 99%, sequence identity to the amino acid sequence of SEQ ID NO:2. Alternatively, ZcytoR14 variants can be characterized as nucleic acid molecules (1) that remain hybridized with a nucleic acid molecule having the nucleotide sequence of SEQ ID NO:1 OR SEQ ID NO:4 (or its complement) under highly stringent washing conditions, in which the wash stringency is equivalent to 0.1x - 0.2x SSC with 0.1% SDS at 50 - 65°C, and (2) that encode a polypeptide having at least 70%, at least 80%, at least 90%, at least 95% or greater than 95%, such as 96%, 97%, 98%, or 99% or greater, sequence identity to the amino acid sequence of SEQ ID NO:2.

Percent sequence identity is determined by conventional methods. See, for example, Altschul *et al.*, *Bull. Math. Bio.* 48:603 (1986), and Henikoff and Henikoff, *Proc. Natl. Acad. Sci. USA* 89:10915 (1992). Briefly, two amino acid sequences are aligned to optimize the alignment scores using a gap opening penalty of 10, a gap extension penalty of 1, and the “BLOSUM62” scoring matrix of Henikoff and Henikoff (*ibid.*) as shown in Table 3 (amino acids are indicated by the standard one-letter codes). The percent identity is then

calculated as: ([Total number of identical matches]/ [length of the longer sequence plus the number of gaps introduced into the longer sequence in order to align the two sequences])(100).

Table 3

	A	R	N	D	C	Q	E	G	H	I	L	K	M	F	P	S	T	W	Y	V
5	A	4																		
	R	-1	5																	
	N	-2	0	6																
	D	-2	-2	1	6															
	C	0	-3	-3	-3	9														
	Q	-1	1	0	0	-3	5													
	E	-1	0	0	2	-4	2	5												
	G	0	-2	0	-1	-3	-2	-2	6											
10	H	-2	0	1	-1	-3	0	0	-2	8										
	I	-1	-3	-3	-3	-1	-3	-3	-4	-3	4									
	L	-1	-2	-3	-4	-1	-2	-3	-4	-3	2	4								
	K	-1	2	0	-1	-3	1	1	-2	-1	-3	-2	5							
	M	-1	-1	-2	-3	-1	0	-2	-3	-2	1	2	-1	5						
15	F	-2	-3	-3	-3	-2	-3	-3	-1	0	0	-3	0	6						
	P	-1	-2	-2	-1	-3	-1	-1	-2	-2	-3	-1	-2	-4	7					
	S	1	-1	1	0	-1	0	0	-1	-2	-2	0	-1	-2	-1	4				
	T	0	-1	0	-1	-1	-1	-1	-2	-1	-1	-1	-1	-2	-1	1	5			
20	W	-3	-3	-4	-4	-2	-2	-3	-2	-2	-3	-2	-1	1	-4	-3	-2	11		
	Y	-2	-2	-2	-3	-2	-1	-2	-3	2	-1	-1	-2	-1	3	-3	-2	-2	2	7
	V	0	-3	-3	-3	-1	-2	-2	-3	-3	3	1	-2	1	-1	-2	0	-3	-1	4

Those skilled in the art appreciate that there are many established algorithms available to align two amino acid sequences. The "FASTA" similarity search algorithm of Pearson and Lipman is a suitable protein alignment method for examining the level of identity shared by an amino acid sequence disclosed herein and the amino acid sequence of a putative ZcytoR14 variant. The FASTA algorithm is described by Pearson and Lipman, *Proc. Nat'l Acad. Sci. USA* 85:2444 (1988), and by Pearson, *Meth. Enzymol.* 183:63 (1990). Briefly, FASTA first characterizes sequence similarity by identifying regions shared by the query sequence (*e.g.*, SEQ ID NO:2 or SEQ ID NO:3) and a test sequence that have either the highest density of identities (if the ktup variable is 1) or pairs of identities (if ktup=2), without considering conservative amino acid substitutions, insertions, or deletions. The ten regions with the highest density of identities are then rescored by comparing the similarity of all paired amino acids using an amino acid substitution matrix, and the ends of the regions are "trimmed" to include only those residues that contribute to the highest score. If there are several regions with scores greater than the "cutoff" value (calculated by a predetermined formula based upon the length of the sequence and the ktup value), then the trimmed initial regions are examined to determine whether the regions can be joined to form an approximate alignment with gaps. Finally, the highest scoring regions of the two amino acid sequences are aligned using a modification of the Needleman-Wunsch-Sellers algorithm (Needleman and Wunsch, *J. Mol. Biol.* 48:444 (1970); Sellers, *SIAM J. Appl. Math.* 26:787 (1974)), which allows for amino acid insertions and deletions. Illustrative parameters for FASTA analysis are: ktup=1, gap opening penalty=10, gap extension penalty=1, and substitution matrix=BLOSUM62. These parameters can be introduced into a FASTA program by modifying the scoring matrix file ("SMATRIX"), as explained in Appendix 2 of Pearson, *Meth. Enzymol.* 183:63 (1990).

FASTA can also be used to determine the sequence identity of nucleic acid molecules using a ratio as disclosed above. For nucleotide sequence comparisons, the ktup value can range between one to six, preferably from three to six, most preferably three, with other parameters set as described above.

The present invention includes nucleic acid molecules that encode a polypeptide having a conservative amino acid change, compared with an amino acid sequence disclosed herein. For example, variants can be obtained that contain one or more amino acid substitutions of SEQ ID NO:2, in which an alkyl amino acid is substituted for an alkyl amino acid in a ZcytoR14 amino acid sequence, an aromatic amino acid is substituted for an aromatic amino acid in a ZcytoR14 amino acid sequence, a sulfur-containing amino acid is substituted for a sulfur-containing amino acid in a ZcytoR14 amino acid sequence, a hydroxy-containing

amino acid is substituted for a hydroxy-containing amino acid in a ZcytoR14 amino acid sequence, an acidic amino acid is substituted for an acidic amino acid in a ZcytoR14 amino acid sequence, a basic amino acid is substituted for a basic amino acid in a ZcytoR14 amino acid sequence, or a dibasic monocarboxylic amino acid is substituted for a dibasic monocarboxylic amino acid in a ZcytoR14 amino acid sequence. Among the common amino acids, for example, a “conservative amino acid substitution” is illustrated by a substitution among amino acids within each of the following groups: (1) glycine, alanine, valine, leucine, and isoleucine, (2) phenylalanine, tyrosine, and tryptophan, (3) serine and threonine, (4) aspartate and glutamate, (5) glutamine and asparagine, and (6) lysine, arginine and histidine. The BLOSUM62 table is an amino acid substitution matrix derived from about 2,000 local multiple alignments of protein sequence segments, representing highly conserved regions of more than 500 groups of related proteins (Henikoff and Henikoff, *Proc. Nat’l Acad. Sci. USA* 89:10915 (1992)). Accordingly, the BLOSUM62 substitution frequencies can be used to define conservative amino acid substitutions that may be introduced into the amino acid sequences of the present invention. Although it is possible to design amino acid substitutions based solely upon chemical properties (as discussed above), the language “conservative amino acid substitution” preferably refers to a substitution represented by a BLOSUM62 value of greater than -1. For example, an amino acid substitution is conservative if the substitution is characterized by a BLOSUM62 value of 0, 1, 2, or 3. According to this system, preferred conservative amino acid substitutions are characterized by a BLOSUM62 value of at least 1 (e.g., 1, 2 or 3), while more preferred conservative amino acid substitutions are characterized by a BLOSUM62 value of at least 2 (e.g., 2 or 3). Particular variants of ZcytoR14 are characterized by having at least 70%, at least 80%, at least 90%, at least 95% or greater than 95% such as 96%, 97%, 98%, or 99% or greater sequence identity to the corresponding amino acid sequence (e.g., SEQ ID NO:2), wherein the variation in amino acid sequence is due to one or more conservative amino acid substitutions.

Conservative amino acid changes in a ZcytoR14 gene can be introduced, for example, by substituting nucleotides for the nucleotides recited in SEQ ID NO:1 OR SEQ ID NO:4. Such “conservative amino acid” variants can be obtained by oligonucleotide-directed mutagenesis, linker-scanning mutagenesis, mutagenesis using the polymerase chain reaction, and the like (see Ausubel (1995); and McPherson (ed.), *Directed Mutagenesis: A Practical Approach* (IRL Press 1991)). A variant ZcytoR14 polypeptide can be identified by the ability to specifically bind anti-ZcytoR14 antibodies.

The proteins of the present invention can also comprise non-naturally occurring amino acid residues. Non-naturally occurring amino acids include, without limitation, *trans*-3-methylproline, 2,4-methanoproline, *cis*-4-hydroxyproline, *trans*-4-hydroxyproline, *N*-methylglycine, *allo*-threonine, methylthreonine, hydroxyethylcysteine, hydroxyethylhomocysteine, nitroglutamine, homoglutamine, pipecolic acid, thiazolidine carboxylic acid, dehydroproline, 3- and 4-methylproline, 3,3-dimethylproline, *tert*-leucine, norvaline, 2-azaphenylalanine, 3-azaphenylalanine, 4-azaphenylalanine, and 4-fluorophenylalanine. Several methods are known in the art for incorporating non-naturally occurring amino acid residues into proteins. For example, an *in vitro* system can be employed wherein nonsense mutations are suppressed using chemically aminoacylated suppressor tRNAs. Methods for synthesizing amino acids and aminoacylating tRNA are known in the art. Transcription and translation of plasmids containing nonsense mutations is typically carried out in a cell-free system comprising an *E. coli* S30 extract and commercially available enzymes and other reagents. Proteins are purified by chromatography. See, for example, Robertson *et al.*, *J. Am. Chem. Soc.* 113:2722 (1991), Ellman *et al.*, *Methods Enzymol.* 202:301 (1991), Chung *et al.*, *Science* 259:806 (1993), and Chung *et al.*, *Proc. Nat'l Acad. Sci. USA* 90:10145 (1993).

In a second method, translation is carried out in *Xenopus* oocytes by microinjection of mutated mRNA and chemically aminoacylated suppressor tRNAs (Turcatti *et al.*, *J. Biol. Chem.* 271:19991 (1996)). Within a third method, *E. coli* cells are cultured in the absence of a natural amino acid that is to be replaced (*e.g.*, phenylalanine) and in the presence of the desired non-naturally occurring amino acid(s) (*e.g.*, 2-azaphenylalanine, 3-azaphenylalanine, 4-azaphenylalanine, or 4-fluorophenylalanine). The non-naturally occurring amino acid is incorporated into the protein in place of its natural counterpart. See, Koide *et al.*, *Biochem.* 33:7470 (1994). Naturally occurring amino acid residues can be converted to non-naturally occurring species by *in vitro* chemical modification. Chemical modification can be combined with site-directed mutagenesis to further expand the range of substitutions (Wynn and Richards, *Protein Sci.* 2:395 (1993)).

A limited number of non-conservative amino acids, amino acids that are not encoded by the genetic code, non-naturally occurring amino acids, and unnatural amino acids may be substituted for ZcytoR14 amino acid residues.

Essential amino acids in the polypeptides of the present invention can be identified according to procedures known in the art, such as site-directed mutagenesis or alanine-scanning mutagenesis (Cunningham and Wells, *Science* 244:1081 (1989), Bass *et al.*,

Proc. Nat'l Acad. Sci. USA 88:4498 (1991), Coombs and Corey, "Site-Directed Mutagenesis and Protein Engineering," in *Proteins: Analysis and Design*, Angeletti (ed.), pages 259-311 (Academic Press, Inc. 1998)). In the latter technique, single alanine mutations are introduced at every residue in the molecule, and the resultant mutant molecules are tested for biological activity to identify amino acid residues that are critical to the activity of the molecule. See also, Hilton *et al.*, *J. Biol. Chem.* 271:4699 (1996).

Although sequence analysis can be used to further define the ZcytoR14 ligand binding region, amino acids that play a role in ZcytoR14 binding activity (such as binding of ZcytoR14 to either IL-17A or IL-17F, or to an anti-ZcytoR14 antibody) can also be determined by physical analysis of structure, as determined by such techniques as nuclear magnetic resonance, crystallography, electron diffraction or photoaffinity labeling, in conjunction with mutation of putative contact site amino acids. See, for example, de Vos *et al.*, *Science* 255:306 (1992), Smith *et al.*, *J. Mol. Biol.* 224:899 (1992), and Wlodaver *et al.*, *FEBS Lett.* 309:59 (1992).

Multiple amino acid substitutions can be made and tested using known methods of mutagenesis and screening, such as those disclosed by Reidhaar-Olson and Sauer (*Science* 241:53 (1988)) or Bowie and Sauer (*Proc. Nat'l Acad. Sci. USA* 86:2152 (1989)). Briefly, these authors disclose methods for simultaneously randomizing two or more positions in a polypeptide, selecting for functional polypeptide, and then sequencing the mutagenized polypeptides to determine the spectrum of allowable substitutions at each position. Other methods that can be used include phage display (*e.g.*, Lowman *et al.*, *Biochem.* 30:10832 (1991), Ladner *et al.*, U.S. Patent No. 5,223,409, Huse, international publication No. WO 92/06204, and region-directed mutagenesis (Derbyshire *et al.*, *Gene* 46:145 (1986), and Ner *et al.*, *DNA* 7:127, (1988)). Moreover, ZcytoR14 labeled with biotin or FITC can be used for expression cloning of ZcytoR14 ligands.

Variants of the disclosed ZcytoR14 nucleotide and polypeptide sequences can also be generated through DNA shuffling as disclosed by Stemmer, *Nature* 370:389 (1994), Stemmer, *Proc. Nat'l Acad. Sci. USA* 91:10747 (1994), and international publication No. WO 97/20078. Briefly, variant DNA molecules are generated by *in vitro* homologous recombination by random fragmentation of a parent DNA followed by reassembly using PCR, resulting in randomly introduced point mutations. This technique can be modified by using a family of parent DNA molecules, such as allelic variants or DNA molecules from different species, to introduce additional variability into the process. Selection or screening for the desired activity, followed by additional iterations of mutagenesis and assay provides for rapid

“evolution” of sequences by selecting for desirable mutations while simultaneously selecting against detrimental changes.

Mutagenesis methods as disclosed herein can be combined with high-throughput, automated screening methods to detect activity of cloned, mutagenized polypeptides in host cells. Mutagenized DNA molecules that encode biologically active polypeptides, or polypeptides that bind with anti-ZcytoR14 antibodies, can be recovered from the host cells and rapidly sequenced using modern equipment. These methods allow the rapid determination of the importance of individual amino acid residues in a polypeptide of interest, and can be applied to polypeptides of unknown structure.

The present invention also includes “functional fragments” of ZcytoR14 polypeptides and nucleic acid molecules encoding such functional fragments. Routine deletion analyses of nucleic acid molecules can be performed to obtain functional fragments of a nucleic acid molecule that encodes a ZcytoR14 polypeptide. As an illustration, DNA molecules having the nucleotide sequence of SEQ ID NO:1 OR SEQ ID NO:4 can be digested with *Bal31* nuclease to obtain a series of nested deletions. The fragments are then inserted into expression vectors in proper reading frame, and the expressed polypeptides are isolated and tested for the ability to bind anti-ZcytoR14 antibodies. One alternative to exonuclease digestion is to use oligonucleotide-directed mutagenesis to introduce deletions or stop codons to specify production of a desired fragment. Alternatively, particular fragments of a ZcytoR14 gene can be synthesized using the polymerase chain reaction.

This general approach is exemplified by studies on the truncation at either or both termini of interferons have been summarized by Horisberger and Di Marco, *Pharmac. Ther.* 66:507 (1995). Moreover, standard techniques for functional analysis of proteins are described by, for example, Treuter *et al.*, *Molec. Gen. Genet.* 240:113 (1993), Content *et al.*, “Expression and preliminary deletion analysis of the 42 kDa 2-5A synthetase induced by human interferon,” in *Biological Interferon Systems, Proceedings of ISIR-TNO Meeting on Interferon Systems*, Cantell (ed.), pages 65-72 (Nijhoff 1987), Herschman, “The EGF Receptor,” in *Control of Animal Cell Proliferation, Vol. 1*, Boynton *et al.*, (eds.) pages 169-199 (Academic Press 1985), Coumailleau *et al.*, *J. Biol. Chem.* 270:29270 (1995); Fukunaga *et al.*, *J. Biol. Chem.* 270:25291 (1995); Yamaguchi *et al.*, *Biochem. Pharmacol.* 50:1295 (1995), and Meisel *et al.*, *Plant Molec. Biol.* 30:1 (1996).

The present invention also contemplates functional fragments of a ZcytoR14 gene that have amino acid changes, compared with an amino acid sequence disclosed herein. A variant ZcytoR14 gene can be identified on the basis of structure by determining the level of

identity with disclosed nucleotide and amino acid sequences, as discussed above. An alternative approach to identifying a variant gene on the basis of structure is to determine whether a nucleic acid molecule encoding a potential variant ZcytoR14 gene can hybridize to a nucleic acid molecule comprising a nucleotide sequence, such as SEQ ID NO:1 OR SEQ ID NO:4.

The present invention also includes using functional fragments of ZcytoR14 polypeptides, antigenic epitopes, epitope-bearing portions of ZcytoR14 polypeptides, and nucleic acid molecules that encode such functional fragments, antigenic epitopes, epitope-bearing portions of ZcytoR14 polypeptides. Such fragments are used to generate polypeptides for use in generating antibodies and binding partners that bind, block, inhibit, reduce, antagonize or neutralize activity of IL-17A or IL-17F or both IL-17A and IL-17F. A “functional” ZcytoR14 polypeptide or fragment thereof as defined herein is characterized by its ability to block, inhibit, reduce, antagonize or neutralize IL-17A or IL-17F inflammatory, proliferative or differentiating activity, by its ability to induce or inhibit specialized cell functions, or by its ability to bind specifically to an anti-ZcytoR14 antibody, cell, IL-17A or IL-17F. As previously described herein, ZcytoR14 is characterized by a unique cytokine receptor structure and domains as described herein. Thus, the present invention further contemplates using fusion proteins encompassing: (a) polypeptide molecules comprising one or more of the domains described above; and (b) functional fragments comprising one or more of these domains. The other polypeptide portion of the fusion protein may be contributed by another cytokine receptor, such as IL-10R, IL-13R, IL-17R, IL-10RB (CRF2-4), or by a non-native and/or an unrelated secretory signal peptide that facilitates secretion of the fusion protein.

The present invention also provides polypeptide fragments or peptides comprising an epitope-bearing portion of a ZcytoR14 polypeptide described herein. Such fragments or peptides may comprise an “immunogenic epitope,” which is a part of a protein that elicits an antibody response when the entire protein is used as an immunogen. Immunogenic epitope-bearing peptides can be identified using standard methods (see, for example, Geysen *et al.*, *Proc. Nat’l Acad. Sci. USA* 81:3998 (1983)).

In contrast, polypeptide fragments or peptides may comprise an “antigenic epitope,” which is a region of a protein molecule to which an antibody can specifically bind. Certain epitopes consist of a linear or contiguous stretch of amino acids, and the antigenicity of such an epitope is not disrupted by denaturing agents. It is known in the art that relatively short synthetic peptides that can mimic epitopes of a protein can be used to stimulate the production

of antibodies against the protein (see, for example, Sutcliffe *et al.*, *Science* 219:660 (1983)). Accordingly, antigenic epitope-bearing peptides, antigenic peptides, epitopes, and polypeptides of the present invention are useful to raise antibodies that bind with the polypeptides described herein, as well as to identify and screen anti-ZcytoR14 monoclonal antibodies that are neutralizing, and that may bind, block, inhibit, reduce, antagonize or neutralize the activity of IL-17F and IL-17A (individually or together). Such neutralizing monoclonal antibodies of the present invention can bind to an ZcytoR14 antigenic epitope. Hopp/Woods hydrophilicity profiles can be used to determine regions that have the most antigenic potential within SEQ ID NO:2 or 4 (Hopp *et al.*, *Proc. Natl. Acad. Sci.* 78:3824-3828, 1981; Hopp, *J. Immun. Meth.* 88:1-18, 1986 and Triquier *et al.*, *Protein Engineering* 11:153-169, 1998). The profile is based on a sliding six-residue window. Buried G, S, and T residues and exposed H, Y, and W residues were ignored. In ZcytoR14 these regions can be determined by one of skill in the art. Moreover, ZcytoR14 antigenic epitopes within SEQ ID NO:2 or 4 as predicted by a Jameson-Wolf plot, e.g., using DNASTAR Protean program (DNASTAR, Inc., Madison, WI) serve as preferred antigenic epitopes, and can be determined by one of skill in the art. The results of this analysis indicated that the following amino acid sequences of SEQ ID NO:2 would provide suitable antigenic peptides: amino acids 26 to 33 ("antigenic peptide 1"), amino acids 41 to 46 ("antigenic peptide 2"), 74 to 81 ("antigenic peptide 3"), amino acids 95 to 105 ("antigenic peptide 4"), amino acids 109 to 119 ("antigenic peptide 5"), amino acids 95 to 119 ("antigenic peptide 6"), amino acids 178 to 185 ("antigenic peptide 7"), amino acids 200 to 206 ("antigenic peptide 8"), amino acids 231 to 238 ("antigenic peptide 9"), amino acids 231 to 241 ("antigenic peptide 10"), amino acids 264 to 270 ("antigenic peptide 11"), amino acids 274 to 281 ("antigenic peptide 12"), amino acids 317 to 324 ("antigenic peptide 13"), amino acids 357 to 363 ("antigenic peptide 14"), amino acids 384 to 392 ("antigenic peptide 15"), amino acids 398 to 411 ("antigenic peptide 16"), amino acids 405 to 411 ("antigenic peptide 17"), amino acids 423 to 429 ("antigenic peptide 18"), and amino acids 434 to 439 ("antigenic peptide 19"). The present invention contemplates the use of any one of antigenic peptides 1 to 19 to generate antibodies to ZcytoR14. The present invention also contemplates polypeptides comprising at least one of antigenic peptides 1 to 19.

In preferred embodiments, antigenic epitopes to which neutralizing antibodies of the present invention bind would contain residues of SEQ ID NO:2 (and corresponding residues of SEQ ID NO:3) or SEQ ID NO:5 that are important to ligand-receptor binding, for example, with ZcytoR14 and IL-17A or IL-17F (individually or together).

Antigenic epitope-bearing peptides and polypeptides can contain at least four to ten amino acids, at least ten to fifteen amino acids, or about 15 to about 30 amino acids of an amino acid sequence disclosed herein. Such epitope-bearing peptides and polypeptides can be produced by fragmenting a ZcytoR14 polypeptide, or by chemical peptide synthesis, as described herein. Moreover, epitopes can be selected by phage display of random peptide libraries (see, for example, Lane and Stephen, *Curr. Opin. Immunol.* 5:268 (1993), and Cortese *et al.*, *Curr. Opin. Biotechnol.* 7:616 (1996)). Standard methods for identifying epitopes and producing antibodies from small peptides that comprise an epitope are described, for example, by Mole, "Epitope Mapping," in *Methods in Molecular Biology*, Vol. 10, Manson (ed.), pages 105-116 (The Humana Press, Inc. 1992), Price, "Production and Characterization of Synthetic Peptide-Derived Antibodies," in *Monoclonal Antibodies: Production, Engineering, and Clinical Application*, Ritter and Ladyman (eds.), pages 60-84 (Cambridge University Press 1995), and Coligan *et al.* (eds.), *Current Protocols in Immunology*, pages 9.3.1 - 9.3.5 and pages 9.4.1 - 9.4.11 (John Wiley & Sons 1997).

For any ZcytoR14 polypeptide, including variants and fusion proteins, one of ordinary skill in the art can readily generate a fully degenerate polynucleotide sequence encoding that variant using the information set forth in Tables 1 and 2 above. Moreover, those of skill in the art can use standard software to devise ZcytoR14 variants based upon the nucleotide and amino acid sequences described herein.

E) Production of ZcytoR14 Polypeptides

The polypeptides of the present invention, including full-length polypeptides; soluble monomeric, homodimeric, heterodimeric and multimeric receptors; full-length receptors; receptor fragments (e.g. ligand-binding fragments and antigenic epitopes), functional fragments, and fusion proteins, can be produced in recombinant host cells following conventional techniques. To express a ZcytoR14 gene, a nucleic acid molecule encoding the polypeptide must be operably linked to regulatory sequences that control transcriptional expression in an expression vector and then, introduced into a host cell. In addition to transcriptional regulatory sequences, such as promoters and enhancers, expression vectors can include translational regulatory sequences and a marker gene which is suitable for selection of cells that carry the expression vector.

Expression vectors that are suitable for production of a foreign protein in eukaryotic cells typically contain (1) prokaryotic DNA elements coding for a bacterial replication origin and an antibiotic resistance marker to provide for the growth and selection of the expression vector in a bacterial host; (2) eukaryotic DNA elements that control initiation of

transcription, such as a promoter; and (3) DNA elements that control the processing of transcripts, such as a transcription termination/polyadenylation sequence. As discussed above, expression vectors can also include nucleotide sequences encoding a secretory sequence that directs the heterologous polypeptide into the secretory pathway of a host cell. For example, an
5 ZcytoR14 expression vector may comprise a ZcytoR14 gene and a secretory sequence derived from any secreted gene.

ZcytoR14 proteins of the present invention may be expressed in mammalian cells. Examples of suitable mammalian host cells include African green monkey kidney cells (Vero; ATCC CRL 1587), human embryonic kidney cells (293-HEK; ATCC CRL 1573), baby
10 hamster kidney cells (BHK-21, BHK-570; ATCC CRL 8544, ATCC CRL 10314), canine kidney cells (MDCK; ATCC CCL 34), Chinese hamster ovary cells (CHO-K1; ATCC CCL61; CHO DG44 (Chasin *et al.*, *Som. Cell. Molec. Genet.* 12:555, 1986)), rat pituitary cells (GH1; ATCC CCL82), HeLa S3 cells (ATCC CCL2.2), rat hepatoma cells (H-4-II-E; ATCC CRL 1548) SV40-transformed monkey kidney cells (COS-1; ATCC CRL 1650) and murine
15 embryonic cells (NIH-3T3; ATCC CRL 1658).

For a mammalian host, the transcriptional and translational regulatory signals may be derived from mammalian viral sources, for example, adenovirus, bovine papilloma virus, simian virus, or the like, in which the regulatory signals are associated with a particular gene which has a high level of expression. Suitable transcriptional and translational regulatory
20 sequences also can be obtained from mammalian genes, for example, actin, collagen, myosin, and metallothionein genes.

Transcriptional regulatory sequences include a promoter region sufficient to direct the initiation of RNA synthesis. Suitable eukaryotic promoters include the promoter of the mouse *metallothionein I* gene (Hamer *et al.*, *J. Molec. Appl. Genet.* 1:273 (1982)), the *TK*
25 promoter of *Herpes* virus (McKnight, *Cell* 31:355 (1982)), the *SV40* early promoter (Benoist *et al.*, *Nature* 290:304 (1981)), the *Rous* sarcoma virus promoter (Gorman *et al.*, *Proc. Nat'l Acad. Sci. USA* 79:6777 (1982)), the cytomegalovirus promoter (Foecking *et al.*, *Gene* 45:101 (1980)), and the mouse mammary tumor virus promoter (see, generally, Etcheverry, "Expression of Engineered Proteins in Mammalian Cell Culture," in *Protein Engineering: Principles and Practice*, Cleland *et al.* (eds.), pages 163-181 (John Wiley & Sons, Inc. 1996)).
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Alternatively, a prokaryotic promoter, such as the bacteriophage T3 RNA polymerase promoter, can be used to control ZcytoR14 gene expression in mammalian cells if the prokaryotic promoter is regulated by a eukaryotic promoter (Zhou *et al.*, *Mol. Cell. Biol.* 10:4529 (1990), and Kaufman *et al.*, *Nucl. Acids Res.* 19:4485 (1991)).

In certain embodiments, a DNA sequence encoding a ZcytoR14 soluble receptor polypeptide, or a fragment of ZcytoR14 polypeptide is operably linked to other genetic elements required for its expression, generally including a transcription promoter and terminator, within an expression vector. The vector will also commonly contain one or more selectable markers and one or more origins of replication, although those skilled in the art will recognize that within certain systems selectable markers may be provided on separate vectors, and replication of the exogenous DNA may be provided by integration into the host cell genome. Selection of promoters, terminators, selectable markers, vectors and other elements is a matter of routine design within the level of ordinary skill in the art. Many such elements are described in the literature and are available through commercial suppliers. Multiple components of a soluble receptor complex can be co-transfected on individual expression vectors or be contained in a single expression vector. Such techniques of expressing multiple components of protein complexes are well known in the art.

An expression vector can be introduced into host cells using a variety of standard techniques including calcium phosphate transfection, liposome-mediated transfection, microprojectile-mediated delivery, electroporation, and the like. The transfected cells can be selected and propagated to provide recombinant host cells that comprise the expression vector stably integrated in the host cell genome. Techniques for introducing vectors into eukaryotic cells and techniques for selecting such stable transformants using a dominant selectable marker are described, for example, by Ausubel (1995) and by Murray (ed.), *Gene Transfer and Expression Protocols* (Humana Press 1991).

For example, one suitable selectable marker is a gene that provides resistance to the antibiotic neomycin. In this case, selection is carried out in the presence of a neomycin-type drug, such as G-418 or the like. Selection systems can also be used to increase the expression level of the gene of interest, a process referred to as "amplification." Amplification is carried out by culturing transfectants in the presence of a low level of the selective agent and then increasing the amount of selective agent to select for cells that produce high levels of the products of the introduced genes. A suitable amplifiable selectable marker is dihydrofolate reductase (DHFR), which confers resistance to methotrexate. Other drug resistance genes (*e.g.*, hygromycin resistance, multi-drug resistance, puromycin acetyltransferase) can also be used. Alternatively, markers that introduce an altered phenotype, such as green fluorescent protein, or cell surface proteins such as CD4, CD8, Class I MHC, placental alkaline phosphatase may be used to sort transfected cells from untransfected cells by such means as FACS sorting or magnetic bead separation technology.

ZcytoR14 polypeptides can also be produced by cultured mammalian cells using a viral delivery system. Exemplary viruses for this purpose include adenovirus, retroviruses, herpesvirus, vaccinia virus and adeno-associated virus (AAV). Adenovirus, a double-stranded DNA virus, is currently the best studied gene transfer vector for delivery of heterologous nucleic acid (for a review, see Becker *et al.*, *Meth. Cell Biol.* 43:161 (1994), and Douglas and Curiel, *Science & Medicine* 4:44 (1997)). Advantages of the adenovirus system include the accommodation of relatively large DNA inserts, the ability to grow to high-titer, the ability to infect a broad range of mammalian cell types, and flexibility that allows use with a large number of available vectors containing different promoters.

By deleting portions of the adenovirus genome, larger inserts (up to 7 kb) of heterologous DNA can be accommodated. These inserts can be incorporated into the viral DNA by direct ligation or by homologous recombination with a co-transfected plasmid. An option is to delete the essential *E1* gene from the viral vector, which results in the inability to replicate unless the *E1* gene is provided by the host cell. Adenovirus vector-infected human 293 cells (ATCC Nos. CRL-1573, 45504, 45505), for example, can be grown as adherent cells or in suspension culture at relatively high cell density to produce significant amounts of protein (see Garnier *et al.*, *Cytotechnol.* 15:145 (1994)).

ZcytoR14 can also be expressed in other higher eukaryotic cells, such as avian, fungal, insect, yeast, or plant cells. The baculovirus system provides an efficient means to introduce cloned ZcytoR14 genes into insect cells. Suitable expression vectors are based upon the *Autographa californica* multiple nuclear polyhedrosis virus (AcMNPV), and contain well-known promoters such as *Drosophila heat shock protein (hsp) 70* promoter, *Autographa californica nuclear polyhedrosis virus immediate-early* gene promoter (*ie-1*) and the *delayed early 39K* promoter, baculovirus *p10* promoter, and the *Drosophila metallothionein* promoter. A second method of making recombinant baculovirus utilizes a transposon-based system described by Luckow (Luckow, *et al.*, *J. Virol.* 67:4566 (1993)). This system, which utilizes transfer vectors, is sold in the BAC-to-BAC kit (Life Technologies, Rockville, MD). This system utilizes a transfer vector, PFASTBAC (Life Technologies) containing a Tn7 transposon to move the DNA encoding the ZcytoR14 polypeptide into a baculovirus genome maintained in *E. coli* as a large plasmid called a "bacmid." See, Hill-Perkins and Possee, *J. Gen. Virol.* 71:971 (1990), Bonning, *et al.*, *J. Gen. Virol.* 75:1551 (1994), and Chazenbalk, and Rapoport, *J. Biol. Chem.* 270:1543 (1995). In addition, transfer vectors can include an in-frame fusion with DNA encoding an epitope tag at the C- or N-terminus of the expressed ZcytoR14 polypeptide, for example, a Glu-Glu epitope tag (Grussenmeyer *et al.*, *Proc. Nat'l Acad. Sci.*

82:7952 (1985)). Using a technique known in the art, a transfer vector containing a *ZcytoR14* gene is transformed into *E. coli*, and screened for bacmids which contain an interrupted *lacZ* gene indicative of recombinant baculovirus. The bacmid DNA containing the recombinant baculovirus genome is then isolated using common techniques.

5 The illustrative PFASTBAC vector can be modified to a considerable degree. For example, the polyhedrin promoter can be removed and substituted with the baculovirus basic protein promoter (also known as *Pcor*, p6.9 or MP promoter) which is expressed earlier in the baculovirus infection, and has been shown to be advantageous for expressing secreted proteins (see, for example, Hill-Perkins and Possee, *J. Gen. Virol.* 71:971 (1990), Bonning, *et*
10 *al.*, *J. Gen. Virol.* 75:1551 (1994), and Chazenbalk and Rapoport, *J. Biol. Chem.* 270:1543 (1995). In such transfer vector constructs, a short or long version of the basic protein promoter can be used. Moreover, transfer vectors can be constructed which replace the native *ZcytoR14* secretory signal sequences with secretory signal sequences derived from insect proteins. For example, a secretory signal sequence from Ecdysteroid Glucosyltransferase (EGT), honey bee
15 Melittin (Invitrogen Corporation; Carlsbad, CA), or baculovirus gp67 (PharMingen: San Diego, CA) can be used in constructs to replace the native *ZcytoR14* secretory signal sequence.

 The recombinant virus or bacmid is used to transfect host cells. Suitable insect host cells include cell lines derived from IPLB-Sf-21, a *Spodoptera frugiperda* pupal ovarian cell line, such as Sf9 (ATCC CRL 1711), Sf21AE, and Sf21 (Invitrogen Corporation; San
20 Diego, CA), as well as *Drosophila* Schneider-2 cells, and the HIGH FIVEO cell line (Invitrogen) derived from *Trichoplusia ni* (U.S. Patent No. 5,300,435). Commercially available serum-free media can be used to grow and to maintain the cells. Suitable media are Sf900 II™ (Life Technologies) or ESF 921™ (Expression Systems) for the Sf9 cells; and Ex-cello405™ (JRH Biosciences, Lenexa, KS) or Express FiveO™ (Life Technologies) for the *T.*
25 *ni* cells. When recombinant virus is used, the cells are typically grown up from an inoculation density of approximately $2-5 \times 10^5$ cells to a density of $1-2 \times 10^6$ cells at which time a recombinant viral stock is added at a multiplicity of infection (MOI) of 0.1 to 10, more typically near 3.

 Established techniques for producing recombinant proteins in baculovirus
30 systems are provided by Bailey *et al.*, "Manipulation of Baculovirus Vectors," in *Methods in Molecular Biology, Volume 7: Gene Transfer and Expression Protocols*, Murray (ed.), pages 147-168 (The Humana Press, Inc. 1991), by Patel *et al.*, "The baculovirus expression system," in *DNA Cloning 2: Expression Systems, 2nd Edition*, Glover *et al.* (eds.), pages 205-244 (Oxford University Press 1995), by Ausubel (1995) at pages 16-37 to 16-57, by Richardson

(ed.), *Baculovirus Expression Protocols* (The Humana Press, Inc. 1995), and by Lucknow, "Insect Cell Expression Technology," in *Protein Engineering: Principles and Practice*, Cleland *et al.* (eds.), pages 183-218 (John Wiley & Sons, Inc. 1996).

Fungal cells, including yeast cells, can also be used to express the genes described herein. Yeast species of particular interest in this regard include *Saccharomyces cerevisiae*, *Pichia pastoris*, and *Pichia methanolica*. Suitable promoters for expression in yeast include promoters from *GALI* (galactose), *PGK* (phosphoglycerate kinase), *ADH* (alcohol dehydrogenase), *AOX1* (alcohol oxidase), *HIS4* (histidinol dehydrogenase), and the like. Many yeast cloning vectors have been designed and are readily available. These vectors include YIp-based vectors, such as YIp5, YRp vectors, such as YRp17, YEp vectors such as YEp13 and YCp vectors, such as YCp19. Methods for transforming *S. cerevisiae* cells with exogenous DNA and producing recombinant polypeptides therefrom are disclosed by, for example, Kawasaki, U.S. Patent No. 4,599,311, Kawasaki *et al.*, U.S. Patent No. 4,931,373, Brake, U.S. Patent No. 4,870,008, Welch *et al.*, U.S. Patent No. 5,037,743, and Murray *et al.*, U.S. Patent No. 4,845,075. Transformed cells are selected by phenotype determined by the selectable marker, commonly drug resistance or the ability to grow in the absence of a particular nutrient (e.g., leucine). A suitable vector system for use in *Saccharomyces cerevisiae* is the *POT1* vector system disclosed by Kawasaki *et al.* (U.S. Patent No. 4,931,373), which allows transformed cells to be selected by growth in glucose-containing media. Additional suitable promoters and terminators for use in yeast include those from glycolytic enzyme genes (see, e.g., Kawasaki, U.S. Patent No. 4,599,311, Kingsman *et al.*, U.S. Patent No. 4,615,974, and Bitter, U.S. Patent No. 4,977,092) and alcohol dehydrogenase genes. See also U.S. Patents Nos. 4,990,446, 5,063,154, 5,139,936, and 4,661,454.

Transformation systems for other yeasts, including *Hansenula polymorpha*, *Schizosaccharomyces pombe*, *Kluyveromyces lactis*, *Kluyveromyces fragilis*, *Ustilago maydis*, *Pichia pastoris*, *Pichia methanolica*, *Pichia guilliermondii* and *Candida maltosa* are known in the art. See, for example, Gleeson *et al.*, *J. Gen. Microbiol.* 132:3459 (1986), and Cregg, U.S. Patent No. 4,882,279. *Aspergillus* cells may be utilized according to the methods of McKnight *et al.*, U.S. Patent No. 4,935,349. Methods for transforming *Acremonium chrysogenum* are disclosed by Sumino *et al.*, U.S. Patent No. 5,162,228. Methods for transforming *Neurospora* are disclosed by Lambowitz, U.S. Patent No. 4,486,533.

For example, the use of *Pichia methanolica* as host for the production of recombinant proteins is disclosed by Raymond, U.S. Patent No. 5,716,808, Raymond, U.S. Patent No. 5,736,383, Raymond *et al.*, *Yeast* 14:11-23 (1998), and in international publication

Nos. WO 97/17450, WO 97/17451, WO 98/02536, and WO 98/02565. DNA molecules for use in transforming *P. methanolica* will commonly be prepared as double-stranded, circular plasmids, which are preferably linearized prior to transformation. For polypeptide production in *P. methanolica*, the promoter and terminator in the plasmid can be that of a *P. methanolica* gene, such as a *P. methanolica* alcohol utilization gene (*AUG1* or *AUG2*). Other useful promoters include those of the dihydroxyacetone synthase (DHAS), formate dehydrogenase (FMD), and catalase (CAT) genes. To facilitate integration of the DNA into the host chromosome, it is preferred to have the entire expression segment of the plasmid flanked at both ends by host DNA sequences. A suitable selectable marker for use in *Pichia methanolica* is a *P. methanolica* *ADE2* gene, which encodes phosphoribosyl-5-aminoimidazole carboxylase (AIRC; EC 4.1.1.21), and which allows *ade2* host cells to grow in the absence of adenine. For large-scale, industrial processes where it is desirable to minimize the use of methanol, host cells can be used in which both methanol utilization genes (*AUG1* and *AUG2*) are deleted. For production of secreted proteins, host cells can be deficient in vacuolar protease genes (*PEP4* and *PRB1*). Electroporation is used to facilitate the introduction of a plasmid containing DNA encoding a polypeptide of interest into *P. methanolica* cells. *P. methanolica* cells can be transformed by electroporation using an exponentially decaying, pulsed electric field having a field strength of from 2.5 to 4.5 kV/cm, preferably about 3.75 kV/cm, and a time constant (t) of from 1 to 40 milliseconds, most preferably about 20 milliseconds.

Expression vectors can also be introduced into plant protoplasts, intact plant tissues, or isolated plant cells. Methods for introducing expression vectors into plant tissue include the direct infection or co-cultivation of plant tissue with *Agrobacterium tumefaciens*, microprojectile-mediated delivery, DNA injection, electroporation, and the like. See, for example, Horsch *et al.*, *Science* 227:1229 (1985), Klein *et al.*, *Biotechnology* 10:268 (1992), and Miki *et al.*, "Procedures for Introducing Foreign DNA into Plants," in *Methods in Plant Molecular Biology and Biotechnology*, Glick *et al.* (eds.), pages 67-88 (CRC Press, 1993).

Alternatively, ZcytoR14 genes can be expressed in prokaryotic host cells. Suitable promoters that can be used to express ZcytoR14 polypeptides in a prokaryotic host are well-known to those of skill in the art and include promoters capable of recognizing the T4, T3, Sp6 and T7 polymerases, the P_R and P_L promoters of bacteriophage lambda, the *trp*, *recA*, heat shock, *lacUV5*, *tac*, *lpp-lacSpr*, *phoA*, and *lacZ* promoters of *E. coli*, promoters of *B. subtilis*, the promoters of the bacteriophages of *Bacillus*, *Streptomyces* promoters, the *int* promoter of bacteriophage lambda, the *bla* promoter of pBR322, and the CAT promoter of the chloramphenicol acetyl transferase gene. Prokaryotic promoters have been reviewed by Glick,

J. Ind. Microbiol. 1:277 (1987), Watson *et al.*, *Molecular Biology of the Gene*, 4th Ed. (Benjamin Cummins 1987), and by Ausubel *et al.* (1995).

Suitable prokaryotic hosts include *E. coli* and *Bacillus subtilis*. Suitable strains of *E. coli* include BL21(DE3), BL21(DE3)pLysS, BL21(DE3)pLysE, DH1, DH4I, 5 DH5, DH5I, DH5IF', DH5IMCR, DH10B, DH10B/p3, DH11S, C600, HB101, JM101, JM105, JM109, JM110, K38, RR1, Y1088, Y1089, CSH18, ER1451, and ER1647 (see, for example, Brown (ed.), *Molecular Biology Labfax* (Academic Press 1991)). Suitable strains of *Bacillus subtilis* include BR151, YB886, MI119, MI120, and B170 (see, for example, Hardy, "Bacillus Cloning Methods," in *DNA Cloning: A Practical Approach*, Glover (ed.) (IRL Press 1985)).

10 When expressing a ZcytoR14 polypeptide in bacteria such as *E. coli*, the polypeptide may be retained in the cytoplasm, typically as insoluble granules, or may be directed to the periplasmic space by a bacterial secretion sequence. In the former case, the cells are lysed, and the granules are recovered and denatured using, for example, guanidine isothiocyanate or urea. The denatured polypeptide can then be refolded and dimerized by 15 diluting the denaturant, such as by dialysis against a solution of urea and a combination of reduced and oxidized glutathione, followed by dialysis against a buffered saline solution. In the latter case, the polypeptide can be recovered from the periplasmic space in a soluble and functional form by disrupting the cells (by, for example, sonication or osmotic shock) to release the contents of the periplasmic space and recovering the protein, thereby obviating the 20 need for denaturation and refolding.

Methods for expressing proteins in prokaryotic hosts are well-known to those of skill in the art (see, for example, Williams *et al.*, "Expression of foreign proteins in *E. coli* using plasmid vectors and purification of specific polyclonal antibodies," in *DNA Cloning 2: Expression Systems*, 2nd Edition, Glover *et al.* (eds.), page 15 (Oxford University Press 1995), 25 Ward *et al.*, "Genetic Manipulation and Expression of Antibodies," in *Monoclonal Antibodies: Principles and Applications*, page 137 (Wiley-Liss, Inc. 1995), and Georgiou, "Expression of Proteins in Bacteria," in *Protein Engineering: Principles and Practice*, Cleland *et al.* (eds.), page 101 (John Wiley & Sons, Inc. 1996)).

Standard methods for introducing expression vectors into bacterial, yeast, insect, 30 and plant cells are provided, for example, by Ausubel (1995).

General methods for expressing and recovering foreign protein produced by a mammalian cell system are provided by, for example, Etcheverry, "Expression of Engineered Proteins in Mammalian Cell Culture," in *Protein Engineering: Principles and Practice*, Cleland *et al.* (eds.), pages 163 (Wiley-Liss, Inc. 1996). Standard techniques for recovering protein

produced by a bacterial system is provided by, for example, Grishammer *et al.*, "Purification of over-produced proteins from *E. coli* cells," in *DNA Cloning 2: Expression Systems, 2nd Edition*, Glover *et al.* (eds.), pages 59-92 (Oxford University Press 1995). Established methods for isolating recombinant proteins from a baculovirus system are described by Richardson
5 (ed.), *Baculovirus Expression Protocols* (The Humana Press, Inc. 1995).

As an alternative, polypeptides of the present invention can be synthesized by exclusive solid phase synthesis, partial solid phase methods, fragment condensation or classical solution synthesis. These synthesis methods are well-known to those of skill in the art (see, for example, Merrifield, *J. Am. Chem. Soc.* 85:2149 (1963), Stewart *et al.*, "Solid Phase Peptide
10 Synthesis" (2nd Edition), (Pierce Chemical Co. 1984), Bayer and Rapp, *Chem. Pept. Prot.* 3:3 (1986), Atherton *et al.*, *Solid Phase Peptide Synthesis: A Practical Approach* (IRL Press 1989), Fields and Colowick, "Solid-Phase Peptide Synthesis," *Methods in Enzymology Volume* 289 (Academic Press 1997), and Lloyd-Williams *et al.*, *Chemical Approaches to the Synthesis of Peptides and Proteins* (CRC Press, Inc. 1997)). Variations in total chemical synthesis
15 strategies, such as "native chemical ligation" and "expressed protein ligation" are also standard (see, for example, Dawson *et al.*, *Science* 266:776 (1994), Hackeng *et al.*, *Proc. Nat'l Acad. Sci. USA* 94:7845 (1997), Dawson, *Methods Enzymol.* 287: 34 (1997), Muir *et al.*, *Proc. Nat'l Acad. Sci. USA* 95:6705 (1998), and Severinov and Muir, *J. Biol. Chem.* 273:16205 (1998)).

Peptides and polypeptides of the present invention comprise at least six, at
20 least nine, or at least 15 contiguous amino acid residues of SEQ ID NO:2 or 5. As an illustration, polypeptides can comprise at least six, at least nine, or at least 15 contiguous amino acid residues of of SEQ ID NO:2 or 5. Within certain embodiments of the invention, the polypeptides comprise 20, 30, 40, 50, 100, or more contiguous residues of these amino acid sequences. Nucleic acid molecules encoding such peptides and polypeptides are useful as
25 polymerase chain reaction primers and probes.

Moreover, ZcytoR14 polypeptides and fragments thereof can be expressed as monomers, homodimers, heterodimers, or multimers within higher eukaryotic cells. Such cells can be used to produce ZcytoR14 monomeric, homodimeric, heterodimeric and multimeric receptor polypeptides that comprise at least one ZcytoR14 polypeptide ("ZcytoR14-comprising
30 receptors" or "ZcytoR14-comprising receptor polypeptides"), or can be used as assay cells in screening systems. Within one aspect of the present invention, a polypeptide of the present invention comprising the ZcytoR14 extracellular domain is produced by a cultured cell, and the cell is used to screen for ligands for the receptor, including the natural ligand, IL-17F, as well as IL-17A, or even agonists and antagonists of the natural ligand. To summarize this approach,

a cDNA or gene encoding the receptor is combined with other genetic elements required for its expression (*e.g.*, a transcription promoter), and the resulting expression vector is inserted into a host cell. Cells that express the DNA and produce functional receptor are selected and used within a variety of screening systems. Each component of the monomeric, homodimeric, heterodimeric and multimeric receptor complex can be expressed in the same cell. Moreover, the components of the monomeric, homodimeric, heterodimeric and multimeric receptor complex can also be fused to a transmembrane domain or other membrane fusion moiety to allow complex assembly and screening of transfectants as described above.

To assay the IL-17A and IL-17F antagonist polypeptides and antibodies of the present invention, mammalian cells suitable for use in expressing ZcytoR14-comprising receptors or other receptors known to bind IL-17A or IL-17F (*e.g.*, cells expressing IL-17R) and transducing a receptor-mediated signal include cells that express other receptor subunits that may form a functional complex with ZcytoR14. It is also preferred to use a cell from the same species as the receptor to be expressed. Within a preferred embodiment, the cell is dependent upon an exogenously supplied hematopoietic growth factor for its proliferation. Preferred cell lines of this type are the human TF-1 cell line (ATCC number CRL-2003) and the AML-193 cell line (ATCC number CRL-9589), which are GM-CSF-dependent human leukemic cell lines and BaF3 (Palacios and Steinmetz, *Cell* 41: 727-734, (1985)) which is an IL-3 dependent murine pre-B cell line. Other cell lines include BHK, COS-1 and CHO cells. Suitable host cells can be engineered to produce the necessary receptor subunits or other cellular component needed for the desired cellular response. This approach is advantageous because cell lines can be engineered to express receptor subunits from any species, thereby overcoming potential limitations arising from species specificity. Species orthologs of the human receptor cDNA can be cloned and used within cell lines from the same species, such as a mouse cDNA in the BaF3 cell line. Cell lines that are dependent upon one hematopoietic growth factor, such as GM-CSF or IL-3, can thus be engineered to become dependent upon another cytokine that acts through the ZcytoR14 receptor, such as IL-17F or IL-17A.

Cells expressing functional receptor are used within screening assays. A variety of suitable assays are known in the art. These assays are based on the detection of a biological response in a target cell. One such assay is a cell proliferation assay. Cells are cultured in the presence or absence of a test compound, and cell proliferation is detected by, for example, measuring incorporation of tritiated thymidine or by colorimetric assay based on the metabolic breakdown of 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) (Mosman, *J. Immunol. Meth.* 65: 55-63, (1983)). An alternative assay format uses cells

that are further engineered to express a reporter gene. The reporter gene is linked to a promoter element that is responsive to the receptor-linked pathway, and the assay detects activation of transcription of the reporter gene. A preferred promoter element in this regard is a serum response element, or SRE. See, e.g., Shaw *et al.*, *Cell* 56:563-572, (1989). A preferred
5 such reporter gene is a luciferase gene (de Wet *et al.*, *Mol. Cell. Biol.* 7:725, (1987)). Expression of the luciferase gene is detected by luminescence using methods known in the art (e.g., Baumgartner *et al.*, *J. Biol. Chem.* 269:29094-29101, (1994); Schenborn and Goiffin, *Promega Notes* 41:11, 1993). Luciferase activity assay kits are commercially available from, for example, Promega Corp., Madison, WI. Target cell lines of this type can be used to screen
10 libraries of chemicals, cell-conditioned culture media, fungal broths, soil samples, water samples, and the like. For example, a bank of cell-conditioned media samples can be assayed on a target cell to identify cells that produce ligand. Positive cells are then used to produce a cDNA library in a mammalian expression vector, which is divided into pools, transfected into host cells, and expressed. Media samples from the transfected cells are then assayed, with
15 subsequent division of pools, re-transfection, subculturing, and re-assay of positive cells to isolate a cloned cDNA encoding the ligand.

An additional screening approach provided by the present invention includes the use of hybrid receptor polypeptides. These hybrid polypeptides fall into two general classes. Within the first class, the intracellular domain of ZcytoR14, is joined to the ligand-
20 binding domain of a second receptor. A second class of hybrid receptor polypeptides comprise the extracellular (ligand-binding) domain of ZcytoR14 (SEQ ID NO:3) with an intracellular domain of a second receptor, preferably a hematopoietic cytokine receptor, and a transmembrane domain. Hybrid ZcytoR14 monomers, homodimers, heterodimers and multimers of the present invention receptors of this second class are expressed in cells known
25 to be capable of responding to signals transduced by the second receptor. Together, these two classes of hybrid receptors enable the identification of a responsive cell type for the development of an assay for detecting IL-17F or IL-17A. Moreover, such cells can be used in the presence of IL-17F or IL-17A to assay the soluble receptor antagonists of the present invention in a competition-type assay. In such assay, a decrease in the proliferation or signal
30 transduction activity of IL-17F or IL-17A in the presence of a soluble receptor of the present invention demonstrates antagonistic activity. Moreover ZcytoR14-soluble receptor binding assays, an cell-based assays, can also be used to assess whether a soluble receptor binds, blocks, inhibits, reduces, antagonizes or neutralizes IL-17F or IL-17A activity.

F) Production of ZcytoR14 Fusion Proteins and Conjugates

One general class of ZcytoR14 analogs are variants having an amino acid sequence that is a mutation of the amino acid sequence disclosed herein. Another general class of ZcytoR14 analogs is provided by anti-idiotypic antibodies, and fragments thereof, as described below. Moreover, recombinant antibodies comprising anti-idiotypic variable domains can be used as analogs (see, for example, Monfardini *et al.*, *Proc. Assoc. Am. Physicians* 108:420 (1996)). Since the variable domains of anti-idiotypic ZcytoR14 antibodies mimic ZcytoR14, these domains can provide ZcytoR14 binding activity. Methods of producing anti-idiotypic catalytic antibodies are known to those of skill in the art (see, for example, Joron *et al.*, *Ann. N Y Acad. Sci.* 672:216 (1992), Friboulet *et al.*, *Appl. Biochem. Biotechnol.* 47:229 (1994), and Avelle *et al.*, *Ann. N Y Acad. Sci.* 864:118 (1998)).

Another approach to identifying ZcytoR14 analogs is provided by the use of combinatorial libraries. Methods for constructing and screening phage display and other combinatorial libraries are provided, for example, by Kay *et al.*, *Phage Display of Peptides and Proteins* (Academic Press 1996), Verdine, U.S. Patent No. 5,783,384, Kay, *et al.*, U.S. Patent No. 5,747,334, and Kauffman *et al.*, U.S. Patent No. 5,723,323.

ZcytoR14 polypeptides have both *in vivo* and *in vitro* uses. As an illustration, a soluble form of ZcytoR14 can be added to cell culture medium to inhibit the effects of the ZcytoR14 ligand (*i.e.* IL-17F, IL-17A or both) produced by the cultured cells.

Fusion proteins of ZcytoR14 can be used to express ZcytoR14 in a recombinant host, and to isolate the produced ZcytoR14. As described below, particular ZcytoR14 fusion proteins also have uses in diagnosis and therapy. One type of fusion protein comprises a peptide that guides a ZcytoR14 polypeptide from a recombinant host cell. To direct a ZcytoR14 polypeptide into the secretory pathway of a eukaryotic host cell, a secretory signal sequence (also known as a signal peptide, a leader sequence, prepro sequence or pre sequence) is provided in the ZcytoR14 expression vector. While the secretory signal sequence may be derived from ZcytoR14, a suitable signal sequence may also be derived from another secreted protein or synthesized *de novo*. The secretory signal sequence is operably linked to a ZcytoR14-encoding sequence such that the two sequences are joined in the correct reading frame and positioned to direct the newly synthesized polypeptide into the secretory pathway of the host cell. Secretory signal sequences are commonly positioned 5' to the nucleotide sequence encoding the polypeptide of interest, although certain secretory signal sequences may be positioned elsewhere in the nucleotide sequence of interest (see, *e.g.*, Welch *et al.*, U.S. Patent No. 5,037,743; Holland *et al.*, U.S. Patent No. 5,143,830).

Although the secretory signal sequence of ZcytoR14 or another protein produced by mammalian cells (*e.g.*, tissue-type plasminogen activator signal sequence, as described, for example, in U.S. Patent No. 5,641,655) is useful for expression of ZcytoR14 in recombinant mammalian hosts, a yeast signal sequence is preferred for expression in yeast
5 cells. Examples of suitable yeast signal sequences are those derived from yeast mating pheromone α -factor (encoded by the *MF α 1* gene), invertase (encoded by the *SUC2* gene), or acid phosphatase (encoded by the *PHO5* gene). See, for example, Romanos *et al.*, "Expression of Cloned Genes in Yeast," in *DNA Cloning 2: A Practical Approach*, 2nd Edition, Glover and Hames (eds.), pages 123-167 (Oxford University Press 1995).

10 ZcytoR14 soluble receptor polypeptides can be prepared by expressing a truncated DNA encoding the extracellular domain, for example, a polypeptide which contains SEQ ID NO:3, or the corresponding region of a non-human receptor. It is preferred that the extracellular domain polypeptides be prepared in a form substantially free of transmembrane and intracellular polypeptide segments. To direct the export of the receptor domain from the
15 host cell, the receptor DNA is linked to a second DNA segment encoding a secretory peptide, such as a t-PA secretory peptide. To facilitate purification of the secreted receptor domain, a C-terminal extension, such as a poly-histidine tag, substance P, FlagTM peptide (Hopp *et al.*, *Biotechnology* 6:1204-1210, (1988); available from Eastman Kodak Co., New Haven, CT) or another polypeptide or protein for which an antibody or other specific binding agent is
20 available, can be fused to the receptor polypeptide. Moreover, ZcytoR14 antigenic epitopes from the extracellular cytokine binding domains are also prepared as described above.

In an alternative approach, a receptor extracellular domain of ZcytoR14 or other cytokine receptor component can be expressed as a fusion with immunoglobulin heavy chain constant regions, typically an F_C fragment, which contains two constant region domains
25 and a hinge region but lacks the variable region (See, Sledziewski, AZ *et al.*, US Patent No. 6,018,026 and 5,750,375). The soluble ZcytoR14 polypeptides of the present invention include such fusions. One such fusion is shown in SEQ ID NO:64. Such fusions are typically secreted as multimeric molecules wherein the Fc portions are disulfide bonded to each other and two receptor polypeptides are arrayed in closed proximity to each other. Fusions of this
30 type can be used to affinity purify the cognate ligand from solution, as an *in vitro* assay tool, to block, inhibit or reduce signals *in vitro* by specifically titrating out ligand, and as antagonists *in vivo* by administering them parenterally to bind circulating ligand and clear it from the circulation. To purify ligand, a ZcytoR14-Ig chimera is added to a sample containing the ligand (*e.g.*, cell-conditioned culture media or tissue extracts) under conditions that facilitate

receptor-ligand binding (typically near-physiological temperature, pH, and ionic strength). The chimera-ligand complex is then separated by the mixture using protein A, which is immobilized on a solid support (e.g., insoluble resin beads). The ligand is then eluted using conventional chemical techniques, such as with a salt or pH gradient. In the alternative, the chimera itself can be bound to a solid support, with binding and elution carried out as above. The chimeras may be used *in vivo* to regulate inflammatory responses including acute phase responses such as serum amyloid A (SAA), C-reactive protein (CRP), and the like. Chimeras with high binding affinity are administered parenterally (e.g., by intramuscular, subcutaneous or intravenous injection). Circulating molecules bind ligand and are cleared from circulation by normal physiological processes. For use in assays, the chimeras are bound to a support via the F_C region and used in an ELISA format.

To assist in isolating anti-ZcytoR14 and binding partners of the present invention, an assay system that uses a ligand-binding receptor (or an antibody, one member of a complement/ anti-complement pair) or a binding fragment thereof, and a commercially available biosensor instrument (BIAcore, Pharmacia Biosensor, Piscataway, NJ) may be advantageously employed. Such receptor, antibody, member of a complement/anti-complement pair or fragment is immobilized onto the surface of a receptor chip. Use of this instrument is disclosed by Karlsson, *J. Immunol. Methods* 145:229-40, 1991 and Cunningham and Wells, *J. Mol. Biol.* 234:554-63, 1993. A receptor, antibody, member or fragment is covalently attached, using amine or sulfhydryl chemistry, to dextran fibers that are attached to gold film within the flow cell. A test sample is passed through the cell. If a ligand, epitope, or opposite member of the complement/anti-complement pair is present in the sample, it will bind to the immobilized receptor, antibody or member, respectively, causing a change in the refractive index of the medium, which is detected as a change in surface plasmon resonance of the gold film. This system allows the determination of on- and off-rates, from which binding affinity can be calculated, and assessment of stoichiometry of binding. Alternatively, ligand/receptor binding can be analyzed using SELDI(TM) technology (Ciphergen, Inc., Palo Alto, CA). Moreover, BIACORE technology, described above, can be used to be used in competition experiments to determine if different monoclonal antibodies bind the same or different epitopes on the ZcytoR14 polypeptide, and as such, be used to aid in epitope mapping of neutralizing antibodies of the present invention that bind, block, inhibit, reduce, antagonize or neutralize IL-17F or both IL-17A and IL-17F.

Ligand-binding receptor polypeptides can also be used within other assay systems known in the art. Such systems include Scatchard analysis for determination of

binding affinity (see Scatchard, Ann. NY Acad. Sci. 51: 660-72, 1949) and calorimetric assays (Cunningham et al., Science 253:545-48, 1991; Cunningham et al., Science 245:821-25, 1991).

The present invention further provides a variety of other polypeptide fusions and related multimeric proteins comprising one or more polypeptide fusions. For example, a soluble ZcytoR14 receptor can be prepared as a fusion to a dimerizing protein as disclosed in U.S. Patents Nos. 5,155,027 and 5,567,584. Preferred dimerizing proteins in this regard include immunoglobulin constant region domains, e.g., IgG γ 1, and the human κ light chain. Immunoglobulin-soluble ZcytoR14 fusions can be expressed in genetically engineered cells to produce a variety of multimeric ZcytoR14 receptor analogs. Auxiliary domains can be fused to soluble ZcytoR14 receptor to target them to specific cells, tissues, or macromolecules (e.g., collagen, or cells expressing the ZcytoR14 ligands, IL-17F or IL-17A). A ZcytoR14 polypeptide can be fused to two or more moieties, such as an affinity tag for purification and a targeting domain. Polypeptide fusions can also comprise one or more cleavage sites, particularly between domains. See, Tuan et al., Connective Tissue Research 34:1-9, 1996.

In bacterial cells, it is often desirable to express a heterologous protein as a fusion protein to decrease toxicity, increase stability, and to enhance recovery of the expressed protein. For example, ZcytoR14 can be expressed as a fusion protein comprising a glutathione S-transferase polypeptide. Glutathione S-transferase fusion proteins are typically soluble, and easily purifiable from *E. coli* lysates on immobilized glutathione columns. In similar approaches, a ZcytoR14 fusion protein comprising a maltose binding protein polypeptide can be isolated with an amylose resin column, while a fusion protein comprising the C-terminal end of a truncated Protein A gene can be purified using IgG-Sepharose. Established techniques for expressing a heterologous polypeptide as a fusion protein in a bacterial cell are described, for example, by Williams *et al.*, "Expression of Foreign Proteins in *E. coli* Using Plasmid Vectors and Purification of Specific Polyclonal Antibodies," in *DNA Cloning 2: A Practical Approach*, 2nd Edition, Glover and Hames (Eds.), pages 15-58 (Oxford University Press 1995). In addition, commercially available expression systems are available. For example, the PINPOINT Xa protein purification system (Promega Corporation; Madison, WI) provides a method for isolating a fusion protein comprising a polypeptide that becomes biotinylated during expression with a resin that comprises avidin.

Peptide tags that are useful for isolating heterologous polypeptides expressed by either prokaryotic or eukaryotic cells include polyHistidine tags (which have an affinity for nickel-chelating resin), *c-myc* tags, calmodulin binding protein (isolated with calmodulin affinity chromatography), substance P, the RYIRS tag (which binds with anti-RYIRS

antibodies), the Glu-Glu tag, and the FLAG tag (which binds with anti-FLAG antibodies). See, for example, Luo *et al.*, *Arch. Biochem. Biophys.* 329:215 (1996), Morganti *et al.*, *Biotechnol. Appl. Biochem.* 23:67 (1996), and Zheng *et al.*, *Gene* 186:55 (1997). Nucleic acid molecules encoding such peptide tags are available, for example, from Sigma-Aldrich Corporation (St. Louis, MO).

Another form of fusion protein comprises a ZcytoR14 polypeptide and an immunoglobulin heavy chain constant region, typically an F_C fragment, which contains two or three constant region domains and a hinge region but lacks the variable region. As an illustration, Chang *et al.*, U.S. Patent No. 5,723,125, describe a fusion protein comprising a human interferon and a human immunoglobulin Fc fragment. The C-terminal of the interferon is linked to the N-terminal of the Fc fragment by a peptide linker moiety. An example of a peptide linker is a peptide comprising primarily a T cell inert sequence, which is immunologically inert. An exemplary peptide linker has the amino acid sequence: GSGGG SGGGG SGGGG S (SEQ ID NO:9). In this fusion protein, an illustrative Fc moiety is a human γ 4 chain, which is stable in solution and has little or no complement activating activity. Accordingly, the present invention contemplates a ZcytoR14 fusion protein that comprises a ZcytoR14 moiety and a human Fc fragment, wherein the C-terminus of the ZcytoR14 moiety is attached to the N-terminus of the Fc fragment via a peptide linker, such as a peptide comprising the amino acid sequence of SEQ ID NO:2 or SEQ ID NO:5. The ZcytoR14 moiety can be a ZcytoR14 molecule or a fragment thereof. For example, a fusion protein can comprise the amino acid of SEQ ID NO:3 and an Fc fragment (*e.g.*, a human Fc fragment) (SEQ ID NO:64).

In another variation, a ZcytoR14 fusion protein comprises an IgG sequence, a ZcytoR14 moiety covalently joined to the aminoterminal end of the IgG sequence, and a signal peptide that is covalently joined to the aminoterminal of the ZcytoR14 moiety, wherein the IgG sequence consists of the following elements in the following order: a hinge region, a CH₂ domain, and a CH₃ domain. Accordingly, the IgG sequence lacks a CH₁ domain. The ZcytoR14 moiety displays a ZcytoR14 activity, as described herein, such as the ability to bind with a ZcytoR14 ligand. This general approach to producing fusion proteins that comprise both antibody and nonantibody portions has been described by LaRochelle *et al.*, EP 742830 (WO 95/21258).

Fusion proteins comprising a ZcytoR14 moiety and an Fc moiety can be used, for example, as an *in vitro* assay tool. For example, the presence of a ZcytoR14 ligand in a biological sample can be detected using a ZcytoR14-immunoglobulin fusion protein, in which

the ZcytoR14 moiety is used to bind the ligand, and a macromolecule, such as Protein A or anti-Fc antibody, is used to bind the fusion protein to a solid support. Such systems can be used to identify agonists and antagonists that interfere with the binding of a ZcytoR14 ligands, e.g., IL-17F or both IL-17A and IL-17F, to their receptor.

5 Other examples of antibody fusion proteins include polypeptides that comprise an antigen-binding domain and a ZcytoR14 fragment that contains a ZcytoR14 extracellular domain. Such molecules can be used to target particular tissues for the benefit of ZcytoR14 binding activity.

The present invention further provides a variety of other polypeptide fusions.
10 For example, part or all of a domain(s) conferring a biological function can be swapped between ZcytoR14 of the present invention with the functionally equivalent domain(s) from another member of the cytokine receptor family. Polypeptide fusions can be expressed in recombinant host cells to produce a variety of ZcytoR14 fusion analogs. A ZcytoR14 polypeptide can be fused to two or more moieties or domains, such as an affinity tag for
15 purification and a targeting domain. Polypeptide fusions can also comprise one or more cleavage sites, particularly between domains. See, for example, Tuan *et al.*, *Connective Tissue Research* 34:1 (1996).

Fusion proteins can be prepared by methods known to those skilled in the art by preparing each component of the fusion protein and chemically conjugating them.
20 Alternatively, a polynucleotide encoding both components of the fusion protein in the proper reading frame can be generated using known techniques and expressed by the methods described herein. General methods for enzymatic and chemical cleavage of fusion proteins are described, for example, by Ausubel (1995) at pages 16-19 to 16-25.

ZcytoR14 binding domains can be further characterized by physical analysis of
25 structure, as determined by such techniques as nuclear magnetic resonance, crystallography, electron diffraction or photoaffinity labeling, in conjunction with mutation of putative contact site amino acids of ZcytoR14 ligand agonists. See, for example, de Vos *et al.*, *Science* 255:306 (1992), Smith *et al.*, *J. Mol. Biol.* 224:899 (1992), and Wlodaver *et al.*, *FEBS Lett.* 309:59 (1992).

30 The present invention also contemplates chemically modified ZcytoR14 compositions, in which a ZcytoR14 polypeptide is linked with a polymer. Illustrative ZcytoR14 polypeptides are soluble polypeptides that lack a functional transmembrane domain, such as a polypeptide consisting of amino acid residues SEQ ID NO:3. Typically, the polymer is water soluble so that the ZcytoR14 conjugate does not precipitate in an aqueous

environment, such as a physiological environment. An example of a suitable polymer is one that has been modified to have a single reactive group, such as an active ester for acylation, or an aldehyde for alkylation. In this way, the degree of polymerization can be controlled. An example of a reactive aldehyde is polyethylene glycol propionaldehyde, or mono-(C1-C10) alkoxy, or aryloxy derivatives thereof (see, for example, Harris, *et al.*, U.S. Patent No. 5,252,714). The polymer may be branched or unbranched. Moreover, a mixture of polymers can be used to produce ZcytoR14 conjugates.

ZcytoR14 conjugates used for therapy can comprise pharmaceutically acceptable water-soluble polymer moieties. Suitable water-soluble polymers include polyethylene glycol (PEG), monomethoxy-PEG, mono-(C1-C10)alkoxy-PEG, aryloxy-PEG, poly-(N-vinyl pyrrolidone)PEG, tresyl monomethoxy PEG, PEG propionaldehyde, bis-succinimidyl carbonate PEG, propylene glycol homopolymers, a polypropylene oxide/ethylene oxide co-polymer, polyoxyethylated polyols (*e.g.*, glycerol), polyvinyl alcohol, dextran, cellulose, or other carbohydrate-based polymers. Suitable PEG may have a molecular weight from about 600 to about 60,000, including, for example, 5,000, 12,000, 20,000 and 25,000. A ZcytoR14 conjugate can also comprise a mixture of such water-soluble polymers.

One example of a ZcytoR14 conjugate comprises a ZcytoR14 moiety and a polyalkyl oxide moiety attached to the *N*-terminus of the ZcytoR14 moiety. PEG is one suitable polyalkyl oxide. As an illustration, ZcytoR14 can be modified with PEG, a process known as "PEGylation." PEGylation of ZcytoR14 can be carried out by any of the PEGylation reactions known in the art (see, for example, EP 0 154 316, Delgado *et al.*, *Critical Reviews in Therapeutic Drug Carrier Systems* 9:249 (1992), Duncan and Spreafico, *Clin. Pharmacokinet.* 27:290 (1994), and Francis *et al.*, *Int J Hematol* 68:1 (1998)). For example, PEGylation can be performed by an acylation reaction or by an alkylation reaction with a reactive polyethylene glycol molecule. In an alternative approach, ZcytoR14 conjugates are formed by condensing activated PEG, in which a terminal hydroxy or amino group of PEG has been replaced by an activated linker (see, for example, Karasiewicz *et al.*, U.S. Patent No. 5,382,657).

PEGylation by acylation typically requires reacting an active ester derivative of PEG with a ZcytoR14 polypeptide. An example of an activated PEG ester is PEG esterified to *N*-hydroxysuccinimide. As used herein, the term "acylation" includes the following types of linkages between ZcytoR14 and a water soluble polymer: amide, carbamate, urethane, and the like. Methods for preparing PEGylated ZcytoR14 by acylation will typically comprise the steps of (a) reacting a ZcytoR14 polypeptide with PEG (such as a reactive ester of an aldehyde derivative of PEG) under conditions whereby one or more PEG groups attach to ZcytoR14, and

(b) obtaining the reaction product(s). Generally, the optimal reaction conditions for acylation reactions will be determined based upon known parameters and desired results. For example, the larger the ratio of PEG:ZcytoR14, the greater the percentage of polyPEGylated ZcytoR14 product.

5 The product of PEGylation by acylation is typically a polyPEGylated ZcytoR14 product, wherein the lysine ϵ -amino groups are PEGylated via an acyl linking group. An example of a connecting linkage is an amide. Typically, the resulting ZcytoR14 will be at least 95% mono-, di-, or tri-pegylated, although some species with higher degrees of PEGylation may be formed depending upon the reaction conditions. PEGylated species can be
10 separated from unconjugated ZcytoR14 polypeptides using standard purification methods, such as dialysis, ultrafiltration, ion exchange chromatography, affinity chromatography, and the like.

PEGylation by alkylation generally involves reacting a terminal aldehyde derivative of PEG with ZcytoR14 in the presence of a reducing agent. PEG groups can be attached to the polypeptide via a $-\text{CH}_2\text{-NH}$ group.

15 Moreover, anti-ZcytoR14 antibodies or antibody fragments of the present invention can be PEGylated using methods in the art and described herein.

Derivatization via reductive alkylation to produce a monoPEGylated product takes advantage of the differential reactivity of different types of primary amino groups available for derivatization. Typically, the reaction is performed at a pH that allows one to
20 take advantage of the pKa differences between the ϵ -amino groups of the lysine residues and the α -amino group of the *N*-terminal residue of the protein. By such selective derivatization, attachment of a water-soluble polymer that contains a reactive group such as an aldehyde, to a protein is controlled. The conjugation with the polymer occurs predominantly at the *N*-terminus of the protein without significant modification of other reactive groups such as the
25 lysine side chain amino groups. The present invention provides a substantially homogenous preparation of ZcytoR14 monopolymer conjugates.

Reductive alkylation to produce a substantially homogenous population of monopolymer ZcytoR14 conjugate molecule can comprise the steps of: (a) reacting a ZcytoR14 polypeptide with a reactive PEG under reductive alkylation conditions at a pH
30 suitable to permit selective modification of the α -amino group at the amino terminus of the ZcytoR14, and (b) obtaining the reaction product(s). The reducing agent used for reductive alkylation should be stable in aqueous solution and able to reduce only the Schiff base formed in the initial process of reductive alkylation. Illustrative reducing agents include sodium

borohydride, sodium cyanoborohydride, dimethylamine borane, trimethylamine borane, and pyridine borane.

For a substantially homogenous population of monopolymer ZcytoR14 conjugates, the reductive alkylation reaction conditions are those that permit the selective attachment of the water-soluble polymer moiety to the *N*-terminus of ZcytoR14. Such reaction conditions generally provide for pKa differences between the lysine amino groups and the α -amino group at the *N*-terminus. The pH also affects the ratio of polymer to protein to be used. In general, if the pH is lower, a larger excess of polymer to protein will be desired because the less reactive the *N*-terminal α -group, the more polymer is needed to achieve optimal conditions. If the pH is higher, the polymer:ZcytoR14 need not be as large because more reactive groups are available. Typically, the pH will fall within the range of 3 to 9, or 3 to 6. This method can be employed for making ZcytoR14-comprising homodimeric, heterodimeric or multimeric soluble receptor conjugates.

Another factor to consider is the molecular weight of the water-soluble polymer. Generally, the higher the molecular weight of the polymer, the fewer number of polymer molecules which may be attached to the protein. For PEGylation reactions, the typical molecular weight is about 2 kDa to about 100 kDa, about 5 kDa to about 50 kDa, or about 12 kDa to about 25 kDa. The molar ratio of water-soluble polymer to ZcytoR14 will generally be in the range of 1:1 to 100:1. Typically, the molar ratio of water-soluble polymer to ZcytoR14 will be 1:1 to 20:1 for polyPEGylation, and 1:1 to 5:1 for monoPEGylation.

General methods for producing conjugates comprising a polypeptide and water-soluble polymer moieties are known in the art. See, for example, Karasiewicz *et al.*, U.S. Patent No. 5,382,657, Greenwald *et al.*, U.S. Patent No. 5,738, 846, Nieforth *et al.*, *Clin. Pharmacol. Ther.* 59:636 (1996), Monkarsh *et al.*, *Anal. Biochem.* 247:434 (1997)). This method can be employed for making ZcytoR14-comprising homodimeric, heterodimeric or multimeric soluble receptor conjugates.

The present invention contemplates compositions comprising a peptide or polypeptide, such as a soluble receptor or antibody described herein. Such compositions can further comprise a carrier. The carrier can be a conventional organic or inorganic carrier. Examples of carriers include water, buffer solution, alcohol, propylene glycol, macrogol, sesame oil, corn oil, and the like.

G) Isolation of ZcytoR14 Polypeptides

The polypeptides of the present invention can be purified to at least about 80% purity, to at least about 90% purity, to at least about 95% purity, or greater than 95%, such as 96%, 97%, 98%, or greater than 99% purity with respect to contaminating macromolecules, particularly other proteins and nucleic acids, and free of infectious and pyrogenic agents. The polypeptides of the present invention may also be purified to a pharmaceutically pure state, which is greater than 99.9% pure. In certain preparations, purified polypeptide is substantially free of other polypeptides, particularly other polypeptides of animal origin.

Fractionation and/or conventional purification methods can be used to obtain preparations of ZcytoR14 purified from natural sources (*e.g.*, human tissue sources), synthetic ZcytoR14 polypeptides, and recombinant ZcytoR14 polypeptides and fusion ZcytoR14 polypeptides purified from recombinant host cells. In general, ammonium sulfate precipitation and acid or chaotrope extraction may be used for fractionation of samples. Exemplary purification steps may include hydroxyapatite, size exclusion, FPLC and reverse-phase high performance liquid chromatography. Suitable chromatographic media include derivatized dextrans, agarose, cellulose, polyacrylamide, specialty silicas, and the like. PEI, DEAE, QAE and Q derivatives are suitable. Exemplary chromatographic media include those media derivatized with phenyl, butyl, or octyl groups, such as Phenyl-Sepharose FF (Pharmacia), Toyopearl butyl 650 (Toso Haas, Montgomeryville, PA), Octyl-Sepharose (Pharmacia) and the like; or polyacrylic resins, such as Amberchrom CG 71 (Toso Haas) and the like. Suitable solid supports include glass beads, silica-based resins, cellulosic resins, agarose beads, cross-linked agarose beads, polystyrene beads, cross-linked polyacrylamide resins and the like that are insoluble under the conditions in which they are to be used. These supports may be modified with reactive groups that allow attachment of proteins by amino groups, carboxyl groups, sulfhydryl groups, hydroxyl groups and/or carbohydrate moieties.

Examples of coupling chemistries include cyanogen bromide activation, N-hydroxysuccinimide activation, epoxide activation, sulfhydryl activation, hydrazide activation, and carboxyl and amino derivatives for carbodiimide coupling chemistries. These and other solid media are well known and widely used in the art, and are available from commercial suppliers. Selection of a particular method for polypeptide isolation and purification is a matter of routine design and is determined in part by the properties of the chosen support. See, for example, *Affinity Chromatography: Principles & Methods* (Pharmacia LKB Biotechnology 1988), and Doonan, *Protein Purification Protocols* (The Humana Press 1996).

Additional variations in ZcytoR14 isolation and purification can be devised by those of skill in the art. For example, anti-ZcytoR14 antibodies, obtained as described below, can be used to isolate large quantities of protein by immunoaffinity purification.

The polypeptides of the present invention can also be isolated by exploitation of particular properties. For example, immobilized metal ion adsorption (IMAC) chromatography can be used to purify histidine-rich proteins, including those comprising polyhistidine tags. Briefly, a gel is first charged with divalent metal ions to form a chelate (Sulkowski, *Trends in Biochem.* 3:1 (1985)). Histidine-rich proteins will be adsorbed to this matrix with differing affinities, depending upon the metal ion used, and will be eluted by competitive elution, lowering the pH, or use of strong chelating agents. Other methods of purification include purification of glycosylated proteins by lectin affinity chromatography and ion exchange chromatography (M. Deutscher, (ed.), *Meth. Enzymol.* 182:529 (1990)). Within additional embodiments of the invention, a fusion of the polypeptide of interest and an affinity tag (*e.g.*, maltose-binding protein, an immunoglobulin domain) may be constructed to facilitate purification. Moreover, the ligand-binding properties of ZcytoR14 extracellular domain can be exploited for purification, for example, of ZcytoR14-comprising soluble receptors; for example, by using affinity chromatography wherein IL-17F ligand is bound to a column and the ZcytoR14-comprising receptor is bound and subsequently eluted using standard chromatography methods.

ZcytoR14 polypeptides or fragments thereof may also be prepared through chemical synthesis, as described above. ZcytoR14 polypeptides may be monomers or multimers; glycosylated or non-glycosylated; PEGylated or non-PEGylated; and may or may not include an initial methionine amino acid residue.

25 H) Production of Antibodies to ZcytoR14 Proteins

Antibodies to ZcytoR14 can be obtained, for example, using the product of a ZcytoR14 expression vector or ZcytoR14 isolated from a natural source as an antigen. Particularly useful anti-ZcytoR14 antibodies “bind specifically” with ZcytoR14. Antibodies are considered to be specifically binding if the antibodies exhibit at least one of the following two properties: (1) antibodies bind to ZcytoR14 with a threshold level of binding activity, and (2) antibodies do not significantly cross-react with polypeptides related to ZcytoR14.

With regard to the first characteristic, antibodies specifically bind if they bind to a ZcytoR14 polypeptide, peptide or epitope with a binding affinity (K_a) of 10^6 M^{-1} or greater, preferably 10^7 M^{-1} or greater, more preferably 10^8 M^{-1} or greater, and most preferably 10^9 M^{-1} or

greater. The binding affinity of an antibody can be readily determined by one of ordinary skill in the art, for example, by Scatchard analysis (Scatchard, *Ann. NY Acad. Sci.* 51:660 (1949)). With regard to the second characteristic, antibodies do not significantly cross-react with related polypeptide molecules, for example, if they detect ZcytoR14, but not presently known polypeptides using a standard Western blot analysis. Examples of known related polypeptides include known cytokine receptors.

Anti-ZcytoR14 antibodies can be produced using antigenic ZcytoR14 epitope-bearing peptides and polypeptides. Antigenic epitope-bearing peptides and polypeptides of the present invention contain a sequence of at least nine, or between 15 to about 30 amino acids contained within SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:5 or another amino acid sequence disclosed herein. However, peptides or polypeptides comprising a larger portion of an amino acid sequence of the invention, containing from 30 to 50 amino acids, or any length up to and including the entire amino acid sequence of a polypeptide of the invention, also are useful for inducing antibodies that bind with ZcytoR14. It is desirable that the amino acid sequence of the epitope-bearing peptide is selected to provide substantial solubility in aqueous solvents (*i.e.*, the sequence includes relatively hydrophilic residues, while hydrophobic residues are typically avoided). Moreover, amino acid sequences containing proline residues may be also be desirable for antibody production.

As an illustration, potential antigenic sites in ZcytoR14 were identified using the Jameson-Wolf method, Jameson and Wolf, *CABIOS* 4:181, (1988), as implemented by the PROTEAN program (version 3.14) of LASERGENE (DNASTAR; Madison, WI). Default parameters were used in this analysis.

The Jameson-Wolf method predicts potential antigenic determinants by combining six major subroutines for protein structural prediction. Briefly, the Hopp-Woods method, Hopp *et al.*, *Proc. Nat'l Acad. Sci. USA* 78:3824 (1981), was first used to identify amino acid sequences representing areas of greatest local hydrophilicity (parameter: seven residues averaged). In the second step, Emini's method, Emini *et al.*, *J. Virology* 55:836 (1985), was used to calculate surface probabilities (parameter: surface decision threshold (0.6) = 1). Third, the Karplus-Schultz method, Karplus and Schultz, *Naturwissenschaften* 72:212 (1985), was used to predict backbone chain flexibility (parameter: flexibility threshold (0.2) = 1). In the fourth and fifth steps of the analysis, secondary structure predictions were applied to the data using the methods of Chou-Fasman, Chou, "Prediction of Protein Structural Classes from Amino Acid Composition," in *Prediction of Protein Structure and the Principles of Protein Conformation*, Fasman (ed.), pages 549-586 (Plenum Press 1990), and Garnier-

Robson, Garnier *et al.*, *J. Mol. Biol.* 120:97 (1978) (Chou-Fasman parameters: conformation table = 64 proteins; α region threshold = 103; β region threshold = 105; Garnier-Robson parameters: α and β decision constants = 0). In the sixth subroutine, flexibility parameters and hydrophathy/solvent accessibility factors were combined to determine a surface contour value, designated as the "antigenic index." Finally, a peak broadening function was applied to the antigenic index, which broadens major surface peaks by adding 20, 40, 60, or 80% of the respective peak value to account for additional free energy derived from the mobility of surface regions relative to interior regions. This calculation was not applied, however, to any major peak that resides in a helical region, since helical regions tend to be less flexible. Hopp/Woods hydrophilicity profiles can be used to determine regions that have the most antigenic potential within SEQ ID NO:3 (Hopp *et al.*, *Proc. Natl. Acad. Sci.* 78:3824-3828, 1981; Hopp, *J. Immun. Meth.* 88:1-18, 1986 and Triquier *et al.*, *Protein Engineering* 11:153-169, 1998). The profile is based on a sliding six-residue window. Buried G, S, and T residues and exposed H, Y, and W residues were ignored. Moreover, ZcytoR14 antigenic epitopes within SEQ ID NO:3 as predicted by a Jameson-Wolf plot, e.g., using DNASTAR Protean program (DNASTAR, Inc., Madison, WI) serve as preferred antigenic epitopes, and can be determined by one of skill in the art. Such antigenic epitopes include (1) amino acid residue 73 to amino acid residue 82 of SEQ ID NO:3; (2) amino acid residue 95 to amino acid residue 104 of SEQ ID NO:3; (3) amino acid residue 111 to amino acid residue 119 of SEQ ID NO:3; (4) amino acid residue 179 to amino acid residue 186 of SEQ ID NO:3; (5) amino acid residue 200 to amino acid residue 205 of SEQ ID NO:3; (6) amino acid residue 229 to amino acid residue 236 of SEQ ID NO:3; (7) amino acid residue 264 to amino acid residue 268 of SEQ ID NO:3; and (8) amino acid residue 275 to amino acid residue 281 of SEQ ID NO:3. The present invention contemplates the use of any one of antigenic peptides X to Y to generate antibodies to ZcytoR14 or as a tool to screen or identify neutralizing monoclonal antibodies of the present invention. The present invention also contemplates polypeptides comprising at least one of antigenic peptides X to Y. The present invention contemplates the use of any antigenic peptides or epitopes described herein to generate antibodies to ZcytoR14, as well as to identify and screen anti-ZcytoR14 monoclonal antibodies that are neutralizing, and that may bind, block, inhibit, reduce, antagonize or neutralize the activity of IL-17F and IL-17A (individually or together).

Moreover, suitable antigens also include the ZcytoR14 polypeptides comprising a ZcytoR14 cytokine binding, or extracellular domain disclosed above in combination with another cytokine extracellular domain, such as a class I or II cytokine

receptor domain, such as those that may form soluble ZcytoR14 heterodimeric or multimeric polypeptides, and the like.

Polyclonal antibodies to recombinant ZcytoR14 protein or to ZcytoR14 isolated from natural sources can be prepared using methods well-known to those of skill in the art. See, for example, Green *et al.*, "Production of Polyclonal Antisera," in *Immunochemical Protocols* (Manson, ed.), pages 1-5 (Humana Press 1992), and Williams *et al.*, "Expression of foreign proteins in *E. coli* using plasmid vectors and purification of specific polyclonal antibodies," in *DNA Cloning 2: Expression Systems, 2nd Edition*, Glover *et al.* (eds.), page 15 (Oxford University Press 1995). The immunogenicity of a ZcytoR14 polypeptide can be increased through the use of an adjuvant, such as alum (aluminum hydroxide) or Freund's complete or incomplete adjuvant. Polypeptides useful for immunization also include fusion polypeptides, such as fusions of ZcytoR14 or a portion thereof with an immunoglobulin polypeptide or with maltose binding protein. The polypeptide immunogen may be a full-length molecule or a portion thereof. If the polypeptide portion is "hapten-like," such portion may be advantageously joined or linked to a macromolecular carrier (such as keyhole limpet hemocyanin (KLH), bovine serum albumin (BSA) or tetanus toxoid) for immunization.

Although polyclonal antibodies are typically raised in animals such as horses, cows, dogs, chicken, rats, mice, rabbits, guinea pigs, goats, or sheep, an anti-ZcytoR14 antibody of the present invention may also be derived from a subhuman primate antibody. General techniques for raising diagnostically and therapeutically useful antibodies in baboons may be found, for example, in Goldenberg *et al.*, international patent publication No. WO 91/11465, and in Losman *et al.*, *Int. J. Cancer* 46:310 (1990).

Alternatively, monoclonal anti-ZcytoR14 antibodies can be generated. Rodent monoclonal antibodies to specific antigens may be obtained by methods known to those skilled in the art (see, for example, Kohler *et al.*, *Nature* 256:495 (1975), Coligan *et al.* (eds.), *Current Protocols in Immunology, Vol. 1*, pages 2.5.1-2.6.7 (John Wiley & Sons 1991) ["Coligan"], Picksley *et al.*, "Production of monoclonal antibodies against proteins expressed in *E. coli*," in *DNA Cloning 2: Expression Systems, 2nd Edition*, Glover *et al.* (eds.), page 93 (Oxford University Press 1995)).

Briefly, monoclonal antibodies can be obtained by injecting mice with a composition comprising a ZcytoR14 gene product, verifying the presence of antibody production by removing a serum sample, removing the spleen to obtain B-lymphocytes, fusing the B-lymphocytes with myeloma cells to produce hybridomas, cloning the hybridomas,

selecting positive clones which produce antibodies to the antigen, culturing the clones that produce antibodies to the antigen, and isolating the antibodies from the hybridoma cultures.

In addition, an anti-ZcytoR14 antibody of the present invention may be derived from a human monoclonal antibody. Human monoclonal antibodies are obtained from transgenic mice that have been engineered to produce specific human antibodies in response to antigenic challenge. In this technique, elements of the human heavy and light chain locus are introduced into strains of mice derived from embryonic stem cell lines that contain targeted disruptions of the endogenous heavy chain and light chain loci. The transgenic mice can synthesize human antibodies specific for human antigens, and the mice can be used to produce human antibody-secreting hybridomas. Methods for obtaining human antibodies from transgenic mice are described, for example, by Green *et al.*, *Nature Genet.* 7:13 (1994), Lonberg *et al.*, *Nature* 368:856 (1994), and Taylor *et al.*, *Int. Immun.* 6:579 (1994).

Monoclonal antibodies can be isolated and purified from hybridoma cultures by a variety of well-established techniques. Such isolation techniques include affinity chromatography with Protein-A Sepharose, size-exclusion chromatography, and ion-exchange chromatography (see, for example, Coligan at pages 2.7.1-2.7.12 and pages 2.9.1-2.9.3; Baines *et al.*, "Purification of Immunoglobulin G (IgG)," in *Methods in Molecular Biology*, Vol. 10, pages 79-104 (The Humana Press, Inc. 1992)).

For particular uses, it may be desirable to prepare fragments of anti-ZcytoR14 antibodies. Such antibody fragments can be obtained, for example, by proteolytic hydrolysis of the antibody. Antibody fragments can be obtained by pepsin or papain digestion of whole antibodies by conventional methods. As an illustration, antibody fragments can be produced by enzymatic cleavage of antibodies with pepsin to provide a 5S fragment denoted F(ab')₂. This fragment can be further cleaved using a thiol reducing agent to produce 3.5S Fab' monovalent fragments. Optionally, the cleavage reaction can be performed using a blocking group for the sulfhydryl groups that result from cleavage of disulfide linkages. As an alternative, an enzymatic cleavage using pepsin produces two monovalent Fab fragments and an Fc fragment directly. These methods are described, for example, by Goldenberg, U.S. patent No. 4,331,647, Nisonoff *et al.*, *Arch Biochem. Biophys.* 89:230 (1960), Porter, *Biochem. J.* 73:119 (1959), Edelman *et al.*, in *Methods in Enzymology Vol. 1*, page 422 (Academic Press 1967), and by Coligan at pages 2.8.1-2.8.10 and 2.10.-2.10.4.

Other methods of cleaving antibodies, such as separation of heavy chains to form monovalent light-heavy chain fragments, further cleavage of fragments, or other

enzymatic, chemical or genetic techniques may also be used, so long as the fragments bind to the antigen that is recognized by the intact antibody.

For example, Fv fragments comprise an association of V_H and V_L chains. This association can be noncovalent, as described by Inbar *et al.*, *Proc. Nat'l Acad. Sci. USA* 69:2659 (1972). Alternatively, the variable chains can be linked by an intermolecular disulfide bond or cross-linked by chemicals such as glutaraldehyde (see, for example, Sandhu, *Crit. Rev. Biotech.* 12:437 (1992)).

The Fv fragments may comprise V_H and V_L chains which are connected by a peptide linker. These single-chain antigen binding proteins (scFv) are prepared by constructing a structural gene comprising DNA sequences encoding the V_H and V_L domains which are connected by an oligonucleotide. The structural gene is inserted into an expression vector which is subsequently introduced into a host cell, such as *E. coli*. The recombinant host cells synthesize a single polypeptide chain with a linker peptide bridging the two V domains. Methods for producing scFvs are described, for example, by Whitlow *et al.*, *Methods: A Companion to Methods in Enzymology* 2:97 (1991) (also see, Bird *et al.*, *Science* 242:423 (1988), Ladner *et al.*, U.S. Patent No. 4,946,778, Pack *et al.*, *Bio/Technology* 11:1271 (1993), and Sandhu, *supra*).

As an illustration, a scFV can be obtained by exposing lymphocytes to ZcytoR14 polypeptide *in vitro*, and selecting antibody display libraries in phage or similar vectors (for instance, through use of immobilized or labeled ZcytoR14 protein or peptide). Genes encoding polypeptides having potential ZcytoR14 polypeptide binding domains can be obtained by screening random peptide libraries displayed on phage (phage display) or on bacteria, such as *E. coli*. Nucleotide sequences encoding the polypeptides can be obtained in a number of ways, such as through random mutagenesis and random polynucleotide synthesis. These random peptide display libraries can be used to screen for peptides which interact with a known target which can be a protein or polypeptide, such as a ligand or receptor, a biological or synthetic macromolecule, or organic or inorganic substances. Techniques for creating and screening such random peptide display libraries are known in the art (Ladner *et al.*, U.S. Patent No. 5,223,409, Ladner *et al.*, U.S. Patent No. 4,946,778, Ladner *et al.*, U.S. Patent No. 5,403,484, Ladner *et al.*, U.S. Patent No. 5,571,698, and Kay *et al.*, *Phage Display of Peptides and Proteins* (Academic Press, Inc. 1996)) and random peptide display libraries and kits for screening such libraries are available commercially, for instance from CLONTECH Laboratories, Inc. (Palo Alto, CA), Invitrogen Inc. (San Diego, CA), New England Biolabs, Inc. (Beverly, MA), and Pharmacia LKB Biotechnology Inc. (Piscataway, NJ). Random

peptide display libraries can be screened using the ZcytoR14 sequences disclosed herein to identify proteins which bind to ZcytoR14.

Another form of an antibody fragment is a peptide coding for a single complementarity-determining region (CDR). CDR peptides ("minimal recognition units") can be obtained by constructing genes encoding the CDR of an antibody of interest. Such genes are prepared, for example, by using the polymerase chain reaction to synthesize the variable region from RNA of antibody-producing cells (see, for example, Larrick *et al.*, *Methods: A Companion to Methods in Enzymology* 2:106 (1991), Courtenay-Luck, "Genetic Manipulation of Monoclonal Antibodies," in *Monoclonal Antibodies: Production, Engineering and Clinical Application*, Ritter *et al.* (eds.), page 166 (Cambridge University Press 1995), and Ward *et al.*, "Genetic Manipulation and Expression of Antibodies," in *Monoclonal Antibodies: Principles and Applications*, Birch *et al.*, (eds.), page 137 (Wiley-Liss, Inc. 1995)).

Alternatively, an anti-ZcytoR14 antibody may be derived from a "humanized" monoclonal antibody. Humanized monoclonal antibodies are produced by transferring mouse complementary determining regions from heavy and light variable chains of the mouse immunoglobulin into a human variable domain. Typical residues of human antibodies are then substituted in the framework regions of the murine counterparts. The use of antibody components derived from humanized monoclonal antibodies obviates potential problems associated with the immunogenicity of murine constant regions. General techniques for cloning murine immunoglobulin variable domains are described, for example, by Orlandi *et al.*, *Proc. Nat'l Acad. Sci. USA* 86:3833 (1989). Techniques for producing humanized monoclonal antibodies are described, for example, by Jones *et al.*, *Nature* 321:522 (1986), Carter *et al.*, *Proc. Nat'l Acad. Sci. USA* 89:4285 (1992), Sandhu, *Crit. Rev. Biotech.* 12:437 (1992), Singer *et al.*, *J. Immun.* 150:2844 (1993), Sudhir (ed.), *Antibody Engineering Protocols* (Humana Press, Inc. 1995), Kelley, "Engineering Therapeutic Antibodies," in *Protein Engineering: Principles and Practice*, Cleland *et al.* (eds.), pages 399-434 (John Wiley & Sons, Inc. 1996), and by Queen *et al.*, U.S. Patent No. 5,693,762 (1997).

Moreover, anti-ZcytoR14 antibodies or antibody fragments of the present invention can be PEGylated using methods in the art and described herein.

Polyclonal anti-idiotypic antibodies can be prepared by immunizing animals with anti-ZcytoR14 antibodies or antibody fragments, using standard techniques. See, for example, Green *et al.*, "Production of Polyclonal Antisera," in *Methods In Molecular Biology: Immunochemical Protocols*, Manson (ed.), pages 1-12 (Humana Press 1992). Also, see Coligan at pages 2.4.1-2.4.7. Alternatively, monoclonal anti-idiotypic antibodies can be

prepared using anti-ZcytoR14 antibodies or antibody fragments as immunogens with the techniques, described above. As another alternative, humanized anti-idiotypic antibodies or subhuman primate anti-idiotypic antibodies can be prepared using the above-described techniques. Methods for producing anti-idiotypic antibodies are described, for example, by Irie,
5 U.S. Patent No. 5,208,146, Greene, *et. al.*, U.S. Patent No. 5,637,677, and Varthakavi and Minocha, *J. Gen. Virol.* 77:1875 (1996).

An anti-ZcytoR14 antibody can be conjugated with a detectable label to form an anti-ZcytoR14 immunoconjugate. Suitable detectable labels include, for example, a radioisotope, a fluorescent label, a chemiluminescent label, an enzyme label, a bioluminescent label or
10 colloidal gold. Methods of making and detecting such detectably-labeled immunoconjugates are well-known to those of ordinary skill in the art, and are described in more detail below.

The detectable label can be a radioisotope that is detected by autoradiography. Isotopes that are particularly useful for the purpose of the present invention are ^3H , ^{125}I , ^{131}I , ^{35}S and ^{14}C .

15 Anti-ZcytoR14 immunoconjugates can also be labeled with a fluorescent compound. The presence of a fluorescently-labeled antibody is determined by exposing the immunoconjugate to light of the proper wavelength and detecting the resultant fluorescence. Fluorescent labeling compounds include fluorescein isothiocyanate, rhodamine, phycoerytherin, phycocyanin, allophycocyanin, o-phthaldehyde and fluorescamine.

20 Alternatively, anti-ZcytoR14 immunoconjugates can be detectably labeled by coupling an antibody component to a chemiluminescent compound. The presence of the chemiluminescent-tagged immunoconjugate is determined by detecting the presence of luminescence that arises during the course of a chemical reaction. Examples of chemiluminescent labeling compounds include luminol, isoluminol, an aromatic acridinium ester, an imidazole, an
25 acridinium salt and an oxalate ester.

Similarly, a bioluminescent compound can be used to label anti-ZcytoR14 immunoconjugates of the present invention. Bioluminescence is a type of chemiluminescence found in biological systems in which a catalytic protein increases the efficiency of the chemiluminescent reaction. The presence of a bioluminescent protein is determined by detecting
30 the presence of luminescence. Bioluminescent compounds that are useful for labeling include luciferin, luciferase and aequorin.

Alternatively, anti-ZcytoR14 immunoconjugates can be detectably labeled by linking an anti-ZcytoR14 antibody component to an enzyme. When the anti-ZcytoR14-enzyme conjugate is incubated in the presence of the appropriate substrate, the enzyme moiety reacts with

the substrate to produce a chemical moiety which can be detected, for example, by spectrophotometric, fluorometric or visual means. Examples of enzymes that can be used to detectably label polyspecific immunoconjugates include β -galactosidase, glucose oxidase, peroxidase and alkaline phosphatase.

5 Those of skill in the art will know of other suitable labels which can be employed in accordance with the present invention. The binding of marker moieties to anti-ZcytoR14 antibodies can be accomplished using standard techniques known to the art. Typical methodology in this regard is described by Kennedy *et al.*, *Clin. Chim. Acta* 70:1 (1976), Schurs *et al.*, *Clin. Chim. Acta* 81:1 (1977), Shih *et al.*, *Int'l J. Cancer* 46:1101 (1990), Stein *et al.*,
10 *Cancer Res.* 50:1330 (1990), and Coligan, *supra*.

 Moreover, the convenience and versatility of immunochemical detection can be enhanced by using anti-ZcytoR14 antibodies that have been conjugated with avidin, streptavidin, and biotin (see, for example, Wilchek *et al.* (eds.), "Avidin-Biotin Technology," *Methods In Enzymology*, Vol. 184 (Academic Press 1990), and Bayer *et al.*, "Immunochemical Applications
15 of Avidin-Biotin Technology," in *Methods In Molecular Biology*, Vol. 10, Manson (ed.), pages 149-162 (The Humana Press, Inc. 1992).

 Methods for performing immunoassays are well-established. See, for example, Cook and Self, "Monoclonal Antibodies in Diagnostic Immunoassays," in *Monoclonal Antibodies: Production, Engineering, and Clinical Application*, Ritter and Ladyman (eds.), pages
20 180-208, (Cambridge University Press, 1995), Perry, "The Role of Monoclonal Antibodies in the Advancement of Immunoassay Technology," in *Monoclonal Antibodies: Principles and Applications*, Birch and Lennox (eds.), pages 107-120 (Wiley-Liss, Inc. 1995), and Diamandis, *Immunoassay* (Academic Press, Inc. 1996).

 The present invention also contemplates kits for performing an immunological
25 diagnostic assay for ZcytoR14 gene expression. Such kits comprise at least one container comprising an anti-ZcytoR14 antibody, or antibody fragment. A kit may also comprise a second container comprising one or more reagents capable of indicating the presence of ZcytoR14 antibody or antibody fragments. Examples of such indicator reagents include detectable labels such as a radioactive label, a fluorescent label, a chemiluminescent label, an
30 enzyme label, a bioluminescent label, colloidal gold, and the like. A kit may also comprise a means for conveying to the user that ZcytoR14 antibodies or antibody fragments are used to detect ZcytoR14 protein. For example, written instructions may state that the enclosed antibody or antibody fragment can be used to detect ZcytoR14. The written material can be

applied directly to a container, or the written material can be provided in the form of a packaging insert.

I) Use of Anti-ZcytoR14 Antibodies to Antagonize ZcytoR14 Binding to IL-17F or both IL-17A and IL-17F

Alternative techniques for generating or selecting antibodies useful herein include *in vitro* exposure of lymphocytes to soluble ZcytoR14 receptor polypeptides or fragments thereof, such as antigenic epitopes, and selection of antibody display libraries in phage or similar vectors (for instance, through use of immobilized or labeled soluble ZcytoR14 receptor polypeptides or fragments thereof, such as antigenic epitopes). Genes encoding polypeptides having potential binding domains such as soluble ZcytoR14 receptor polypeptides or fragments thereof, such as antigenic epitopes can be obtained by screening random peptide libraries displayed on phage (phage display) or on bacteria, such as *E. coli*. Nucleotide sequences encoding the polypeptides can be obtained in a number of ways, such as through random mutagenesis and random polynucleotide synthesis. These random peptide display libraries can be used to screen for peptides that interact with a known target that can be a protein or polypeptide, such as a ligand or receptor, a biological or synthetic macromolecule, or organic or inorganic substances. Techniques for creating and screening such random peptide display libraries are known in the art (Ladner et al., US Patent NO. 5,223,409; Ladner et al., US Patent NO. 4,946,778; Ladner et al., US Patent NO. 5,403,484 and Ladner et al., US Patent NO. 5,571,698) and random peptide display libraries and kits for screening such libraries are available commercially, for instance from Clontech (Palo Alto, CA), Invitrogen Inc. (San Diego, CA), New England Biolabs, Inc. (Beverly, MA) and Pharmacia LKB Biotechnology Inc. (Piscataway, NJ). Random peptide display libraries can be screened using the soluble ZcytoR14 receptor polypeptides or fragments thereof, such as antigenic epitope polypeptide sequences disclosed herein to identify proteins which bind to ZcytoR14-comprising receptor polypeptides. These "binding polypeptides," which interact with soluble ZcytoR14-comprising receptor polypeptides, can be used for tagging cells; for isolating homolog polypeptides by affinity purification; they can be directly or indirectly conjugated to drugs, toxins, radionuclides and the like. These binding polypeptides can also be used in analytical methods such as for screening expression libraries and neutralizing activity, e.g., for binding, blocking, inhibiting, reducing, antagonizing or neutralizing interaction between IL-17A and IL-17F (individually or together) and ZcytoR14, or viral binding to a receptor. The binding polypeptides can also be used for diagnostic assays for determining circulating levels

of soluble ZcytoR14-comprising receptor polypeptides; for detecting or quantitating soluble or non-soluble ZcytoR14-comprising receptors as marker of underlying pathology or disease. These binding polypeptides can also act as "antagonists" to block or inhibit soluble or membrane-bound ZcytoR14 monomeric receptor or ZcytoR14 homodimeric, heterodimeric or multimeric polypeptide binding (e.g. to ligand) and signal transduction *in vitro* and *in vivo*. Again, these binding polypeptides serve as anti-ZcytoR14 monomeric receptor or anti-ZcytoR14 homodimeric, heterodimeric or multimeric polypeptides and are useful for inhibiting IL-17F or both IL-17A and IL-17F activity, as well as receptor activity or protein-binding. Antibodies raised to the natural receptor complexes of the present invention, and ZcytoR14-epitope-binding antibodies, and anti-ZcytoR14 neutralizing monoclonal antibodies may be preferred embodiments, as they may act more specifically against the ZcytoR14 and can inhibit IL-17F or both IL-17A and IL-17F. Moreover, the antagonistic and binding activity of the antibodies of the present invention can be assayed in an IL-17A or IL-17F proliferation, signal trap, luciferase or binding assays in the presence of IL-17A or IL-17F respectively, and ZcytoR14-comprising soluble receptors, and other biological or biochemical assays described herein.

Antibodies to soluble ZcytoR14 receptor polypeptides (e.g., antibodies to SEQ ID NO:3) or fragments thereof, such as antigenic epitopes may be used for inhibiting the inflammatory effects of IL-17A, IL-17F, or both IL-17A and IL-17F *in vivo*, for therapeutic use against inflammation and inflammatory diseases such as psoriasis, psoriatic arthritis, rheumatoid arthritis, endotoxemia, inflammatory bowel disease (IBD), colitis, asthma, allograft rejection, immune mediated renal diseases, hepatobiliary diseases, multiple sclerosis, atherosclerosis, promotion of tumor growth, or degenerative joint disease and other inflammatory conditions disclosed herein; tagging cells that express ZcytoR14 receptors; for isolating soluble ZcytoR14-comprising receptor polypeptides by affinity purification; for diagnostic assays for determining circulating levels of soluble ZcytoR14-comprising receptor polypeptides; for detecting or quantitating soluble ZcytoR14-comprising receptors as marker of underlying pathology or disease; in analytical methods employing FACS; for screening expression libraries; for generating anti-idiotypic antibodies that can act as IL-17F or IL-17A agonists; and as neutralizing antibodies or as antagonists to bind, block, inhibit, reduce, or antagonize ZcytoR14 receptor function, or to bind, block, inhibit, reduce, antagonize or neutralize IL-17F and/or IL-17A activity (either individually or together) *in vitro* and *in vivo*. Suitable direct tags or labels include radionuclides, enzymes, substrates, cofactors, biotin, inhibitors, fluorescent markers, chemiluminescent markers, magnetic particles and the like;

indirect tags or labels may feature use of biotin-avidin or other complement/anti-complement pairs as intermediates. Antibodies herein may also be directly or indirectly conjugated to drugs, toxins, radionuclides and the like, and these conjugates used for *in vivo* diagnostic or therapeutic applications. Moreover, antibodies to soluble ZcytoR14-comprising receptor polypeptides, or fragments thereof may be used *in vitro* to detect denatured or non-denatured ZcytoR14-comprising receptor polypeptides or fragments thereof in assays, for example, Western Blots or other assays known in the art.

Antibodies to soluble ZcytoR14 receptor or soluble ZcytoR14 homodimeric, heterodimeric or multimeric receptor polypeptides are useful for tagging cells that express the corresponding receptors and assaying their expression levels, for affinity purification, within diagnostic assays for determining circulating levels of receptor polypeptides, analytical methods employing fluorescence-activated cell sorting. Moreover, divalent antibodies, and anti-idiotypic antibodies may be used as agonists to mimic the effect of the ZcytoR14 ligand, IL-17F or IL-17A.

Antibodies herein can also be directly or indirectly conjugated to drugs, toxins, radionuclides and the like, and these conjugates used for *in vivo* diagnostic or therapeutic applications. For instance, antibodies or binding polypeptides which recognize soluble ZcytoR14 receptor or soluble ZcytoR14 homodimeric, heterodimeric or multimeric receptor polypeptides can be used to identify or treat tissues or organs that express a corresponding anti-complementary molecule (i.e., a ZcytoR14-comprising soluble or membrane-bound receptor). More specifically, antibodies to soluble ZcytoR14-comprising receptor polypeptides, or bioactive fragments or portions thereof, can be coupled to detectable or cytotoxic molecules and delivered to a mammal having cells, tissues or organs that express the ZcytoR14-comprising receptor such as ZcytoR14-expressing cancers.

Suitable detectable molecules may be directly or indirectly attached to polypeptides that bind ZcytoR14-comprising receptor polypeptides, such as "binding polypeptides," (including binding peptides disclosed above), antibodies, or bioactive fragments or portions thereof. Suitable detectable molecules include radionuclides, enzymes, substrates, cofactors, inhibitors, fluorescent markers, chemiluminescent markers, magnetic particles and the like. Suitable cytotoxic molecules may be directly or indirectly attached to the polypeptide or antibody, and include bacterial or plant toxins (for instance, diphtheria toxin, *Pseudomonas* exotoxin, ricin, abrin and the like), as well as therapeutic radionuclides, such as iodine-131, rhenium-188 or yttrium-90 (either directly attached to the polypeptide or antibody, or indirectly attached through means of a chelating moiety, for instance). Binding polypeptides or

antibodies may also be conjugated to cytotoxic drugs, such as adriamycin. For indirect attachment of a detectable or cytotoxic molecule, the detectable or cytotoxic molecule can be conjugated with a member of a complementary/ anticomplementary pair, where the other member is bound to the binding polypeptide or antibody portion. For these purposes,
5 biotin/streptavidin is an exemplary complementary/ anticomplementary pair.

In another embodiment, binding polypeptide-toxin fusion proteins or antibody-toxin fusion proteins can be used for targeted cell or tissue inhibition or ablation (for instance, to treat cancer cells or tissues). Alternatively, if the binding polypeptide has multiple functional domains (i.e., an activation domain or a ligand binding domain, plus a targeting
10 domain), a fusion protein including only the targeting domain may be suitable for directing a detectable molecule, a cytotoxic molecule or a complementary molecule to a cell or tissue type of interest. In instances where the fusion protein including only a single domain includes a complementary molecule, the anti-complementary molecule can be conjugated to a detectable or cytotoxic molecule. Such domain-complementary molecule fusion proteins thus represent a
15 generic targeting vehicle for cell/tissue-specific delivery of generic anti-complementary-detectable/ cytotoxic molecule conjugates.

In another embodiment, ZcytoR14 binding polypeptide-cytokine or antibody-cytokine fusion proteins can be used for enhancing *in vivo* killing of target tissues (for example, spleen, pancreatic, blood, lymphoid, colon, and bone marrow cancers), if the binding
20 polypeptide-cytokine or anti- ZcytoR14 receptor antibody targets the hyperproliferative cell (See, generally, Hornick et al., Blood 89:4437-47, 1997). The described fusion proteins enable targeting of a cytokine to a desired site of action, thereby providing an elevated local concentration of cytokine. Suitable anti-ZcytoR14 monomer, homodimer, heterodimer or multimer antibodies target an undesirable cell or tissue (i.e., a tumor or a leukemia), and the
25 fused cytokine mediates improved target cell lysis by effector cells. Suitable cytokines for this purpose include interleukin 2 and granulocyte-macrophage colony-stimulating factor (GM-CSF), for instance.

Alternatively, ZcytoR14 receptor binding polypeptides or antibody fusion proteins described herein can be used for enhancing *in vivo* killing of target tissues by directly
30 stimulating a ZcytoR14 receptor-modulated apoptotic pathway, resulting in cell death of hyperproliferative cells expressing ZcytoR14-comprising receptors.

J) Therapeutic Uses of Polypeptides Having ZcytoR14 Activity or Antibodies to ZcytoR14

Amino acid sequences having soluble ZcytoR14 activity can be used to modulate the immune system by binding ZcytoR14 ligands IL-17A and IL-17F (either singly or together), and thus, preventing the binding of ZcytoR14 ligand with endogenous ZcytoR14 receptor. ZcytoR14 antagonists, such as soluble ZcytoR14 or anti-ZcytoR14 antibodies, can also be used to modulate the immune system by inhibiting the binding of ZcytoR14 ligand with the endogenous ZcytoR14 receptor. Accordingly, the present invention includes the use of proteins, polypeptides, and peptides having ZcytoR14 activity (such as soluble ZcytoR14 polypeptides, ZcytoR14 polypeptide fragments, ZcytoR14 analogs (*e.g.*, anti-ZcytoR14 anti-idiotypic antibodies), and ZcytoR14 fusion proteins) to a subject which lacks an adequate amount of this polypeptide, or which produces an excess of ZcytoR14 ligand. ZcytoR14 antagonists (*e.g.*, anti-ZcytoR14 antibodies) can be also used to treat a subject which produces an excess of either ZcytoR14 ligand or ZcytoR14. Suitable subjects include mammals, such as humans. For example, such ZcytoR14 polypeptides and anti-ZcytoR14 antibodies are useful in binding, blocking, inhibiting, reducing, antagonizing or neutralizing IL-17A and IL-17F (either singly or together), in the treatment of inflammation and inflammatory diseases such as psoriasis, psoriatic arthritis, rheumatoid arthritis, endotoxemia, inflammatory bowel disease (IBD), colitis, asthma, allograft rejection, immune mediated renal diseases, hepatobiliary diseases, multiple sclerosis, atherosclerosis, promotion of tumor growth, or degenerative joint disease and other inflammatory conditions disclosed herein.

Within preferred embodiments, the soluble receptor form of ZcytoR14, SEQ ID NO:3) is a monomer, homodimer, heterodimer, or multimer that binds to, blocks, inhibits, reduces, antagonizes or neutralizes IL-17F and IL-17A (individually or together) *in vivo*. Antibodies and binding polypeptides to such ZcytoR14 monomer, homodimer, heterodimer, or multimers also serve as antagonists of ZcytoR14 activity, and as IL-17A and IL-17F antagonists (singly or together), as described herein.

In addition, we have described herein that both polyclonal and monoclonal neutralizing anti-IL-17F antibodies bind to, block, inhibit, reduce, antagonize or neutralize IL-17F and IL-17A activity in cell based neutralization assays. Analysis of the tissue distribution of the mRNA corresponding ZcytoR14 cDNA showed that mRNA the *ZcytoR14* gene is strongly expressed in thyroid, adrenal gland, prostate, and liver tissues, and expressed to a lesser extent in heart, small intestine, stomach, and trachea tissues. In particular, ZcytoR14 is consistently expressed in non-T cell peripheral blood cell lines, including monocytes, B-cells,

and cells of the myeloid lineage. Also, ZcytoR14 mRNA is reliably expressed in cell lines derived from skin. Other cell lines that express ZcytoR14 are all 5 of the large intestine cell lines that were present on the array. In contrast, there is little or no expression in brain, placenta, lung, skeletal muscle, kidney, pancreas, spleen, thymus, testis, ovary, colon, peripheral blood leukocytes, spinal cord, lymph node, and bone marrow. The ligand to which ZcytoR14 binds (IL-17F and/or IL-17A) is implicated in inducing inflammatory response and contributing to inflammatory diseases, primarily via its ability to enhance production of inflammatory mediators, including IL-1b, IL-6 and TNF-a, as well as those mediators that are involved in the proliferation, maturation and chemotaxis of neutrophils (reviewed in Witowski et al. Cell. Mol. Life Sci. 61:567-579 [2004]).

Thus, particular embodiments of the present invention are directed toward use of soluble ZcytoR14 and anti-ZcytoR14 antibodies as antagonists in inflammatory and immune diseases or conditions such as psoriasis, psoriatic arthritis, atopic dermatitis, inflammatory skin conditions, rheumatoid arthritis, inflammatory bowel disease (IBD), Crohn's Disease, diverticulosis, asthma, pancreatitis, type I diabetes (IDDM), pancreatic cancer, pancreatitis, Graves Disease, colon and intestinal cancer, autoimmune disease, sepsis, organ or bone marrow transplant; inflammation due to endotoxemia, trauma, surgery or infection; amyloidosis; splenomegaly; graft versus host disease; and where inhibition of inflammation, immune suppression, reduction of proliferation of hematopoietic, immune, inflammatory or lymphoid cells, macrophages, T-cells (including Th1 and Th2 cells), suppression of immune response to a pathogen or antigen, or other instances where inhibition of IL-17F or IL-17A cytokines is desired.

Moreover, antibodies or binding polypeptides that bind ZcytoR14 polypeptides described herein, and ZcytoR14 polypeptides themselves are useful to:

1) Block, inhibit, reduce, antagonize or neutralize signaling via IL-17A or IL-17F receptors in the treatment of acute inflammation, inflammation as a result of trauma, tissue injury, surgery, sepsis or infection, and chronic inflammatory diseases such as asthma, inflammatory bowel disease (IBD), chronic colitis, splenomegaly, rheumatoid arthritis, recurrent acute inflammatory episodes (e.g., tuberculosis), and treatment of amyloidosis, and atherosclerosis, Castleman's Disease, asthma, and other diseases associated with the induction of acute-phase response.

2) Block, inhibit, reduce, antagonize or neutralize signaling via IL-17A or IL-17F receptors in the treatment of autoimmune diseases such as IDDM, multiple sclerosis (MS),

systemic Lupus erythematosus (SLE), myasthenia gravis, rheumatoid arthritis, and IBD to prevent or inhibit signaling in immune cells (e.g. lymphocytes, monocytes, leukocytes) via ZcytoR14. Alternatively antibodies, such as monoclonal antibodies (MAb) to ZcytoR14-comprising receptors, can also be used as an antagonist to deplete unwanted immune cells to treat autoimmune disease. Asthma, allergy and other atopic disease may be treated with an MAb against, for example, soluble ZcytoR14 soluble receptors to inhibit the immune response or to deplete offending cells. Blocking, inhibiting, reducing, or antagonizing signaling via ZcytoR14, using the polypeptides and antibodies of the present invention, may also benefit diseases of the pancreas, kidney, pituitary and neuronal cells. IDDM, NIDDM, pancreatitis, and pancreatic carcinoma may benefit. ZcytoR14 may serve as a target for MAb therapy of cancer where an antagonizing MAb inhibits cancer growth and targets immune-mediated killing. (Holliger P, and Hoogenboom, H: Nature Biotech. 16: 1015-1016, 1998). Mabs to soluble ZcytoR14 may also be useful to treat nephropathies such as glomerulosclerosis, membranous neuropathy, amyloidosis (which also affects the kidney among other tissues), renal arteriosclerosis, glomerulonephritis of various origins, fibroproliferative diseases of the kidney, as well as kidney dysfunction associated with SLE, IDDM, type II diabetes (NIDDM), renal tumors and other diseases.

3) Agonize, enhance, increase or initiate signaling via IL-17A or IL-17F receptors in the treatment of autoimmune diseases such as IDDM, MS, SLE, myasthenia gravis, rheumatoid arthritis, and IBD. Anti-ZcytoR14 neutralizing and monoclonal antibodies may signal lymphocytes or other immune cells to differentiate, alter proliferation, or change production of cytokines or cell surface proteins that ameliorate autoimmunity. Specifically, modulation of a T-helper cell response to an alternate pattern of cytokine secretion may deviate an autoimmune response to ameliorate disease (Smith JA et al., J. Immunol. 160:4841-4849, 1998). Similarly, agonistic anti-soluble ZcytoR14 monomers, homodimers, heterodimers and multimer monoclonal antibodies may be used to signal, deplete and deviate immune cells involved in asthma, allergy and atopoic disease. Signaling via ZcytoR14 may also benefit diseases of the pancreas, kidney, pituitary and neuronal cells. IDDM, NIDDM, pancreatitis, and pancreatic carcinoma may benefit. ZcytoR14 may serve as a target for MAb therapy of pancreatic cancer where a signaling MAb inhibits cancer growth and targets immune-mediated killing (Tutt, AL et al., J Immunol. 161: 3175-3185, 1998). Similarly renal cell carcinoma may be treated with monoclonal antibodies to ZcytoR14-comprising soluble receptors of the present invention.

Soluble ZcytoR14 polypeptides described herein can be used to bind, block, inhibit, reduce, antagonize or neutralize IL-17F or IL-17A activity, either singly or together, in the treatment of autoimmune disease, atopic disease, NIDDM, pancreatitis and kidney dysfunction as described above. A soluble form of ZcytoR14 may be used to promote an antibody response mediated by Th cells and/or to promote the production of IL-4 or other cytokines by lymphocytes or other immune cells.

The soluble ZcytoR14-comprising receptors of the present invention are useful as antagonists of IL-17A or IL-17F cytokine. Such antagonistic effects can be achieved by direct neutralization or binding of IL-17A or IL-17F. In addition to antagonistic uses, the soluble receptors of the present invention can bind IL-17F and act as carrier proteins for IL-17A or IL-17F cytokine, in order to transport the ligand to different tissues, organs, and cells within the body. As such, the soluble receptors of the present invention can be fused or coupled to molecules, polypeptides or chemical moieties that direct the soluble-receptor-Ligand complex to a specific site, such as a tissue, specific immune cell, or tumor. For example, in acute infection or some cancers, benefit may result from induction of inflammation and local acute phase response proteins by the action of IL-17F. Thus, the soluble receptors of the present invention can be used to specifically direct the action of IL-17A or IL-17F. See, Cosman, D. Cytokine 5: 95-106, 1993; and Fernandez-Botran, R. Exp. Opin. Invest. Drugs 9:497-513, 2000.

Moreover, the soluble receptors of the present invention can be used to stabilize the IL-17F or IL-17A, to increase the bioavailability, therapeutic longevity, and/or efficacy of the Ligand by stabilizing the Ligand from degradation or clearance, or by targeting the ligand to a site of action within the body. For example the naturally occurring IL-6/soluble IL-6R complex stabilizes IL-6 and can signal through the gp130 receptor. See, Cosman, D. supra., and Fernandez-Botran, R. supra. Moreover, ZcytoR14 may be combined with a cognate ligand such as IL-17F to comprise a ligand/soluble receptor complex. Such complexes may be used to stimulate responses from cells presenting a companion receptor subunit such as, for example, pDIRS1 (IL-17ARB) or CRF2-4 (IL-10RB). The cell specificity of ZcytoR14/ligand complexes may differ from that seen for the ligand administered alone. Furthermore the complexes may have distinct pharmacokinetic properties such as affecting half-life, dose/response and organ or tissue specificity. ZcytoR14/IL-17F or ZcytoR14/IL-17A complexes thus may have agonist activity to enhance an immune response or stimulate mesangial cells or to stimulate hepatic cells. Alternatively only tissues expressing a signaling subunit the heterodimerizes with the complex may be affected analogous to the response to

IL6/IL6R complexes (Hirota H. et al., Proc. Nat'l. Acad. Sci. 92:4862-4866, 1995; Hirano, T. in Thomason, A. (Ed.) "The Cytokine Handbook", 3rd Ed., p. 208-209). Soluble receptor/cytokine complexes for IL-12 and CNTF display similar activities.

Moreover Inflammation is a protective response by an organism to fend off an
5 invading agent. Inflammation is a cascading event that involves many cellular and humoral
mediators. On one hand, suppression of inflammatory responses can leave a host
immunocompromised; however, if left unchecked, inflammation can lead to serious
complications including chronic inflammatory diseases (e.g., psoriasis, arthritis, rheumatoid
arthritis, multiple sclerosis, inflammatory bowel disease and the like), septic shock and
10 multiple organ failure. Importantly, these diverse disease states share common inflammatory
mediators. The collective diseases that are characterized by inflammation have a large impact
on human morbidity and mortality. Therefore it is clear that anti-inflammatory proteins, such
as ZcytoR14, and anti-ZcytoR14 antibodies, could have crucial therapeutic potential for a vast
number of human and animal diseases, from asthma and allergy to autoimmunity and septic
15 shock.

1. Arthritis

Arthritis, including osteoarthritis, rheumatoid arthritis, arthritic joints as a
result of injury, and the like, are common inflammatory conditions which would benefit from
the therapeutic use of anti-inflammatory proteins, such as ZcytoR14 polypeptides of the
20 present invention. For example, rheumatoid arthritis (RA) is a systemic disease that affects the
entire body and is one of the most common forms of arthritis. It is characterized by the
inflammation of the membrane lining the joint, which causes pain, stiffness, warmth, redness
and swelling. Inflammatory cells release enzymes that may digest bone and cartilage. As a
result of rheumatoid arthritis, the inflamed joint lining, the synovium, can invade and damage
25 bone and cartilage leading to joint deterioration and severe pain amongst other physiologic
effects. The involved joint can lose its shape and alignment, resulting in pain and loss of
movement.

Rheumatoid arthritis (RA) is an immune-mediated disease particularly
characterized by inflammation and subsequent tissue damage leading to severe disability and
30 increased mortality. A variety of cytokines are produced locally in the rheumatoid joints.
Numerous studies have demonstrated that IL-1 and TNF-alpha, two prototypic pro-
inflammatory cytokines, play an important role in the mechanisms involved in synovial
inflammation and in progressive joint destruction. Indeed, the administration of TNF-alpha and
IL-1 inhibitors in patients with RA has led to a dramatic improvement of clinical and biological

signs of inflammation and a reduction of radiological signs of bone erosion and cartilage destruction. However, despite these encouraging results, a significant percentage of patients do not respond to these agents, suggesting that other mediators are also involved in the pathophysiology of arthritis (Gabay, Expert. Opin. Biol. Ther. 2(2):135-149, 2002). One of
5 those mediators could be IL-17A or IL-17F, and as such a molecule that binds or inhibits IL-17F or IL-17A activity, such as soluble ZcytoR14, ZcytoR14 polypeptides, or anti ZcytoR14 antibodies or binding partners, could serve as a valuable therapeutic to reduce inflammation in rheumatoid arthritis, and other arthritic diseases.

There are several animal models for rheumatoid arthritis known in the art. For
10 example, in the collagen-induced arthritis (CIA) model, mice develop chronic inflammatory arthritis that closely resembles human rheumatoid arthritis. Since CIA shares similar immunological and pathological features with RA, this makes it an ideal model for screening potential human anti-inflammatory compounds. The CIA model is a well-known model in mice that depends on both an immune response, and an inflammatory response, in order to
15 occur. The immune response comprises the interaction of B-cells and CD4+ T-cells in response to collagen, which is given as antigen, and leads to the production of anti-collagen antibodies. The inflammatory phase is the result of tissue responses from mediators of inflammation, as a consequence of some of these antibodies cross-reacting to the mouse's native collagen and activating the complement cascade. An advantage in using the CIA model
20 is that the basic mechanisms of pathogenesis are known. The relevant T-cell and B-cell epitopes on type II collagen have been identified, and various immunological (e.g., delayed-type hypersensitivity and anti-collagen antibody) and inflammatory (e.g., cytokines, chemokines, and matrix-degrading enzymes) parameters relating to immune-mediated arthritis have been determined, and can thus be used to assess test compound efficacy in the CIA model
25 (Wooley, Curr. Opin. Rheum. 3:407-20, 1999; Williams et al., Immunol. 89:9784-788, 1992; Myers et al., Life Sci. 61:1861-78, 1997; and Wang et al., Immunol. 92:8955-959, 1995).

One group has shown that an anti-mouse IL-17 antibody reduces symptoms in a mouse CIA-model relative to control mice, thus showing conceptually that soluble ZcytoR14-Fc may be beneficial in treating human disease. The administration of a single mouse-IL-17-specific rat antisera reduced the symptoms of arthritis in the animals when introduced
30 prophylactically or after symptoms of arthritis were already present in the model (Lubberts et al., Arthritis Rheum. 50:650-9, 2004). Therefore, ZcytoR14-Fc can be used to neutralize IL-17A and/or IL-17F in the treatment of specific human diseases such as arthritis, psoriasis, psoriatic

arthritis, endotoxemia, inflammatory bowel disease (IBD), colitis, and other inflammatory conditions disclosed herein.

The administration of soluble ZcytoR14 comprising polypeptides (ZcytoR14), such as ZcytoR14-Fc4 or other ZcytoR14 soluble and fusion proteins to these CIA model mice is used to evaluate the use of soluble ZcytoR14 as an antagonist to IL-17F used to ameliorate symptoms and alter the course of disease. Moreover, results showing inhibition of IL-17F by ZcytoR14 would provide proof of concept that other IL-17F antagonists, such as soluble ZcytoR14 or neutralizing antibodies thereto, can also be used to ameliorate symptoms and alter the course of disease. Furthermore, since IL-17A and/or IL-17F induces production of IL-1b and TNF-a, both of which are implicated in the pathogenesis and progression of rheumatoid arthritis, the systemic or local administration of soluble ZcytoR14 comprising polypeptides, such as ZcytoR14-Fc4 or other IL-17F soluble receptors (e.g., ZcytoR14; SEQ ID NO:3) and anti-ZcytoR14 antibodies, and fusion proteins can potentially suppress the inflammatory response in RA. By way of example and without limitation, the injection of 10 - 200 ug Zcytor14-Fc per mouse (one to seven times a week for up to but not limited to 4 weeks via s.c., i.p., or i.m route of administration) can significantly reduce the disease score (paw score, incident of inflammation, or disease). Depending on the initiation of Zcytor14-Fc administration (e.g. prior to or at the time of collagen immunization, or at any time point following the second collagen immunization, including those time points at which the disease has already progressed), Zcytor14 can be efficacious in preventing rheumatoid arthritis, as well as preventing its progression. Other potential therapeutics include ZcytoR14 polypeptides, anti-ZcytoR14 antibodies, or anti IL-17F antibodies or binding partners, and the like.

2. Endotoxemia

Endotoxemia is a severe condition commonly resulting from infectious agents such as bacteria and other infectious disease agents, sepsis, toxic shock syndrome, or in immunocompromised patients subjected to opportunistic infections, and the like. Therapeutically useful of anti-inflammatory proteins, such as ZcytoR14 polypeptides and antibodies of the present invention, could aid in preventing and treating endotoxemia in humans and animals. ZcytoR14 polypeptides, or anti-ZcytoR14 antibodies or binding partners, could serve as a valuable therapeutic to reduce inflammation and pathological effects in endotoxemia.

Lipopolysaccharide (LPS) induced endotoxemia engages many of the proinflammatory mediators that produce pathological effects in the infectious diseases and LPS induced endotoxemia in rodents is a widely used and acceptable model for studying the

pharmacological effects of potential pro-inflammatory or immunomodulating agents. LPS, produced in gram-negative bacteria, is a major causative agent in the pathogenesis of septic shock (Glausner et al., Lancet 338:732, 1991). A shock-like state can indeed be induced experimentally by a single injection of LPS into animals. Molecules produced by cells
5 responding to LPS can target pathogens directly or indirectly. Although these biological responses protect the host against invading pathogens, they may also cause harm. Thus, massive stimulation of innate immunity, occurring as a result of severe Gram-negative bacterial infection, leads to excess production of cytokines and other molecules, and the development of a fatal syndrome, septic shock syndrome, which is characterized by fever,
10 hypotension, disseminated intravascular coagulation, and multiple organ failure (Dumitru et al. Cell 103:1071-1083, 2000).

These toxic effects of LPS are mostly related to macrophage activation leading to the release of multiple inflammatory mediators. Among these mediators, TNF appears to play a crucial role, as indicated by the prevention of LPS toxicity by the administration of
15 neutralizing anti-TNF antibodies (Beutler et al., Science 229:869, 1985). It is well established that 1ug injection of *E. coli* LPS into a C57Bl/6 mouse will result in significant increases in circulating IL-6, TNF-alpha, IL-1, and acute phase proteins (for example, SAA) approximately 2 hours post injection. The toxicity of LPS appears to be mediated by these cytokines as passive immunization against these mediators can result in decreased mortality (Beutler et al.,
20 Science 229:869, 1985). The potential immunointervention strategies for the prevention and/or treatment of septic shock include anti-TNF mAb, IL-1 receptor antagonist, LIF, IL-10, and G-CSF.

The administration of soluble ZcytoR14 comprising polypeptides, such as ZcytoR14-Fc4 or other ZcytoR14 soluble and fusion proteins to these LPS-induced model may
25 be used to to evaluate the use of ZcytoR14 to ameliorate symptoms and alter the course of LPS-induced disease. Moreover, results showing inhibition of IL-17F by ZcytoR14 provide proof of concept that other IL-17F antagonists, such as soluble ZcytoR14 or antibodies thereto, can also be used to ameliorate symptoms in the LPS-induced model and alter the course of disease. The model will show induction of IL-17F by LPS injection and the potential treatment
30 of disease by ZcytoR14 polypeptides. Since LPS induces the production of pro-inflammatory factors possibly contributing to the pathology of endotoxemia, the neutralization of IL-17F activity or other pro-inflammatory factors by an antagonist ZcytoR14 polypeptide can be used to reduce the symptoms of endotoxemia, such as seen in endotoxic shock. Other

potential therapeutics include ZcytoR14 polypeptides, anti-ZcytoR14 antibodies, or binding partners, and the like.

3. Inflammatory Bowel Disease IBD

5 In the United States approximately 500,000 people suffer from Inflammatory Bowel Disease (IBD) which can affect either colon and rectum (Ulcerative colitis) or both, small and large intestine (Crohn's Disease). The pathogenesis of these diseases is unclear, but they involve chronic inflammation of the affected tissues. ZcytoR14 polypeptides, anti-ZcytoR14 antibodies, or binding partners, could serve as a valuable therapeutic to reduce inflammation and pathological effects in IBD and related diseases.

10 Ulcerative colitis (UC) is an inflammatory disease of the large intestine, commonly called the colon, characterized by inflammation and ulceration of the mucosa or innermost lining of the colon. This inflammation causes the colon to empty frequently, resulting in diarrhea. Symptoms include loosening of the stool and associated abdominal cramping, fever and weight loss. Although the exact cause of UC is unknown, recent research
15 suggests that the body's natural defenses are operating against proteins in the body which the body thinks are foreign (an "autoimmune reaction"). Perhaps because they resemble bacterial proteins in the gut, these proteins may either instigate or stimulate the inflammatory process that begins to destroy the lining of the colon. As the lining of the colon is destroyed, ulcers form releasing mucus, pus and blood. The disease usually begins in the rectal area and may
20 eventually extend through the entire large bowel. Repeated episodes of inflammation lead to thickening of the wall of the intestine and rectum with scar tissue. Death of colon tissue or sepsis may occur with severe disease. The symptoms of ulcerative colitis vary in severity and their onset may be gradual or sudden. Attacks may be provoked by many factors, including respiratory infections or stress.

25 Although there is currently no cure for UC available, treatments are focused on suppressing the abnormal inflammatory process in the colon lining. Treatments including corticosteroids immunosuppressives (eg. azathioprine, mercaptopurine, and methotrexate) and aminosalicitylates are available to treat the disease. However, the long-term use of immunosuppressives such as corticosteroids and azathioprine can result in serious side effects
30 including thinning of bones, cataracts, infection, and liver and bone marrow effects. In the patients in whom current therapies are not successful, surgery is an option. The surgery involves the removal of the entire colon and the rectum.

There are several animal models that can partially mimic chronic ulcerative colitis. The most widely used model is the 2,4,6-trinitrobenesulfonic acid/ethanol (TNBS)

induced colitis model, which induces chronic inflammation and ulceration in the colon. When TNBS is introduced into the colon of susceptible mice via intra-rectal instillation, it induces T-cell mediated immune response in the colonic mucosa, in this case leading to a massive mucosal inflammation characterized by the dense infiltration of T-cells and macrophages throughout the entire wall of the large bowel. Moreover, this histopathologic picture is accompanied by the clinical picture of progressive weight loss (wasting), bloody diarrhea, rectal prolapse, and large bowel wall thickening (Neurath et al. Intern. Rev. Immunol. 19:51-62, 2000).

Another colitis model uses dextran sulfate sodium (DSS), which induces an acute colitis manifested by bloody diarrhea, weight loss, shortening of the colon and mucosal ulceration with neutrophil infiltration. DSS-induced colitis is characterized histologically by infiltration of inflammatory cells into the lamina propria, with lymphoid hyperplasia, focal crypt damage, and epithelial ulceration. These changes are thought to develop due to a toxic effect of DSS on the epithelium and by phagocytosis of lamina propria cells and production of TNF-alpha and IFN-gamma. Despite its common use, several issues regarding the mechanisms of DSS about the relevance to the human disease remain unresolved. DSS is regarded as a T cell-independent model because it is observed in T cell-deficient animals such as SCID mice.

The administration of soluble ZcytoR14 comprising polypeptides, such as ZcytoR14-Fc4 or other ZcytoR14 soluble and fusion proteins to these TNBS or DSS models can be used to evaluate the use of soluble ZcytoR14 to ameliorate symptoms and alter the course of gastrointestinal disease. Moreover, the results showing inhibition of IL-17F by ZcytoR14 provide proof of concept that other IL-17F antagonists, such as soluble ZcytoR14 or antibodies thereto, can also be used to ameliorate symptoms in the colitis/IBD models and alter the course of disease.

4. Psoriasis

Psoriasis is a chronic skin condition that affects more than seven million Americans. Psoriasis occurs when new skin cells grow abnormally, resulting in inflamed, swollen, and scaly patches of skin where the old skin has not shed quickly enough. Plaque psoriasis, the most common form, is characterized by inflamed patches of skin ("lesions") topped with silvery white scales. Psoriasis may be limited to a few plaques or involve moderate to extensive areas of skin, appearing most commonly on the scalp, knees, elbows and trunk. Although it is highly visible, psoriasis is not a contagious disease. The pathogenesis of the disease involves chronic inflammation of the affected tissues. ZcytoR14 polypeptides, anti-ZcytoR14 antibodies, or binding partners, could serve as a valuable therapeutic to reduce

inflammation and pathological effects in psoriasis, other inflammatory skin diseases, skin and mucosal allergies, and related diseases.

Psoriasis is a T-cell mediated inflammatory disorder of the skin that can cause considerable discomfort. It is a disease for which there is no cure and affects people of all ages. Psoriasis affects approximately two percent of the populations of European and North America. Although individuals with mild psoriasis can often control their disease with topical agents, more than one million patients worldwide require ultraviolet or systemic immunosuppressive therapy. Unfortunately, the inconvenience and risks of ultraviolet radiation and the toxicities of many therapies limit their long-term use. Moreover, patients usually have recurrence of psoriasis, and in some cases rebound, shortly after stopping immunosuppressive therapy.

ZcytoR14 soluble receptor polypeptides and antibodies thereto may also be used within diagnostic systems for the detection of circulating levels of IL-17F or IL-17A ligand, and in the detection of IL-17F associated with acute phase inflammatory response. Within a related embodiment, antibodies or other agents that specifically bind to ZcytoR14 soluble receptors of the present invention can be used to detect circulating receptor polypeptides; conversely, ZcytoR14 soluble receptors themselves can be used to detect circulating or locally-acting IL-17F or IL-17A polypeptides. Elevated or depressed levels of ligand or receptor polypeptides may be indicative of pathological conditions, including inflammation or cancer. IL-17F is known to induce associated acute phase inflammatory response. Moreover, detection of acute phase proteins or molecules such as IL-17A or IL-17F can be indicative of a chronic inflammatory condition in certain disease states (e.g., asthma, psoriasis, rheumatoid arthritis, colitis, IBD). Detection of such conditions serves to aid in disease diagnosis as well as help a physician in choosing proper therapy.

In utero administration of soluble ZcytoR14 can be used to show efficacy *in vivo* in disease models by reducing or eliminating the phenotype associated with IL-17F transgenic pups which over express IL-17F, or IL-17A transgenic pups which over express IL-17A. There are precedents in the art for *in utero* treatment with antagonists such as neutralizing monoclonal antibodies (mAbs). In one case, the development of the B-1 subset of B cells was dramatically affected by treating pregnant female mice with a mAb specific for the B cell-specific molecule, CD19 (e.g., Krop I. Et al., Eur. J. Immunol. 26(1):238-42, 1996). Krop et al. injected timed pregnant mice intraperitoneally with 500ug of rat anti-mouse CD19 mAb (or a rat isotype-matched control Ab) in PBS beginning on day 9 of gestation, with subsequent injections every other day until birth. Pups were also injected once with 500ug of

these antibodies at 10 days of age. In another case, Tanaka et al., found that in utero treatment with monoclonal antibody to IL-2 receptor beta-chain completely abrogates development of Thy-1+ dendritic epidermal cells. The two distinct subunits of the IL-2 receptor, i.e. the alpha-chain (IL-2R alpha) and the beta-chain (IL-2R beta), are expressed in an almost mutually exclusive fashion throughout fetal thymus ontogeny. Blocking IL-2R beta, a signal transducing component of IL-2R, by administering a neutralizing mAb to IL-2R beta, resulted in the complete and selective disappearance of Thy-1+ skin dendritic epidermal cells. Development of any other T cell subsets was uncompromised. This indicated that IL-2 plays a crucial role in the development of fetal V gamma 5+ cells and their descendants (see, Tanaka, T. et al., Int Immunol. 4(4):487-9, 1992). In addition, Schattemann GC et al., showed that PDGF-A is required for normal murine cardiovascular development using an in utero system. Several lines of evidence suggest that platelet-derived growth factor A chain (PDGF-A) is required for normal embryonic cardiovascular development. Introduction of anti-PDGF-A neutralizing antibodies into mouse deciduas *in utero* resulted in the selective disruption of PDGF-A ligand-receptor interactions in vivo for a period of 18-24 hr and allowed assessment of whether PDGF-A is required for cardiovascular development and when it is required (see, Schattemann GC et al., Dev. Biol. 176(1):133-42, 1996). These results, as well as others described in the art, provide evidence that antagonists such as neutralizing mAbs or soluble receptors can elicit strong effects *in utero*. Similarly, data showing the efficacy of soluble receptors and/or neutralizing IL-17A or IL-17F with monoclonal antibodies *in vivo* in disease models to reduce or eliminate the skin phenotype found in IL-17A and IL-17F transgenic pups which over express IL-17A and IL-17F respectively can be shown.

In addition to other disease models described herein, the activity of soluble ZcytoR14 and/or anti-ZcytoR14 antibodies on inflammatory tissue derived from human psoriatic lesions can be measured *in vivo* using a severe combined immune deficient (SCID) mouse model. Several mouse models have been developed in which human cells are implanted into immunodeficient mice (collectively referred to as xenograft models); see, for example, Cattan AR, Douglas E, Leuk. Res. 18:513-22, 1994 and Flavell, DJ, Hematological Oncology 14:67-82, 1996. As an in vivo xenograft model for psoriasis, human psoriatic skin tissue is implanted into the SCID mouse model, and challenged with an appropriate antagonist. Moreover, other psoriasis animal models in the art may be used to evaluate IL-17A and IL-17F antagonists, such as human psoriatic skin grafts implanted into AGR129 mouse model, and challenged with an appropriate antagonist (e.g., see, Boyman, O. et al., J. Exp. Med. Online publication #20031482, 2004, incorporated hereing by reference). Soluble ZcytoR14 or

Anti-ZcytoR14 antibodies that bind, block, inhibit, reduce, antagonize or neutralize the activity of IL-17F or both IL-17A and IL-17F are preferred antagonists, however, anti-IL-17A and anti-IL-22 antibodies (alone or in combination), soluble ZcytoR14, as well as other IL-17A and IL-17F antagonists can be used in this model. Similarly, tissues or cells derived from human colitis, IBD, arthritis, or other inflammatory lesions can be used in the SCID model to assess the anti-inflammatory properties of the IL-17A and IL-17F antagonists described herein.

Therapies designed to abolish, retard, or reduce inflammation using soluble ZcytoR14, anti-ZcytoR14 antibodies or its derivatives, agonists, conjugates or variants can be tested by administration of anti-ZcytoR14 antibodies or soluble ZcytoR14 compounds to SCID mice bearing human inflammatory tissue (e.g., psoriatic lesions and the like), or other models described herein. Efficacy of treatment is measured and statistically evaluated as increased anti-inflammatory effect within the treated population over time using methods well known in the art. Some exemplary methods include, but are not limited to measuring for example, in a psoriasis model, epidermal thickness, the number of inflammatory cells in the upper dermis, and the grades of parakeratosis. Such methods are known in the art and described herein. For example, see Zeigler, M. et al. Lab Invest 81:1253, 2001; Zollner, T. M. et al. J. Clin. Invest. 109:671, 2002; Yamanaka, N. et al. Microbiol Immunol. 45:507, 2001; Raychaudhuri, S. P. et al. Br. J. Dermatol. 144:931, 2001; Boehncke, W. H et al. Arch. Dermatol. Res. 291:104, 1999; Boehncke, W. H et al. J. Invest. Dermatol. 116:596, 2001; Nickoloff, B. J. et al. Am. J. Pathol. 146:580, 1995; Boehncke, W. H et al. J. Cutan. Pathol. 24:1, 1997; Sugai, J., M. et al. J. Dermatol. Sci. 17:85, 1998; and Villadsen L.S. et al. J. Clin. Invest. 112:1571, 2003. Inflammation may also be monitored over time using well-known methods such as flow cytometry (or PCR) to quantitate the number of inflammatory or lesional cells present in a sample, score (weight loss, diarrhea, rectal bleeding, colon length) for IBD, paw disease score and inflammation score for CIA RA model. For example, therapeutic strategies appropriate for testing in such a model include direct treatment using soluble ZcytoR14, anti-ZcytoR14 antibodies, other IL-17A and IL-17F antagonists (singly or together), or related conjugates or antagonists based on the disrupting interaction of soluble ZcytoR14 with its ligands IL-17A and IL-17F, or for cell-based therapies utilizing soluble ZcytoR14 or anti-ZcytoR14 antibodies or its derivatives, agonists, conjugates or variants.

Moreover, Psoriasis is a chronic inflammatory skin disease that is associated with hyperplastic epidermal keratinocytes and infiltrating mononuclear cells, including CD4+ memory T cells, neutrophils and macrophages (Christophers, Int. Arch. Allergy Immunol.,

110:199, 1996). It is currently believed that environmental antigens play a significant role in initiating and contributing to the pathology of the disease. However, it is the loss of tolerance to self-antigens that is thought to mediate the pathology of psoriasis. Dendritic cells and CD4⁺ T cells are thought to play an important role in antigen presentation and recognition that mediate the immune response leading to the pathology. We have recently developed a model of psoriasis based on the CD4+CD45RB transfer model (Davenport et al., Internat. Immunopharmacol., 2:653-672). Soluble ZcytoR14 or anti-ZcytoR14 antibodies of the present invention are administered to the mice. Inhibition of disease scores (skin lesions, inflammatory cytokines) indicates the effectiveness of IL-17A and IL-17F antagonists in psoriasis, e.g., anti-ZcytoR14 antibodies or ZcytoR14 soluble receptors.

5. Atopic Dermatitis.

AD is a common chronic inflammatory disease that is characterized by hyperactivated cytokines of the helper T cell subset 2 (Th2). Although the exact etiology of AD is unknown, multiple factors have been implicated, including hyperactive Th2 immune responses, autoimmunity, infection, allergens, and genetic predisposition. Key features of the disease include xerosis (dryness of the skin), pruritus (itchiness of the skin), conjunctivitis, inflammatory skin lesions, *Staphylococcus aureus* infection, elevated blood eosinophilia, elevation of serum IgE and IgG1, and chronic dermatitis with T cell, mast cell, macrophage and eosinophil infiltration. Colonization or infection with *S. aureus* has been recognized to exacerbate AD and perpetuate chronicity of this skin disease.

AD is often found in patients with asthma and allergic rhinitis, and is frequently the initial manifestation of allergic disease. About 20% of the population in Western countries suffer from these allergic diseases, and the incidence of AD in developed countries is rising for unknown reasons. AD typically begins in childhood and can often persist through adolescence into adulthood. Current treatments for AD include topical corticosteroids, oral cyclosporin A, non-corticosteroid immunosuppressants such as tacrolimus (FK506 in ointment form), and interferon-gamma. Despite the variety of treatments for AD, many patients' symptoms do not improve, or they have adverse reactions to medications, requiring the search for other, more effective therapeutic agents. The soluble ZcytoR14 polypeptides and anti-ZcytoR14 antibodies of the present invention, including the neutralizing anti-human ZcytoR14 antibodies of the present invention, can be used to neutralize IL-17F and IL-17A in the treatment of specific human diseases such as atopic dermatitis, inflammatory skin conditions, and other inflammatory conditions disclosed herein.

6. Asthma

IL-17 plays an important role in allergen-induced T cell activation and neutrophilic influx in the airways. The receptor for IL-17 is expressed in the airways (Yao, et al. *Immunity* 3:811 (1995)) and IL-17 mediated neutrophil recruitment in allergic asthma is largely induced by the chemoattractant IL-8, GRO- α and macrophage inflammatory protein-2 (MIP-2) produced by IL-17 stimulated human bronchial epithelial cells (HBECs) and human bronchial fibroblasts (Yao, et al. *J Immunol* 155:5483 (1995)); Molet, et al. *J Allergy Clin Immunol* 108:430 (2001)). IL-17 also stimulates HBECs to release IL-6, a neutrophil-activating factor (Fossiez, et al, *J Exp Med* 183:2593 (1996), and Linden, et al. *Int Arch Allergy Immunol* 126:179 (2001)) and has been shown to synergize with TNF- α to prolong the survival of human neutrophils in vitro (Laan, et al. *Eur Respir J* 21:387 (2003)). Moreover, IL-17 is capable of amplifying the inflammatory responses in asthma by its ability to enhance the secretion of cytokines implicated in airway remodeling such as the profibrotic cytokines, IL-6 and IL-11 and inflammatory mediators granulocyte colony-stimulating factor (G-CSF) and granulocyte macrophage colony-stimulating factor (GM-CSF) (Molet, et al. *J Allergy Clin Immunol* 108:430 (2001)).

Clinical evidence shows that acute, severe exacerbations of asthma are associated with recruitment and activation of neutrophils in the airways, thus IL-17 is likely to play a significant role in asthma. Patients with mild asthma display a detectable increase in the local concentration of free, soluble IL-17A protein (Molet, et al. *J Allergy Clin Immunol* 108:430 (2001)) while healthy human volunteers with induced, severe airway inflammation due to the exposure to a swine confinement, display a pronounced increase in the concentration of free, soluble IL-17A protein in the bronchoalveolar space (Fossiez, et al, *J Exp Med* 183:2593 (1996), and Linden, et al. *Int Arch Allergy Immunol* 126:179 (2001)). Furthermore, IL-17 levels in sputum have correlated with individuals who have increased airway hyper-reactivity Barczyk, et al. *Respir Med* 97:726 (2003).

In animal models of airway hyper-responsiveness, chronic inhalation of ovalbumin by sensitized mice resulted in bronchial eosinophilic inflammation and early induction of IL-17 mRNA expression in inflamed lung tissue, together with a bronchial neutrophilia Hellings, et al. *Am J Respir Cell Mol Biol* 28:42 (2003). Anti-IL-17 monoclonal antibodies strongly reduced bronchial neutrophilic influx but significantly enhanced IL-5 levels in both bronchoalveolar lavage fluid and serum, and aggravated allergen-induced bronchial eosinophilic influx, suggesting that IL-17A may be involved in determining the balance between neutrophil and eosinophil accumulation following antigen insult Id..

Among the IL-17 family members, IL-17F is most closely related to IL-17A. The biological activities mediated by IL-17F are similar to those of IL-17A, where IL-17F stimulates production of IL-6, IL-8 and G-CSF Hurst, et al. J Immunol 169:443 (2002). IL-17F also induces production of IL-2, transforming growth factor (TGF)- β , and monocyte chemoattractant protein (MCP) in endothelial cells Starnes, et al. J Immunol 167:4137 (2001). Similarly, allergen challenge can increase local IL-17F in patients with allergic asthma Kawaguchi, et al. J Immunol 167:4430 (2001). Gene delivery of IL-17F in murine lung increases neutrophils in the bronchoalveolar space, while mucosal transfer of the IL-17F gene enhances the levels of Ag-induced pulmonary neutrophilia and airway responsiveness to methacholine Oda, et al. Am J Respir Crit Care Med 171:12 (2005).

Apart from asthma, several chronic inflammatory airway diseases are characterized by neutrophil recruitment in the airways and IL-17 has been reported to play an important role in the pathogenesis of respiratory conditions such as chronic obstructive pulmonary disease (COPD), bacterial pneumonia and cystic fibrosis (Linden, et al. Eur Respir J 15:973 (2000), Ye, et al. Am J Respir Cell Mol Biol 25:335 (2001), Rahman, et al. Clin Immunol 115:268 (2005)). An anti-IL-17A and/or anti-IL-17F therapeutic molecule could be demonstrated to be efficacious for chronic inflammatory airway disease in an in vitro model of inflammation. The ability of antagonists to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention to inhibit IL-17A or and/or IL-17F-induced cytokine and chemokine production from cultured HBECs or bronchial fibroblasts could be used as a measure of efficacy for such antagonists in the prevention of the production of inflammatory mediators directly resulting from IL-17A and/or F stimulation. If the addition of antagonists to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention markedly reduces the production and expression of inflammatory mediators, it would be expected to be efficacious in inflammatory aspects associated with chronic airway inflammation.

For pharmaceutical use, the soluble ZcytoR14 or anti-ZcytoR14 antibodies of the present invention are formulated for parenteral, particularly intravenous or subcutaneous, delivery according to conventional methods. Intravenous administration will be by bolus injection, controlled release, e.g, using mini-pumps or other appropriate technology, or by infusion over a typical period of one to several hours. In general, pharmaceutical formulations will include a hematopoietic protein in combination with a pharmaceutically acceptable

vehicle, such as saline, buffered saline, 5% dextrose in water or the like. Formulations may further include one or more excipients, preservatives, solubilizers, buffering agents, albumin to prevent protein loss on vial surfaces, etc. When utilizing such a combination therapy, the cytokines may be combined in a single formulation or may be administered in separate formulations. Methods of formulation are well known in the art and are disclosed, for example, in Remington's Pharmaceutical Sciences, Gennaro, ed., Mack Publishing Co., Easton PA, 1990, which is incorporated herein by reference. Therapeutic doses will generally be in the range of 0.1 to 100 mg/kg of patient weight per day, preferably 0.5-20 mg/kg per day, with the exact dose determined by the clinician according to accepted standards, taking into account the nature and severity of the condition to be treated, patient traits, etc. Determination of dose is within the level of ordinary skill in the art. The proteins will commonly be administered over a period of up to 28 days following chemotherapy or bone-marrow transplant or until a platelet count of $>20,000/\text{mm}^3$, preferably $>50,000/\text{mm}^3$, is achieved. More commonly, the proteins will be administered over one week or less, often over a period of one to three days. In general, a therapeutically effective amount of soluble ZcytoR14 or anti-ZcytoR14 antibodies of the present invention is an amount sufficient to produce a clinically significant increase in the proliferation and/or differentiation of lymphoid or myeloid progenitor cells, which will be manifested as an increase in circulating levels of mature cells (e.g. platelets or neutrophils). Treatment of platelet disorders will thus be continued until a platelet count of at least $20,000/\text{mm}^3$, preferably $50,000/\text{mm}^3$, is reached. The soluble ZcytoR14 or anti-ZcytoR14 antibodies of the present invention can also be administered in combination with other cytokines such as IL-3, -6 and -11; stem cell factor; erythropoietin; G-CSF and GM-CSF. Within regimens of combination therapy, daily doses of other cytokines will in general be: EPO, 150 U/kg; GM-CSF, 5-15 lg/kg; IL-3, 1-5 lg/kg; and G-CSF, 1-25 lg/kg. Combination therapy with EPO, for example, is indicated in anemic patients with low EPO levels.

Generally, the dosage of administered soluble ZcytoR14 (or ZcytoR14 analog or fusion protein) or anti-ZcytoR14 antibodies will vary depending upon such factors as the patient's age, weight, height, sex, general medical condition and previous medical history. Typically, it is desirable to provide the recipient with a dosage of soluble ZcytoR14 or anti-ZcytoR14 antibodies which is in the range of from about 1 pg/kg to 10 mg/kg (amount of agent/body weight of patient), although a lower or higher dosage also may be administered as circumstances dictate.

Administration of soluble ZcytoR14 or anti-ZcytoR14 antibodies to a subject can be intravenous, intraarterial, intraperitoneal, intramuscular, subcutaneous, intrapleural,

intrathecal, by perfusion through a regional catheter, or by direct intralesional injection. When administering therapeutic proteins by injection, the administration may be by continuous infusion or by single or multiple boluses.

Additional routes of administration include oral, mucosal-membrane, pulmonary, and transcutaneous. Oral delivery is suitable for polyester microspheres, zein microspheres, proteinoid microspheres, polycyanoacrylate microspheres, and lipid-based systems (see, for example, DiBase and Morrel, "Oral Delivery of Microencapsulated Proteins," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 255-288 (Plenum Press 1997)). The feasibility of an intranasal delivery is exemplified by such a mode of insulin administration (see, for example, Hinchcliffe and Illum, *Adv. Drug Deliv. Rev.* 35:199 (1999)). Dry or liquid particles comprising soluble ZcytoR14 or anti-ZcytoR14 antibodies can be prepared and inhaled with the aid of dry-powder dispersers, liquid aerosol generators, or nebulizers (e.g., Pettit and Gombotz, *TIBTECH* 16:343 (1998); Patton *et al.*, *Adv. Drug Deliv. Rev.* 35:235 (1999)). This approach is illustrated by the AERX diabetes management system, which is a hand-held electronic inhaler that delivers aerosolized insulin into the lungs. Studies have shown that proteins as large as 48,000 kDa have been delivered across skin at therapeutic concentrations with the aid of low-frequency ultrasound, which illustrates the feasibility of transcutaneous administration (Mitragotri *et al.*, *Science* 269:850 (1995)). Transdermal delivery using electroporation provides another means to administer a molecule having ZcytoR14 binding activity (Potts *et al.*, *Pharm. Biotechnol.* 10:213 (1997)).

A pharmaceutical composition comprising a soluble ZcytoR14 or anti-ZcytoR14 antibody can be formulated according to known methods to prepare pharmaceutically useful compositions, whereby the therapeutic proteins are combined in a mixture with a pharmaceutically acceptable carrier. A composition is said to be a "pharmaceutically acceptable carrier" if its administration can be tolerated by a recipient patient. Sterile phosphate-buffered saline is one example of a pharmaceutically acceptable carrier. Other suitable carriers are well-known to those in the art. See, for example, Gennaro (ed.), *Remington's Pharmaceutical Sciences*, 19th Edition (Mack Publishing Company 1995).

For purposes of therapy, soluble ZcytoR14 or anti-ZcytoR14 antibody molecules and a pharmaceutically acceptable carrier are administered to a patient in a therapeutically effective amount. A combination of a therapeutic molecule of the present invention and a pharmaceutically acceptable carrier is said to be administered in a "therapeutically effective amount" if the amount administered is physiologically significant. An agent is physiologically significant if its presence results in a detectable change in the

physiology of a recipient patient. For example, an agent used to treat inflammation is physiologically significant if its presence alleviates the inflammatory response.

A pharmaceutical composition comprising ZcytoR14 (or ZcytoR14 analog or fusion protein) or neutralizing anti-ZcytoR14 antibody can be furnished in liquid form, in an aerosol, or in solid form. Liquid forms, are illustrated by injectable solutions and oral suspensions. Exemplary solid forms include capsules, tablets, and controlled-release forms. The latter form is illustrated by miniosmotic pumps and implants (Bremer *et al.*, *Pharm. Biotechnol.* 10:239 (1997); Ranade, "Implants in Drug Delivery," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 95-123 (CRC Press 1995); Bremer *et al.*, "Protein Delivery with Infusion Pumps," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 239-254 (Plenum Press 1997); Yewey *et al.*, "Delivery of Proteins from a Controlled Release Injectable Implant," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 93-117 (Plenum Press 1997)).

Liposomes provide one means to deliver therapeutic polypeptides to a subject intravenously, intraperitoneally, intrathecally, intramuscularly, subcutaneously, or via oral administration, inhalation, or intranasal administration. Liposomes are microscopic vesicles that consist of one or more lipid bilayers surrounding aqueous compartments (see, generally, Bakker-Woudenberg *et al.*, *Eur. J. Clin. Microbiol. Infect. Dis.* 12 (Suppl. 1):S61 (1993), Kim, *Drugs* 46:618 (1993), and Ranade, "Site-Specific Drug Delivery Using Liposomes as Carriers," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 3-24 (CRC Press 1995)). Liposomes are similar in composition to cellular membranes and as a result, liposomes can be administered safely and are biodegradable. Depending on the method of preparation, liposomes may be unilamellar or multilamellar, and liposomes can vary in size with diameters ranging from 0.02 μm to greater than 10 μm . A variety of agents can be encapsulated in liposomes: hydrophobic agents partition in the bilayers and hydrophilic agents partition within the inner aqueous space(s) (see, for example, Machy *et al.*, *Liposomes In Cell Biology And Pharmacology* (John Libbey 1987), and Ostro *et al.*, *American J. Hosp. Pharm.* 46:1576 (1989)). Moreover, it is possible to control the therapeutic availability of the encapsulated agent by varying liposome size, the number of bilayers, lipid composition, as well as the charge and surface characteristics of the liposomes.

Liposomes can adsorb to virtually any type of cell and then slowly release the encapsulated agent. Alternatively, an absorbed liposome may be endocytosed by cells that are phagocytic. Endocytosis is followed by intralysosomal degradation of liposomal lipids and release of the encapsulated agents (Scherphof *et al.*, *Ann. N.Y. Acad. Sci.* 446:368 (1985)).

After intravenous administration, small liposomes (0.1 to 1.0 μm) are typically taken up by cells of the reticuloendothelial system, located principally in the liver and spleen, whereas liposomes larger than 3.0 μm are deposited in the lung. This preferential uptake of smaller liposomes by the cells of the reticuloendothelial system has been used to deliver
5 chemotherapeutic agents to macrophages and to tumors of the liver.

The reticuloendothelial system can be circumvented by several methods including saturation with large doses of liposome particles, or selective macrophage inactivation by pharmacological means (Claassen *et al.*, *Biochim. Biophys. Acta* 802:428 (1984)). In addition, incorporation of glycolipid- or polyethelene glycol-derivatized
10 phospholipids into liposome membranes has been shown to result in a significantly reduced uptake by the reticuloendothelial system (Allen *et al.*, *Biochim. Biophys. Acta* 1068:133 (1991); Allen *et al.*, *Biochim. Biophys. Acta* 1150:9 (1993)).

Liposomes can also be prepared to target particular cells or organs by varying phospholipid composition or by inserting receptors or ligands into the liposomes. For example,
15 liposomes, prepared with a high content of a nonionic surfactant, have been used to target the liver (Hayakawa *et al.*, Japanese Patent 04-244,018; Kato *et al.*, *Biol. Pharm. Bull.* 16:960 (1993)). These formulations were prepared by mixing soybean phosphatidylcholine, α -tocopherol, and ethoxylated hydrogenated castor oil (HCO-60) in methanol, concentrating the mixture under vacuum, and then reconstituting the mixture with water. A liposomal
20 formulation of dipalmitoylphosphatidylcholine (DPPC) with a soybean-derived sterylglucoside mixture (SG) and cholesterol (Ch) has also been shown to target the liver (Shimizu *et al.*, *Biol. Pharm. Bull.* 20:881 (1997)).

Alternatively, various targeting ligands can be bound to the surface of the liposome, such as antibodies, antibody fragments, carbohydrates, vitamins, and transport
25 proteins. For example, liposomes can be modified with branched type galactosyllipid derivatives to target asialoglycoprotein (galactose) receptors, which are exclusively expressed on the surface of liver cells (Kato and Sugiyama, *Crit. Rev. Ther. Drug Carrier Syst.* 14:287 (1997); Murahashi *et al.*, *Biol. Pharm. Bull.* 20:259 (1997)). Similarly, Wu *et al.*, *Hepatology* 27:772 (1998), have shown that labeling liposomes with asialofetuin led to a shortened
30 liposome plasma half-life and greatly enhanced uptake of asialofetuin-labeled liposome by hepatocytes. On the other hand, hepatic accumulation of liposomes comprising branched type galactosyllipid derivatives can be inhibited by preinjection of asialofetuin (Murahashi *et al.*, *Biol. Pharm. Bull.* 20:259 (1997)). Polyaconitylated human serum albumin liposomes provide another approach for targeting liposomes to liver cells (Kamps *et al.*, *Proc. Nat'l Acad. Sci.*

USA 94:11681 (1997)). Moreover, Geho, *et al.* U.S. Patent No. 4,603,044, describe a hepatocyte-directed liposome vesicle delivery system, which has specificity for hepatobiliary receptors associated with the specialized metabolic cells of the liver.

5 In a more general approach to tissue targeting, target cells are prelabeled with biotinylated antibodies specific for a ligand expressed by the target cell (Harasym *et al.*, *Adv. Drug Deliv. Rev.* 32:99 (1998)). After plasma elimination of free antibody, streptavidin-conjugated liposomes are administered. In another approach, targeting antibodies are directly attached to liposomes (Harasym *et al.*, *Adv. Drug Deliv. Rev.* 32:99 (1998)).

10 Polypeptides and antibodies can be encapsulated within liposomes using standard techniques of protein microencapsulation (see, for example, Anderson *et al.*, *Infect. Immun.* 31:1099 (1981), Anderson *et al.*, *Cancer Res.* 50:1853 (1990), and Cohen *et al.*, *Biochim. Biophys. Acta* 1063:95 (1991), Alving *et al.* "Preparation and Use of Liposomes in Immunological Studies," in *Liposome Technology*, 2nd Edition, Vol. III, Gregoriadis (ed.), page 317 (CRC Press 1993), Wassef *et al.*, *Meth. Enzymol.* 149:124 (1987)). As noted above,
15 therapeutically useful liposomes may contain a variety of components. For example, liposomes may comprise lipid derivatives of poly(ethylene glycol) (Allen *et al.*, *Biochim. Biophys. Acta* 1150:9 (1993)).

Degradable polymer microspheres have been designed to maintain high systemic levels of therapeutic proteins. Microspheres are prepared from degradable polymers
20 such as poly(lactide-co-glycolide) (PLG), polyanhydrides, poly (ortho esters), nonbiodegradable ethylvinyl acetate polymers, in which proteins are entrapped in the polymer (Gombotz and Pettit, *Bioconjugate Chem.* 6:332 (1995); Ranade, "Role of Polymers in Drug Delivery," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 51-93 (CRC Press 1995); Roskos and Maskiewicz, "Degradable Controlled Release Systems Useful for Protein
25 Delivery," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 45-92 (Plenum Press 1997); Bartus *et al.*, *Science* 281:1161 (1998); Putney and Burke, *Nature Biotechnology* 16:153 (1998); Putney, *Curr. Opin. Chem. Biol.* 2:548 (1998)). Polyethylene glycol (PEG)-coated nanospheres can also provide carriers for intravenous administration of therapeutic proteins (see, for example, Gref *et al.*, *Pharm. Biotechnol.* 10:167 (1997)).

30 The present invention also contemplates chemically modified polypeptides having binding ZcytoR14 activity such as ZcytoR14 monomeric, homodimeric, heterodimeric or multimeric soluble receptors, and ZcytoR14 antagonists, for example anti-ZcytoR14 antibodies or binding polypeptides, or neutralizing anti-ZcytoR14 antibodies, which a polypeptide is linked with a polymer, as discussed above.

Other dosage forms can be devised by those skilled in the art, as shown, for example, by Ansel and Popovich, *Pharmaceutical Dosage Forms and Drug Delivery Systems*, 5th Edition (Lea & Febiger 1990), Gennaro (ed.), *Remington's Pharmaceutical Sciences*, 19th Edition (Mack Publishing Company 1995), and by Ranade and Hollinger, *Drug Delivery Systems* (CRC Press 1996).

As an illustration, pharmaceutical compositions may be supplied as a kit comprising a container that comprises a polypeptide with a ZcytoR14 extracellular domain, e.g., ZcytoR14 monomeric, homodimeric, heterodimeric or multimeric soluble receptors, or a ZcytoR14 antagonist (e.g., an antibody or antibody fragment that binds a ZcytoR14 polypeptide, or neutralizing anti-ZcytoR14 antibody). Therapeutic polypeptides can be provided in the form of an injectable solution for single or multiple doses, or as a sterile powder that will be reconstituted before injection. Alternatively, such a kit can include a dry-powder disperser, liquid aerosol generator, or nebulizer for administration of a therapeutic polypeptide. Such a kit may further comprise written information on indications and usage of the pharmaceutical composition. Moreover, such information may include a statement that the ZcytoR14 composition is contraindicated in patients with known hypersensitivity to ZcytoR14.

A pharmaceutical composition comprising Anti-ZcytoR14 antibodies or binding partners (or Anti-ZcytoR14 antibody fragments, antibody fusions, humanized antibodies and the like), or ZcytoR14 soluble receptor, can be furnished in liquid form, in an aerosol, or in solid form. Liquid forms, are illustrated by injectable solutions, aerosols, droplets, topological solutions and oral suspensions. Exemplary solid forms include capsules, tablets, and controlled-release forms. The latter form is illustrated by miniosmotic pumps and implants (Bremer *et al.*, *Pharm. Biotechnol.* 10:239 (1997); Ranade, "Implants in Drug Delivery," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 95-123 (CRC Press 1995); Bremer *et al.*, "Protein Delivery with Infusion Pumps," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 239-254 (Plenum Press 1997); Yewey *et al.*, "Delivery of Proteins from a Controlled Release Injectable Implant," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 93-117 (Plenum Press 1997)). Other solid forms include creams, pastes, other topological applications, and the like.

Liposomes provide one means to deliver therapeutic polypeptides to a subject intravenously, intraperitoneally, intrathecally, intramuscularly, subcutaneously, or via oral administration, inhalation, or intranasal administration. Liposomes are microscopic vesicles that consist of one or more lipid bilayers surrounding aqueous compartments (see, generally, Bakker-Woudenberg *et al.*, *Eur. J. Clin. Microbiol. Infect. Dis.* 12 (Suppl. 1):S61 (1993), Kim,

Drugs 46:618 (1993), and Ranade, "Site-Specific Drug Delivery Using Liposomes as Carriers," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 3-24 (CRC Press 1995)). Liposomes are similar in composition to cellular membranes and as a result, liposomes can be administered safely and are biodegradable. Depending on the method of preparation, liposomes may be unilamellar or multilamellar, and liposomes can vary in size with diameters ranging from 0.02 μm to greater than 10 μm . A variety of agents can be encapsulated in liposomes: hydrophobic agents partition in the bilayers and hydrophilic agents partition within the inner aqueous space(s) (see, for example, Machy *et al.*, *Liposomes In Cell Biology And Pharmacology* (John Libbey 1987), and Ostro *et al.*, *American J. Hosp. Pharm.* 46:1576 (1989)). Moreover, it is possible to control the therapeutic availability of the encapsulated agent by varying liposome size, the number of bilayers, lipid composition, as well as the charge and surface characteristics of the liposomes.

Liposomes can adsorb to virtually any type of cell and then slowly release the encapsulated agent. Alternatively, an absorbed liposome may be endocytosed by cells that are phagocytic. Endocytosis is followed by intralysosomal degradation of liposomal lipids and release of the encapsulated agents (Scherphof *et al.*, *Ann. N.Y. Acad. Sci.* 446:368 (1985)). After intravenous administration, small liposomes (0.1 to 1.0 μm) are typically taken up by cells of the reticuloendothelial system, located principally in the liver and spleen, whereas liposomes larger than 3.0 μm are deposited in the lung. This preferential uptake of smaller liposomes by the cells of the reticuloendothelial system has been used to deliver chemotherapeutic agents to macrophages and to tumors of the liver.

The reticuloendothelial system can be circumvented by several methods including saturation with large doses of liposome particles, or selective macrophage inactivation by pharmacological means (Claassen *et al.*, *Biochim. Biophys. Acta* 802:428 (1984)). In addition, incorporation of glycolipid- or polyethelene glycol-derivatized phospholipids into liposome membranes has been shown to result in a significantly reduced uptake by the reticuloendothelial system (Allen *et al.*, *Biochim. Biophys. Acta* 1068:133 (1991); Allen *et al.*, *Biochim. Biophys. Acta* 1150:9 (1993)).

Liposomes can also be prepared to target particular cells or organs by varying phospholipid composition or by inserting receptors or ligands into the liposomes. For example, liposomes, prepared with a high content of a nonionic surfactant, have been used to target the liver (Hayakawa *et al.*, Japanese Patent 04-244,018; Kato *et al.*, *Biol. Pharm. Bull.* 16:960 (1993)). These formulations were prepared by mixing soybean phosphatidylcholine, α -tocopherol, and ethoxylated hydrogenated castor oil (HCO-60) in methanol, concentrating the

mixture under vacuum, and then reconstituting the mixture with water. A liposomal formulation of dipalmitoylphosphatidylcholine (DPPC) with a soybean-derived sterylglucoside mixture (SG) and cholesterol (Ch) has also been shown to target the liver (Shimizu *et al.*, *Biol. Pharm. Bull.* 20:881 (1997)).

5 Alternatively, various targeting ligands can be bound to the surface of the liposome, such as antibodies, antibody fragments, carbohydrates, vitamins, and transport proteins. For example, liposomes can be modified with branched type galactosyllipid derivatives to target asialoglycoprotein (galactose) receptors, which are exclusively expressed on the surface of liver cells (Kato and Sugiyama, *Crit. Rev. Ther. Drug Carrier Syst.* 14:287
10 (1997); Murahashi *et al.*, *Biol. Pharm. Bull.* 20:259 (1997)). Similarly, Wu *et al.*, *Hepatology* 27:772 (1998), have shown that labeling liposomes with asialofetuin led to a shortened liposome plasma half-life and greatly enhanced uptake of asialofetuin-labeled liposome by hepatocytes. On the other hand, hepatic accumulation of liposomes comprising branched type galactosyllipid derivatives can be inhibited by preinjection of asialofetuin (Murahashi *et al.*,
15 *Biol. Pharm. Bull.* 20:259 (1997)). Polyaconitylated human serum albumin liposomes provide another approach for targeting liposomes to liver cells (Kamps *et al.*, *Proc. Nat'l Acad. Sci. USA* 94:11681 (1997)). Moreover, Geho, *et al.* U.S. Patent No. 4,603,044, describe a hepatocyte-directed liposome vesicle delivery system, which has specificity for hepatobiliary receptors associated with the specialized metabolic cells of the liver.

20 In a more general approach to tissue targeting, target cells are prelabeled with biotinylated antibodies specific for a ligand expressed by the target cell (Harasym *et al.*, *Adv. Drug Deliv. Rev.* 32:99 (1998)). After plasma elimination of free antibody, streptavidin-conjugated liposomes are administered. In another approach, targeting antibodies are directly attached to liposomes (Harasym *et al.*, *Adv. Drug Deliv. Rev.* 32:99 (1998)).

25 Anti-ZcytoR14 neutralizing antibodies and binding partners with IL-17F OR IL-17A binding activity, or ZcytoR14 soluble receptor, can be encapsulated within liposomes using standard techniques of protein microencapsulation (see, for example, Anderson *et al.*, *Infect. Immun.* 31:1099 (1981), Anderson *et al.*, *Cancer Res.* 50:1853 (1990), and Cohen *et al.*, *Biochim. Biophys. Acta* 1063:95 (1991), Alving *et al.* "Preparation and Use of Liposomes in
30 Immunological Studies," in *Liposome Technology*, 2nd Edition, Vol. III, Gregoriadis (ed.), page 317 (CRC Press 1993), Wassef *et al.*, *Meth. Enzymol.* 149:124 (1987)). As noted above, therapeutically useful liposomes may contain a variety of components. For example, liposomes may comprise lipid derivatives of poly(ethylene glycol) (Allen *et al.*, *Biochim. Biophys. Acta* 1150:9 (1993)).

Degradable polymer microspheres have been designed to maintain high systemic levels of therapeutic proteins. Microspheres are prepared from degradable polymers such as poly(lactide-co-glycolide) (PLG), polyanhydrides, poly (ortho esters), nonbiodegradable ethylvinyl acetate polymers, in which proteins are entrapped in the polymer (Gombotz and Pettit, Bioconjugate Chem. 6:332 (1995); Ranade, "Role of Polymers in Drug Delivery," in *Drug Delivery Systems*, Ranade and Hollinger (eds.), pages 51-93 (CRC Press 1995); Roskos and Maskiewicz, "Degradable Controlled Release Systems Useful for Protein Delivery," in *Protein Delivery: Physical Systems*, Sanders and Hendren (eds.), pages 45-92 (Plenum Press 1997); Bartus *et al.*, Science 281:1161 (1998); Putney and Burke, Nature Biotechnology 16:153 (1998); Putney, Curr. Opin. Chem. Biol. 2:548 (1998)). Polyethylene glycol (PEG)-coated nanospheres can also provide carriers for intravenous administration of therapeutic proteins (see, for example, Gref *et al.*, Pharm. Biotechnol. 10:167 (1997)).

The present invention also contemplates chemically modified Anti-ZcytoR14 antibody or binding partner, for example anti-Anti-ZcytoR14 antibodies or ZcytoR14 soluble receptor, linked with a polymer, as discussed above.

Other dosage forms can be devised by those skilled in the art, as shown, for example, by Ansel and Popovich, *Pharmaceutical Dosage Forms and Drug Delivery Systems*, 5th Edition (Lea & Febiger 1990), Gennaro (ed.), *Remington's Pharmaceutical Sciences*, 19th Edition (Mack Publishing Company 1995), and by Ranade and Hollinger, *Drug Delivery Systems* (CRC Press 1996).

The present invention contemplates compositions of anti-IL-17F antibodies, and methods and therapeutic uses comprising an antibody, peptide or polypeptide described herein. Such compositions can further comprise a carrier. The carrier can be a conventional organic or inorganic carrier. Examples of carriers include water, buffer solution, alcohol, propylene glycol, macrogol, sesame oil, corn oil, and the like.

K) Production of Transgenic Mice

Transgenic mice can be engineered to over-express the either IL-17F, IL-17A or the Zcytor14 gene in all tissues or under the control of a tissue-specific or tissue-preferred regulatory element. These over-producers can be used to characterize the phenotype that results from over-expression, and the transgenic animals can serve as models for human disease caused by excess IL-17F, IL-17A or Zcytor14. Transgenic mice that over-express any of these also provide model bioreactors for production of Zcytor14, such as soluble Zcytor14, in the milk or blood of larger animals. Methods for producing transgenic mice are well-known to those of skill in the art (see, for example, Jacob, "Expression and Knockout of Interferons in

Transgenic Mice,” in *Overexpression and Knockout of Cytokines in Transgenic Mice*, Jacob (ed.), pages 111-124 (Academic Press, Ltd. 1994), Monastersky and Robl (eds.), *Strategies in Transgenic Animal Science* (ASM Press 1995), and Abbud and Nilson, “Recombinant Protein Expression in Transgenic Mice,” in *Gene Expression Systems: Using Nature for the Art of Expression*, Fernandez and Hoeffler (eds.), pages 367-397 (Academic Press, Inc. 1999)).

For example, a method for producing a transgenic mouse that expresses a Zcytor14 gene can begin with adult, fertile males (studs) (B6C3f1, 2-8 months of age (Taconic Farms, Germantown, NY)), vasectomized males (duds) (B6D2f1, 2-8 months, (Taconic Farms)), prepubescent fertile females (donors) (B6C3f1, 4-5 weeks, (Taconic Farms)) and adult fertile females (recipients) (B6D2f1, 2-4 months, (Taconic Farms)). The donors are acclimated for one week and then injected with approximately 8 IU/mouse of Pregnant Mare’s Serum gonadotrophin (Sigma Chemical Company; St. Louis, MO) I.P., and 46-47 hours later, 8 IU/mouse of human Chorionic Gonadotropin (hCG (Sigma)) I.P. to induce superovulation. Donors are mated with studs subsequent to hormone injections. Ovulation generally occurs within 13 hours of hCG injection. Copulation is confirmed by the presence of a vaginal plug the morning following mating.

Fertilized eggs are collected under a surgical scope. The oviducts are collected and eggs are released into urinanalysis slides containing hyaluronidase (Sigma). Eggs are washed once in hyaluronidase, and twice in Whitten’s W640 medium (described, for example, by Menino and O’Claray, *Biol. Reprod.* 77:159 (1986), and Dienhart and Downs, *Zygote* 4:129 (1996)) that has been incubated with 5% CO₂, 5% O₂, and 90% N₂ at 37°C. The eggs are then stored in a 37°C/5% CO₂ incubator until microinjection.

Ten to twenty micrograms of plasmid DNA containing a Zcytor14 encoding sequence is linearized, gel-purified, and resuspended in 10 mM Tris-HCl (pH 7.4), 0.25 mM EDTA (pH 8.0), at a final concentration of 5-10 nanograms per microliter for microinjection. For example, the Zcytor14 encoding sequences can encode a polypeptide comprising amino acid residues 21 to 452 of SEQ ID NO:2.

Plasmid DNA is microinjected into harvested eggs contained in a drop of W640 medium overlaid by warm, CO₂-equilibrated mineral oil. The DNA is drawn into an injection needle (pulled from a 0.75mm ID, 1mm OD borosilicate glass capillary), and injected into individual eggs. Each egg is penetrated with the injection needle, into one or both of the haploid pronuclei.

Picoliters of DNA are injected into the pronuclei, and the injection needle withdrawn without coming into contact with the nucleoli. The procedure is repeated until all

the eggs are injected. Successfully microinjected eggs are transferred into an organ tissue-culture dish with pre-gassed W640 medium for storage overnight in a 37°C/5% CO₂ incubator.

The following day, two-cell embryos are transferred into pseudopregnant recipients. The recipients are identified by the presence of copulation plugs, after copulating with vasectomized duds. Recipients are anesthetized and shaved on the dorsal left side and transferred to a surgical microscope. A small incision is made in the skin and through the muscle wall in the middle of the abdominal area outlined by the ribcage, the saddle, and the hind leg, midway between knee and spleen. The reproductive organs are exteriorized onto a small surgical drape. The fat pad is stretched out over the surgical drape, and a baby serrefine (Roboz, Rockville, MD) is attached to the fat pad and left hanging over the back of the mouse, preventing the organs from sliding back in.

With a fine transfer pipette containing mineral oil followed by alternating W640 and air bubbles, 12-17 healthy two-cell embryos from the previous day's injection are transferred into the recipient. The swollen ampulla is located and holding the oviduct between the ampulla and the bursa, a nick in the oviduct is made with a 28 g needle close to the bursa, making sure not to tear the ampulla or the bursa.

The pipette is transferred into the nick in the oviduct, and the embryos are blown in, allowing the first air bubble to escape the pipette. The fat pad is gently pushed into the peritoneum, and the reproductive organs allowed to slide in. The peritoneal wall is closed with one suture and the skin closed with a wound clip. The mice recuperate on a 37°C slide warmer for a minimum of four hours.

The recipients are returned to cages in pairs, and allowed 19-21 days gestation. After birth, 19-21 days postpartum is allowed before weaning. The weanlings are sexed and placed into separate sex cages, and a 0.5 cm biopsy (used for genotyping) is snipped off the tail with clean scissors.

Genomic DNA is prepared from the tail snips using, for example, a QIAGEN DNEASY kit following the manufacturer's instructions. Genomic DNA is analyzed by PCR using primers designed to amplify a Zcytor14 gene or a selectable marker gene that was introduced in the same plasmid. After animals are confirmed to be transgenic, they are back-crossed into an inbred strain by placing a transgenic female with a wild-type male, or a transgenic male with one or two wild-type female(s). As pups are born and weaned, the sexes are separated, and their tails snipped for genotyping.

To check for expression of a transgene in a live animal, a partial hepatectomy is performed. A surgical prep is made of the upper abdomen directly below the zyphoid

process. Using sterile technique, a small 1.5-2 cm incision is made below the sternum and the left lateral lobe of the liver exteriorized. Using 4-0 silk, a tie is made around the lower lobe securing it outside the body cavity. An atraumatic clamp is used to hold the tie while a second loop of absorbable Dexon (American Cyanamid; Wayne, N.J.) is placed proximal to the first tie. A distal cut is made from the Dexon tie and approximately 100 mg of the excised liver tissue is placed in a sterile petri dish. The excised liver section is transferred to a 14 ml polypropylene round bottom tube and snap frozen in liquid nitrogen and then stored on dry ice. The surgical site is closed with suture and wound clips, and the animal's cage placed on a 37°C heating pad for 24 hours post operatively. The animal is checked daily post operatively and the wound clips removed 7-10 days after surgery. The expression level of Zcytor14 mRNA is examined for each transgenic mouse using an RNA solution hybridization assay or polymerase chain reaction.

In addition to producing transgenic mice that over-express IL-17F, IL-17A or Zcytor14, it is useful to engineer transgenic mice with either abnormally low or no expression of any of these genes. Such transgenic mice provide useful models for diseases associated with a lack of IL-17F, IL-17A or Zcytor14. As discussed above, Zcytor14 gene expression can be inhibited using anti-sense genes, ribozyme genes, or external guide sequence genes. To produce transgenic mice that under-express the Zcytor14 gene, such inhibitory sequences are targeted to Zcytor14 mRNA. Methods for producing transgenic mice that have abnormally low expression of a particular gene are known to those in the art (see, for example, Wu *et al.*, "Gene Underexpression in Cultured Cells and Animals by Antisense DNA and RNA Strategies," in *Methods in Gene Biotechnology*, pages 205-224 (CRC Press 1997)).

An alternative approach to producing transgenic mice that have little or no Zcytor14 gene expression is to generate mice having at least one normal Zcytor14 allele replaced by a nonfunctional Zcytor14 gene. One method of designing a nonfunctional Zcytor14 gene is to insert another gene, such as a selectable marker gene, within a nucleic acid molecule that encodes Zcytor14. Standard methods for producing these so-called "knockout mice" are known to those skilled in the art (see, for example, Jacob, "Expression and Knockout of Interferons in Transgenic Mice," in *Overexpression and Knockout of Cytokines in Transgenic Mice*, Jacob (ed.), pages 111-124 (Academic Press, Ltd. 1994), and Wu *et al.*, "New Strategies for Gene Knockout," in *Methods in Gene Biotechnology*, pages 339-365 (CRC Press 1997)).

The invention is further illustrated by the following non-limiting examples.

EXAMPLES**EXAMPLE 1****Expression of the ZcytoR14 Gene**

Northern analyses were performed using Human Multiple Tissue Blots (CLONTECH Laboratories, Inc., Palo Alto, CA). Two probes were generated from gel purified PCR products. The first probe was made using ZC21798 (5' CGG CGT GGT GGT CTT GCT CTT 3'; SEQ ID NO:8) and ZC21808 (5' TCC CGT CCC CCG CCC CAG GTC 3'; SEQ ID NO:31) as primers. The probe was radioactively labeled using the Multiprime labeling kit from Amersham (Arlington Heights, IL) according to the manufacturer's protocol. The probe was purified using a NUCTRAP push column (STRATAGENE, La Jolla, CA). EXPRESSHYB (CLONTECH) solution was used for the prehybridization and hybridization solutions for the northern blots. Hybridization took place overnight at 65°C. Following hybridization, the blots were washed for 30 minutes each in solutions that contained 0.1% SDS and SSC as follows: twice in 2xSSC at room temperature, three times in 0.1x SSC at 50°C, once in 0.1x SSC at 55°C, and once in 0.1x SSC at 65°C. The results demonstrated the *ZcytoR14* gene is strongly expressed in thyroid, adrenal gland, prostate, and liver tissues, and expressed to a lesser extent in heart, small intestine, stomach, and trachea tissues. In contrast, there is little or no expression in brain, placenta, lung, skeletal muscle, kidney, pancreas, spleen, thymus, testis, ovary, colon, peripheral blood leukocytes, spinal cord, lymph node, and bone marrow.

EXAMPLE 2**Distribution of mRNA in Cell Line Panels Using PCR**

Total RNA was purified from resting and stimulated cell lines grown in-house and purified using a Qiagen (Valencia, CA) RNeasy kit according to the manufacturer's instructions, or an acid-phenol purification protocol (Chomczynski and Sacchi, Analytical Biochemistry, 162:156-9, 1987). The quality of the RNA was assessed by running an aliquot on an Agilent Bioanalyzer. If the RNA was significantly degraded, it was not used for subsequent creation of first strand cDNA. Presence of contaminating genomic DNA was assessed by a PCR assay on an aliquot of the RNA with zc41011 (5'CTCTCCATCCTTATCTTTCATCAAC 3'; SEQ ID NO:32) and zc41012 (5'CTCTCTGCTGGCTAAACAAAACAC 3'; SEQ ID NO:33), primers that amplify a single site of intergenic genomic DNA. The PCR conditions for the contaminating genomic DNA assay were as follows: 2.5µl 10X buffer and 0.5µl Advantage 2 cDNA polymerase mix (BD Biosciences Clontech, Palo Alto, CA), 2µl 2.5mM dNTP mix (Applied Biosystems, Foster

City, CA), 2.5µl 10X Rediload (Invitrogen, Carlsbad, CA), and 0.5µl 20uM zc41011 and zc41012, in a final volume of 25 ul. Cycling parameters were 94°C 20", 40 cycles of 94°C 20" 60°C 1'20" and one cycle of 72°C 7'. 10ul of each reaction was subjected to agarose gel electrophoresis and gels were examined for presence of a PCR product from contaminating genomic DNA. If contaminating genomic DNA was observed, the total RNA was DNAsed using DNA-free reagents (Ambion, Inc, Austin, TX) according to the manufacturer's instructions, then retested as described above. Only RNAs which appeared to be free of contaminating genomic DNA were used for subsequent creation of first strand cDNA.

20µg total RNA from 82 human cell lines were each brought to 98µl with H₂O, then split into two 49ul aliquots, each containing 10µg total RNA, and placed in two 96-well PCR plates. To each aliquot was added reagents for first strand cDNA synthesis (Invitrogen First Strand cDNA Synthesis System, Carlsbad, CA): 20µl 25mM MgCl₂, 10ul 10X RT buffer, 10ul 0.1M DTT, 2µl oligo dT, 2ul RNaseOut. Then, to one aliquot from each cell line 2µl Superscript II Reverse Transcriptase was added, and to the corresponding cell line aliquot 2µl H₂O was added to make a minus Reverse Transcriptase negative control. All samples were incubated as follows: 25°C 10', 42°C 50', 70°C 15'. Samples were arranged in deep well plates and diluted to 1.7ml with H₂O. A Multipette (Saigan) robot was used to aliquot 16.5µl into each well of a 96-well PCR plate multiple times, generating numerous one-use PCR panels of the cell lines, which were then sealed and stored at -20°C. Each well in these panels represents first strand cDNA from approximately 100ng total RNA. The 82 cell lines are spread across two panels, array #118A and #118B. Quality of first strand cDNA on the panels was assessed by a multiplex PCR assay on one set of the panels using primers to two widely expressed, but only moderately abundant genes, CLTC (clathrin) and TFRC (transferrin receptor C). 0.5ul each of Clathrin primers zc42901 (5'CTCATATTGCTCAACTGTGTGAAAAG 3'; SEQ ID NO:34), zc42902(5'TAGAAGCCACCTGAACACAAATCTG3'; SEQ ID NO:35), and TFRC primers zc42599 (5'ATCTTGCGTTGTATGTTGAAAATCAATT3'; SEQ ID NO:36), zc42600 (5'TTCTCCACCAGGTAAACAAGTCTAC3'; SEQ ID NO:37), were mixed with 2.5µl 10X buffer and 0.5µl Advantage 2 cDNA polymerase mix (BD Biosciences Clontech, Palo Alto, CA), 2µl 2.5mM dNTP mix (Applied Biosystems,, Foster City, CA), 2.5µl 10X Rediload (Invitrogen, Carlsbad, CA), and added to each well of a panel of array#118A and array #118B. Cycling parameters were as follows: 94°C 20", 35 cycles of 94°C 20", 67°C 80", and one cycle of 72°C 7'. 10µl of each reaction was subjected to agarose gel electrophoresis and gels were

scored for the presence of a robust PCR product for each gene specific to the +RT wells for each cell line.

Expression of mRNA in the human first strand cDNA panels for ZcytoR14 was assayed by PCR with sense oligo ZC42756 (5'ctctccaggcccaagtcgtgctct3'; SEQ ID NO:38) and antisense oligo ZC42757 (5'tgtcctgggggcctcgtgtctcc3'; SEQ ID NO:39) under these PCR conditions per sample: 2.5µl 10X buffer and 0.5µl advantage 2 cDNA polymerase mix (BD Biosciences Clontech, Palo Alto, CA), 2µl 2.5mM dNTP mix (Applied Biosystems,), 2.5ul 10X Rediload (Invitrogen, Carlsbad, CA), and 0.5µl 20uM each sense and antisense primer. Cycling conditions were 94°C 2', 35 cycles of 94°C 1', 66°C 30", 72°C 1.5', and one cycle of 72°C 7'. 10µl of each reaction was subjected to agarose gel electrophoresis and gels were scored for positive or negative expression of ZcytoR14.

ZcytoR14 mRNA is widely expressed in many cell lines representing a broad spectrum of tissue and cell types. In particular, ZcytoR14 is consistently expressed in non-T cell peripheral blood cell lines, including monocytes, B-cells, and cells of the myeloid lineage. Also, ZcytoR14 mRNA is reliably expressed in cell lines derived from skin. Other cell lines that express ZcytoR14 are all 5 of the large intestine cell lines that were present on the array.

EXAMPLE 3

Distribution of mRNA in Mouse Cell Line Panels Using RT PCR

Total RNA was purified from 60 resting and stimulated cell lines grown in-house and purified using a Qiagen (Valencia, CA) RNeasy kit according to the manufacturer's instructions, an acid-phenol purification protocol (Chomczynski and Sacchi, Analytical Biochemistry, 162:156-9, 1987), or a Trizol reagent protocol (Invitrogen, Carlsbad, CA).

5µg of total RNA from each cell line was arranged in a deep well 96-well plate, 125µl 3M NaOAc and 100µl Pellet Paint (Novagen, Madison, WI) were added to each well, then the final volume was adjusted to 1.25ml with H₂O. A Multipette (Saigan) robot was used to aliquot 25µl of the RNA mixture followed by 75ul EtOH into each well of a 96-well PCR plate multiple times, generating numerous one-use RT PCR panels of the cell lines, which were then sealed and stored at -20°C. RT PCR screening was performed by first centrifuging a panel in a Qiagen (Valencia, CA) 96-well centrifuge for 10' at 6000 RPM. Supernatant was removed by inverting the plate onto absorbent paper. RNA pellets were washed with 100µl 70% EtOH, followed by a 5' centrifugation at 6000 RPM. Supernatant was again removed and plates allowed to air-dry until the remaining EtOH was evaporated. RNA pellets were resuspended in 15µl H₂O.

Expression of ZcytoR14 mRNA in the mouse cell line RNA panels was assayed by RT PCR with zc38910 (5'acgaagcccaggtaccagaaagag3'; SEQ ID NO:40) and zc38679 (5'aaaagcgccgcagccaagagtagg3'; SEQ ID NO:41) under these RT PCR conditions per sample: SuperScript One-Step PCR with Platinum Taq kit, Invitrogen, Carlsbad, CA. Cycling conditions were: 1 cycle of 48°C for 30 minutes, 94°C for 2 minutes, followed by 35 cycles of 94°C for 15 seconds, 55°C for 30 seconds, 72°C for 1.5 minutes, followed by 1 cycle of 72°C for 7 minutes. 10µl of each reaction was subjected to agarose gel electrophoresis and gels were scored for positive or negative expression of ZcytoR14.

Murine ZcytoR14mRNA is expressed in several mouse cell lines, notably in cell lines derived from bone marrow, including osteoblast, adipocyte, and preadipocyte cell lines. Also, mouse ZcytoR14 mRNA is represented in several samples from the endocrine system, such as pancreas stromal cell lines, pancreas islet cell lines, and hypothalamus, salivary gland, and testis cell lines.

EXAMPLE 4

Refolding and Purification pIL-17F Produced in *E.coli*

A) Inclusion body isolation and extraction of pIL-17F

Following induction of protein expression in either batch ferment or shaker flask culture, the *E.coli* broth is centrifuged in 1 liter bottles @ 3000 RPM in a Sorvall swinging bucket rotor. Washing of the cell paste to remove any broth contaminants is performed with 50 mM Tris pH 8.0 containing 200 mM NaCl and 5 mM EDTA until the supernate is clear.

The cell pellets are then suspended in ice-cold lysis buffer (50 mM Tris pH 8.0; 5 mM EDTA; 200 mM NaCl, 10% sucrose (w/v); 5mM DTT; 5 mM Benzamidine;) to 10-20 Optical Density units at 600 nm. This slurry is then subjected to 3 passes at 8500-9000 psi in a chilled APV 2000 Lab Homogenizer producing a disrupted cell lysate. The insoluble fraction (inclusion bodies) is recovered by centrifugation of the cell lysate at 20,000 X G for 1 hour at 4°C.

The inclusion body pellet resulting from the 20,000 X G spin is weighed and then re-suspended in wash buffer (50 mM Tris pH 8 containing 200 mM NaCl, 5 mM EDTA, 5mM DTT, 5mM Benzamidine) at 10 ml wash buffer per gram inclusion bodies. Complete dispersion is achieved by homogenizing with an OMNI international rotor stator generator. This suspension is centrifuged at 20,000 X G for 30 minutes at 4°C. The wash cycle is repeated 3-5 times until the supernatant is clear.

The final washed pellet is solubilized in 7M Guanidine HCl in 40 mM Tris buffer at pH 8 containing 0.1M Sodium Sulfite and 0.02 M Sodium Tetrathionate. The extraction and sulfitolysis reaction is allowed to proceed with gentle stirring at 4°C overnight. The resulting pinkish colored solution is centrifuged at 35,000 X g for 1 hour at 4°C and the clarified supernate, containing the soluble pIL-17F, is 0.45 um filtered.

B) pIL-17F refolding procedure

The solubilized, sulfitolyzed pIL-17F is refolded by drop wise dilution into ice cold refolding buffer containing 55 mM MES, 10.56 mM NaCl, 0.44 mM KCl, 0.055% PEG (3400 K), 1.1 mM EDTA, 20% Glycerol, 0.5M Guanidine HCl, 0.75 M Arginine and the Glutathione redox pair at a 1:1 ratio (1mM GSH : 1mM GSSG). The pH of the refolding buffer is adjusted to 6.5 with HCl and the pIL-17F is added to a final concentration of 100 ug/ml. Once diluted, the mixture is allowed to stir slowly in the cold room for 72 hours.

C) Product recovery & purification

The refolded pIL-17F is concentrated 10X vs. a 10kDa cutoff membrane on a lab scale TFF system. Next it is filtered using a 0.45 micron membrane and the pH is adjusted to 5.1 with the addition of Acetic acid. The pH-adjusted material is captured by cation exchange chromatography on a Pharmacia SP Fast Flow column equilibrated in 50 mM Acetate buffer, pH 5.1. The pIL-17F is loaded by inline proportioning at 1:5 with equilibration buffer at a flow rate of 190 cm/hr. This dilution lowers the ionic strength enabling efficient binding of the target to the matrix. After sample loading is complete, the column is washed to baseline absorbance with equilibration buffer. The column is washed with 0.4 M NaCl in 50 mM Acetate buffer at pH 5.1 and then the bound protein is eluted with a 5 CV gradient from 0.4 M to 1.5 M NaCl in 50 mM Acetate buffer at pH 5.1. The protein elutes at ~ 1M NaCl and is approximately 85% dimeric by SDS PAGE analysis of eluate fractions. The fractions containing pIL-17F are pooled and concentrated against a 10 kDa cutoff ultrafiltration membrane using an Amicon stirred cell in preparation for the final purification and buffer exchange by size exclusion chromatography.

D) Size exclusion buffer exchange and formulation

The concentrated cation pool (at a volume of 3-4% of CV) is injected at a flow rate of 30 cm/hr onto a Pharmacia Superdex 75 size exclusion column equilibrated in 50 mM Sodium Phosphate buffer containing 109 mM NaCl, pH 7.2. The symmetric eluate peak containing the product is diluted to a concentration of 1 mg/ml in 50 mM Sodium Phosphate buffer containing 109 mM NaCl, pH 7.2. Finally the pIL-17F is 0.2 micron sterile filtered, aliquoted and stored at -80°C. The final process yield is 20%.

EXAMPLE 5**Construction of Mammalian Soluble ZcytoR14 Expression Construct**

An expression construct containing human ZcytoR14 [L21-K451]-mFc1 (mouse BALB/c μ 2a Fc) is constructed via overlap PCR and homologous recombination using
 5 a DNA fragment (SEQ ID NO:42) encoding a ZcytoR14 polypeptide (SEQ ID NO:43), a DNA fragment encoding mFc1 (SEQ ID NO:44), and the expression vector pZMP20. The fragments are generated by PCR amplification.

The PCR fragment encoding ZcytoR14 [L21-K451] contains a 5' overlap with the pZMP20 vector sequence in the optimized tissue plasminogen activator pre-pro secretion
 10 leader sequence coding region, the ZcytoR14 extracellular domain coding [L21-K451], and a 3' overlap with the mFc1 coding region. The PCR amplification reaction uses the 5' oligonucleotide

[GTTTCGCTCAGCCAGGAAATCCATGCCGAGTTGAGACGCTTCCGTAGACTGGAGA
 GGCTTGTGGGGCCT; SEQ ID NO:46], the 3' oligonucleotide
 15 [TGTGGGCCCTCTGGGCTCCTTGTGGATGTATTTGTC; SEQ ID NO:47], and a previously generated DNA clone of ZcytoR14 as the template.

The PCR fragment encoding mFc1 contains a 5' overlap with the ZcytoR14 sequence, the mFc1 coding region, and a 3' overlap with the pZMP20 vector in the poliovirus
 internal ribosome entry site region. The PCR amplification reaction uses the 5 oligonucleotide
 20 [GACAAATACATCCACAAGGAGCCCAGAGGGCCCACA; SEQ ID NO:48], the 3' oligonucleotide

[CAACCCCAGAGCTGTTTTAAGGCGCGCCTCTAGATTATTTACCCGGAGTCCGGGA; SEQ ID NO:49], and a previously generated DNA clone of mFc1 as the template.

The PCR amplification reaction conditions are as follows: 1 cycle, 94 °C, 5
 25 minutes; 35 cycles, 94 °C, 1 minute, followed by 55 °C, 2 minutes, followed by 72 °C, 3 minutes; 1 cycle, 72 °C, 10 minutes. The PCR reaction mixtures are run on a 1% agarose gel and the DNA fragments corresponding to the expected sizes are extracted from the gel using a QIAquick™ Gel Extraction Kit (Qiagen, Cat. No. 28704).

The two PCR fragments are joined by overlap PCR. Approximately 1 μ l each
 30 of the two gel extracted fragments are combined in a PCR amplification reaction using the 5' oligonucleotide

[GTTTCGCTCAGCCAGGAAATCCATGCCGAGTTGAGACGCTTCCGTAGACTGGAGA
 GGCTTGTGGGGCCT; SEQ ID NO: 46] and the 3' oligonucleotide
 [CAACCCCAGAGCTGTTTTAAGGCGCGCCTCTAGATTATTTACCCGGAGTCCGGGA;

SEQ ID NO:49]. PCR conditions used are as follows: 1 cycle, 94 °C, 5 minutes; 35 cycles, 94 °C, 1 minute, followed by 55 °C, 2 minutes, followed by 72 °C, 3 minutes; 1 cycle, 72 °C, 10 minutes. The PCR reaction mixture is run on a 1% agarose gel and the DNA fragment corresponding to the size of the insert is extracted from the gel using a QIAquick™ Gel
5 Extraction Kit (Qiagen, Cat. No. 28704).

Plasmid pZMP20 is a mammalian expression vector containing an expression cassette having the MPSV promoter, a *Bgl*II site for linearization prior to yeast recombination, an otPA signal peptide sequence, an internal ribosome entry element from poliovirus, the extracellular domain of CD8 truncated at the C-terminal end of the transmembrane domain; an
10 *E. coli* origin of replication; a mammalian selectable marker expression unit comprising an SV40 promoter, enhancer and origin of replication, a DHFR gene, and the SV40 terminator; and URA3 and CEN-ARS sequences required for selection and replication in *S. cerevisiae*.

The plasmid pZMP20 is digested with *Bgl*II prior to recombination in yeast with the gel extracted ZcytoR14[L21-K451]-mFc1 PCR fragment. 100µl of competent yeast (*S.*
15 *cerevisiae*) cells are combined with 10µl of the ZcytoR14[L21-K451]-mFc1 insert DNA and 100 ng of *Bgl*II digested pZMP20 vector, and the mix is transferred to a 0.2 cm electroporation cuvette. The yeast/DNA mixture is electropulsed using power supply (BioRad Laboratories, Hercules, CA) settings of 0.75 kV (5 kV/cm), ∞ ohms, and 25 µF. Six hundred µl of 1.2 M sorbitol is added to the cuvette, and the yeast is plated in 100 µl and 300 µl aliquots onto two
20 URA-D plates and incubated at 30°C. After about 72 hours, the Ura⁺ yeast transformants from a single plate are resuspended in 1 ml H₂O and spun briefly to pellet the yeast cells. The cell pellet is resuspended in 0.5 ml of lysis buffer (2% Triton X-100, 1% SDS, 100 mM NaCl, 10 mM Tris, pH 8.0, 1 mM EDTA). The five hundred µl of the lysis mixture is added to an Eppendorf tube containing 250 µl acid-washed glass beads and 300 µl phenol-chloroform, is
25 vortexed for 3 minutes, and spun for 5 minutes in an Eppendorf centrifuge at maximum speed. Three hundred µl of the aqueous phase is transferred to a fresh tube, and the DNA is precipitated with 600 µl ethanol, followed by centrifugation for 30 minutes at maximum speed. The tube is decanted and the pellet is washed with 1 mL of 70% ethanol. The tube is decanted and the DNA pellet is resuspended in 30 µl 10 mM Tris, pH 8.0, 1 mM EDTA.

30 Transformation of electrocompetent *E. coli* host cells (DH12S) is done using 5 µl of the yeast DNA preparation and 50 µl of *E. coli* cells. The cells are electropulsed at 2.0 kV, 25 µF, and 400 ohms. Following electroporation, 1 ml SOC (2% Bacto™ Tryptone (Difco, Detroit, MI), 0.5% yeast extract (Difco), 10 mM NaCl, 2.5 mM KCl, 10 mM MgCl₂, 10 mM

MgSO₄, 20 mM glucose) is added and then the cells are plated in 50 µl and 200 µl aliquots on two LB AMP plates (LB broth (Lennox), 1.8% Bacto™ Agar (Difco), 100 mg/L Ampicillin).

The inserts of three DNA clones for the construct is subjected to sequence analysis and one clone containing the correct sequence is selected. Large scale plasmid DNA is isolated using a commercially available kit (QIAGEN Plasmid Mega Kit, Qiagen, Valencia, CA) according to manufacturer's instructions.

EXAMPLE 6

Construction of Mammalian Soluble ZcytoR14 Expression Constructs that Express

10 ZcytoR14-CEE, ZcytoR14-CHIS, and ZcytoR14-CFLAG

An expression construct containing human ZcytoR14 [L21-K451] with a C-terminal tag, either Glu-Glu (CEE), six His (CHIS), or FLAG (CFLAG), is constructed via PCR and homologous recombination using a DNA fragment encoding ZcytoR14 [L21-K451] (SEQ ID NO:42) and the expression vector pZMP20.

15 The PCR fragment encoding ZcytoR14CEE contains a 5' overlap with the pZMP20 vector sequence in the optimized tissue plasminogen activator pre-pro secretion leader sequence coding region, the ZcytoR14 extracellular domain coding [L21-K451], the sequence of the Glu-Glu tag (Glu Glu Tyr Met Pro Met Glu; SEQ ID NO:53), and a 3' overlap with the pZMP20 vector in the poliovirus internal ribosome entry site region. The PCR
20 amplification reaction uses the 5' oligonucleotide [GTTTCGCTCAGCCAGGAAATCCATGCCGAGTTGAGACGCTTCCGTAGACTGGAGA GGCTTGTGGGGCCT; SEQ ID NO:46], the 3' oligonucleotide [CAACCCCAGAGCTGTTTTAAGGCGCGCCTCTAGATTATTCCATGGGCATGTATTCT TCCTTGTGGATGTATTTGTC; SEQ ID NO:50], and a previously generated DNA clone of
25 ZcytoR14 as the template.

The PCR amplification reaction condition is as follows: 1 cycle, 94 °C, 5 minutes; 35 cycles, 94 °C, 1 minute, followed by 55 °C, 2 minutes, followed by 72 °C, 3 minutes; 1 cycle, 72 °C, 10 minutes. The PCR reaction mixture is run on a 1% agarose gel and the DNA fragment corresponding to the expected size is extracted from the gel using a
30 QIAquick™ Gel Extraction Kit (Qiagen, Cat. No. 28704).

The plasmid pZMP20 is digested with *Bgl*/II prior to recombination in yeast with the gel extracted ZcytoR14CEE PCR fragment. One hundred µl of competent yeast (*S. cerevisiae*) cells are combined with 10 µl of the ZcytoR14CEE insert DNA and 100 ng of *Bgl*/II digested pZMP20 vector, and the mix is transferred to a 0.2 cm electroporation cuvette. The

yeast/DNA mixture is electropulsed using power supply (BioRad Laboratories, Hercules, CA) settings of 0.75 kV (5 kV/cm), ∞ ohms, and 25 μ F. Six hundred μ l of 1.2 M sorbitol is added to the cuvette, and the yeast is plated in 100 μ l and 300 μ l aliquots onto two URA-D plates and incubated at 30°C. After about 72 hours, the Ura⁺ yeast transformants from a single plate are resuspended in 1 ml H₂O and spun briefly to pellet the yeast cells. The cell pellet is resuspended in 0.5 ml of lysis buffer (2% Triton X-100, 1% SDS, 100 mM NaCl, 10 mM Tris, pH 8.0, 1 mM EDTA). The five hundred μ l of the lysis mixture is added to an Eppendorf tube containing 250 μ l acid-washed glass beads and 300 μ l phenol-chloroform, is vortexed for 3 minutes, and spun for 5 minutes in an Eppendorf centrifuge at maximum speed. Three hundred μ l of the aqueous phase is transferred to a fresh tube, and the DNA is precipitated with 600 μ l ethanol, followed by centrifugation for 30 minutes at maximum speed. The tube is decanted and the pellet is washed with 1 mL of 70% ethanol. The tube is decanted and the DNA pellet is resuspended in 30 μ l 10 mM Tris, pH 8.0, 1 mM EDTA.

Transformation of electrocompetent *E. coli* host cells (DH12S) is done using 5 μ l of the yeast DNA preparation and 50 μ l of *E. coli* cells. The cells are electropulsed at 2.0 kV, 25 μ F, and 400 ohms. Following electroporation, 1 ml SOC (2% Bacto™ Tryptone (Difco, Detroit, MI), 0.5% yeast extract (Difco), 10 mM NaCl, 2.5 mM KCl, 10 mM MgCl₂, 10 mM MgSO₄, 20 mM glucose) is added and then the cells are plated in 50 μ l and 200 μ l aliquots on two LB AMP plates (LB broth (Lennox), 1.8% Bacto™ Agar (Difco), 100 mg/L Ampicillin).

The inserts of three DNA clones for the construct is subjected to sequence analysis and one clone containing the correct sequence is selected. Large scale plasmid DNA is isolated using a commercially available kit (QIAGEN Plasmid Mega Kit, Qiagen, Valencia, CA) according to manufacturer's instructions.

The same process is used to prepare the ZcytoR14 with a C-terminal his tag, composed of Gly Ser Gly Gly His His His His His His (ZcytoR14CHIS; SEQ ID NO:51) or the C-terminal FLAG tag, composed of Gly Ser Asp Tyr Lys Asp Asp Asp Asp Lys (ZcytoR14CFLAG; SEQ ID NO:52). To prepare these constructs, instead of the 3' oligonucleotide of SEQ ID NO:50; the 3' oligonucleotide [CAACCCCAGAGCTGTTTTAAGGCGCGCCTCTAGATTAGTGATGGTGATGGTGATG TCCACCAGATCCCTTGTGGATGTATTTGTC; SEQ ID NO:54] is used to generate ZcytoR14CHIS or the 3' oligonucleotide [CAACCCCAGAGCTGTTTTAAGGCGCGCCTCTAGATTACTTATCATCATCATCCTTA TAATCGGATCCCTTGTGGATGTATTTGTC; SEQ ID NO:55] is used to generate ZcytoR14CFLAG.

EXAMPLE 7**Transfection and Expression of Soluble ZcytoR14 Receptor Expression Constructs that Express the ZcytoR14-mFc1 Fusion Protein, and the ZcytoR14-CEE, ZcytoR14-CHIS, and ZcytoR14-CFLAG C-Terminal Tagged Proteins**

5 Three sets of 200 µg of each of the soluble ZcytoR14 fusion or tagged expression constructs are separately digested with 200 units of *PvuI* at 37°C for three hours, precipitated with isopropyl alcohol, and centrifuged in a 1.5 mL microfuge tube. The supernatant is decanted off the pellet, and the pellet is washed with 1 mL of 70% ethanol and allowed to incubate for 5 minutes at room temperature. The tube is spun in a microfuge for 10
10 minutes at 14,000 RPM and the supernatant is decanted off the pellet. The pellet is then resuspended in 750 µl of CHO cell tissue culture medium in a sterile environment, allowed to incubate at 60° C for 30 minutes, and is allowed to cool to room temperature. Approximately 5 x 10⁶ CHO cells are pelleted in each of three tubes and are resuspended using the DNA-medium solution. The DNA/cell mixtures are placed in a 0.4 cm gap cuvette and
15 electroporated using the following parameters; 950 µF, high capacitance, at 300 V. The contents of the cuvettes are then removed, pooled, and diluted to 25 mLs with CHO cell tissue culture medium and placed in a 125 mL shake flask. The flask is placed in an incubator on a shaker at 37 °C, 6% CO₂ with shaking at 120 RPM.

The CHO cells are subjected to nutrient selection followed by step
20 amplification to 200 nM methotrexate (MTX), and then to 1 µM MTX. Fusion or tagged protein expression is confirmed by Western blot, and the CHO cell pool is scaled-up for harvests for protein purification.

EXAMPLE 8**25 Expression of Soluble ZcytoR14**

An expression plasmid containing ZcytoR14-Tbx-C(Fc9) (SEQ ID NO:64) was constructed via homologous recombination using a DNA fragment of ZcytoR14 _Tbx and the expression vector pZMP40. The fragment was generated by PCR amplification using primers zc44531 and zc44545.

30 The PCR fragment ZcytoR14_Tbx contains a partial ZcytoR14 extracellular domain coding region, which was made using a previously generated clone of ZcytoR14 as the template. The fragment includes a 5' overlap with the pZMP40 vector sequence in the otPA coding region, the ZcytoR14 segment (amino acid residue 21 to 451 of SEQ ID NO:2), a linker sequence, a thrombin cleavage site, and a 3' overlap with the pZMP40 vector in the Fc9 coding

region. PCR conditions used were as follows: 1 cycle, 94°C, 5 minutes; 35 cycles, 94°C, 1 minute, followed by 55°C, 2 minutes, followed by 72°C, 3 minutes; 1 cycle, 72°C, 10 minutes.

The PCR reaction mixtures were run on a 1% agarose gel and a band corresponding to the sizes of the inserts were gel-extracted using a QIAquick™ Gel Extraction Kit (Qiagen, Cat. No. 28704).

Plasmid pZMP40 is a mammalian expression vector containing an expression cassette having the MPSV promoter, multiple restriction sites for insertion of coding sequences, an otPA signal peptide sequence, and the sequence for Fc9; an internal ribosome entry site (IRES) element from poliovirus, and the extracellular domain of CD8 truncated at the C-terminal end of the transmembrane domain; an *E. coli* origin of replication; a mammalian selectable marker expression unit comprising an SV40 promoter, enhancer and origin of replication, a DHFR gene, and the SV40 terminator; and URA3 and CEN-ARS sequences required for selection and replication in *S. cerevisiae*. It was constructed from pZMP21 (Patent Pub. No. US 2003/0232414 A1; deposited at the American Type Culture Collection and designated as ATCC# PTA-5266).

The plasmid pZMP40 was cut with BglII prior to recombination in yeast with the PCR fragment. One hundred microliters of competent yeast (*S. cerevisiae*) cells were independently combined with 10 µl of the insert DNA (SEQ ID NO:66) and 100ng of cut pZMP40 vector, and the mix was transferred to a 0.2-cm electroporation cuvette. The yeast/DNA mixture was electropulsed using power supply (BioRad Laboratories, Hercules, CA) settings of 0.75 kV (5 kV/cm), ∞ ohms, and 25 µF. Six hundred µl of 1.2 M sorbitol was added to the cuvette, and the yeast was plated in a 100-µl and 300µl aliquot onto two URA-D plates and incubated at 30°C. After about 72 hours, the Ura⁺ yeast transformants from a single plate were resuspended in 1 ml H₂O and spun briefly to pellet the yeast cells. The cell pellet was resuspended in 0.5 ml of lysis buffer (2% Triton X-100, 1% SDS, 100 mM NaCl, 10 mM Tris, pH 8.0, 1 mM EDTA). The five hundred microliters of the lysis mixture was added to an Eppendorf tube containing 250 µl acid-washed glass beads and 300 µl phenol-chloroform, was vortexed for 3 minutes, and spun for 5 minutes in an Eppendorf centrifuge at maximum speed. Three hundred microliters of the aqueous phase was transferred to a fresh tube, and the DNA was precipitated with 600 µl ethanol (EtOH), followed by centrifugation for 30 minutes at maximum speed. The tube was decanted and the pellet was washed with 1 mL of 70% ethanol. The tube was decanted and the DNA pellet was resuspended in 30 µl TE.

Transformation of electrocompetent *E. coli* host cells (DH12S) was done using 5 µl of the yeast DNA prep and 50 µl of cells. The cells were electropulsed at 2.0 kV, 25 µF,

and 400 ohms. Following electroporation, 1 ml SOC (2% Bacto™ Tryptone (Difco, Detroit, MI), 0.5% yeast extract (Difco), 10 mM NaCl, 2.5 mM KCl, 10 mM MgCl₂, 10 mM MgSO₄, 20 mM glucose) was added and then the cells were plated in a 50 µl and a 200 µl aliquot on two LB AMP plates (LB broth (Lennox), 1.8% Bacto™ Agar (Difco), 100 mg/L Ampicillin).

5 The inserts of three clones for the construct was subjected to sequence analysis and one clone for each construct, containing the correct sequence, was selected. Larger scale plasmid DNA was isolated using a commercially available kit (QIAGEN Plasmid Mega Kit, Qiagen, Valencia, CA) according to manufacturer's instructions.

10 Three sets of 200µg of the ZcytoR14[L21-K451]_Tbx_C(Fc9) construct were then each digested with 200 units of Pvu I at 37°C for three hours and then were precipitated with IPA and spun down in a 1.5 mL microfuge tube. The supernatant was decanted off the pellet, and the pellet was washed with 1 mL of 70% ethanol and allowed to incubate for 5 minutes at room temperature. The tube was spun in a microfuge for 10 minutes at 14,000 RPM and the supernatant was decanted off the pellet. The pellet was then resuspended in 750 µl of
15 PF-CHO media in a sterile environment, allowed to incubate at 60°C for 30 minutes, and was allowed to cool to room temperature. 5E6 APFDXB11 cells were spun down in each of three tubes and were resuspended using the DNA-media solution. The DNA/cell mixtures were placed in a 0.4 cm gap cuvette and electroporated using the following parameters: 950 µF, high capacitance, and 300 V. The contents of the cuvettes were then removed, pooled, and
20 diluted to 25 mLs with PF-CHO media and placed in a 125 mL shake flask. The flask was placed in an incubator on a shaker at 37°C, 6% CO₂, and shaking at 120 RPM.

 The cell line was subjected to nutrient selection followed by step amplification to 200nM methotrexate (MTX), and then to 1µM MTX. Expression was confirmed by western blot, and the cell line was scaled-up and protein purification followed.

25

EXAMPLE 9

Purification of Soluble ZcytoR14 from CHO Cells

 Conditioned media from CHO cells expressing ZcytoR14-TbX-Fc9 (SEQ ID NO:64) was concentrated approximately 10-fold with a Pellicon-II tangential flow system
30 against two Biomax 0.1 m² 30kD molecular weight cutoff membrane cassettes (Millipore, Bedford, MA). The concentrated media was pH adjusted to 5.5 with glacial acetic acid, 0.2 µm sterile filtered then loaded onto a Protein G sepharose fast flow resin (Pharmacia, Piscataway, NJ) via batch chromatography overnight at 4C. Prior to loading the pH adjusted conditioned media, the Protein G resin was pre-equilibrated with, 5 column volumes

(approximately 150ml) of 25mM sodium acetate, 150mM NaCl, pH5.5. The ratio of filtered, pH adjusted conditioned media to resin was 33:1 (v/v).

The batched chromatography process was performed at ambient room temperature (approximately 21C). The batched, pH adjusted, 0.22 μ m filtered, conditioned media was poured into an empty 5.5 x 20.5 cm glass column (BioRad, Hercules, CA) and packed via gravity. The column was washed with 10 column volumes (approximately 300ml) of 25mM sodium acetate, 150mM NaCl, pH5.5. Bound protein was then pH eluted with 100mM glycine, pH 2.7. 9.0ml fractions were collected and immediately neutralized with 1.0 ml 2.0M Tris, pH 8.0. The collected fractions were analyzed via SDS-PAGE Coomassie staining. Fractions containing ZcytoR14-Tbx-Fc9 were pooled and concentrated approximately 6-fold using a 5kD molecular weight cutoff Biomax membrane spin concentrator (Millipore, Bedford, MA) according to the manufacturer's instructions.

The pooled, concentrated fractions were then dialyzed ,at 4C, extensively against 1X phosphate buffered saline, pH 7.3 (Sigma, St. Louis, MO) using a 7kD molecular weight cutoff membrane Slide-A-Lyzer (Pierce, Rockford, IL). ZcytoR14-TbX-Fc9 as formulated in 1x phosphate buffered saline, pH 7.3 was 0.22 μ m sterile filtered prior to aliquoting and storage at -80C.

EXAMPLE 10

Binding of IL-17A and IL-17F to Human ZcytoR14

A) Binding of biotinylated cytokines to transfected cells

Baby Hamster Kidney (BHK) cells that had been transfected with expression vectors encoding human IL-17 receptor (SEQ ID NO:21), human ZcytoR14 (SEQ ID NO:2), or both of these receptors are assessed for their ability to bind biotinylated human IL-17A and human IL-17F. Cells are harvested with versene, counted and diluted to 10^7 cells per ml in staining media (SM), which is HBSS plus 1 mg/ml bovine serum albumin (BSA), 10 mM Hepes, and 0.1% sodium azide (w/v). Biotinylated human IL-17A (SEQ ID NO:14) and human IL-17F (SEQ ID NO:16) are incubated with the cells on ice for 30 minutes at various concentrations. After 30 minutes, excess cytokine is washed away with SM and the cells are incubated with a 1:100 dilution of streptavidin conjugated to phycoerythrin (SA-PE) for 30 minutes on ice. Excess SA-PE is washed away and cells are analyzed by flow cytometry. The amount of cytokine binding was quantitated from the mean fluorescence intensity of the cytokine staining. From this analysis, we find that human IL-17A binds both the human IL-

17R and ZcytoR14 to a similar extent. Also, human IL-17F binds ZcytoR14 to a similar level, but binds IL-17R detectably, but to a much lower level than was seen with IL-17A.

B) Binding of biotinylated cytokines to human peripheral blood mononuclear cells

Human peripheral blood mononuclear cells (PBMC) were prepared from whole blood by ficoll density gradient centrifugation. PBMC at 10^7 cells per ml were simultaneously incubated with biotinylated IL-17A or IL-17F at 1 μ g/ml and fluorochrome conjugated antibodies to specific cell surface proteins that were designed to distinguish various white blood cell lineages lineages. These markers include CD4, CD8, CD19, CD11b, CD56 and CD16. Excess antibody and cytokine are washed away, and specific cytokine binding is detected by incubating with SA-PE as described above. Samples were analyzed by flow cytometry and from this analysis, we find that human IL-17A binds to virtually all PBMC populations examined, but that human IL-17F does not detectably bind to any population.

C) Inhibition of specific binding of biotinylated human IL-17A and IL-17F with unlabeled cytokine

Binding studies are performed as discussed above, but excess unlabeled human IL-17A and IL-17F are included in the binding reaction. In studies with BHK cells, the amount of unlabeled cytokine was varied over a range of concentrations and we find that addition of unlabeled IL-17A competed for binding of both IL-17A and IL-17F to both ZcytoR14 and IL-17R. However, unlabeled IL-17F competed for binding of both IL-17A and IL-17F to ZcytoR14, but it did not compete effectively for binding to IL-17R. This indicates that both IL-17A and IL-17F specifically bind to ZcytoR14, and that they bind at a site that is either identical or overlaps significantly since they cross-compete for binding. Also, IL-17A competes for the relatively weak binding of IL-17F for IL-17R, indicating these two cytokines also bind to a similar region in the IL-17R, but IL-17F binds IL-17R with much reduced affinity relative to ZcytoR14.

D) Inhibition of specific binding of biotinylated human IL-17A and IL-17F with soluble ZcytoR14 and IL-17R

Binding studies are performed as discussed above, except that a soluble form of ZcytoR14 or IL-17R are included in the binding reactions. These soluble receptors are fusion proteins derived from the extracellular domain of each receptor fused to the human IgG1 constant (Fc) region. We find that soluble ZcytoR14 inhibits binding of both human IL-17A and IL-17F to both IL-17R and ZcytoR14 transfected BHK cells. However, soluble IL-17R inhibits binding of IL-17A to either receptor, but does not effectively block binding of IL-17F to ZcytoR14, consistent with the poor binding of IL-17F for the IL-17R.

EXAMPLE 11**IL-17A and IL-17F Bind to ZcytoR14****A) Binding Inhibition with Cold Ligand**

BHK cells transfected with hZcytoR14 (SEQ ID NO:2) and IL-17R (SEQ ID NO:21) were plated at 40,000 cells/well in a 24-well dish (Costar 3527) two days prior to assay. IL-17A (SEQ ID NO:14) and IL-17F (SEQ ID NO:16) that had been radiolabeled by the iodobead method were added independently to wells in triplicate at 10ng/ml with a total of 250ul/well in binding buffer (RPMI 1640 media (JRH 51502-500M) with 10mg/ml bovine serum albumin (Gibco 15260-037)). Cold competitors were added in 100 fold molar excess. Competitors tested included IL-17A, IL-17B, IL-17C, IL-17D, IL-17E, IL-17F and IL-21. Wells were incubated on ice for 1-hour followed by two washes with PBS (Invitrogen 20012-027) and one wash with a high salt solution (1.5M NaCl, 50mM HEPES pH 7.4). Wells were extracted with 500ul of 0.8M NaOH for 30min. at room temperature and counts per minute were measured in a gamma counter (Packard Cobra II A5005).

The results indicated that 100x molar cold IL-17A and IL-17F were able to reduce binding of ¹²⁵I IL-17A to BHK hZcytoR14 by approximately 7 fold while IL-17B,C,D,E and IL-21 had no effect on binding. 100x molar cold IL-17A reduced the binding of ¹²⁵I IL-17A to BHK IL-17R by approximately 4 fold while IL-17B,C,D,E,F and IL-21 had no effect on binding. 100x molar cold IL-17A and IL-17F reduced the binding of ¹²⁵I IL-17F to BHK hZcytoR14 by approximately 4 fold and 5 fold, respectively, while IL-17B,C,D,E and IL-21 had no effect on binding.

B) Binding Inhibition with Soluble Receptor:

Binding to hZcytoR14 (SEQ ID NO:2) and IL-17R (SEQ ID NO:21) transfected BHK cells was performed as in one, but 100 fold molar excess soluble hZcytoR14x1/Fc9 (Example 8) and soluble IL-17R/Fc (obtained from R&D; Ref. 177-IR) were used in place of cold ligand in the competition. Cells were washed, extracted and counted as in part one.

Soluble hZcytoR14/Fc inhibited binding of ¹²⁵I IL-17F to BHK hZcytoR14 with an IC₅₀ of 10X molar excess average from three experiments. Soluble hZcytoR14/Fc inhibition of ¹²⁵I IL-17A on the same cell line gave an average IC₅₀ of 20X molar excess and soluble IL-17R/Fc inhibition of ¹²⁵I IL-17A gave an average IC₅₀ of 20X molar excess.

C) Binding Saturation

Transfected BHK cells were plated into 24-well dishes as in one. Radiolabeled IL-17A and IL-17F were added starting at a concentration of 4nM in eight 1:3 dilutions (to a concentration of 1.83 pM) in triplicate with a total of 250ul/well in binding

buffer. Separately, 100 fold molar excess of cold ligand was added at each dilution point. Cells were washed, extracted and counted as in one. Specific counts per minute were plotted against concentration of radiolabeled ligand added by subtracting the 100 fold excess counts from the the uncompleted counts at each dilution point. These normalized data were plotted to generate saturation binding curves for each combination of radiolabeled ligand and transfected BHK cells. Table 4 shows the affinity values calculated from all three experiments.

Table 4

125I IL-17A + BHK hZcytoR14	125I IL-17A + BHK IL-17R
1. 180pM	1. 2.5 +/- 0.2nM
2. 200pM	2. 4.5 +/- 0.3nM
3. 370pM	3. 5.9 +/- 0.1nM
125I IL-17F + BHK hZcytoR14	125I IL-17F + BHK IL-17R
1. 50pM	1. Very low affinity
2. 60pM	2. Very low affinity
3. 80pM	3. Very low affinity

One-site binding curve fits agreed most closely with IL-17A & IL-17F binding to IL-17R. Two-site binding curve fits agreed most closely with IL-17A and IL-17F binding to hZcytoR14. The high affinity binding site is the value shown above. The low affinity binding site had very low affinity and varied widely between the three experiments.

EXAMPLE 12

15 Murine Nih3t3 Cells Respond to Human IL-17A and IL-17F

A) Cell plating and kz142 adenovirus reporter infection.

Nih3t3 cells, derived from mouse fibroblasts (described in ATCC) Nih3t3 were plated at 5000 cells/well in solid white, cell culture coated 96 well plates, (Cat. #3917. Costar) using DMEM/10% FBS, containing glutamine and amended with pyruvate and cultured overnight at 37oC and 5% CO₂. On this second day, the plating media was removed and Kz142 adenovirus particles at a multiplicity of infection of 5000 particles/cell were prepared in DMEM/1% FBS, containing glutamine and amended with pyruvate and cultured overnight at 37oC and 5% CO₂.

25 B) Luciferase assay measuring IL-17A and F activation of kz142 adenovirus reporter infected nih3t3 cells.

Following the overnight incubation with the adenovirus particle reporter, human IL-17A and IL-17F Ligand treatments were prepared in serum free media ()amended to

.28% BSA. The adenovirus particles and media were removed and the appropriate ligand doses were given in triplicates. Incubation at 37°C and 5% CO₂ was continued for 4 hours, after which the media was removed, cells lysed for 15 minutes and mean fluorescence intensity (MFI) measured using the luciferase assay system and reagents. (Cat.#e1531 Promega. Madison, WI.) and a Microplate luminometer. Activity was detected at concentrations ranging from .1-1000ng/ml human IL-17A and IL-17F, generating EC₅₀ values of about 50ng/ml for both ligands. These data suggest that nih3t3 cells carry receptors to these ligands and that IL-17A and IL-17F activate the NfKb/Ap-1 transcription factor.

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EXAMPLE 13

Murine Nih3t3 Cells Express Both IL-17 Receptor and ZcytoR14 Receptor

RTPCR analysis of nih3t3 RNA demonstrated that these cells are positive for both IL-17 Receptor and ZcytoR14 receptor, consistent with their nfkb/ap1 response to human IL-17A and IL-17F mediation being mediated through one or both of these receptors.

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RTPCR DETAILS:

A) Mouse cytor14 PCR

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First strand cDNA was prepared from total RNA isolated from nih3t3 cells using standard methods. PCR was applied using hot star polymerase and the manufacturer's recommendations (Qiagen, Valencia, CA) using sense primer, zc38910, 5' ACGAAGCCCAGGTACCAGAAAGAG 3' (SEQ ID NO:56) and antisense primer, zc 38679, 5' AAAAGCGCCGCAGCCAAGAGTAGG 3' (SEQ ID NO:57) and 35 cycles of amplification. Agarose gel electrophoresis revealed a single, robust amplicon of the expected, 850 bp size.

B) Mouse IL-17R PCR

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First strand cDNA was prepared from total RNA isolated from nih3t3 cells using standard methods. PCR was applied using hot star polymerase and the manufacturer's recommendations (Qiagen, Valencia, CA) using sense primer, zc38520, 5' CGTAAGCGGTGGCGGTTTTC 3'(SEQ ID NO:58) and antisense primer, zc 38521, 5' TGGGCAGGGCACAGTCACAG 3' (SEQ ID NO:59) and 35 cycles of amplification.

30

Agarose gel electrophoresis revealed a single, robust amplicon of the expected, 498 bp size.

EXAMPLE 14**Creation of a Stable Nih3t3 Assay Clone Expressing the ap1/nfkb Transcription Factor**

The murine nih3t3 cell line described above was stably transfected with the kz142 ap1/nfkb reporter construct, containing a neomycin-selectable marker. The Neo resistant transfection pool was plated at clonal density. Clones were isolated using cloning rings and screened by luciferase assay using the human IL-17A ligand as an inducer. Clones with the highest mean fluorescence intensity (MFI) (via ap1/Nfkb luciferase) and the lowest background were selected. A stable transfectant cell line was selected and called nih3t3/kz142.8.

EXAMPLE 15**Inhibition of Activation by Human IL-17A and IL-17F in Murine Nih3t3 Cells Using Soluble ZcytoR14 and IL-17 Receptor/FC Chimeras**

Soluble forms of ZcytoR14 or IL-17R were used as antagonists of human IL-17A and IL-17F activation of ap1/nfkb elements in a luciferase assay. These soluble receptors are fusion proteins derived from the extracellular domain of each receptor fused to the human IgG1 constant (Fc) region. The soluble human IL-17R FC fusion protein was purchased. (recombinant human IL-17R/FC chimera, catalog number 177-IR-100, R&D Systems, Inc., Minneapolis, Mn.) The soluble human ZcytoR14 FC chimera (ZcytoR14sR/FC9) was constructed as described above. We find that an excess ZcytoR14sR/FC9 and human IL17RsR/FC chimera inhibit EC50 levels of both human IL-17A and IL-17F mediation of ap1/nfkb activation of the murine nih3t3/kz142.8 assay cell line.

The ZcytoR14sR/FC9 protein showed the greatest potency in antagonizing IL-17F activation and IL17RsR/FC chimera showed the greatest potency in antagonizing IL-17A activation.

EXAMPLE 16**IL-17F mRNA is Upregulated in a Murine Model of Asthma**

IL-17F mRNA levels were measured in a sensitization and airway challenge model in mice. Groups of mice, 8 to 10 wks of age, were sensitized by intraperitoneal injection of 10 ug of recombinant *Dermatophagoides pteronyssinus* allergen 1 (DerP1) (Indoor biotechnologies, Cardiff, UK) in 50 % Inject Alum (Pierce) on days 0 and 7. Seven days later, mice were challenged on 3 consecutive days (days 14, 15 and 16) with 20 ug of DerP1 in 50 ul PBS. There were 4 mice representing this group. Negative controls included 5 mice given

phosphate buffered saline (PBS) sensitization, followed by PBS challenge. In addition to 3 mice given DerP1 sensitization, followed by PBS challenge. Forty-eight hours following allergen, or control challenge whole lung tissue was harvested and total RNA was isolated.

First strand cDNA was prepared using identical amounts of total RNA from each subject. IL-17F PCR was applied using Qiagen hotstar polymerase (Qiagen, Valencia, CA) and the manufacturer's recommendations. The IL-17F PCR utilized 35 cycles of amplification with sense primer, zc46098, 5' ACTTGCCATTCTGAGGGAGGTAGC 3' (SEQ ID NO:60) and antisense primer, 46099, 5' CACAGGTGCAGCCAACTTTTAGGA 3' (SEQ ID NO:61). In order to establish that the template quality was uniform amongst all subjects, Beta Actin PCR was applied to the same amount of each template used in the IL-17F amplification. B actin PCR included 25 cycles of PCR with sense primer, zc44779, 5' GTGGGCCGCTCTAGGCACCA 3' (SEQ ID NO:62) and antisense primer, zcc44776, 5' CGGTTGGCCTTAGGGTTCAGGGGGG 3' (SEQ ID NO:63).

All 4 mice from the DerP1 sensitized, DerP1 challenged treatment group (the asthma simulation) showed robust IL-17F amplification. In contrast, weak IL-17F amplification was seen from the negative controls, including 3 of 3 subjects representing the DerP1 sensitized/PBS challenged treatment group and 5 of 5 subjects from the PBS sensitized/PBS challenged treatment group. B actin amplification was at least as robust for the negative controls as for the asthma-simulated subjects, demonstrating that the weak negative control IL-17F amplification was not due to template problems.

EXAMPLE 17

COS Cell Transfection and Secretion Trap

A) Cos cell transfection and secretion trap assays show that ZcytoR14sR/Fc9 and IL-17F is a receptor/ligand pair

A secretion trap assay was used to match the human ZcytoR14 (SEQ ID NO:2) to the human IL-17F (SEQ ID NO:16). The soluble ZcytoR14sR/Fc9 fusion protein (Example 8) was used as a binding reagent in a secretion assay. SV40 ori containing expression vectors containing cDNA of human IL-17B,C,D,E, and F was transiently transfected into COS cells. The binding of ZcytoR14sR/Fc9 to transfected COS cells was carried out using the secretion trap assay described below. Positive binding of ZcytoR14sR/Fc9 was only seen to human IL-17F. These results demonstrate the novel finding that human ZcytoR14 and IL-17F is a receptor/ligand pair.

B) COS Cell Transfections

The COS cell transfection was performed as follows: Mix 3ul pooled DNA and 5ul Lipofectamine™ in 92ul serum free DMEM media (55mg sodium pyruvate, 146mg L-glutamine, 5mg transferrin, 2.5mg insulin, 1μg selenium and 5mg fetuin in 500ml DMEM), incubate at room temperature for 30 minutes and then add 400ul serum free DMEM media. Add this 500ul mixture onto 1.5×10^5 COS cells/well plated on 12-well tissue culture plate and incubate for 5 hours at 37°C. Add 500ul 20% FBS DMEM media (100 ml FBS, 55 mg sodium pyruvate and 146mg L-glutamine in 500ml DMEM) and incubate overnight.

C) Secretion Trap Assay

The secretion trap was performed as follows: Media was rinsed off cells with PBS and then fixed for 15 minutes with 1.8% Formaldehyde in PBS. Cells were then washed with TNT (0.1M Tris-HCL, 0.15M NaCl, and 0.05% Tween-20 in H₂O), and permeated with 0.1% Triton-X in PBS for 15 minutes, and again washed with TNT. Cells were blocked for 1 hour with TNB (0.1M Tris-HCL, 0.15M NaCl and 0.5% Blocking Reagent (NEN Renaissance TSA-Direct Kit) in H₂O), and washed again with TNT. The cells were incubated for 1 hour with 1μg/ml human ZcytoR14x1sR/FC9 soluble receptor fusion protein. Cells were then washed with TNT. Cells were incubated for another hour with 1:200 diluted goat-anti-human Ig-HRP (Fc specific). Again cells were washed with TNT.

Positive binding was detected with fluorescein tyramide reagent diluted 1:50 in dilution buffer (NEN kit) and incubated for 4-6 minutes, and washed with TNT. Cells were preserved with Vectashield Mounting Media (Vector Labs Burlingame, CA) diluted 1:5 in TNT. Cells were visualized using a FITC filter on fluorescent microscope.

EXAMPLE 18

Generation of Murine Anti-Human ZcytoR14 Monoclonal Antibodies

A. Immunization for generation of anti-ZcytoR14 Antibodies

1. Soluble ZcytoR14-muFc

Six to twelve week old intact or ZcytoR14 knockout mice are immunized by intraperitoneal injection with 25-50 ug of soluble human ZcytoR14-muFc protein (Example 23) mixed 1:1 (v:v) with Ribi adjuvant (Sigma) on a biweekly schedule. Seven to ten days following the third immunization, blood samples were taken via retroorbital bleed, the serum harvested and evaluated for its ability to inhibit the binding of IL-17 or IL-17F to ZcytoR14 in neutralization assays (e.g., described herein) and to stain ZcytoR14 transfected versus untransfected 293 cells in a FACS staining assay. Mice continued to be immunized and blood

samples taken and evaluated as described above until neutralization titers reached a plateau. At that time, mice with the highest neutralization titers were injected intravascularly with 25-50 ug of soluble ZcytoR14-Fc protein in PBS. Three days later, the spleen and lymph nodes from these mice were harvested and used for hybridoma generation, for example using mouse myeloma (P3-X63-Ag8.653.3.12.11) cells or other appropriate cell lines in the art, using standard methods known in the art (e.g., see Kearney, J.F. et al., *J Immunol.* 123:1548-50, 1979; and Lane, R.D. *J Immunol Methods* 81:223-8, 1985).

2. Soluble ZcytoR14, ZcytoR14-CEE, ZcytoR14-CHIS, ZcytoR14-CFLAG

Six to twelve week old intact or ZcytoR14 knockout mice are immunized by intraperitoneal injection with 25-50 ug of soluble human ZcytoR14-CEE, ZcytoR14-CHIS, or ZcytoR14-CFLAG mixed 1:1 (v:v) with Ribi adjuvant (Sigma) on a biweekly schedule. Seven to ten days following the third immunization, blood samples are taken via retroorbital bleed, the serum harvested and evaluated for its ability to inhibit the binding of IL-17 or IL-17F to ZcytoR14 in neutralization assays (e.g., described herein) and to stain ZcytoR14 transfected versus untransfected 293 cells in a FACS staining assay. Mice are continued to be immunized and blood samples taken and evaluated as described above until neutralization titers reached a plateau. At that time, mice with the highest neutralization titers are injected intravascularly with 25-50 ug of soluble ZcytoR14, ZcytoR14-CEE, zcytor-CHIS, or ZcytoR14-CFLAG antigen protein in PBS. Three days later, the spleen and lymph nodes from these mice are harvested and used for hybridoma generation, for example using mouse myeloma (P3-X63-Ag8.653.3.12.11) cells or other appropriate cell lines in the art, using standard methods known in the art (e.g., see Kearney, J.F. et al., *J Immunol.* 123:1548-50, 1979; and Lane, R.D. *J Immunol Methods* 81:223-8, 1985).

3. P815 transfectants that express the ZcytoR14

Six to ten week old female DBA/2 mice are immunized by intraperitoneal injection of 1×10^5 live, transfected P815 cells, for example P815/ZcytoR14 cells (e.g., 0.5 ml at a cell density of 2×10^5 cells/ml). Prior to injection, the cells are maintained in the exponential growth phase. For injection the cells are harvested, washed three times with PBS and then resuspended in PBS to a density of 2×10^5 cells/ml. In this model, the mice develop an ascites tumor within 2-3 weeks and progress to death by 4-6 weeks unless an immune response to the transfected target antigen has been mounted. At three weeks mice with no apparent abdominal swelling (indicative of ascites) are re-immunized as above at 2-3 week intervals. Seven to ten days following the second immunization, blood samples are taken via retroorbital bleed, the serum harvested and evaluated for its ability to inhibit the binding of IL-

17 or IL-17F to IL-17 or ZcytoR14 in neutralization assays (e.g., described herein) and to stain ZcytoR14 transfected versus untransfected 293 cells in a FACS staining assay. Mice continue to be immunized and blood samples taken and evaluated as described above until neutralization titers reach a plateau. At that time, the mice with the highest neutralization titers are injected intraperitoneally with 1×10^5 live, transfected P815 cells. Four days later, the spleen and lymph nodes from these mice are harvested and used for hybridoma generation, for example using mouse myeloma (P3-X63-Ag8.653.3.12.11) cells or other appropriate cell lines in the art, using standard methods known in the art (e.g., see Kearney, J.F. et al., *supra.*; and Lane, R.D. *supra.*).

An alternative to the above immunization scheme with live, transfected P815 cells involves intraperitoneal injection of $1-5 \times 10^6$ irradiated, transfected cells every 2-3 weeks. In this approach, no animals develop and die of ascites. Instead, animals are monitored for a neutralizing immune response to ZcytoR14 in their serum as outlined above, starting with a bleed after the second immunization. Once neutralization titers have reached a maximal level, the mice with highest titers are given a pre-fusion, intraperitoneal injection of 5×10^6 irradiated cells and four days later, the spleen and lymph nodes from these mice are harvested and used for hybridoma generation, for example using mouse myeloma (P3-X63-Ag8.653.3.12.11) cells or other appropriate cell lines in the art, using standard methods known in the art (e.g., see Kearney, J.F. et al., *supra.*; and Lane, R.D. *supra.*).

B. Screening the Hybridoma Fusions for Antibodies that bind ZcytoR14 and Inhibit the Binding of IL-17 or IL-17F to ZcytoR14

Three different primary screens are performed on the hybridoma supernatants at 8-10 days post-fusion. For the first assay, antibodies in supernatants were tested for their ability to bind to plate bound soluble human ZcytoR14, ZcytoR14-muFc, ZcytoR14-CEE, ZcytoR14-CHIS, or ZcytoR14-CFLAG protein by ELISA using HRP-conjugated goat anti-mouse kappa and anti-lambda light chain second step reagents to identify bound mouse antibodies. To demonstrate specificity for the ZcytoR14 portion of the ZcytoR14 fusion proteins, positive supernatants in the initial assay were evaluated on an irrelevant protein fused to the same murine Fc region (mG2a), EE sequence, HIS sequence, or FLAG sequence. Antibody in those supernatants that bound to ZcytoR14-fusion protein and not the irrelevant muFc or other proteins containing fusion protein sequence were deemed to be specific for ZcytoR14. For the second assay, antibodies in all hybridoma supernatants were evaluated by ELISA for their ability to inhibit the binding of biotinylated human IL-17 or biotinylated human IL-17F to plate bound ZcytoR14-muFc or ZcytoR14-fusion proteins.

All supernatants containing antibodies that bound specifically to ZcytoR14, whether they inhibited the binding of IL-17 or IL-17F to ZcytoR14 or not in the ELISA assay, were subsequently tested for their ability to inhibit the binding of IL-17 or IL-17F to ZcytoR14 transfected Baf3 or BHK cells or normal human bronchial epithelial cells. All supernatants that were neutralization positive in either the IL-17 or IL-17F inhibition assays or both the IL-17 and IL-17F inhibition assays were subsequently evaluated for their ability to stain ZcytoR14 transfected versus non-transfected Baf3 or BHK cells by FACS analysis. This analysis was designed to confirm that inhibition of IL-17 or IL-17F binding to ZcytoR14, was indeed due to an antibody that specifically binds the ZcytoR14 receptor. Additionally, since the FACS analysis was performed with an anti-IgG second step reagent, specific FACS positive results indicate that the neutralizing antibody was likely to be of the IgG class. By these means, a master well was identified that bound ZcytoR14 in the plate bound ELISA, inhibited the binding of IL-17 or IL-17F to ZcytoR14 in the ELISA based inhibition assay, blocked the interaction of IL-17 and IL-17F with ZcytoR14 transfected Baf3 or BHK cells, respectively, and was strongly positive for the staining of ZcytoR14 transfected Baf3 or BHK cells with an anti-mouse IgG second step reagent.

The third assay consists of primary human bronchial epithelial cells which express ZcytoR14 and can be induced to secrete IL-8 or IL-6 in response to IL-17F treatment. The specific monoclonal antibody is assayed by its ability to inhibit the IL-17 or IL-17F stimulated IL-8 or IL-6 production by these cells. IL-8 and IL-6 production is assayed in response to IL-17 or IL-17F as described herein.

Alternatively, the monoclonal antibody; anti-ZcytoR14, mediated inhibition of IL-17 or IL-17F induced luciferase production in NIH 3T3 or other ZcytoR14 containing cells can be used with or in place of one of the bioactivity neutralization assays noted above. The NFkB mediated luciferase assay in NIH 3T3 cells is described herein.

C) Cloning Anti-ZcytoR14 Specific Antibody Producing Hybridomas

Hybridoma cell lines producing a specific anti-ZcytoR14 mAb that cross-neutralized the binding of IL-17 and IL-17F to appropriately transfected BaF3 or BHK cells are cloned by a standard low-density dilution (less than 1 cell per well) approach. Approximately 5-7 days after plating, the clones are screened by ELISA on, for example, plate bound human ZcytoR14-muFc followed by a retest of positive wells by ELISA on irrelevant muFc containing fusion protein as described above.. Selected clones, whose supernatants bind to ZcytoR14-muFc and not the irrelevant muFc containing fusion protein, are further confirmed for specific antibody activity by repeating both neutralization assays as well as the FACS analysis. All

selected ZcytoR14 antibody positive clones are cloned a minimum of two times to help insure clonality and to assess stability of antibody production. Further rounds of cloning are performed and screened as described until, preferably, at least 95% of the resulting clones were positive for neutralizing anti-ZcytoR14 antibody production.

5 D) Biochemical Characterization of the Molecule Recognized by Anti-ZcytoR14 mAbs

Biochemical confirmation that the target molecule, ZcytoR14, recognized by the putative anti-ZcytoR14 mAbs is indeed ZcytoR14 are performed by standard immunoprecipitation followed by SDS-PAGE analysis or western blotting procedures, both employing soluble membrane preparations from ZcytoR14 transfected versus untransfected
10 Baf3 or BHK cells. Moreover, soluble membrane preparations of non-transfected cell lines that express ZcytoR14 are used show that the mAbs recognize the native receptor chain as well as the transfected one. Alternatively, the mAbs are tested for their ability to specifically immunoprecipitate or western blot the soluble ZcytoR14-muFc protein.

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EXAMPLE 19

Neutralization of Human ZcytoR14 by Sera from Mice Injected with P815 Cells

Transfected with Human ZcytoR14

Using a cell based neutralization assay, serum from mice injected with live human ZcytoR14 transfected P815 cells (Example 17) is added as a serial dilution at 1%, 0.5%,
20 0.25%, 0.13%, 0.06%, 0.03%, 0.02%, and 0%. The assay plates are incubated at 37°C, 5% CO₂ for 4 days at which time Alamar Blue (Accumed, Chicago, IL) is added at 20µl/well. Plates are again incubated at 37°C, 5% CO₂ for 16 hours. Results showed that serum from four of the animals could neutralize signaling of both huIL-17 and huIL-17F through human ZcytoR14.

25

Results such as these provide additional evidence that effectively blocking ZcytoR14 by binding, blocking, inhibiting, reducing, antagonizing or neutralizing IL-17 or IL-17F activity (individually or together), for example via a neutralizing monoclonal antibody to ZcytoR14 of the present invention, could be advantageous in reducing the effects of IL-17 and IL-17F (alone or together) *in vivo* and may reduce IL-17 and/or IL-17F-induced inflammation,
30 such as that seen in, for example in psoriasis, IBD, colitis, chronic obstructive pulmonary disease, cystic fibrosis or other inflammatory diseases induced by IL-17, and or IL-17F including IBD, arthritis, asthma, psoriatic arthritis, colitis, inflammatory skin conditions, and atopic dermatitis.

EXAMPLE 20**Pharmacokinetics of an Anti-human ZcytoR14 Monoclonal Antibody**

The test monoclonal antibody, anti-human ZcytoR14 mAb, is provided in, for example, 3x 3 mL aliquots at a concentration of approximately 1 mg/mL (determined by UV Absorbance at 280 nM) and was stored at -80 °C until use. The vehicle is 1X PBS (50mM NaPO₄, 109mM NaCl), pH 7.3. The mAb is thawed at room temperature before use and aliquots 1 and 2 are used as provided for the 100 µg IV and SC dosing groups, respectively. Half of aliquot 3 is diluted 1:2 in 1X PBS for the 50 µg SC dose group and the second half of aliquot 3 is diluted 1:10 in 1X PBS for the 10 µg SC dose group. Female SCID mice (n=96) are obtained from Charles River Labs. Animals are checked for health on arrival and group-housed (3 animals per cage). The mice are 12 weeks old with an average body weight of approximately 22 g at the beginning of the study.

A) Dosing Protocol

Female SCID mice (n=24/dose group) are randomly placed into four dosing groups (Table 5). Group 1 was administered the anti-human ZcytoR14 mAb via IV injection of approximately 93 µL in a tail vein and Groups 2, 3, and 4 are administered the mAb via SC injection of approximately 93 µL in the scruff of the neck.

B) Sample Collection

Prior to blood collection, mice were fully anesthetized with halothane or isofluorane. Blood samples were collected via cardiac stick for all time points except the 168 hr timepoint (collected via eye bleed and the same animals were bled again at the 504 hr timepoint via cardiac stick). Blood was collected into serum separator tubes and allowed to clot for 15 minutes. Samples were subsequently centrifuged for 3 minutes at 14,000 rpm. Following centrifugation, aliquots of 125-150uL were dispensed into labeled eppendorf tubes and immediately stored at -80 °C until analysis.

Table 5

Group #	Dose (ROA)	Animals	PK Timepoints
1	100 μ g (IV)	3 mice/timepoint*	0.25, 1, 4, 8, 24, 72, 168, 336 and 504 hr
2	100 μ g (SC)	3 mice/timepoint*	0.25, 1, 4, 8, 24, 72, 168, 336 and 504 hr
3	50 μ g (SC)	3 mice/timepoint*	0.25, 1, 4, 8, 24, 72, 168, 336 and 504 hr
4	10 μ g (SC)	3 mice/timepoint*	0.25, 1, 4, 8, 24, 72, 168, 336 and 504 hr

* The same animals were used for the 168 and 504 hr timepoints.

C) Quantification of Serum Anti-human ZcytoR14 mAb Concentrations by ELISA

5 An Enzyme Linked Immunosorbant Assay (ELISA) is developed and qualified to analyze mouse serum samples from animals dosed with anti-ZcytoR14 mAb during pharmacokinetic studies. This assay is designed to take advantage of a commercially available secondary antibody and colorimetric detection using TMB. The dilutions used for the standard curve were modified to improve the definition of the linear portion of the standard curve. A standard curve in the range of 100 ng/mL to 0.231 ng/mL with 2-fold dilutions
10 allows for quantitation of the mouse serum samples. QC samples are diluted to 1:100, 1:1000 and 1:10000 in 10% SCID mouse serum and back calculated from the standard curve.

D) Pharmacokinetic Analysis

Serum concentration versus time data are downloaded into WinNonlin Professional 4.0 software (Pharsight, Inc.; Cary, NC) for pharmacokinetic analysis.
15 Noncompartmental analysis is used to determine pharmacokinetic parameters based on the mean data at each time point.

EXAMPLE 21

Neutralization of IL-17 and IL-17F Activity by a Anti- Human ZcytoR14 Monoclonal Antibody

20 Using a cell-based neutralization assay, a purified mouse anti-human ZcytoR14 monoclonal antibody is added as a serial dilution, for example, at 10 μ g/ml, 5 μ g/ml, 2.5 μ g/ml, 1.25 μ g/ml, 625ng/ml, 313ng/ml, 156ng/ml and 78ng/ml. The assay plates are incubated at 37°C, 5% CO₂ for 4 days at which time Alamar Blue (Accumed, Chicago, IL) is
25 added at 20 μ l/well. Plates are again incubated at 37°C, 5% CO₂ for 16 hours. This assay is

able to demonstrate that the purified anti-human ZcytoR14 monoclonal antibody is able to neutralize signaling of both huIL-17 and huIL-17F through human ZcytoR14. For highly effective antibodies, when used at approx. 10µg/ml concentration, the antibody completely neutralizes proliferation induced by huIL-17 or huIL-17F, with the inhibition of proliferation decreasing in a dose dependent fashion at the lower concentrations. An isotype-matched negative control mouse mAb, tested at the concentrations described above, is expected to provide no inhibition of proliferation of either cytokine. These results are able to further demonstrate that monoclonal antibodies to ZcytoR14 could indeed antagonize the activity of the pro-inflammatory ligands, IL-17 and IL-17F at low concentrations.

EXAMPLE 22

IL-17A Induces Elevated Levels of IFN-gamma and TNF-alpha in Human Peripheral Blood Mononuclear Cells

Human peripheral blood mononuclear cells (PBMC) are purified by ficoll density gradient centrifugation and then incubated overnight at 37°C in media alone, 50 ng/ml anti-human CD3 antibody, or the combination of 50 ng/ml anti-human CD3 antibody plus 1 µg/ml anti-human CD28 antibody. Replicate cultures for each of these conditions are set up and are given no cytokine, 25 ng/ml human IL-17A, or 25 ng/ml human IL-17F. After 24-hour incubations, supernatants from each culture are harvested and assayed for cytokine content using B-D Bioscience's human Th1/Th2 Cytometric Bead Array (CBA). We found that cultures that had been stimulated with either anti-CD3 or anti-CD3 plus anti-CD28 and had been supplemented with IL-17A contained significantly elevated levels of IFN-gamma and TNF-alpha (3-5-fold elevation of each) over cultures with no cytokine added or those that received IL-17F. Cultures in which no anti-CD3 stimulation was added did not show significant changes in cytokine levels. In addition, IL-17A addition induced no significant changes in other cytokines assayed for with the CBA including IL-2, IL-4, IL-5, and IL-10. This data indicates that IL-17A, but not IL-17F, can augment the production of IFN-gamma and TNF-alpha in PBMC cultures stimulated with anti-CD3 or anti-CD3 plus anti-CD28.

EXAMPLE 23**ZcytoR14-Fc Decreases Disease Incidence and Progression in Mouse Collagen Induced Arthritis (CIA) Model****A) Mouse Collagen Induced Arthritis (CIA) Model**

5 Ten week old male DBA/1J mice (Jackson Labs) are divided into 3 groups of 13 mice/group. On day-21, animals are given an intradermal tail injection of 50-100 µl of 1mg/ml chick Type II collagen formulated in Complete Freund's Adjuvant (prepared by Chondrex, Redmond, WA), and three weeks later on Day 0 they are given the same injection except prepared in Incomplete Freund's Adjuvant. ZcytoR14-Fc is administered as an
10 intraperitoneal injection 3 times a week for 4 weeks, at different time points ranging from Day 0, to a day in which the majority of mice exhibit moderate symptoms of disease. Groups receive either 10 or 100 µg of ZcytoR14-Fc per animal per dose, and control groups receive the vehicle control, PBS (Life Technologies, Rockville, MD). Animals begin to show symptoms of arthritis following the second collagen injection, with most animals developing
15 inflammation within 1.5-3 weeks. The extent of disease is evaluated in each paw by using a caliper to measure paw thickness, and by assigning a clinical score (0-3) to each paw: 0=Normal, 0.5=Toe(s) inflamed, 1=Mild paw inflammation, 2=Moderate paw inflammation, and 3=Severe paw inflammation as detailed below.

B) Monitoring Disease

20 Animals can begin to show signs of paw inflammation soon after the second collagen injection, and some animals may even begin to have signs of toe inflammation prior to the second collagen injection. Most animals develop arthritis within 1.5-3 weeks of the boost injection, but some may require a longer period of time. Incidence of disease in this model is typically 95-100%, and 0-2 non-responders (determined after 6 weeks of observation) are
25 typically seen in a study using 40 animals. Note that as inflammation begins, a common transient occurrence of variable low-grade paw or toe inflammation can occur. For this reason, an animal is not considered to have established disease until marked, persistent paw swelling has developed.

30 All animals are observed daily to assess the status of the disease in their paws, which is done by assigning a qualitative clinical score to each of the paws. Every day, each animal has its 4 paws scored according to its state of clinical disease. To determine the clinical score, the paw can be thought of as having 3 zones, the toes, the paw itself (manus or pes), and the wrist or ankle joint. The extent and severity of the inflammation relative to these zones is noted including: observation of each toe for swelling; torn nails or redness of toes; notation of

any evidence of edema or redness in any of the paws; notation of any loss of fine anatomic demarcation of tendons or bones; evaluation of the wrist or ankle for any edema or redness; and notation if the inflammation extends proximally up the leg. A paw score of 1, 2, or 3 is based first on the overall impression of severity, and second on how many zones are involved.

5 The scale used for clinical scoring is shown below.

C) Clinical Score

0 = Normal

0.5 = One or more toes involved, but only the toes are inflamed

10 1 = mild inflammation involving the paw (1 zone), and may include a toe or toes

2 = moderate inflammation in the paw and may include some of the toes and/or the wrist/ankle (2 zones)

3 = severe inflammation in the paw, wrist/ankle, and some or all of the toes (3 zones)

15 Established disease is defined as a qualitative score of paw inflammation ranking 2 or more, that persists for two days in a row. Once established disease is present, the date is recorded and designated as that animal's first day with "established disease".

20 Blood is collected throughout the experiment to monitor serum levels of anti-collagen antibodies, as well as serum immunoglobulin and cytokine levels. Serum anti-collagen antibodies correlate well with severity of disease. Animals are euthanized on Day 21, and blood collected for serum and CBC's. From each animal, one affected paw is collected in 10%NBF for histology and one is frozen in liquid nitrogen and stored at -80°C for mRNA analysis. Also, 1/2 spleen, 1/2 thymus, 1/2 mesenteric lymph node, one liver lobe and the left kidney are collected in RNAlater for RNA analysis, and 1/2 spleen, 1/2 thymus, 1/2 mesenteric lymph node, the remaining liver, and the right kidney are collected in 10% NBF for histology. Serum is collected and frozen at -80°C for immunoglobulin and cytokine assays.

25 Groups of mice receiving ZcytoR14-Fc at all time points are characterized by a delay in the onset and/or progression of paw inflammation. These results indicate that ZcytoR14 can reduce inflammation, as well as disease incidence and progression associated with this model. These results are further supported by the observation that ZcytoR14-Fc
30 resulted in decreased levels of serum TNF α , IL-1 β , and anti-collagen antibodies.

EXAMPLE 24**Stable Over-Expression of ZcytoR14 in the Murine Assay Cell Line, Nih3t3/kz142.8****Expressing the ap1/nfkb Transcription Factor**

The murine nih3t3/kz142.8 assay cell line was transfected with a human
5 zcytor14x1 (SEQ ID NO:2) in an expression vector with a methotrexate resistance gene
(dihydrofolate reductase,DHFR) This transfection was performed using a commercially
available kit and the manufacturer's recommendations. (Mirus, Madison,WI. Cat. #MIR218)
Cells were placed in 1 μ M mtx amended growth medium to select for the expression vector
containing the human zcytor14X1 transgene. After selection a human zcytor14x1 transfection
10 pool was generated, and called nih3t3/kz142.8/hcytor14x1.

A) Luciferase assay using the nih3t3/kz142.8 assay cell line

Since nih3t3/kz142.8 has a stable kz142 reporter, there is no need for
adenovirus infection to add this reporter. Thus the luciferase assay protocol was shorted and
done the following way:

15 1. Cell plating

nih3t3/kz142.8 cells were plated at 5000 cells/well in solid white, cell culture
coated 96 well plates, (Cat. #3917. Costar) using DMEM/10% FBS, containing glutamine and
amended with pyruvate and cultured overnight at 37oC and 5% CO2. On this second day, the
plating media was removed and exchanged for DMEM/1% FBS, containing glutamine and
20 amended with pyruvate and cultured overnight at 37oC and 5% CO2.

**2. Luciferase assay measuring IL-17A and F activation of the stable kz142
reporter**

Following the overnight incubation in the 1% fbs, DMEM media, human IL-
17A,and IL-17F ligand dilutions were made in serum free media, amended with BSA to a .28%
25 level. After adding the ligand dilutions, cells were incubated at 37oC and 5% CO2 for 4 hours,
after which the media was removed, cells lysed for 15 minutes and mean fluorescence intensity
(MFI) measured using the luciferase assay system and reagents, (Cat.#e1531 Promega.
Madison, WI.) and a Microplate luminometer. Activity was detected for both ligands at
concentrations ranging from .1-1000ng/ml. The nih3t3/kz142.8/hcytor14x1 transfection pool
30 showed similar activity for the murine IL-17A ligand as did the parental cell line. (example 14)
However, the cytor14x1 transfectant pool showed an elevated responsiveness to human IL-17A
and F treatments, even when these ligand concentrations were as low as 20 femptograms. The
fact that the mIL-17A signaling is comparable to that in the parental cell line (example14)
suggests that there isn't a general, non-specific problem with human ZcytoR14-expressing cells

and that the murine IL-17A is probably signaling through the endogenous murine nih3t3 cell IL-17R or ZcytoR14 receptor. Thus, the fact that human IL-17A and IL-17F cause an elevation of MFI at such low ligand concentrations may indicate a specific hyper-responsiveness of the cells to those ligands, which is mediated through the over-expressed human ZcytoR14 receptor.

This result has significant clinical and biological ramifications and utility. For example, physiological situations could cause local up-regulation of the ZcytoR14 receptors which could then make these areas hyper-responsive to IL-17A and IL-17F, resulting in biological activation at much lower ligand concentrations than those suggested without ZcytoR14 over-expression. Thus, far lower soluble receptor levels may be sufficient to antagonize these hypothetically lower ligand concentrations, than previously thought or recognized by those in the field.

EXAMPLE 25

Antagonists to IL-17F and IL-17A activity Decrease Disease Incidence and Progression in an Inflammatory Bowel Disease (IBD) Model

This model is designed to show that cultured intestinal tissue from patients with IBD produce higher levels of inflammatory mediators compared to tissue from healthy controls. This enhanced production of inflammatory mediators (including but not limited to IL-1b, IL-4, IL-5, IL-6, IL-8, IL-12, IL-13, IL-15, IL-17 A and F, IL-18, IL-23, TNF-a, IFN-g, MIP family members, MCP-1, G- and GM-CSF, etc.) contributes to the symptoms and pathology associated with IBDs such as Crohn's disease (CD) and ulcerative colitis (UC) by way of their effect(s) on activating inflammatory pathways and downstream effector cells. These pathways and components then lead to tissue and cell damage/destruction observed in vivo. Therefore, this model can simulate this enhanced inflammatory mediator aspect of IBD. Furthermore, when intestinal tissue from healthy controls or from human intestinal epithelial cell (IEC) lines is cultured in the presence of these inflammatory components, inflammatory pathway signaling can be observed, as well as evidence of tissue and cell damage.

Therapeutics that would be efficacious in human IBD in vivo would work in the above ex vivo or IEC models by inhibiting and/or neutralizing the production and/or presence of inflammatory mediators.

In this model, human intestinal tissue is collected from patients with IBD or from healthy controls undergoing intestinal biopsy, re-sectioning or from post-mortem tissue collection, and processed using a modification of Alexakis et al (Gut 53:85-90; 2004). Under

aseptic conditions, samples are gently cleaned with copious amounts of PBS, followed by culturing of minced sections of tissue, in the presence of complete tissue culture media (plus antibiotics to prevent bacterial overgrowth). Samples from the same pool of minced tissue are treated with one of the following: vehicle (PBS); recombinant human (rh) IL-17A; rhIL-17F; or
5 rhIL-17A+rhIL-17F. In addition, these are treated with or without an antagonist of either IL-17A or IL-17F, alone or in combination (such as a soluble ZcytoR14). This experimental protocol is followed for studies with human IEC lines, with the exception that cells are passaged from existing stocks. After varying times in culture (from 1 h to several days), supernatants are collected and analyzed for levels of inflammatory mediators, including those
10 listed above. In samples from patients with IBD or in samples treated with rhIL-17A and/or F, levels of inflammatory cytokines and chemokines are elevated compared to untreated healthy control tissue samples. The addition of antagonists to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention markedly reduces the
15 production of inflammatory mediators, and thus, would expect to be efficacious in human IBD.

EXAMPLE 26

Antagonists to IL-17F and IL-17A activity Decrease Disease Incidence and Progression in a Multiple Sclerosis (MS) Model

20 Multiple sclerosis (MS) is a complex disease that is thought to be mediated by a number of factors, including the presence of lymphocytic and mononuclear cell inflammatory infiltrates and demyelination throughout the CNS. Microglia are macrophage-like cells that populate the central nervous system (CNS) and become activated upon injury or infection. Microglia have been implicated as playing critical roles in various CNS diseases including MS,
25 and may be used to study mechanism(s) of initiation, progression, and therapy of the disease (Nagai et al. Neurobiol Dis 8:1057-1068; 2001; Olson et al. J Neurosci Methods 128:33-43; 2003). Immortalized human microglial cell lines and/or established human astroglia cell lines can, therefore, be used to study some of the effects of inflammatory mediators on these cell types and their potential for neutralization. Inflammatory mediators (including but not limited
30 to IL-1b, IL-6, IL-8, IL-12, IL-13, IL-15, IL-17 A and F, IL-18, IL-23, TNF-a, IFN-g, MIP family members, RANTES, IP-10, MCP-1, G- and GM-CSF, etc.) can contribute to the symptoms and pathology associated with MS by way of their effect(s) on activating inflammatory pathways and downstream effector cells.

In order to evaluate the pro-inflammatory actions of IL-17A and IL-17F, and the ability of an antagonist to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention to neutralize or decrease these effects, cultured glial cells are treated with one of the following: vehicle; rhIL-17A; rhIL-17F; rhIL-17A+IL-17F. In addition, these are treated with or without an antagonist of either IL-17A or IL-17F, alone or in combination (such as a soluble ZcytoR14). After varying times in culture (from 1 h to several days), supernatants and cells are collected and analyzed for levels and/or expression of inflammatory mediators, including those listed above. Levels of inflammatory cytokines and chemokines are elevated in the presence of rhIL-17A and/or IL-17F compared to cultures treated with vehicle alone. The addition of antagonists to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention markedly reduces the production and expression of inflammatory mediators, and thus, would expect to be efficacious in inflammatory aspects associated with human MS.

EXAMPLE 27

Antagonists to IL-17F and IL-17A activity Decrease Disease Incidence and Progression in a Rheumatoid Arthritis (RA) and Osteoarthritis (OA) Model

This model is designed to show that human synovial cultures (including synovial macrophages, synovial fibroblasts, and articular chondrocytes) and explants from patients with RA and OA produce higher levels of inflammatory mediators compared to cultures/explants from healthy controls. This enhanced production of inflammatory mediators (including but not limited to oncostatin M, IL-1b, IL-6, IL-8, IL-12, IL-15, IL-17 A and F, IL-18, IL-23, TNF-a, IFN-g, IP-10, RANTES, RANKL, MIP family members, MCP-1, G- and GM-CSF, nitric oxide, etc.) contributes to the symptoms and pathology associated with RA and OA by way of their effect(s) on activating inflammatory pathways and downstream effector cells. These pathways and components then lead to inflammatory infiltrates, cartilage and matrix loss/destruction, bone loss, and upregulation of prostaglandins and cyclooxygenases. Therefore, this model can simulate the destructive inflammatory aspects of RA and OA in in vitro and ex vivo experiments. Furthermore, when explants and synovial cultures from healthy controls are cultured in the presence of several of these inflammatory components (e.g. oncostatin M, TNF-a, IL-1b, IL-6, IL-17A and F, IL-15, etc.), inflammatory pathway signaling can be observed. Therapeutics that would be efficacious in human RA in vivo would work in

the above in vitro and ex vivo models by inhibiting and/or neutralizing the production and/or presence of inflammatory mediators.

In this model, human synovial explants are collected from patients with RA, OA, or from healthy controls undergoing joint replacement or from post-mortem tissue collection, and processed using a modification of Wooley and Tetlow (Arthritis Res 2: 65-70; 2000) and van 't Hof et al (Rheumatology 39:1004-1008; 2000). Cultures of synovial fibroblasts, synovial macrophages and articular chondrocytes are also studied. Replicate samples are treated with one of the following: vehicle (PBS); recombinant human (rh) IL-17A; rhIL-17F; or rhIL-17A+rhIL-17F, and some samples contain various combinations of oncostatin M, TNF- α , IL-1b, IL-6, IL-17A, IL-17F, and IL-15. In addition, these are treated with or without an antagonist to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention. After varying time of culture (from 1 h to several days), supernatants are collected and analyzed for levels of inflammatory mediators, including those listed above. In samples from patients with RA or OA, or in samples treated with rhIL-17A and/or F (either alone or in combination with other inflammatory cytokines), levels of inflammatory cytokines and chemokines are elevated compared to untreated healthy control explants or in untreated cell cultures. The addition of antagonists to IL-17F and/or IL-17A activity, such as ZcytoR14 soluble receptors and antibodies thereto including the anti-human-ZcytoR14 monoclonal and neutralizing antibodies of the present invention markedly reduces the production of inflammatory mediators, and thus, would expect to be efficacious in human RA and OA.

EXAMPLE 28

IL-17A and IL-17F Functional Responses

NIH-3T3/KZ142 cells were stably transfected with human zcytoR14x1 (SEQ ID NO:1) and mouse zcytoR14x1 (SEQ ID NO:25). As described above, each line was treated for 7 and 15 minutes with a dose response of IL-17A, IL-17F, murine IL-17F, and appropriate controls. Both IL-17A and IL-17F gave a dose dependent response in phosphorylated I κ B- α and p38 MAPK transcription factors when ZcytoR14x1 (SEQ ID NO:1) was transfected, approximately 30% greater than the inherent signaling from the control line. IL-17A and IL-17F gave no increase in signaling when the murine ZcytoR14x1 (SEQ ID NO:25) was transfected. Murine IL-17F gave no increase in signaling for either human or murine ZcytoR14x1.

EXAMPLE 29**IL-17A, IL-17F, IL-17R and ZcytoR14 Expression in Murine Disease Models**

Four murine models of disease (asthma, DSS colitis, atopic dermatitis and experimental allergic encephalomyelitis) were analyzed using know techniques for the
5 expression of IL-17A, IL-17F, IL-17R and ZcytoR14.

In the asthma model, IL-17A and IL-17F are expressed at very low to undetectable levels in lung, spleen, lung draining lymph nodes and lung infiltrating cells in diseased and non-diseased mice. Zcytor14 message was found to be more highly expressed in lung compared to spleen and lymph node but was not regulated with disease. IL-17R was more
10 highly expressed in spleen and lung draining lymph node compared to lung but was also not regulated with disease.

Contrary to the asthma model, IL-17A and IL-17F were highly up-regulated in diseased but not normal mice in the DSS-colitis model in both proximal and distal colon. Neither cytokine was significantly up-regulated in the mesenteric lymph node. Further, it was
15 found that up-regulation of both cytokines in the context of acute DSS-induced colitis and not in chronic DSS-induced colitis. IL-17R was found to be prominently expressed in mesenteric lymph nodes as compared to proximal and distal colon, but was not regulated with disease. In contrast, ZcytoR14 was more highly expressed in proximal distal colon tissue compared to mesenteric lymph nodes. ZcytoR14 expression was also not regulated with disease.

In atopic dermatitis, IL-17A mRNA was not detectable. IL-17F was found to be expressed in both skin and skin-draining lymph nodes but did not appear to be significantly regulated with disease. IL-17R mRNA was more highly expressed in skin-draining lymph nodes as compared to skin but was not regulated with disease. Zcytor14 was more highly
20 expressed in skin compared to skin-draining lymph nodes but was also not regulated with
25 disease.

In experimental allergic encephalomyelitis, both IL-17A and IL-17F appeared to up-regulated in spinal chord in diseased but not healthy mice. IL-17F may have been more highly expressed in lymph nodes compared to spinal cord but expression in the lymph nodes was not regulated with disease. However, overall levels of expression in these tissues was
30 quite low. IL-17R was more highly expressed in lymph node tissue compared to brain and spinal cord. Zcytor14 was not tested.

In short, IL-17A and IL-17F expression appears to be regulated with disease in the context of the DSS-induced colitis and experimental allergic encephalomyelitis models but apparently not for asthma or atopic dermatitis. IL-17R and zcytor14 expression does not

appear to be regulated with disease but IL-17R expression appears to be enriched in lymphoid tissues while zcytor14 expression appears to be enriched in non-lymphoid tissues.

EXAMPLE 30

5 ZcytoR14 is a Mediator of Activation to Both IL-17A and IL-17F

The murine nih3t3/kz142.8 assay cell line was transfected with a human ZcytoR14X1 (SEQ ID NO:2) in an expression vector with a methotrexate resistance gene. (dihydrofolate reductase,DHFR) Human IL-17RA (SEQ ID NO:21) was similarly tranfected into this cell line. Transfections were performed using a commercially available kit and the
10 manufacturer's recommendations. (Mirus, Madison,WI. Cat. #MIR218) Cells were placed in 1 μ M mtx amended growth medium to select for the expression vector containing the expression constructs. After selection transfection pools were generated, and called nih3t3/kz142.8/hcytor14X1 and nih3t3/kz142.8/IL-17R.

A) Luciferase assay using the nih3t3/kz142.8- based cell lines.

15 Since nih3t3/kz142.8 based cell lines have stable ap1/nfkb reporters (kz142), there is no need for adenovirus infection to add this reporter. Thus the luciferase assay protocol was shorted and done the following way:

1. Cell plating

Cells were plated at 5000 cells/well in solid white, cell culture coated 96 well
20 plates, (Cat. #3917. Costar) using DMEM/10% FBS, containing glutamine and amended with pyruvate and cultured overnight at 37oC and 5% CO₂. On this second day, the plating media was removed and exchanged for DMEM/1% FBS, containing glutamine and amended with pyruvate and cultured overnight at 37oC and 5% CO₂.

2. Luciferase assay measuring IL-17A and F activation of the stable kz142 25 reporter

Following the overnight incubation in the 1% fbs, DMEM media, human IL-17A,and IL-17F ligand dilutions were made in serum free media, amended with BSA to a .28% level. After adding the ligand dilutions, cells were incubated at 37oC and 5% CO₂ for 4 hours, after which the media was removed, cells lysed for 15 minutes and mean fluorescence intensity
30 (MFI) measured using the luciferase assay system and reagents, (Cat.#e1531 Promega. Madison, WI.) and a Microplate luminometer. Activity was detected for both ligands at concentrations ranging from .1-100ng/ml.

The EC_{50s} discussed below are averages of at least 4 experiments. The nih3t3/kz142.8/hcytor14x1 transfection pool showed similar activity for the murine IL-17A

ligand as did the parental cell line, with an EC_{50} of about 4ng/ml. (example 14) The fact that the mIL-17A signaling in the hcytor14x1 recombinant line is comparable to that in the parental cell line (example14) suggests that murine IL-17A is probably signaling through the endogenous murine nih3t3 cell IL-17RA or zcytor14 receptors and does not activate the cells through hcytor14X1. However, the hzcytor14X1 transfectant pool showed an elevated responsiveness to human IL-17A treatment, with an EC_{50} of .41 ng/ml Vs 2.8 ng/ml (averages of 4 experiments) in the parental line (a 6.8 fold more potent EC_{50} in the recombinant line) In addition, the hIL-17RCX1 recombinant line had an enhanced responsiveness to hIL-17F, with an EC_{50} of .61ng/ml in the recombinant line Vs 10ng/ml in the parental line. (a 17 fold more potent EC_{50} in the recombinant line). The increased potency to hIL-17A and F in the hIL-17RCX1 line is consistent with human zcytor14X1 being a high affinity receptor for both human IL-17A and IL-17F. In contrast, the hIL-17RA recombinant line had enhanced sensitivity only to hIL-17A, with an EC_{50} of .6ng/ml vs 2.8 ng/ml for the parental line. There was not an enhancement of the hIL-17F EC_{50} in the hIL-17RA recombinant line, with an IL-17F EC_{50} of 12.4 ng/ml vs 8.9ng/ml in the parental line.

This result is significant because it specifically implicates hzcytor14X1 as a mediator of activation to both hIL-17A and hIL-17F and suggests that hIL-17RA mediates signaling only to hIL-17A activation and not hIL-17F.

EXAMPLE 31

Intravenous Administration of IL-17A and IL-17F

To determine the effect of i.v. delivery of murine or human IL-17A or IL-17F on complete blood counts (CBC) and serum cytokines/chemokines in BALB/c mice at various time points.

I.V. administration of 1 ug mIL-17A resulted in an approximate 2-fold increase in circulating neutrophils (by CBC) and approximate 10-fold increase in serum KC and MCP-1 (by Luminex) 1-2 h following administration; similar results in these chemokines were observed with 5 ug hIL-17A. Blood monocyte levels were also significantly increased in mice treated with 1 ug mIL-17A (showed the greatest increase), 5 ug hIL-17A or 5 ug hIL-17F at the 2 h timepoint. I.V. administration of m and hIL-17F resulted in marked increases in serum IL-15 (by Luminex) at the 1 and 2 h time points, and small increases in serum KC and MCP-1 at these same timepoints.

EXAMPLE 32**Neutralization of i.v. administered IL-17A and IL-17F**

To neutralize the i.v. IL-17A and IL-17F-mediated increases in cytokines and chemokines with i.p. soluble receptors (mIL-17RA:Fc for murine ligands; soluble human ZcytoR14 for human ligands). Female BALB/c mice were administered by i.p. injection either
5 PBS, 100 ug mIL-17RA:Fc, or 100 ug soluble human ZcytoR14 three hours prior to receiving by i.v. tail injection: PBS; 2 ug of either mIL-17A, mIL-17F, or 2 ug of both mIL-17A and F (for mice that received mIL-17RA:Fc); or 2 ug of either hIL-17A, hIL-17F, or 2 ug of both hIL-17A and F (for mice that received soluble human ZcytoR14). Serum was collected 1 h
10 following ligand administration and analyzed for a small number of serum cytokines and chemokines.

Mice pretreated with i.p. soluble receptor had marked reductions in IL-17A-mediated increases in serum concentrations of IL-17A and KC compared to mice treated with PBS +IL-17A.

15

From the foregoing, it will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by the appended claims.

DEMANDES OU BREVETS VOLUMINEUX

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JUMBO APPLICATIONS / PATENTS

**THIS SECTION OF THE APPLICATION / PATENT CONTAINS MORE
THAN ONE VOLUME.**

THIS IS VOLUME __1__ OF __2__

NOTE: For additional volumes please contact the Canadian Patent Office.

CLAIMS

What is claimed is:

1. An isolated soluble receptor comprising at least one ZcytoR14 subunit, wherein the ZcytoR14 subunit comprises a polypeptide having an amino acid sequence of SEQ ID NO: 3.
2. An isolated soluble receptor comprising at least one ZcytoR14 subunit, wherein the ZcytoR14 subunit comprises amino acid residue 1 to amino acid residue 427 of SEQ ID NO:24.
3. The soluble receptor of claim 1 or claim 2, wherein the soluble receptor comprises two ZcytoR14 subunits, wherein said subunits are linked together by a polypeptide linker.
4. The soluble receptor of claim 3, wherein the polypeptide linker has about 100 to 240 amino acid residues.
5. An isolated soluble receptor comprising ZcytoR14, wherein ZcytoR14 comprises a polypeptide having a sequence of amino acid residues as shown in SEQ ID NO:3; and wherein said soluble receptor reduces the pro-inflammatory activity of either IL-17A (SEQ ID NO:14) or IL-17F (SEQ ID NO:16).
6. The soluble receptor of claim 5, wherein said soluble receptor reduces the pro-inflammatory activity of both IL-17A (SEQ ID NO:14) or IL-17F (SEQ ID NO:16).
7. An antibody or antibody fragment that binds to a polypeptide comprising a sequence of amino acid residues as shown in SEQ ID NO:2; and wherein said antibody or antibody fragment reduces the pro-inflammatory activity of either either IL-17A (SEQ ID NO:14) or IL-17F (SEQ ID NO:16).
8. The antibody or antibody fragment according to claim 7, wherein the antibody or antibody fragment reduces the pro-inflammatory activity of both IL-17A (SEQ ID NO:14) and IL-17F (SEQ ID NO:16).

9. The antibody or antibody fragment according to claim 8, wherein the or antibody fragment is (a) a polyclonal antibody, (b) a murine monoclonal antibody, (c) a humanized antibody derived from (b), (d) an antibody fragment, or (e) a human monoclonal antibody.
10. The antibody or antibody fragment according to claim 8, wherein the antibody further comprises a radionuclide, enzyme, substrate, cofactor, fluorescent marker, chemiluminescent marker, peptide tag, magnetic particle, drug, or toxin.
11. The antibody of claim 9, wherein the antibody further comprises PEGylation.
12. The antibody or antibody fragment according to claim 8, wherein the or antibody fragment is (a) a polyclonal antibody, (b) a murine monoclonal antibody, (c) a humanized antibody derived from (b), (d) an antibody fragment, or (e) a human monoclonal antibody.
13. The antibody or antibody fragment according to claim 8, wherein the antibody further comprises a radionuclide, enzyme, substrate, cofactor, fluorescent marker, chemiluminescent marker, peptide tag, magnetic particle, drug, or toxin.
14. The antibody of claim 12, wherein the antibody further comprises PEGylation.
15. A method of reducing IL-17A-induced or IL-17F-induced inflammation comprising administering to a mammal with inflammation an amount of a composition of an antibody according to claim 7 sufficient to reduce inflammation.
16. A method of reducing IL-17A-induced or IL-17F-induced inflammation comprising administering to a mammal with inflammation an amount of a composition of a ZcytoR14 soluble receptor according to claim 1 sufficient to reduce inflammation.
17. A method of treating a mammal afflicted with an inflammatory disease in which IL-17A or IL-17F plays a role, comprising:
administering an antagonist of IL-17A or IL-17F to the mammal such that he inflammation is reduced, wherein the antagonist comprises (i) an antibody, antibody fragment, or binding polypeptide that specifically binds a polypeptide or polypeptide

fragment of ZcytoR14 (SEQ ID NO:2), or (ii) a polypeptide or polypeptide fragment of ZcytoR14 (SEQ ID NO:3); and

wherein the inflammatory activity of either IL-17A (SEQ ID NO:14) or IL-17F (SEQ ID NO:16) is reduced.

18. The method of claim 17, wherein the disease is asthma.
19. The method of claim 17, wherein the disease is a chronic inflammatory disease.
20. The method of claim 19, wherein the disease is a chronic inflammatory disease comprising inflammatory bowel disease, ulcerative colitis, Crohn's disease, arthritis, atopic dermatitis, or psoriasis.
21. The method of claim 17, wherein the disease is an acute inflammatory disease.
22. The method of claim 21, wherein the disease is an acute inflammatory disease comprising endotoxemia, septicemia, toxic shock syndrome or infectious disease.
23. The method of claim 17, wherein the antibody, antibody fragment, or binding polypeptide further comprises a radionuclide, enzyme, substrate, cofactor, fluorescent marker, chemiluminescent marker, peptide tag, magnetic particle, drug, or toxin.
24. A method of treating a mammal afflicted with an inflammatory disease in which IL-17A and IL-17F plays a role, comprising:

administering an antagonist of both IL-17A and IL-17F to the mammal such that the inflammation is reduced, wherein the antagonist comprises (i) an antibody, antibody fragment, or binding polypeptide that specifically binds a polypeptide or polypeptide fragment of ZcytoR14 (SEQ ID NO:2) or (ii) a polypeptide or polypeptide fragment of ZcytoR14 (SEQ ID NO:3); and

wherein the inflammatory activity of both IL-17A (SEQ ID NO:14) and IL-17F (SEQ ID NO:16) is reduced.
25. The method of claim 24, wherein the disease is asthma.

26. The method of claim 24, wherein the disease is a chronic inflammatory disease.
27. The method of claim 26, wherein the disease is a chronic inflammatory disease comprising inflammatory bowel disease, ulcerative colitis, Crohn's disease, arthritis, atopic dermatitis, or psoriasis.
28. The method of claim 24, wherein the disease is an acute inflammatory disease.
29. The method of claim 28, wherein the disease is an acute inflammatory disease comprising endotoxemia, septicemia, toxic shock syndrome or infectious disease.
30. The method of claim 24, wherein the antibody, antibody fragment, or binding polypeptide further comprises a radionuclide, enzyme, substrate, cofactor, fluorescent marker, chemiluminescent marker, peptide tag, magnetic particle, drug, or toxin.
31. A method of treating a pathological condition in a subject associated with ZcytoR14 activity comprising administering an effective amount of the soluble receptor of claim 1, thereby treating said pathological condition.
32. The method of claim 31, wherein said pathological condition is asthma.
33. The method of claim 31, wherein said pathological condition is a chronic inflammatory condition.
34. The method of claim 33, wherein said chronic inflammatory condition comprising inflammatory bowel disease, ulcerative colitis, Crohn's disease, arthritis, atopic dermatitis, or psoriasis.
35. The method of claim 31, wherein said pathological condition is an acute inflammatory condition.
36. The method of claim 35, wherein said acute inflammatory condition comprises endotoxemia, septicemia, toxic shock syndrome, or infectious disease.

37. A method of treating a mammal afflicted with an inflammatory disease in which ZcytoR14 plays a role, comprising:
- administering an antagonist of ZcytoR14 to the mammal such that the inflammation is reduced, wherein the antagonist comprises an antibody, antibody fragment, ZcytoR14 soluble receptor or binding polypeptide that specifically binds a polypeptide or polypeptide fragment of ZcytoR14 (SEQ ID NO:2); and
- wherein the inflammatory activity is reduced.
38. The method of claim 37, wherein the disease is asthma.
39. The method of claim 37, wherein the disease is a chronic inflammatory disease.
40. The method of claim 39, wherein the disease is a chronic inflammatory disease comprising inflammatory bowel disease, ulcerative colitis, Crohn's disease, arthritis, atopic dermatitis, or psoriasis.
41. The method of claim 37, wherein the disease is an acute inflammatory disease.
42. The method of claim 41, wherein the disease is an acute inflammatory disease comprising endotoxemia, septicemia, toxic shock syndrome or infectious disease.
43. The method of claim 37, wherein the antibody, antibody fragment, or binding polypeptide further comprises a radionuclide, enzyme, substrate, cofactor, fluorescent marker, chemiluminescent marker, peptide tag, magnetic particle, drug, or toxin.
44. The method of claim 37, wherein the antibody, antibody fragment, or binding polypeptide further comprises PEGylation.