



Human IFN γ / IL-4 Dual ELISpot

Instructions for use

Catalogue Numbers:

	Without Plates	With non-Sterile Plates	With sterile Plates
1x96 tests	EA101896	EA101897	EA101898
5x96 tests	EA101899	EA101900	EA101901
10x96 tests	EA101902	EA101903	EA101904
15x96 tests	EA101905	EA101906	EA101907
20x96 tests	EA101908	EA101909	EA101910

For research use only

Fast Track Your Research.....

Table of Contents

1.	Intended Use	2
2.	Introduction	2
2.1.	Summary.....	2
2.2.	Principle Of The Method.....	4
3.	Reagents Provided (Contents Shown For 5x96 Test Format)	5
4.	Materials/Reagents Required But Not Provided	5
5.	Storage Instructions	5
6.	Safety & Precautions For Use	6
7.	Reagent Preparation	7
7.1.	1x Phosphate Buffered Saline (PBS) (Coating Buffer)	7
7.2.	Cell Culture Media + 10% Serum (Blocking Buffer)	7
7.3.	1% BSA PBS Solution (Dilution Buffer)	7
7.4.	0.05% PBS-T Solution (Wash Buffer).....	7
7.5.	35% Ethanol (PVDF Membrane Activation Buffer)	7
7.6.	Capture Antibodies.....	7
7.7.	Detection Antibodies	7
7.8.	Streptavidin-AP Conjugate and Anti-FITC Antibody-HRP Conjugate.....	8
7.9.	AEC Substrate	8
8.	Sample And Control Preparation	9
8.1.	Cell Stimulation	9
8.2.	Positive Assay Control, IFN γ / IL-4 Production	9
8.3.	Negative Assay Control	9
8.4.	Sample	9
9.	Method	10
10.	Bibliography	11

Human IFN γ / IL-4 Dual ELISpot

1. Intended use

OriGene **ELISpot** is a highly specific immunoassay for the analysis of cytokine and other soluble molecule production and secretion from T-cells at a single cell level in conditions closely comparable to the *in-vivo* environment with minimal cell manipulation. This technique is designed to determine the frequency of cytokine producing cells under a given stimulation and the comparison of such frequency against a specific treatment or pathological state. The ELISpot assay constitutes an ideal tool in the investigation of Th1 / Th2 responses, vaccine development, viral infection monitoring and treatment, cancerology, infectious disease, autoimmune diseases and transplantation.

Utilising sandwich immuno-enzyme technology, OriGene ELISpot assays can detect both secreted cytokines and single cells that simultaneously produce multiple cytokines. Cell secreted cytokines or soluble molecules are captured by coated antibodies avoiding diffusion in supernatant, protease degradation or binding on soluble membrane receptors. After cell removal, the captured cytokines are revealed by tracer antibodies and appropriate conjugates.

This Dual Colour ELISpot kit allows you to analysis the production of two cytokines simultaneously in the same well.

This kit has been configured for research use only and is not to be used in diagnostic procedures.

2. Introduction

2.1. Summary

IFN γ (1-21)

IFN γ , also called Type II interferon, is a homodimeric glycoprotein containing approximately 21 to 24 kD subunits. The human IFN γ gene, situated on chromosome 12, contains three introns; the four exons code for a polypeptide of 166 amino acids, 20 of which constitute the signal peptide (11). In contrast to IFN α and IFN β synthesis, which can occur in any cell, production of IFN γ is a function of T cells and NK cells. All IFN γ inducers activate T cells either in a polyclonal (mitogens or antibodies) or in a clonally restricted, antigen-specific, manner. IFN γ is produced during infection by T cells of the cytotoxic/suppressor phenotype (CD8) and by a subtype of helper T cells, the Th1 cells. Th1 cells secrete IL-2, IL-3, TNF α and IFN γ , whereas Th2 cells main produce IL-3, IL-4, IL-5, and IL-10, but little or no IFN γ (9). IFN γ preferentially inhibits the proliferation of Th2 but not Th1 cells, indicating that the presence of IFN γ during an immune response will result in the preferential proliferation of Th1cells (7).

Type II IFN or IFN γ is a lymphokine that displays no molecular homology with type I IFN, but shares some important biologic activities. Specifically, IFN γ induces an anti-viral state and is anti-proliferative. In addition, IFN γ has several properties related to immunoregulation. **1)** IFN γ is a potent activator of mononuclear phagocytes, e.g. IFN γ stimulates the expression of Mac-1, augments endocytosis and phagocytosis by monocytes (15), and activates macrophages to kill tumor cells by releasing reactive oxygen intermediates and TNF α (21). **2)** IFN γ induces or augments the expression of MHC antigens on macrophages, T and B cells and some tumor cell lines (3). **3)** On T and B cells IFN γ promotes differentiation. It enhances proliferation of activated B cells and can act synergistically with IL-2 to increase immunoglobulin light-chain synthesis. (8,13). IFN γ is one of the natural B-cell differentiation factors (17). **4)** Finally, IFN γ activates neutrophils, NK cells and vascular endothelial cells (6).

The role of IFN γ as a disease marker has been demonstrated for a number of different pathological situations:

- *Infections*: IFN γ is produced during viral infections (4). IFN γ is a diagnostic tool for distinguishing tuberculous from other nontuberculous ascites (5,18). IFN γ values in pleural fluid are significantly higher in tuberculous pleuritis patients than those in non- tuberculous pleuritis patients, with a sensitivity and a specificity of 100% (1, 2). Therapy-induced (treatment with thalidomide) alleviation of clinical symptoms of erythema nodosum leprosum correlates with IFN γ and TNF α levels (14). Tuberculoid leprosy patients show increased lymphocyte proliferation and IFN γ production in response to stimulation with *Mycobacterium leprae* as compared to lepromatous leprosy patients and healthy individuals (16).
- *Autoimmune diseases*: Accurate measurements of cellular production of cytokines, e.g. IFN γ is important in the design and monitoring of immunotherapy of multiple sclerosis (12).
- *Transplant rejection*: Intragraft IFN γ mRNA expression occurs in active acute transplant rejection preceding clinical transplant rejection, thus offering an early diagnostic tool for detection of transplant rejection (10).
- *Allergy*: IFN γ production by isolated lymphocytes is not detectable in patients with cow's milk allergy as compared to control individuals (19). Infants who develop atopy produce significantly less IFN γ at birth compared to infants who do not develop atopy (20).
- *Diabetes*: Peripheral blood lymphomononuclear cells from newly diagnosed type I diabetes produce significantly less IFN γ in comparison to controls and long standing diabetes (4).

IL-4 (22-28)

IL-4 is a lymphokine that co-stimulates the proliferation of activated B- and T-cells, augments the cytotoxic activity of lymphocytes and monocytes and enhances the functional activity of myeloid cells (22). Produced by mast cells, T-cells and bone marrow stromal cells, IL-4 regulates the differentiation of naive CD4 $^{+}$ cells into helper Th2 cells characterized by their cytokine secretion-profile that includes secretion of IL-4, IL-5, IL-6, IL-10 and IL-13 which favour a humoral immune response (23, 24). In addition, IL-4 can inhibit the proliferation of TNF, IL-1 and IL-6 by macrophages (25, 26)

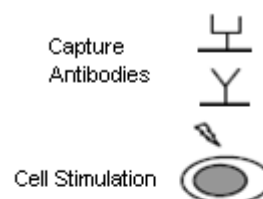
IL-4 induces B-cell class switching to IgE and IgG1 isotypes, and up regulates MHC Class II production and CD23 expression (27)

IL-4 is a 15kDa globular glycoprotein containing 129 amino acid residues. The non-glycosylated form of the protein is fully biologically active. (28)

2.2. Principle of the method

Capture antibodies highly specific for the analytes of interest are coated to the wells of a PVDF bottomed 96 well microtitre plate either during kit manufacture or in the laboratory. The plate is then blocked to minimise any non-antibody dependent unspecific binding and finally washed before adding the cells to be investigated. Cell suspension and stimulant are added to the coated and blocked microtitre plate and the plate incubated allowing the specific antibodies to bind any analytes produced. Biotinylated and FITC detection antibodies are then added which bind to the previously captured analyte. HRP conjugated anti-FITC antibodies and Streptavidin Alkaline Phosphatase are added binding to the detection antibodies. Any excess unbound analyte and antibodies are removed by careful washing. Colour substrate is then applied to the wells resulting in coloured spots which can be quantified using appropriate analysis software or manually using microscopes.

1. 96 PVDF-bottomed-well plates are first treated with 35% ethanol and then coated with anti-IFN γ and anti-IL-4 capture antibodies



2. Cells are incubated in the presence of the antigen. Upon stimulation they release cytokines which bind to the capture antibodies.



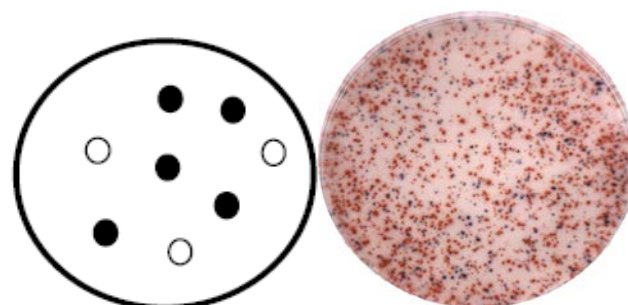
3. Anti-IFN γ -FITC and anti-IL-4 biotin detection antibodies are added and bind to the captured cytokines



4. Detection antibodies are in turn bound by anti-FITC-HRP for IFN γ and Streptavidin-AP for IL-4.



5. Finally coloured spots are developed by separate incubations with first AEC and then BCIP/NBT substrate buffers. Cells producing IFN γ give red/brownish spots while those producing IL-4 give blue/purple spots.



3. Reagents provided (Contents shown for 5x96 test format)

- 96 well PVDF bottomed plates (5 if ordered)
- Capture Antibody for human IFN γ (0.5ml supplied sterile)
- Capture Antibody for human IL-4 (0.5ml supplied sterile)
- FITC conjugated detection antibody for IFN γ (lyophilised, resuspend in 0.55ml)
- Biotinylated detection antibody for IL-4 (lyophilised, resuspend in 0.55ml)
- Anti-FITC antibody HRP conjugate (100 μ l)
- Streptavidin-Alkaline Phosphatase conjugate (50 μ l)
- Bovine Serum Albumin (BSA)
- 50x Concentrated AEC substrate buffer (1ml)
- 10x Concentrated dilution buffer for AEC substrate (5ml)
- Ready to use BCIP/NBT substrate buffer (50ml)

Please note for 1x96 demo kits, detection antibodies are provided in liquid form.

4. Materials/Reagents required but not provided

- Miscellaneous laboratory plastic and/or glass, if possible sterile
- Ethanol
- Cell culture reagents (e.g. RPMI-1640, L-glutamine, FCS)
- Cell stimulation reagents (e.g. PMA and Ionomycin)
- CO₂ incubator
- Tween 20
- Phosphate Buffered Saline (PBS)
- 96 well PVDF bottomed plates if not ordered (we recommended Millipore plates catalogue # MSIPN4510, MSIPS4510 and M8IPS4510)

5. Storage Instructions

Store kit reagents between 2 and 8°C except uncoated plates which should be stored at RT. Immediately after use remaining reagents should be returned to cold storage (2 to 8°C). Expiry of the kit and reagents is stated on box front labels. The expiry of the kit components can only be guaranteed if the components are stored properly, and if in the case of repeated use of one component, the reagent is not contaminated by the first handling.

6. Safety & Precautions for use

- For **research use only** not to be used as a diagnostic test
- Handling of reagents, serum or plasma specimens should be in accordance with local safety procedures, e.g. CDC/NIH Health manual : " Biosafety in Microbiological and Biomedical Laboratories" 1984
- Do not eat, drink, smoke or apply cosmetics where kit reagents are used
- Do not pipette by mouth
- When not in use, kit components should be stored refrigerated or frozen as indicated on vials or bottles labels
- All reagents should be warmed to room temperature before use
- Cover or cap all reagents when not in use
- Do not mix or interchange reagents between different lots
- Do not use reagents beyond the expiration date of the kit
- Use a clean disposable plastic pipette tip for each reagent, standard, or specimen addition in order to avoid cross contamination
- Use a clean plastic container to prepare the washing solution
- Thoroughly mix the reagents and samples before use by agitation or swirling
- All residual washing liquid must be drained from the wells by efficient aspiration or by decantation followed by tapping the plate forcefully on absorbent paper. Never insert absorbent paper directly into the wells
- When pipetting reagents, maintain a consistent order of addition from well-to-well. This will ensure equal incubation times for all wells
- **AEC and BCIP/NBT buffers** are potentially carcinogenic and should be disposed of appropriately, caution should be taken when handling these reagent's, always wear gloves
- Follow incubation times described in the assay procedure

7. Reagent Preparation

7.1. 1X Phosphate Buffered Saline (PBS) (Coating Buffer)

For 1 litre of 10X PBS weigh-out:

80g NaCl
2g KH ₂ PO ₄
14.4g Na ₂ HPO ₄ · 2H ₂ O.

Add distilled water to 1 litre. Adjust the pH of the solution to 7.4 +/- 0.1 were required.

Dilute the solution to 1X before use.

7.2. Cell culture media + 10% Serum (Blocking Buffer)

For one plate add 1ml Serum (e.g. FCS) to 9ml of culture media (use same cell culture medium as used to derive the cell suspension).

7.3. 1% BSA PBS Solution (Dilution Buffer)

For one plate dissolve 0.2 g of BSA in 20 ml of 1X PBS.

7.4. 0.05% PBS-T Solution (Wash Buffer)

For one plate dilute 50µl of Tween 20 in 100 ml of 1X PBS.

7.5. 35% Ethanol (PVDF Membrane Activation Buffer)

For one plate, dilute 3.5 ml of ethanol with 6.5 ml of distilled water.

7.6. Capture Antibodies

These reagents are supplied sterile once opened keep the vials sterile or aliquot and store at -20°C. For optimal performance prepare the Capture Antibodies dilution immediately before use.

Dilute 100µl of each capture antibody in 10 mL of 1X PBS and mix well.

7.7. Detection Antibodies

Reconstitute the lyophilised antibodies with 0.55mL of distilled water. Gently mix the solution and wait until all the lyophilised material is back into solution.

If not used within a short period of time, reconstituted Detection Antibody should be aliquoted and stored at -20°C. In these conditions the reagent is stable for at least one year. For optimal performance prepare the reconstituted antibody dilution immediately prior to use.

Dilute 100µl of each antibody into 10ml of Dilution Buffer and mix well.

Please note for 1x96 demo kits, detection antibodies are provided in liquid form.

7.8. Streptavidin-AP conjugate and Anti-FITC antibody-HRP conjugate (Diluted conjugates)

For optimal performance prepare the dilution immediately prior to use

For one plate, dilute 10µl of Streptavidin-AP conjugate and 20µl of anti-FITC antibody HRP conjugate in 10mL of Dilution Buffer. Mix well.

DO NOT KEEP THE DILUTIONS FOR FURTHER EXPERIMENTS

7.9. AEC Substrate

For one plate, dilute 1 ml of AEC buffer A 10X with 9 ml of distilled water.
Then add 200µl of AEC substrate B 50X .

8. Sample and Control Preparation

8.1. Cell Stimulation

Cells can either be stimulated directly in the antibody coated wells (Direct) or, first stimulated in 24 well plates or flask, harvested, and then plated into the coated wells (Indirect).

The method used is dependent on 1) the type of cell assayed 2) the expected cell frequency. When a low number of cytokine producing cells are expected it is also advised to test them with the direct method, however, when this number is particularly high it is better to use the indirect ELISpot method.

All the method steps following stimulation of the cells are the same whatever the method (direct/indirect) chosen.

8.2. Positive Assay Control, IFN γ / IL-4 production

We recommend using the following polyclonal activation as a positive control in your assay.

Dilute CD4+ T cells in culture media (e.g. RPMI 1640 supplemented with 2mM L-glutamine and 10% heat inactivated fetal calf serum) containing 1ng/ml PMA and 500ng/ml ionomycin (Sigma, Saint Louis, MO). Distribute 2×10^4 to 3×10^4 cells per 100 μ l in required wells of an antibody coated 96-well PVDF plates and incubate for 15-20 hours in an incubator.

For other stimulators incubation times may vary, depending on the frequency of cytokine producing cells, and should be optimised in each situation.

8.3. Negative Assay Control

Dilute CD4+ T cells in culture media to give an appropriate cell number (same number of unstimulated cells as stimulated sample cells) per 100 μ l with no stimulation.

8.4. Sample

Dilute CD4+ T cells in culture medium and stimulator of interest (i.e. Sample, Vaccine, Peptide pool or infected cells) to give an appropriate cell number per 100 μ l.

Optimal assay performances are observed between 2×10^4 to 3×10^4 cells per 100 μ l.

Stimulators and incubation times can be varied depending on the frequency of cytokine producing cells and therefore should be optimised by the testing laboratory.

9. Method

Prepare all reagents as shown in section 7 and 8.

Assay Step		Details
1.	Addition	Add 25µl of 35% ethanol to every well
2.	Incubation	Incubate plate at room temperature (RT) for 30 seconds
3.	Wash	Empty the wells by flicking the plate over a sink & gently tapping on absorbent paper. Thoroughly wash the plate 3x with 100µl of 1X PBS per well
4.	Addition	Add 100µl of diluted capture antibodies to every well
5.	Incubation	Cover the plate and incubate at 4°C overnight
6.	Wash	Empty the wells as previous and wash the plate once with 100µl of 1X PBS per well
7.	Addition	Add 100µl of blocking buffer to every well
8.	Incubation	Cover the plate and incubate at RT for 2 hours
9.	Wash	Empty the wells as previous and thoroughly wash three times with 100µl of 1X PBS per well
10.	Addition	Add 100µl of sample, positive and negative controls cell suspension to appropriate wells providing the required concentration of cells and stimulant (cells may have been previously stimulated see section 8.)
11.	Incubation	Cover the plate and incubate at 37°C in a CO ₂ incubator for an appropriate length of time (15-20 hours). Note: do not agitate or move the plate during this incubation
12.	Addition	Empty the wells and remove excess solution then add 100µl of Wash Buffer to every well
13.	Incubation	Incubate the plate at 4°C for 10 min
14.	Wash	Empty the wells as previous and wash the plate 3x with 100µl of Wash Buffer
15.	Addition	Add 100µl of diluted detection antibodies to every well
16.	Incubation	Cover the plate and incubate at RT for 1 hour 30 min
17.	wash	Empty the wells as previous and wash the plate 3x with 100µl of Wash Buffer
18.	Addition	Add 100 µl per wells of diluted HRP and AP conjugates
19.	Incubation	Cover the plate and incubate at RT for 1 hour
20.	Wash	Empty the wells and wash the plate 3x with 100µl of Wash Buffer
21.	Wash	Peel of the plate bottom and wash both sides of the membrane 3x under running distilled water, once washing complete remove any excess solution by repeated tapping on absorbent paper.
22.	Addition	Add 100µl of prepared AEC substrate to every well
23.	Development	Incubate the plate for 5-20 min monitoring spot formation visually throughout the incubation period to assess sufficient colour development
24.	Wash	Empty the wells and rinse both sides of the membrane 3x under running distilled water. Completely remove any excess solution by gentle repeated tapping on absorbent paper
25.	Addition	Add 100µl of ready to use BCIP/NBT buffer to every well
26.	Development	Incubate the plate for 5-15 min monitoring spot formation visually throughout the incubation period to assess sufficient colour development
27.	Wash	Empty the wells and rinse both sides of the membrane 3x under running distilled water. Completely remove any excess solution by gentle repeated tapping on absorbent paper
<p>Read Spots: allow the wells to dry and then read results. The frequency of the resulting coloured spots corresponding to the cytokine producing cells can be determined using an appropriate ELISpot reader and analysis software or manually using a microscope.</p> <p>Note: spots may become sharper after overnight incubation at 4°C</p>		

Plate should be stored at RT away from direct light, but please note colour may fade over prolonged periods so read results within 24 hours.

10. Bibliography

IFN γ

1. Aoki, Y., Katoh, O., Nakanishi, Y., Kuroki, S., and Yamada, H. (1994). A comparison study of IFN-gamma, ADA, and CA125 as the diagnostic parameters in tuberculous pleuritis. *Respir. Med.* 88, 139-143.
2. Capobianchi, M. R., Ameglio, F., Tosi, R., and Dolei, A. (1985). Differences in the expression and release of DR, BR, and DQ molecules in human cells treated with recombinant interferon gamma: comparison to other interferons. *Hum. Immunol.* 13, 1-11.
3. Ciampolillo, A., Guastamacchia, E., Caragiulo, L., Lollino, G., De Robertis, O., Lattanzi, V., and Giorgino, R. (1993). In vitro secretion of interleukin-1 beta and interferon-gamma by peripheral blood lymphomononuclear cells in diabetic patients. *Diabetes Res. Clin. Pract.* 21, 87-93.
4. Cunningham, A. L., Nelson, P. A., Fathman, C. G., and Merigan, T. C. (1985). Interferon gamma production by herpes simplex virus antigen-specific T cell clones from patients with recurrent herpes labialis. *J. Gen. Virol.* 66, 249-258.
5. Davidson, P. M., Creati, L., Wood, P. R., Robertson, D. M., and Hosking, C. S. (1993). Lymphocyte production of gamma-interferon as a test for non-tuberculous mycobacterial lymphadenitis in childhood. *Eur. J. Pediatr.* 152, 31-35.
6. Edwards, B. S., Merritt, J. A., Fuhlbrigge, R. C., and Borden, E. C. (1985). Low doses of interferon alpha result in more effective clinical natural killer cell activation. *J. Clin. Invest.* 75, 1908-1913.
7. Gajewski, T. F., and Fitch, F. W. (1993). Anti-proliferative effect of IFN-gamma in immune regulation. I. IFN-gamma inhibits the proliferation of Th2 but not Th1 murine helper T lymphocyte clones. *J. Immunol.* 140, 4245-4252.
8. Le thi Bich Thuy, Queen, C., and Fauci, A. S. (1986). Interferon- gamma induces light chain synthesis in interleukin 2 stimulated human B cells. *Eur. J. Immunol.* 16, 547-550.
9. Mosmann, T. R., Cherwinski, H., Bond, M. W., Giedlin, M. A., and Coffman, R. L. (1986). Two types of murine helper T cell clone. I. Definition according to profiles of lymphokine activities and secreted proteins. *J. Immunol.* 136, 2348-2357.
10. Nast, C. C., Zuo, X. J., Prehn, J., Danovitch, G. M., Wilkinson, A., and Jordan, S. C. (1994). Gamma-interferon gene expression in human renal allograft fine-needle aspirates. *Transplantation* 57, 498-502.
11. Naylor, S. L., Sakaguchi, A. Y., Shows, T. B., Law, M. L., Goeddel, D. V., and Gray, P. W. (1983). Human immune interferon gene is located on chromosome 12. *J. Exp. Med.* 157, 1020-1027.
12. Olsson, T. Multiple sclerosis, cerebrospinal fluid. (1994). *Ann. Neurol.* 36 Suppl, 100-102.
13. Romagnani, S., Giudizi, M. G., Biagiotti, R., Almerigogna, F., Mingari, C., Maggi, E., Liang, C. M., and Moretta, L. (1986). B cell growth factor activity of interferon-gamma. Recombinant human interferon-gamma promotes proliferation of anti-mu-activated human B lymphocytes. *J. Immunol.* 136, 3513-3516.
14. Sampaio, E. P., Kaplan, G., Miranda, A., Nery, J. A., Miguel, C. P., Viana, S. M., and Sarno, E. N. (1993). The influence of thalidomide on the clinical and immunologic manifestation of erythema nodosum leprosum. *J. Infect. Dis.* 168, 408-414.
15. Sastre, L., Roman, J. M., Teplow, D. B., Dreyer, W. J., Gee, C. E., Larson, R. S., Roberts, T. M., and Springer, T. A. (1986). A partial genomic DNA clone for the alpha subunit of the mouse complement receptor type 3 and cellular adhesion molecule Mac-1. *Proc. Natl. Acad. Sci. U. S. A.* 83, 5644-5648.
16. Shinde, S. R., Chiplunkar, S. V., Butlin, R., Samson, P. D., Deo, M. G., and Gangal, S. G. (1993). Lymphocyte proliferation, IFN-gamma production and limiting dilution analysis of T-cell responses to ICRC and Mycobacterium leprae antigens in leprosy patients. *Int. J. Lepr. Other Mycobact. Dis.* 61, 51-58.
17. Sidman, C. L., Marshall, J. D., Shultz, L. D., Gray, P. W., and Johnson, H. M. (1984). Gamma-interferon is one of several direct B cell-maturing lymphokines. *Nature* 309, 801-804.
18. Soliman, A. A., el Aggan, H. A., el Hefnawy, A. M., Mahmoud, S. A., and Abo Deya, S. H. (1994). The value of ascites adenosine deaminase activity and interferon gamma level in discriminating tuberculous from nontuberculous ascites. *J. Egypt. Soc. Parasitol.* 24, 93-105.
19. Suomalainen, H., Soppi, E., Laine, S., and Isolauri, E. (1993). Immunologic disturbances in cow's milk allergy, 2: Evidence for defective interferon-gamma generation. *Pediatr. Allergy Immunol.* 4, 203-207.

20. Tang, M. L. K., Kemp, A. S., Thorburn, J., and Hill, D. J. (1994). Reduced interferon-gamma secretion in neonates and subsequent atopy. *Lancet* 344, 983-985.
21. Urban, J. L., Shepard, H. M., Rothstein, J. L., Sugarman, B. J., and Schreiber, H. (1986). Tumor necrosis factor: a potent effector molecule for tumor cell killing by activated macrophages. *Proc. Natl. Acad. Sci. U. S. A.* 83, 5233-5237.

IL-4

22. Howard M., Paul W.E. (1982) *lymphokine res.* (1-4)
23. Paul W. E. , and R. A. Seder. (1994) *Cell* 76, 241-251.
24. Hart P.H., G. F. Vitti, D. R. Burgess, G. A. Whitty, D. S. Piccoli, and J. A. Hamilton. (1989) *Proc. Natl. Acad. Sci, USA* 86, 3803-3807.
25. Lee J. D. , S. G. Swisher, E. H. Minehart, W. H. McBride, and J. S. Economou. (1990) *J. Leukocyte Biol.* 47, 475-479.
26. Coffman R. L., J. Ohara, M. W. Bond, J. Carty, A. Zlotnik, and W. E. Paul. (1986) *J. Immunol.* 141.504-501
27. Sideras P. , S. Bergstedt-Lindqvist, H. R. MacDonald, and e. Severison. (1985) *Eur. J. Immunol.* 15, 586-596.
28. Paul, W. E. (1991) *Blood* 77, 1859-1830.

TECHNICAL CONSULTATION

OriGene Technologies, Inc.
9620 Medical Center Dr., Suite 200
Rockville, MD 20850

Phone: 1.888.267.4436
Fax: 301-340-9254
Email: techsupport@origene.com
Web: www.origene.com

FOR RESEARCH USE ONLY
NOT FOR USE IN DIAGNOSTIC PROCEDURES