

# Dual-Color ELISpot

## Mouse IFN- $\gamma$ /IL-4 Kit

Catalog Number ELD5217

For the quantitative determination of the frequency of cells releasing mouse Interferon gamma (IFN- $\gamma$ ) and/or mouse Interleukin 4 (IL-4).

This package insert must be read in its entirety before using this product.  
For research use only. Not for use in diagnostic procedures.

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## INTRODUCTION

The Dual-Color Mouse IFN- $\gamma$ /IL-4 ELISpot assay is designed for the simultaneous detection of mouse IFN- $\gamma$  and mouse IL-4 secreting cells at the single cell level and can be used to simultaneously quantitate the frequency of mouse IFN- $\gamma$  and IL-4 secreting cells. ELISpot assays are well suited for monitoring immune responses to various treatments and therapies and have been used for the quantitation of antigen-specific CD4<sup>+</sup> and/or CD8<sup>+</sup> T cell responses. Other methods for assessment of antigen-specific T cell responses, such as chromium release assays with quantitation by limiting dilution, are tedious and require previous *in vitro* expansion of T cells for several days. These assays typically are not suitable for measuring infrequent T cell responses that occur at less than 1 in 1000. ELISpot assays are highly reproducible and sensitive and can be used to measure responses with frequencies well below 1 in 100,000. ELISpot assays do not require prior *in vitro* expansion of T cells and are suitable for high-throughput analysis using only small volumes of primary cells. As such, ELISpot assays are useful tools for research in vaccine development and for the monitoring of various clinical trials.

## PRINCIPLE OF THE ASSAY

The enzyme-linked immunospot (ELISpot) assay was originally developed for the detection of individual B cells secreting antigen-specific antibodies (1, 2). This method has since been adapted for the detection of individual cells secreting specific cytokines or other antigens (3, 4). ELISpot assays employ the quantitative sandwich enzyme-linked immunosorbent assay (ELISA) technique.

A monoclonal antibody specific for mouse IFN- $\gamma$  and a polyclonal antibody specific for mouse IL-4 are pre-coated onto a polyvinylidene difluoride (PVDF)-backed microplate. Appropriately stimulated cells are pipetted into the wells, and the microplate is placed into a humidified 37 °C CO<sub>2</sub> incubator for a specified period of time. During this incubation period, the immobilized antibodies in the immediate vicinity of the secreting cells bind secreted IFN- $\gamma$  and IL-4. After washing away any cells and unbound substances, a biotinylated polyclonal antibody specific for mouse IL-4 and a horseradish peroxidase-conjugated polyclonal antibody specific for mouse IFN- $\gamma$  are added to the wells. Following a wash to remove any unbound antibodies, alkaline-phosphatase conjugated to streptavidin is added. Unbound enzyme is subsequently removed by washing and a substrate solution (BCIP/NBT) is added. After washing the BCIP/NBT from the wells with deionized water, an AEC chromogen solution is added to the wells. A blue-black colored precipitate forms and appears as spots at the sites of cytokine localization, with each individual spot representing an individual IL-4 secreting cell. A red precipitate also forms and appears as spots, with each red spot representing an individual IFN- $\gamma$  secreting cell. The spots can be counted with an ELISpot reader system or using a stereomicroscope.

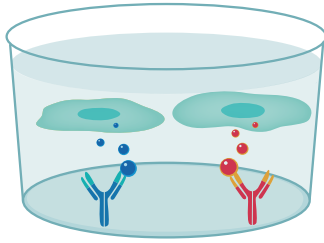
## LIMITATIONS OF THE PROCEDURE

- FOR RESEARCH USE ONLY. NOT FOR USE IN DIAGNOSTIC PROCEDURES.
- The kit should not be used beyond the expiration date on the kit label.
- Do not mix or substitute reagents with those from other lots or sources.
- Any variation in pipetting and washing techniques, incubation time or temperature, or kit age can cause variation in the density of spots, intensity of specific staining, and background levels.

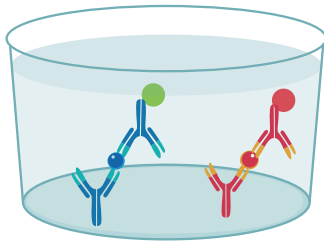
## TECHNICAL HINTS

- To minimize edge effect, place the microplate (bottom down) onto a piece of aluminum foil (about 4 x 6 inches). Add cells, cover the microplate with the lid, and shape the foil around the edges of the microplate. The foil may be left on the microplate for the rest of the experimental procedure and removed after the AEC Chromogen has been washed off.
- Do not remove the flexible plastic underdrain on the bottom of the microplate before or during incubation and development. It may damage the PVDF membrane filter. The underdrain cover may be removed only after completing the incubation with AEC chromogen.
- Do not touch PVDF membrane filters with pipette tips when pipetting cells and reagents to avoid damage to the membrane.
- Upon completing the experiment, do not dry the microplate at a temperature above 37 °C. It may cause the PVDF membrane filters to crack.
- The 96-well microplate provided in this kit is not sterile. Due to the short incubation period and the presence of antibiotics in the culture media, microbial contamination has not been shown to be an issue with this ELISpot procedure.
- This kit is designed for single use only. The layout of the assay should be carefully planned to maximize the use of the provided microplate and reagents.
- The controls listed are recommended for each ELISpot experiment:
  - Positive Control** - Use recombinant mouse IFN- $\gamma$  and recombinant mouse IL-4 in separate wells.
  - Unstimulated/Negative Control** - Use the same number of unstimulated cells as stimulated cells.
  - Background Control** - Use sterile culture media.
  - Detection Antibody Control** - Substitute phosphate buffered saline for detection antibody.

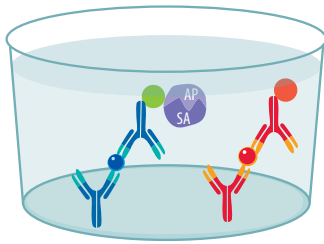
# ELISPOT SCHEMATIC



Two different proteins secreted by cultured cells bind to the capture antibodies coated on the well.



Remove cells by washing. Add the biotinylated detection antibody which binds to the FIRST captured protein and the HRP-conjugated detection antibody which binds to the SECOND captured protein.

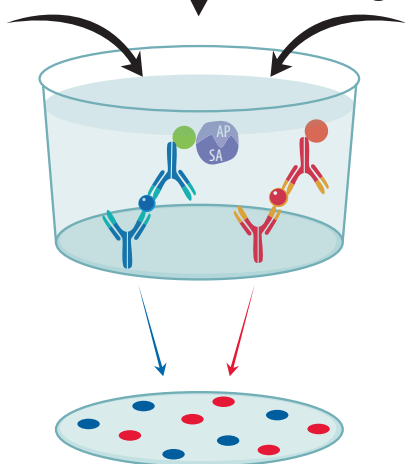


Wash to remove any unbound antibodies.

Add the alkaline phosphatase-conjugated streptavidin.






Add BCIP/NBT Substrate

Add AEC Chromogen



Add BCIP/NBT Substrate to develop the blue spots representing the FIRST protein. After finishing the incubation with BCIP/NBT Substrate, wash the wells with deionized water and add the AEC Chromogen to develop the red spots representing the SECOND protein. Analyze using either an ELISpot reader capable of detecting blue and red spots or a dissection microscope.

## KEY

- FIRST secreted protein
- SECOND secreted protein
-  Capture antibody against the FIRST secreted protein
-  Capture antibody against the SECOND secreted protein
-  Biotin-conjugated detection antibody against the FIRST protein
-  HRP-conjugated detection antibody against the SECOND protein
-  Alkaline phosphatase-conjugated streptavidin

## MATERIALS PROVIDED & STORAGE CONDITIONS

Store the unopened kit at 2-8 °C. Do not use past kit expiration date.

**Note:** *This kit is validated for single use only. Results obtained using previously opened or reconstituted reagents may not be reliable.*

PART	PART #	DESCRIPTION
Mouse IFN- $\gamma$ /IL-4 Microplate	893357	96-well PVDF-backed microplate coated with a monoclonal antibody specific for mouse IFN- $\gamma$ and a polyclonal antibody specific for mouse IL-4.
Detection Antibody Concentrate A Mouse IL-4	893242	150 $\mu$ L of a 120X concentrated solution of biotinylated polyclonal antibody specific for mouse IL-4 with preservatives.
Detection Antibody Concentrate B Mouse IFN- $\gamma$	893240	250 $\mu$ L of a 60X concentrated solution of horseradish peroxidase-conjugated polyclonal antibody specific for mouse IFN- $\gamma$ with preservatives.
Streptavidin-AP Concentrate A	895358	150 $\mu$ L of a 120X concentrated solution of Streptavidin conjugated to Alkaline Phosphatase with preservatives.
Dilution Buffer 1	895307	12 mL of a buffer for diluting Detection Antibody Concentrates with preservatives.
Dilution Buffer 2	895354	12 mL of a buffer for diluting Streptavidin-AP Concentrate A with preservatives.
Wash Buffer Concentrate	895308	50 mL of a 10X concentrated solution of a buffered surfactant with preservative.
BCIP/NBT Substrate	895867	12 mL of a stabilized mixture of 5-Bromo-4-Chloro-3' Indolylphosphate p-Toluidine Salt (BCIP) and Nitro Blue Tetrazolium Chloride (NBT).
Mouse IFN- $\gamma$ Positive Control	890896	8 ng of recombinant mouse IFN- $\gamma$ with preservatives; lyophilized.
Mouse IL-4 Positive Control	890908	2 ng of recombinant mouse IL-4 with preservatives; lyophilized.
AEC Chromogen	895922	300 $\mu$ L of 2% 3-Amino-9-Ethyl-Carbazole (AEC) in stabilizing buffer.
AEC Chromogen Buffer	895923	12 mL of a buffer (<10% methanol, DMSO, and water) for diluting AEC Chromogen.

## OTHER SUPPLIES REQUIRED

- Dissection microscope or an ELISpot reader capable of detecting blue and red spots.
- Pipettes and pipette tips.
- Deionized water.
- Squirt bottle, manifold dispenser, or automated microplate washer.
- 500 mL graduated cylinder.
- 37 °C CO<sub>2</sub> incubator.
- Sterile culture media.

## PRECAUTIONS

Some components of this kit contain sodium azide, which may react with lead and copper plumbing to form explosive metallic azides. Flush with large volumes of water during disposal.

BCIP/NBT is toxic if swallowed, in contact with skin, or if inhaled. It is a highly flammable liquid and vapor may cause serious irritation and damage to organs. Do not eat, drink, or smoke when using this product. Do not breathe fumes. Use only in a well-ventilated area. Keep away from heat, sparks, open flames, and hot surfaces. Keep the container tightly closed.

Some components in this kit contain a preservative which may cause an allergic skin reaction. Avoid breathing mist.

Wear protective gloves, clothing, eye, and face protection. Wash hands thoroughly after handling. Refer to the MSDS on our website prior to use.

## SAMPLE PREPARATION

The types of effector and responder cells used, method of cell separation, mode of stimulation, and length of incubation are to be determined by each investigator.

## REAGENT PREPARATION

**Bring all reagents to room temperature, except the Detection Antibody Concentrate A, Detection Antibody Concentrate B, and Dilution Buffer 1, which should remain at 2-8 °C.**

**1X Wash Buffer** - If crystals have formed in the concentrate, warm to room temperature and mix gently until the crystals have completely dissolved. To prepare Wash Buffer, add 50 mL of Wash Buffer Concentrate to 450 mL of deionized water and mix well.

**Positive Controls** - Reconstitute the lyophilized Mouse IFN- $\gamma$  Positive Control and Mouse IL-4 Positive Control with 250  $\mu$ L of culture medium that is used to incubate cells.

**Detection Antibody Mixture (Concentrate A + Concentrate B)** - Tap or vortex each vial to release reagent collected in the cap. Transfer 100  $\mu$ L of Detection Antibody Concentrate A and 200  $\mu$ L of Detection Antibody Concentrate B into the vial labeled Dilution Buffer 1 and mix well. **For optimal performance, prepare the Detection Antibody Mixture immediately before use.**

**Streptavidin-AP Concentrate A** - Tap or vortex the vial to release reagent collected in the cap. Transfer 100  $\mu$ L of Streptavidin-AP Concentrate A into the vial labeled Dilution Buffer 2 and mix well. **For optimal performance, prepare the Streptavidin-AP immediately before use.**

**AEC Chromogen Solution** - Transfer 250  $\mu$ L of AEC Chromogen to the vial labeled AEC Chromogen Buffer and mix well. **For optimal performance, prepare the AEC Chromogen immediately before use.**

## ASSAY PROCEDURE

**Bring all reagents to room temperature, except the Detection Antibody Mixture (Concentrate A + B), which should remain at 2-8 °C. All samples and controls should be assayed at least in duplicate. A plate layout is provided at the back of this insert to record controls and samples assayed.**

1. Fill all wells in the microplate with 200  $\mu$ L of sterile culture media and incubate for approximately 20 minutes at room temperature.
2. When cells are ready to be plated, aspirate the culture media from the wells. Immediately add 100  $\mu$ L of the appropriate cells or controls to each well (see Technical Hints for appropriate controls).
3. Incubate cells in a humidified 37 °C CO<sub>2</sub> incubator. Optimal incubation time for each stimulus should be determined by the investigator. **Do not disturb the cells during the incubation period.**
4. Aspirate each well and wash, repeating the process three times for a total of four washes. Wash by filling each well with Wash Buffer (250-300  $\mu$ L) using a squirt bottle, manifold dispenser, or autowasher. Complete removal of liquid at each step is essential to good performance. After the last wash, remove any remaining Wash Buffer by aspirating or decanting. Invert the plate and blot it against clean paper towels.  
**Note:** *Adjust the height of the prongs of the manifold dispenser or autowasher to prevent damage to the membranes.*
5. Add 100  $\mu$ L of diluted Detection Antibody Mixture (Concentrate A + B) into each well, and incubate overnight at 2-8 °C. Alternatively, incubation with detection antibodies can be done for 2 hours at room temperature on a rocking platform.
6. Repeat the wash procedure described in step 4.
7. Add 100  $\mu$ L of diluted Streptavidin-AP Concentrate A into each well, and incubate for 2 hours at room temperature.
8. Repeat the wash procedure described in step 4.
9. Add 100  $\mu$ L of BCIP/NBT Substrate into each well, and incubate for 1 hour at room temperature.  
**Protect from light.**
10. Decant the BCIP/NBT Substrate from the microplate, and rinse the microplate with deionized water. Invert the microplate, and tap to remove excess water.
11. Add 100  $\mu$ L of AEC Chromogen Solution into each well, and incubate for 20 minutes at room temperature. **Protect from light.**
12. Decant the AEC Chromogen Solution from the microplate, and rinse the microplate with deionized water. Invert the microplate, and tap to remove excess water. Remove the flexible plastic underdrain from the bottom of the microplate, wipe the bottom of the microplate thoroughly with paper towels, and dry completely either at room temperature (60-90 minutes) or 37 °C (15-30 minutes).



## CALCULATION OF RESULTS

The developed microplate can be analyzed by counting spots using either a dissection microscope or an ELISpot reader capable of detecting blue and red spots. Specific spots are round and have a dark center with slightly fuzzy edges. Quantification of results can be done, for example, by calculating the number of spot forming cells (SFC) per number of cells added to the well.

## REPRODUCIBILITY DATA

Splenocytes from a C57BL mouse ( $1.0 \times 10^6$  cells/mL) were stimulated with 4.0  $\mu\text{g/mL}$  of Concanavalin A (Con A), 50 ng/mL of phorbol 12-myristate-13-acetate (PMA), and 0.5  $\mu\text{g/mL}$  of calcium ionomycin overnight at 37 °C in a 5% CO<sub>2</sub> incubator. The sample was assayed in eight wells according to the procedure and analyzed with a dissection microscope.

Well	Number of Blue-Black (IL-4) Spots Counted	Number of Red (IFN- $\gamma$ ) Spots Counted
1	119	174
2	103	172
3	111	176
4	109	184
5	108	186
6	121	182
7	126	172
8	122	170

## TROUBLESHOOTING GUIDE

Observation	Problem	Corrective Action
Following the incubation with BCIP/NBT (or AEC) chromogen and rinsing the microplate with deionized water, the dark blue (or red) background color of the filter membrane attenuates visualization and quantitation of spots.	The membrane is wet.	Microplates cannot be analyzed accurately until the PVDF filter membranes are completely dry. Wait until the membrane becomes dry (typically 15-30 minutes at 37 °C or 60-90 minutes at room temperature).
The number of spots in the wells that contained the cells is high, but their contrast as well as intensity of staining in the Positive Control wells is low.	Underdevelopment; perhaps the result of using Streptavidin-AP, BCIP/NBT, and/or AEC solutions that have not been brought to room temperature.	Warm the appropriate reagents to room temperature before adding them to the wells.
The number of spots in the wells that contained cells is lower than expected whereas Positive Control wells turned black-blue (or red).	Cell stimulation problem.	Ensure that reagents used to stimulate the cytokine release from the cells retained their biological activity. One way to check is to perform immunocytochemistry on fixed cells after stimulation.
	Too few cells were added to the wells.	Increase the number of cells added per well.
Following incubation with AEC and drying the microplate, the density of the spots makes it difficult to quantify.	Too many cells were added to the wells.	Make dilutions of cells ( $1 \times 10^6$ , $5 \times 10^5$ , $1 \times 10^5$ , $5 \times 10^4$ , $1 \times 10^4$ cells per well) to determine the optimal number of cells that will result in formation of distinct spots.

## REFERENCES

1. Czerkinsky, C.C. *et al.* (1983) *J. Immunol. Methods* **65**:109.
2. Sedgwick, J.D. and P.G. Holt (1983) *J. Immunol. Methods* **57**:301.
3. Czerkinsky, C.C. *et al.* (1984) *J. Immunol. Methods* **72**:489.
4. Helms, T. *et al.* (2000) *J. Immunol.* **164**:3723.

# PLATE LAYOUT

Use this plate layout to record controls and samples assayed.

12								
11								
10								
9								
8								
7								
6								
5								
4								
3								
2								
1								
	A	B	C	D	E	F	G	H

**NOTES**

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