

**Adenylyl Cyclase Activation  
FlashPlate<sup>®</sup> Assay<sup>\*</sup>  
A Direct cAMP [<sup>125</sup>I]  
Detection Assay**

**Catalog Number**

**SMP701B, 40-plate kit, Stimulation Buffer contains IBMX**

**SMP701C, 40-plate kit, Stimulation Buffer does not  
contain IBMX**

**For Laboratory Use Only.**

**Caution: Research chemicals for research purposes only.**

\* Adenylyl Cyclase Activation Assay is protected under US Patent 5,739,001 and foreign equivalents.



I.	PROPRIETARY NAME.....	1
II.	INTENDED USE.....	1
III.	BACKGROUND INFORMATION.....	1
IV.	PRINCIPLES OF THE PROCEDURE.....	2
V.	REAGENT AND EQUIPMENT.....	3
VI.	ADDITIONAL MATERIALS AND EQUIPMENT REQUIRED.....	5
PART 2: ASSAY PROCEDURE.....		5
VII.	CELL PREPARATION.....	6
VIII.	REAGENT PREPARATION.....	6
IX.	ASSAY PROTOCOL.....	7
X.	CALCULATIONS.....	8
XI.	TYPICAL DATA.....	9
XII.	PRECAUTIONS.....	11
XIII.	PERFORMANCE CHARACTERISTICS.....	11
XIV.	REFERENCES.....	13





## I. PROPRIETARY NAME

Adenylyl Cyclase Activation FlashPlate<sup>®</sup> Assay.

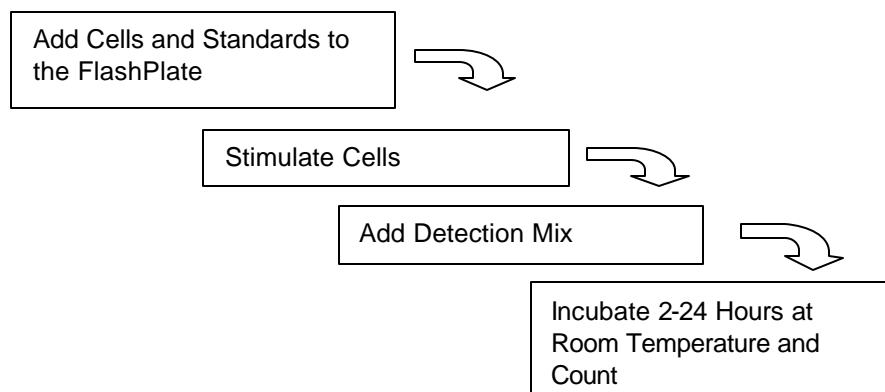
## II. INTENDED USE

This product is intended to quantify levels of cAMP (adenosine 3', 5' -cyclic monophosphate) in whole cell preparations after stimulation of adenylyl cyclase. This assay is designed for use as a primary or secondary high throughput screen for G-protein coupled receptors in a 384-well format.

## III. BACKGROUND INFORMATION

Adenosine 3', 5' cyclic monophosphate (cAMP) plays a critical role in the transmission of hormonal signals by functioning as a "second messenger" (1,2). The binding of a hormone to its receptor can either enhance or inhibit the rate at which cAMP is produced. This is accomplished by altering the enzymatic activity of adenylyl cyclase, the membrane associated enzyme which catalyzes the production of cAMP from ATP (3). By this mechanism, intracellular levels of cAMP are altered in response to hormonal stimulation. In turn, the intracellular level of cAMP regulates the enzymatic activity of a protein kinase which phosphorylates other substances setting off a cascade of cellular events which leads to the expression of the hormones(4).

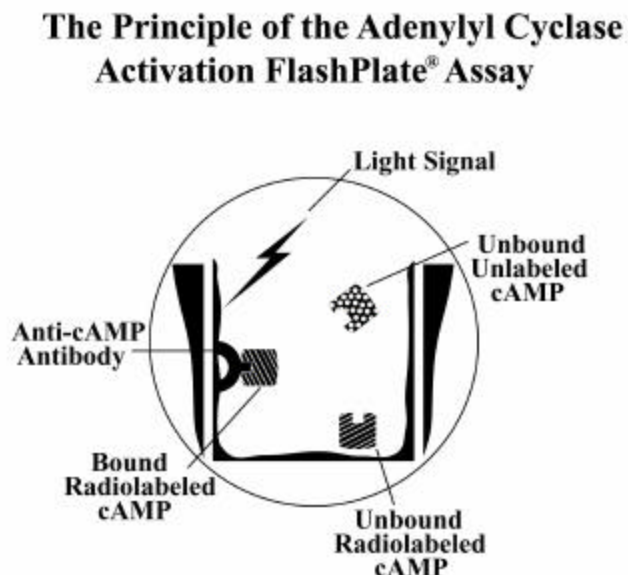
The Adenylyl Cyclase Activation FlashPlate Assay allows direct measurement of receptor mediated adenylyl cyclase activation/inhibition in G-protein coupled receptor systems. The protocol is a fully homogeneous cellular assay, which measures a true second messenger response (cAMP). This relevant functional data permits faster qualification of lead compounds in high throughput screening than is possible with conventional primary screens. The assay is performed by adding live cells to the FlashPlate, stimulating (or stimulating and inhibiting), lysing and detecting without wash steps. Cyclic AMP can be measured in the range of 10 to 1000 pmol/mL. The assay is accurate over a wide range of values and has a high degree of specificity.



#### IV. PRINCIPLES OF THE PROCEDURE

The basic principle of the Adenylyl Cyclase Activation FlashPlate Assay is the competition between radioactive and non-radioactive cAMP for a fixed number of binding sites. This interaction is illustrated in Figure 1:

Figure 1



1. The wells of the FlashPlate are pre-coated with anti-cyclic AMP antibody.
2. A fixed amount of radiolabeled cAMP is added and binds to the anti-cAMP antibody.
3. Cells are added and stimulated. The unlabeled cAMP produced by these cells displaces the fixed amount of radiolabeled cAMP.
4. The light signal is detected. Increasing amounts of unlabeled cAMP will displace more radiolabeled cAMP, resulting in a decrease of detectable signal over time (see representative data on page 9).
5. After incubation, the FlashPlates are read on a microplate scintillation counter. The data is used to construct a standard curve from which the cAMP values produced by the stimulated cells are obtained by interpolation.

## V. REAGENT AND EQUIPMENT

All necessary reagents are supplied and are intended for LABORATORY USE ONLY. Kits are shipped at ambient temperatures and must be stored upon receipt at (2-8°C). The reagents are stable for the times indicated if the specific precautions given below are followed. Sodium azide has been added as an antibacterial agent where appropriate.

1. Stimulation Buffer, 1 bottle, 1 L

The buffer contains a phosphodiesterase inhibitor (IBMX), protein and a stabilizer. The buffer is stable for at least two months when stored at 2-8°C. Refer to bottle label for the expiration date of the reagent.

- OR** Stimulation Buffer without IBMX, 1 bottle, 1 L

The buffer contains protein and a stabilizer. It does not contain IBMX. The buffer is stable for at least two months when stored at 2-8°C. Refer to bottle label for the expiration date of the reagent.

Note: The Stimulation Buffer contains IBMX, a xanthine derivative, which may demonstrate antagonist properties with the adenosine family of receptors. As well, IBMX may interfere with constitutively active receptors. It is recommended if using such receptors, to order the assay kit that includes stimulation buffer that does not contain IBMX.

SMP701, 2-plate kit contains both stimulation buffers  
SMP701A, 10-plate kit contains both stimulation buffers  
SMP701B, 40-plate kit contains stimulation buffer with IBMX  
SMP701C, 40-plate kit contains stimulation buffer without IBMX

2. Detection Buffer, 2 bottles 250 mL each

The buffer contains a permeabilizer and 0.09% sodium azide\*. The buffer is stable for at least two months when stored at 2-8°C. Refer to bottle label for the expiration date of the reagent.

3. cAMP Standard, four vials, 10,000 pmol cAMP/vial.

Reconstitute each vial with exactly 2.0 mL of distilled water. The reconstituted solution will contain: cAMP at a concentration of 5000 pmol/mL, sodium acetate buffer, 0.1% sodium azide and an inert ingredient. The cAMP Standard has been calibrated spectrophotometrically using the molar absorption coefficient, =  $14.6 \times 10^3 \text{ mol}^{-1}\text{cm}^{-1}$  at 259 nm, pH 6.9. The reconstituted standard is stable

for at least two months when stored at 2-8°C. Refer to vial label for the expiration date of lyophilized reagent

4. Adenylyl Cyclase Activation FlashPlate, 384-well 40 microplates

The microplates are coated with solid scintillant to which anti-cyclic AMP antisera has been bound are supplied. Each plate is packaged in a sealed pouch and should not be opened until ready to use. Refer to the label for the expiration date of the plates.

5. TopSeal<sup>®</sup>- A Plate Cover, 40 covers

6. cAMP [<sup>125</sup>I] Tracer (Succinyl cAMP Tyrosine Methyl Ester [<sup>125</sup>I])  
Seven vials: Six vials (50 µCi in 2.5 mL), one vial (5 µCi in 250 mL.)

Tracer is shipped separately. Use one vial at a time as directed. The concentrate is stable for the shelf life of the kit when stored at 2-8°C. This material is radioactive and the user should follow the precautions listed below:

INSTRUCTIONS RELATING TO THE HANDLING, USE, STORAGE, AND DISPOSAL OF THIS RADIOACTIVE MATERIAL.

This radioactive material may be received, acquired, possessed, and used only by research laboratories for *in vitro* laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use and transfer are subject to the regulations and a general license of the U.S. Nuclear Regulatory Commission or of a State with which the Commission has entered into an agreement for the exercise of regulatory authority.

1. All radioactive materials must be labeled and secured in specifically designated posted areas. Records of receipt and survey must be maintained.
2. All work with these materials must be carried out only in authorized areas.
3. Prohibit mouth pipetting of radioactive materials.
4. There must be no smoking or eating within the work area.
5. Hands must be washed after handling radioactive materials.
6. Any spilled material must be wiped up quickly and thoroughly and the contaminated substances transferred to a suitable receptacle. The surfaces involved must be washed thoroughly with an appropriate decontaminate. Monitor to ensure the area has been effectively decontaminated.
7. When use of the tracer reagent has been completed, empty and decontaminate the vial. This radioactive material can be discarded into the sanitary sewerage

system, using copious amounts of water to ensure a minimal discharge concentration.

8. Prior to disposal of the empty, uncontaminated kit and tracer containers to unrestricted areas, remove or deface the radioactive material labels or otherwise clearly indicate that the containers no longer contain radioactive material.

\*NOTE about Sodium Azide: The National Institute for Occupational Safety and Health has issued a bulletin citing the potentially explosive hazard due to the reaction of sodium azide with copper, lead, brass, or solder in plumbing systems. Although sodium azide is added at a minimal concentration, it is still recommended that copious amounts of water be used to flush the drain pipeline after disposal of these reagents in the plumbing system. Copper-free and lead-free discharge lines should be used whenever possible. Decontamination procedures should be followed prior to maintenance on drain lines, which have been used for azide-containing reagents. Recommended decontamination procedures are available from NEN Technical Services.

## **VI. ADDITIONAL MATERIALS AND EQUIPMENT REQUIRED**

In addition to the reagents supplied with the kit, the following materials are required:

1. Pipettors and/or pipets that can accurately and precisely deliver the required volumes.
2. 384-Well Microplate Scintillation Counter
3. Laboratory vortex mixer
4. Test tube rack
5. Distilled water
6. Test tubes - 12 x 75 mm - polypropylene
7. A polypropylene container capable of containing the required reagent volume for the number of FlashPlates being processed
8. Radioactive waste container
9. 2 - 8°C refrigerator or equivalent
10. Centrifuge capable of 400 X g for cell processing

## **PART 2: ASSAY PROCEDURE**

## VII. CELL PREPARATION

Harvest the number of cells from tissue culture flasks as needed according to standard methods. Wash the cells by centrifugation at 400 X g (~1000 rpms) for 5 minutes to form a pellet. Aspirate the supernatant and resuspend the pellet in the Stimulation Buffer.

**NOTE:** Usage of a non-enzymatic cell dissociation buffer (i.e.: Sigma Cat#: C1544) is recommended for dislodging adherent cells from the culture flask.

## VIII. REAGENT PREPARATION

The following is a suggested protocol for the preparation of standards. Mix each solution thoroughly before adding it to the next tube. Prepare the standards fresh each day. Adjust reagent volumes accordingly for the number of wells required.

1. Reconstitute cAMP standard with exactly 2.0 mL of distilled water. The cAMP concentration of the reconstituted solution is 5000 pmol/mL.
2. Prepare a “zero standard” tube containing only 1.0 mL Stimulation Buffer.
3. Label seven standard tubes in accordance with their concentration:

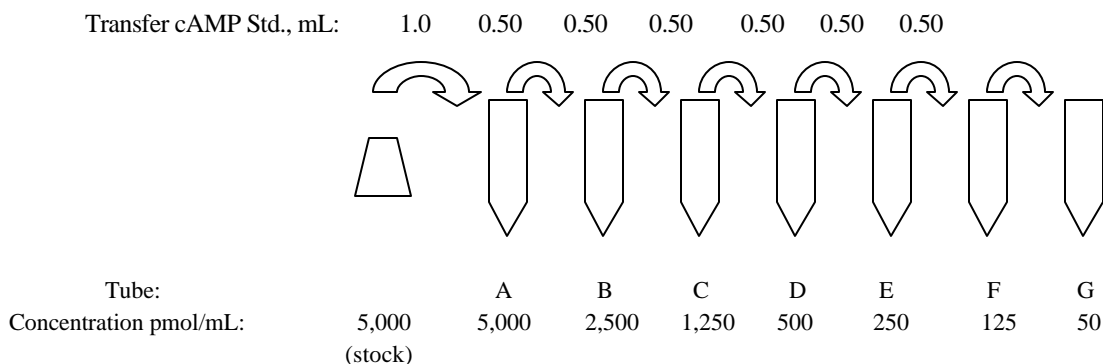
A	5000 pmol/mL
B	2500 pmol/mL
C	1250 pmol/mL
D	500 pmol/mL
E	250 pmol/mL
F	125 pmol/mL
G	50 pmol/mL

4. Pipette the appropriate volume of Stimulation Buffer into each of the seven tubes according to the scheme below.

Tube A:	- 0 -
Tube B:	0.5 mL
Tube C:	0.5 mL
Tube D:	0.75 mL
Tube E:	0.5 mL
Tube F:	0.5 mL
Tube G:	0.75 mL

5. Begin serial dilutions from the stock solution of cAMP standard:
  - a. Pipette 1.0 mL cAMP Stock Standard solution into Tube A.
  - b. Transfer 0.50 mL of Tube A into Tube B. Mix well.

- c. Transfer 0.50 mL of Tube B into Tube C. Mix well.
- d. Continue the serial dilution three more times according to the same dilution scheme.



6. Prepare the stimulator such as Forskolin, or a ligand matched to a particular receptor of interest. Perform a serial dilution in the suggested range of 100  $\mu\text{M}$  to 1  $\mu\text{M}$ . **Dilution of the compounds must be done in water or PBS.**

**NOTE:** The user must determine the optimum cell number/well and the concentration of compounds required to either stimulate or inhibit adenylyl cyclase. As a starting point it is recommended that the user do a serial dilution of cells starting with  $5 \times 10^6$  cells/mL. For each cell concentration, several levels of stimulator should be evaluated to determine what concentration gives approximately a 50% increase in cAMP over basal level. The chosen cell concentration selected should yield a low basal level but be adequate to respond to a relatively low stimulator concentration. If the user is evaluating inhibitory compounds, the level of stimulator should be as low as possible so that the sensitivity to the inhibitor would be high.

7. Prepare Detection Mix by adding 3.75 mL of cAMP [ $^{125}\text{I}$ ]-Tracer to 110 mL of Detection Buffer. This is enough tracer for 10 plates. Rinse original vials. Prepare only the amount of Detection Mix that is required for the number of wells being assayed.

## IX. ASSAY PROTOCOL

1. Add 10  $\mu\text{L}$  of standards to the appropriate wells. It is recommended to run duplicate wells for both standards and samples.

2. Add 10  $\mu\text{L}$  of cells to the appropriate wells.
3. Add compound/stimulator (suggested 5  $\mu\text{L}$  for compound and 10  $\mu\text{L}$  for stimulator) to the wells containing cells and the same volume of the compound/stimulator vehicle to the wells containing standards (the final matrix for samples and standards should be the same). A non-stimulated cell control should be run for a baseline.

**NOTE:** Total volume should be 25  $\mu\text{L}$  in the well during the stimulation step. If only one addition (no inhibitor) is made to the sample or standard, the difference is made up with water or PBS. Do not make up the difference with stimulation buffer. The maximum amount of Stimulation Buffer that should be present/well is 10  $\mu\text{L}$ . More than 10  $\mu\text{L}$  of Stimulation Buffer per well will cause a decrease in signal.

4. Incubate for an appropriate time at room temperature. Depending on the system, the concentrations and time and temperature of stimulation will need to be optimized by the user.
5. Add 25  $\mu\text{L}$  of Detection Mix to all wells.
6. Place a plate cover on the plate and incubate (2-24 hours) at room temperature.

Note: Do not remove plate cover after sealing.

7. After incubation, count on a 384-well microplate scintillation counter.

## **X. CALCULATIONS**

1. If all wells have been counted for the same period of time, use the total accumulated counts, otherwise, correct all counts to a common count rate.
2. Average the counts for each set of duplicates.
3. Express the average counts for each standard and sample as a percentage of the average counts for the zero standard. (This is termed "normalized" percent bound or % B/Bo).

$$\% \text{ B/Bo} = \frac{\text{Average Net Counts of Standard or Sample} \times 100}{\text{Average Net Counts of Zero Standard}}$$

4. Using semi-logarithmic graph paper, log-logit graph paper, or a statistical software package, plot % B/Bo for each standard against the corresponding concentration of cAMP in pmol/mL or pmol/well.

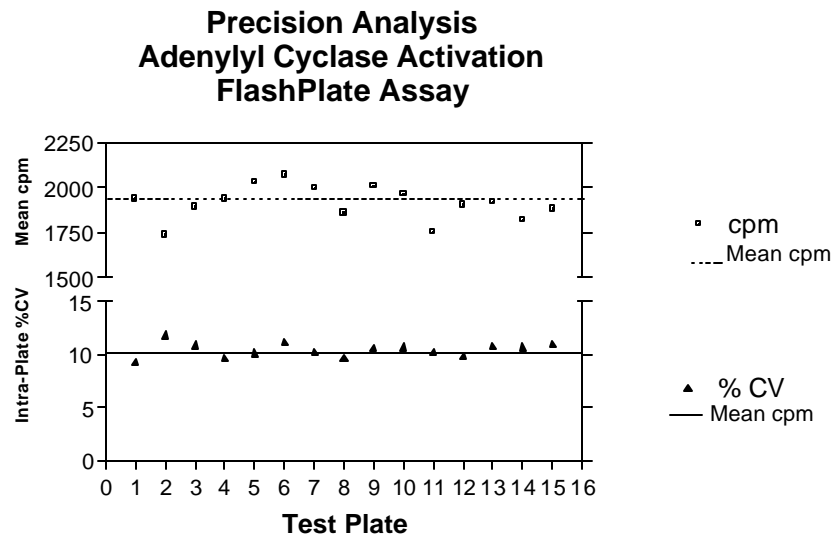
- Determine the concentration of cAMP in the samples by interpolation from the standard curve. Since identical volumes are used for standards and samples, and the standard curve is expressed as pmol/mL or pmol/well of cAMP, samples can be read as pmol/mL or pmol/well. Any samples with concentrations above the range of the standard curve must be re-assayed by decreasing the number of cells/well or the concentration of the stimulator.

**NOTE:** Depending on the cell line, the baseline value of cAMP may increase with time and needs to be subtracted to obtain a more accurate result.

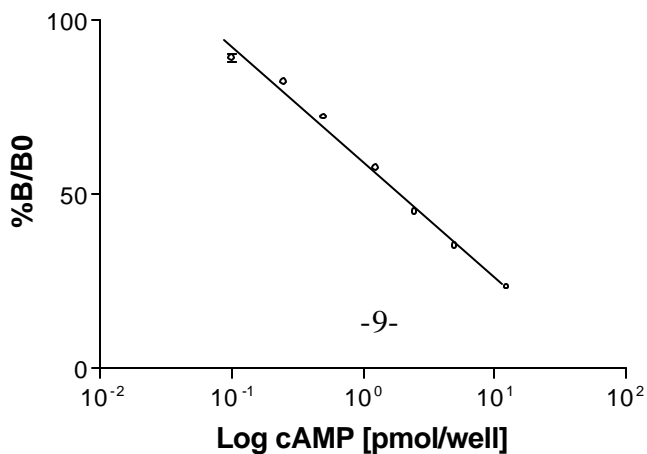
## XI. TYPICAL DATA

### 1. Intra-Plate Precision

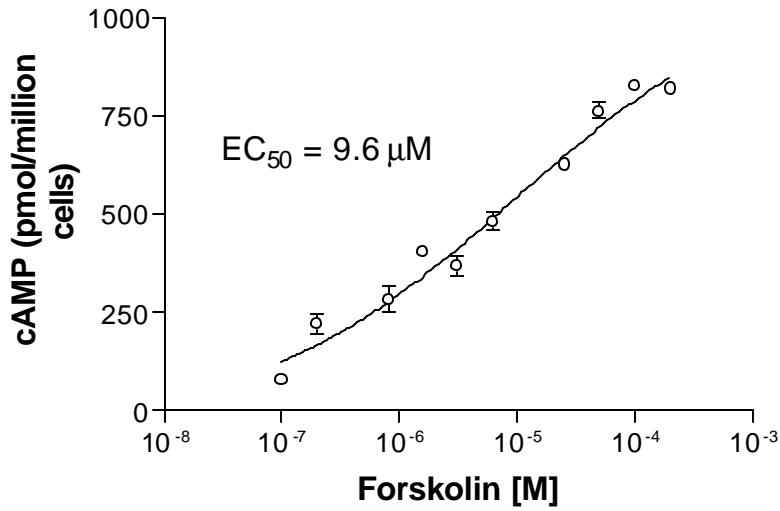
Within plate (intra-plate) precision was determined on fifteen plates in an Adenylyl Cyclase assay using Forskolin run at EC<sub>50</sub>. The intra-plate % CV and mean cpm value for each test plate is shown below.



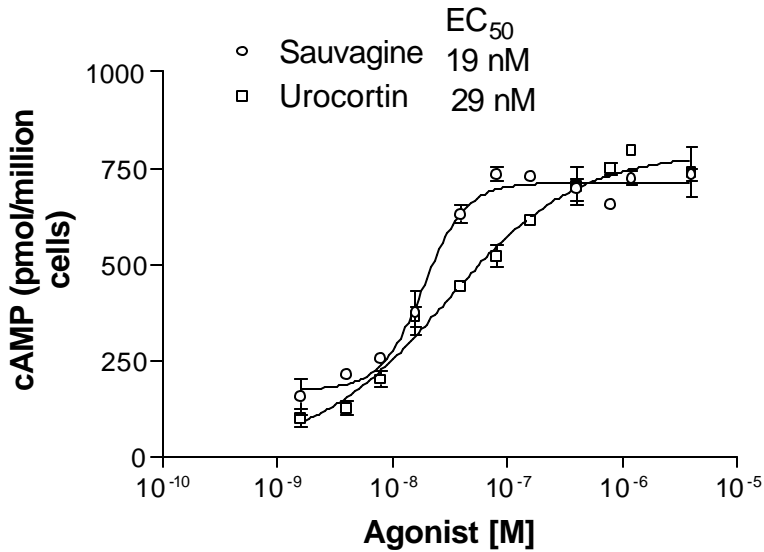
- This graph represents a typical standard curve for cAMP.



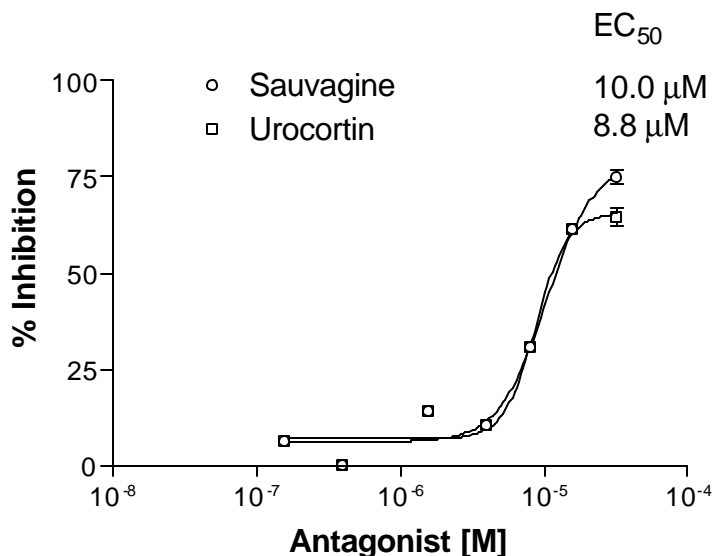
3. This graph represents a typical dose response curve for forskolin stimulation of 15,000 HEK293 CRF2 cells/well conducted on 384-well Adenylyl Cyclase FlashPlates. The stimulation was done for 30 minutes at room temperature.



4. This graph represents a typical dose response curve for Sauvagine and Urocortin stimulation of 15,000 HEK293 CRF2 cells/well conducted on 384-well Adenylyl Cyclase FlashPlates. The stimulation was done for 30 minutes at room temperature.



5. The Adenylyl Cyclase assay can also be used to study the inhibition of ligand stimulation as is done in some HTS labs. This graph represents the inhibition of a ligand stimulation using a known antagonist. HEK293 cells expressing the CRF2 receptor were stimulated with 200 nM Sauvagine conducted on 384-well Adenylyl Cyclase FlashPlates..The antagonist was added simultaneously at several different concentrations to determine the inhibitory effect.



## XII. PRECAUTIONS

1. Incubation conditions should be standardized for proper day to day internal quality control.
2. As with all immunoassay procedures, pipetting is crucial. It is essential that pipetting be accurate and reproducible.
3. The reagents in this kit should be used as a unit. Do not mix different lots of any component within a given assay.
4. This product has not been tested for use with any methods other than those stated in this Instruction Manual.

5. **WARNING:** This product contains a chemical known to the state of California to cause cancer. (<sup>125</sup>I Tracer)

## XIII. PERFORMANCE CHARACTERISTICS

1. Reproducibility

Within plate precision was determined by assaying multiple wells of cells at different levels. Between plate precision was determined by averaging standard curves from different plates.

Results showed that the % C.V. for either within plate or between plate reproducibility is approximately 10 %.

2. Sensitivity

The mean and standard deviation were determined for 6 duplicate measurements of the zero standard binding. The sensitivity of the method, defined as the cAMP concentration corresponding to the mean cpm minus twice the standard deviation, is 0.2 pmol/well.

3. Specificity

The following compounds have been checked for cross-reactivity. The percentages are calculated at the 50 % B/B0 point.

% Cross-reactivity

GMP	< 0.002 %
ATP	< 0.002 %
AMP	< 0.002 %
cGMP	< 0.04 %

#### XIV. REFERENCES

1. Sutherland, E. W., Robinson, G. A., and Butcher, R. W. Some aspects of the biological role of adenosine 3', 5'-monophosphate (cAMP). Circulation, 37 (1968), 279-306.
2. Jost, J. P. and Rickenburg, H. A. cAMP. Annual Review of Biochemistry, 40 (1971), 741-774.
3. Perkins, J. P. (1973): Adenyl cyclase. In: Greengard, P. and Robinson, G. A. (Eds.) Advances in Cyclic Nucleotide Research, Vol. 3:1-64. Raven Press, NY.
4. Langan, T. A. (1973): Protein kinase and protein kinase substrates. In: Greengard, P. and Robinson, G. A. (Eds.). Advances in Cyclic Nucleotide Research, Vol. 3:99-153, Raven Press, NY.
5. Frandsen, E. K. and Krishna, G. (1976): A simple ultrasensitive method for the assay of cyclic AMP and cyclic GMP in tissues. Life Sciences, 18:529-541.
6. Harper, J. F. and Brooker, G. J. (1975): Femtomole Sensitive Radioimmunoassay for cAMP and cGMP after 2'0 acetylation by Acetic Anhydride in Aqueous Solution. Cyclic Nucleotide Research 1 (4) 207-218.
7. Yallow, R. S. and Berson, S. A. in Principles of Competitive Protein Binding Assays, Eds. Odell, W. D. and Daughaday, W. H. J. B. Lippincott Co., Philadelphia, 1971, Ch. 1.

Adenylyl Cyclase Activation Assay is protected under US Patent 5,739,001 and foreign equivalents. FlashPlate is a registered trademark of Packard Instrument Company licensed exclusively to NEN Life Science Products, Inc. TopSeal is a trademark of Packard Instrument Company. The FlashPlate product is protected under US Patent 5,496,502 and foreign equivalents, to all of which NEN Life Science Products, Inc. holds an exclusive, worldwide license.

**Manufactured by:**

**NEN<sup>®</sup> Life Science Products, Inc.  
549 Albany Street  
Boston, MA 02118 USA**

**Toll Free 800-551-2121**

**International: 617-482-9595**