

**Human Arginine Vasopressin Receptor 1A
Reporter Assay System
(AVPR1A)**

384-well Format Assays
Product # IB37002

▪

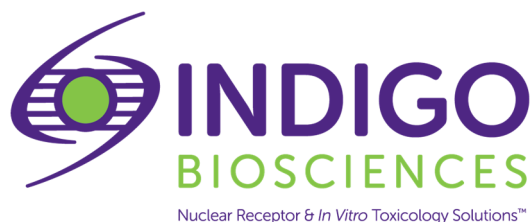
Technical Manual
(version 8.0i)

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Human AVPR1A Reporter Assay System 384-well Format Assays

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I. Description

▪ Background ▪

The Arginine Vasopressin Receptor 1A (AVPR1A) is a member of the family of G-Protein-coupled receptors (GPCR)². There are three subtypes of vasopressin receptors identified in humans, which are AVPR1A, AVPR1B and AVPR2³.

The natural ligand of AVPR1A is vasopressin, which is synthesized in the hypothalamus and secreted into the posterior pituitary¹. Like the closely similar neuropeptide, oxytocin, vasopressin is a nine amino acid neuropeptide that is classified as an antidiuretic hormone (ADH)¹. Release of vasopressin is mediated by stimuli such as hemorrhage or dehydration. When vasopressin binds to AVPR1A signal transduction is mediated through $G\alpha_{q/11}$ GTP binding proteins⁴.

Like their respective ligands, vasopressin receptors and the oxytocin receptor (OXTR) are structurally similar (*e.g.*, 85% between AVPR1A and OXTR)⁵. However, ligand selectivity for those receptors is different. The affinity of vasopressin for AVPR1A and AVPR1B is same as OXTR, whereas oxytocin has a significantly higher affinity for OXTR than for the vasopressin receptors⁵.

The physiological roles induced by AVPR1A vary in both the peripheral and central system. For example, AVPR1A is highly distributed on vascular smooth muscle and plays a role as a vasoconstrictor to maintain water balance in our body⁶. Expression of AVPR1A is also detected in the liver, kidney⁷ and the uterus⁸. The distribution of AVPR1A is not only limited to the peripheral tissues but also expressed in the brain⁹. AVPR1A has been implicated to play a role in social cognition and behavior in humans¹⁰.

Much effort has been made to investigate the roles of AVPR1A and to identify bioactive peptide analogues and small molecule ligands. Many peptide analogues are utilized as agonists to induce antidiuretic or vasoconstricting activities¹¹. In contrast, small molecules are better therapeutic agents as antagonists due to relatively improved bioavailability and stability¹². Several clinical approaches using AVPR1A antagonists have been shown to improve social communications and social sensitivity in Autism¹³.

▪ The Assay System ▪

This assay utilizes proprietary human cells that have been engineered to provide constitutive expression of the Human Arginine Vasopressin Receptor 1A (AVPR1A).

Upon activation by its physiological ligand vasopressin, AVPR1A activates $G\alpha_{q/11}$ to mediate several downstream pathways. This includes activation of the phospholipase C (PLC) pathway, which leads to the release of inositol triphosphate (IP3), resulting in an increase in intracellular calcium and the concomitant activation of calcineurin, a calcium-dependent phosphatase. Ca^{+2} -calcineurin acts to dephosphorylate and activate the transcription factor NFAT¹⁴. The AVPR1A signal transduction cascade that leads to activation of Ca^{+2} -calcineurin > NFAT is the pathway exploited by the reporter cells provided in this kit.

INDIGO's AVPR1A Reporter Cells contain an engineered luciferase reporter gene functionally linked to tandem consensus sequences of the NFAT genetic response elements and a minimal promoter. Activated NFAT binds to these response elements to seed the formation of a complete transcription complex that drives luciferase reporter gene expression. Quantifying relative changes in luciferase activity in the treated reporter cells relative to the untreated cells provides a sensitive surrogate measure of drug-induced changes in AVPR1A activity.

The principal application of this reporter assay is in the screening of test samples to quantify functional interactions, either activating or inhibitory, that they may exert against AVPR1A, or the coupled Ca^{+2} -calcineurin / NFAT signal transduction pathway.

INDIGO's Reporter Cells are transiently transfected and prepared as frozen stocks using a proprietary **CryoMite™** process. This cryo-preservation method allows for the immediate dispensing of healthy, division-competent reporter cells into assay plates. There is no need for intermediate treatment steps such as spin-and-rinse of cells, extended pre-culture, viability determinations, or cell titer adjustments prior to assay setup.

INDIGO's assay kits provide the convenience of an all-inclusive cell-based assay system. In addition to AVPR1A Reporter Cells, provided are two optimized media for use in recovering the cryopreserved cells and for diluting test samples, the reference activator Vasopressin, Luciferase Detection Reagents, and a cell culture-ready assay plate.

▪ The Assay Chemistry ▪

INDIGO's nuclear receptor reporter assays capitalize on the extremely low background, high-sensitivity, and broad linear dynamic range of bio-luminescence reporter gene technology.

Reporter Cells incorporate the cDNA encoding beetle luciferase, a 62 kD protein originating from the North American firefly (*Photinus pyralis*). Luciferase catalyzes the mono-oxidation of D-luciferin in a Mg^{+2} -dependent reaction that consumes O_2 and ATP as co-substrates, and yields as products oxyluciferin, AMP, PP_i , CO_2 , and photon emission. Luminescence intensity of the reaction is quantified using a luminometer and is reported in terms of Relative Light Units (RLU's).

INDIGO's Nuclear Receptor Assays feature a luciferase detection reagent specially formulated to provide stable light emission between 30 and 100+ minutes after initiating the luciferase reaction. Incorporating a 30-minute reaction-rest period ensures that light emission profiles attain maximal stability, thereby allowing assay plates to be processed in batch. By doing so, the signal output from all sample wells, from one plate to the next, may be directly compared within an experimental set.

▪ Considerations for the Preparation and Automated Dispensing of Test compounds ▪

Small-molecule test compounds are typically solvated in DMSO at high concentrations; ideally 1,000x-concentrated stocks relative to the highest desired treatment concentration in the assay. Using high-concentration stocks minimizes DMSO carry-over into the assay plates.

Stocks of test materials that are **Protein** or **Poly-peptide** ligands, or **Antibodies**, should be solvated in aqueous buffered solutions with carrier protein (*e.g.*, PBS + 0.1% BSA).

For **384-well format assays** the user will choose to dilute master stocks using one of two alternative methods. The selection of dispensing method to be used will be dictated by the type of instrument that will be used. This Technical Manual provides detailed protocols for each of these two alternative methods:

a.) Assay setups in which a conventional **tip-based** instrument is used to dispense **μL volumes** of for both **small-molecule** and **proteinaceous** test samples into assay wells (protocol is presented in black text). Use **Compound Screening Medium (CSM)** to generate a series of **2x-concentration** test compound treatment media, as described in *Step 2a* of the **Assay Protocol**. The final concentration of DMSO carried over into assay reactions should not exceed 0.4%; strive to use 1,000x-concentrated stocks when they are prepared in DMSO.

NOTE: CSM is formulated to help stabilize hydrophobic test compounds in the aqueous environment of the assay mixture. Nonetheless, high concentrations of extremely hydrophobic test compounds diluted in CSM may lack long-term stability and/or solubility, especially if further stored at low temperatures. Hence, it is recommended that test compound dilutions are prepared in CSM immediately prior to assay setup and are considered to be 'single-use' reagents.

and,

a.) **Acoustic transfer** or **Pin-based dispensing of nL volumes** of test compounds into assay wells (protocol is presented in blue text). Use CSM (for proteinaceous test samples) or DMSO for small molecule test samples) to make a series of **1,000x-concentrated** test compound stocks that correspond to each desired final assay concentration, as described in *Step 2b* of the **Assay Protocol**.

▪ **Considerations for Automated Dispensing of Other Assay Reagents** ▪

When dispensing into a small number of assay plates, first carefully consider the dead volume requirement of your tip-based dispensing instrument before committing assay reagents to its setup. In essence, "dead volume" is the volume of reagent that is dedicated to the instrument; it will *not* be available for final dispensing into assay wells. The following Table provides information on reagent volume requirements, and available excesses on a *per kit* basis. Always pool the individual reporter cell suspensions and all other respective assay kit reagents before processing multiple 384-well assay plates.

Stock Reagent & Volume provided	Volume to be Dispensed (384-well plate)	Excess rgt. volume available for instrument dead volume
<i>when using tip dispensing of test cmpds</i> Reporter Cell Suspension 7.5 ml	15 µl / well 5.8 ml / plate	~ 1.7 ml
<i>when using acoustic dispensing of test cmpds</i> Reporter Cell Suspension 15 ml	30 µl / well 11.5 ml / plate	~ 3.4 ml
Detection Substrate 7.8 ml	15 µl / well 5.8 ml / plate	~ 2 ml

▪ **Assay Scheme** ▪

The *Day 1* preparation, volumes, and chronology of dispensed cells and test compounds are different between assay setups using a *tip-based dispenser (1a)* and those using an *acoustic transfer device (1b)*. Following 22 -24 hours incubation Detection Substrate is added. Light emission from each assay well is quantified using a plate-reading luminometer.

Figure 1a. Assay workflow if using conventional **tip-based** dispensing of test compounds.

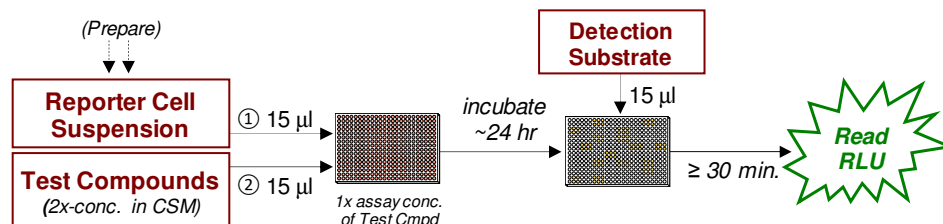
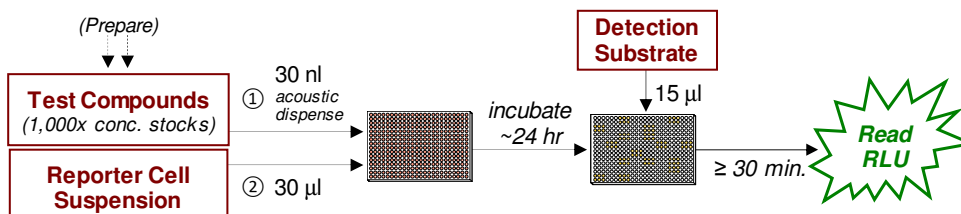


Figure 1b. Assay workflow if using **acoustic** dispensing of test compounds.



▪ Assay Performance ▪

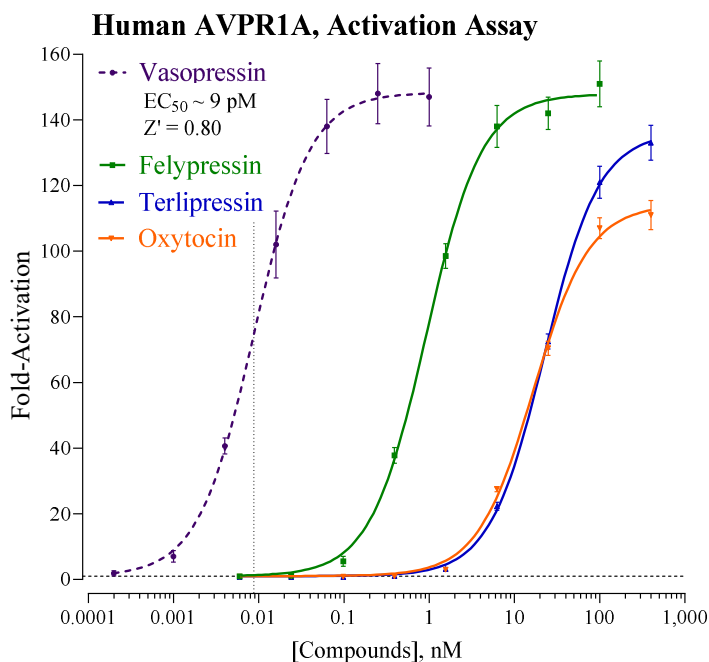


Figure 2. Activation of AVPR1A. Activation assays were performed using the reference polypeptides Vasopressin (provided), Felypressin, Terlipressin and Oxytocin.

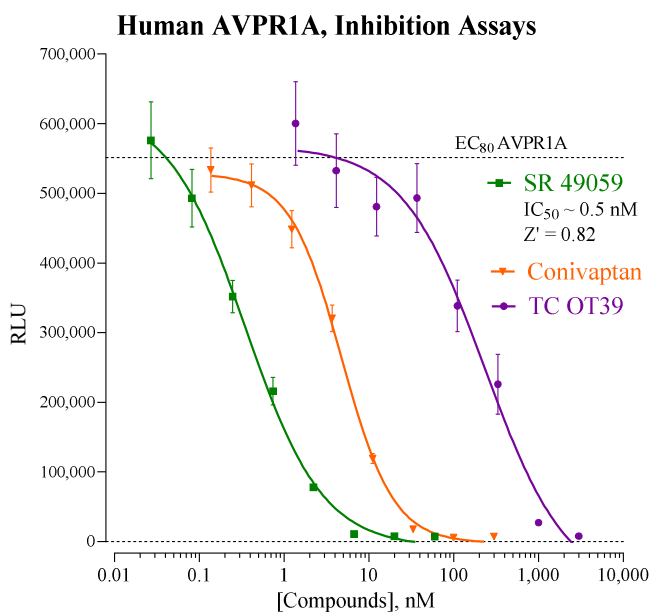


Figure 3. Inhibition of AVPR1A. AVPR1A reporter cells were co-treated with an EC_{80} concentration of the activator vasopressin and varying concentrations of the AVPR1A inhibitors, SR 49059, Conivaptan and TC OT39. INDIGO's Live Cell Multiplex (LCM) Assay confirmed that no treatment concentrations were cytotoxic (data not shown).

For both Activation and Inhibition assays, luminescence was quantified and values of average ($n = 3$) relative light units (RLU), corresponding standard deviation (SD), Fold-Activation, and Z' ¹⁵ were calculated. The least-squares method of non-linear regression was used to plot Fold-Activation or RLU vs. Log_{10} [Compound, nM] and EC_{50} / IC_{50} values were determined using GraphPad Prism software. Polypeptide activators were procured from Prospec (East Brunswick, NJ). Small molecule inhibitors are from Tocris (Minneapolis, MN) or MedChem Express, (Monmouth Junction, NJ).

II. Product Components & Storage Conditions

This Human AVPR1A Reporter Assay kit contains materials to perform assays in a single 384-well assay plate.

Cryopreserved mammalian cells are temperature sensitive! To ensure maximal viability the tube of Reporter Cells must be maintained at -80°C until immediately prior to the rapid-thaw procedure described in this protocol.

Assay kits are shipped on dry ice. Upon receipt of the kit transfer it to -80°C storage. If you wish to first inventory the individual kit components be sure to first transfer and submerge the tube of cells in dry ice.

The aliquot of Reporter Cells is provided as a single-use reagent. Once thawed, the cells can NOT be refrozen. Nor can they be maintained in extended culture with any hope of retaining downstream assay performance. Therefore, extra volumes of these reagents should be discarded after assay setup.

The date of product expiration is printed on the Product Qualification Insert (PQI) enclosed with each kit.

<u>Kit Components</u>	<u>Amount</u>	<u>Storage Temp.</u>
▪ AVPR1A Reporter Cells	1 x 1.0 mL	-80°C
▪ Cell Recovery Medium (CRM)	1 x 7.0 mL	-20°C
▪ Compound Screening Medium (CSM)	1 x 45 mL	-20°C
▪ Vasopressin, 1.0 µM (in PBS-0.1%BSA) reference agonist for AVPR1A	1 x 80 µL	-20°C
▪ Detection Substrate (Note: contains DTT)	1 x 7.8 mL	-80°C
▪ 384-well assay plate (white, sterile, cell-culture ready)	1	ambient

III. Materials to be Supplied by the User

The following materials must be provided by the user, and should be made ready prior to initiating the assay procedure:

DAY 1

- dry ice container
- cell culture-rated laminar flow hood.
- mammalian cell culture incubator (37°C, ≥ 70% humidity, 5% CO₂)
- 37°C water bath.
- 70% alcohol wipes
- 8-channel electronic, repeat-dispensing pipettes & tips suitable for dispensing 15 µl.
- disposable media basins, sterile.
- sterile multi-channel media basins *or* deep-well plates, *or* appropriate similar vessel for generating dilution series of reference compound(s) and test compound(s).
- *Optional:* antagonist reference compound (*e.g.*, Fig. 2B)

DAY 2 plate-reading luminometer.

IV. Assay Protocol

Review the entire Assay Protocol before starting. Completing the assay requires an overnight incubation. *Steps 1-8* are performed on **Day 1**, requiring less than 2 hours to complete. *Steps 9-13* are performed on **Day 2** and require less than 1 hour to complete.

▪ A word about Antagonist-mode assay setup ▪

Receptor inhibition assays expose the Reporter Cells to a constant, sub-maximal concentration (typically between EC₅₀ – EC₈₅) of a known agonist AND varying concentrations of the test compound(s) to be evaluated for antagonist activity. This assay kit includes a 1.0 µM stock solution of Vasopressin, a potent agonist of AVPR1A that may be used to set up antagonist-mode assays. 0.025 nM Vasopressin typically approximates EC₇₀₋₈₀ in this assay. Hence, it presents a suitable *final assay concentration* of agonist to be used when screening test compounds for inhibitory activity.

Adding the challenge agonist vasopressin to the bulk suspension of Reporter Cells (*i.e.*, prior to dispensing into assay wells) is the most efficient and precise method of setting up antagonist assays, and it is the method presented in *Step 5b* of the protocol when performing tip-based dispensing, and *Step 6b of the protocol when using an acoustic transfer device to dispense test compounds*.

Note that when using a *tip-based instrument* for the dispensing of 2x-concentrated test compounds the cell suspension must also be supplemented with a **2x**-concentration (0.05 nM) of the challenge agonist vasopressin.

When using an *acoustic transfer device* for the dispensing of 1,000x-concentrated test compounds the cell suspension should be supplemented with a **1x**-concentration 0.025 nM of the challenge agonist vasopressin.

DAY 1 Assay Protocol:

All steps must be performed using proper aseptic technique.

1.) Remove **Cell Recovery Medium (CRM)** and **Compound Screening Medium (CSM)** from freezer storage and thaw in a 37°C water bath.

2.) **Prepare dilutions of treatment compounds:** Prepare Test Compound treatment media for *Agonist-* or *Antagonist-mode* screens. NOTE that both the test and reference samples will be prepared differently depending on the researcher's choice to use tip-based dispensing or *acoustic dispensing*. Regardless of the method, the total DMSO carried over into assay wells should not exceed 0.4%.

a. *Tip dispensing method:* In *Step 6*, 15 µl / well of the prepared treatment media is added into assay wells that have been pre-dispensed with 15 µl /well of Reporter Cells. Hence, to achieve the desired *final* assay concentrations one must prepare treatment media with a **2x**-concentration of the test and reference material(s). Use **CSM** to prepare the appropriate dilution series. Plan dilution volumes carefully; this assay kit provides 45 ml of CSM.

b. *Acoustic dispensing method:* In *Step 6*, 30 nl / well of **1,000x**-concentrated test compound solutions are added to the assay plate using an acoustic transfer device.

**NOTE:* Stocks of test samples that are small-molecules chemicals / drugs are typically prepared in DMSO and, for acoustic transfer dispensing, we recommend that DMSO (not CSM) is used as the diluent to generate the desired series of 1,000x-treatment concentrations. However, stocks of test samples that are solvated in aqueous solution, such as protein ligands and antibodies, should be further diluted using CSM (not DMSO).

Preparing the positive control: This assay kit includes a 1,000x-concentrated stock of the poly-peptide vasopressin, 1.0 µM prepared in PBS+0.1% BSA. The following 7-point treatment series, with concentrations presented in 4-fold decrements, provides a complete dose-response: 1.00, 0.250, 0.063, 0.016, 0.0040, 0.0010, and 0.00025 nM. Always include 'no treatment' (or 'vehicle') control wells.

APPENDIX 1a provides an example for generating this dilution series to be used when *tip-based dispensing* of test samples prepared in CSM (15 µl / well).

(continued...)

APPENDIX 1b provides an example for generating such a series of 1,000x-concentrated solutions of compounds to be used when performing *acoustic dispensing* (30 nl / well). As noted in *Step 2b*, use CSM to dilute sample and reference stocks that have been prepared in aqueous solutions (e.g., protein ligands, antibodies, etc.), or use DMSO to further dilute sample stocks that were initially solvated in DMSO (e.g. small molecule chemicals).

When using *tip-based* instrumentation for dispensing test compounds ...

3.) *First*, retrieve the tube of **CRM** from the 37°C water bath, sanitize the outside with a 70% ethanol swab;

Second, retrieve **Reporter Cells** from -80°C storage and immerse in dry ice to transport the tube to a laminar flow hood. Perform a *rapid thaw* of the frozen cells by transferring a **6.5 ml** volume of 37°C CRM into the tube of frozen cells. Recap the tube of Reporter Cells and place it in a 37°C water bath for 5 - 10 minutes. The resulting volume of cell suspension will be 7.5 ml.

4.) Retrieve the tube of Reporter Cell Suspension from the water bath. Sanitize the outside surface of the tube with a 70% alcohol swab, then transfer it into the cell culture hood.

5.) *Gently* invert the tube of cells several times to gain a homogenous suspension.

a. for Agonist-mode assays: Dispense **15 µl / well** of cell suspension into the Assay Plate.

~ or ~

b. for Antagonist-mode assays: First supplement the bulk volume of Reporter Cell suspension with a 2x-concentration of the challenge agonist Vasopressin (refer to "A word about antagonist-mode assay setup", pg. 8). Dispense **15 µl / well** of cell suspension into the assay plate.

6.) Dispense **15 µl / well** of 2x-concentrated treatment media (from *Step 2a*) into the assay plate.

When using an *acoustic transfer* device for dispensing test compounds ...

3.) Dispense **30 nl / well** of the 1,000x-concentrated compounds (from *Step 2b*) into the assay plate.

4.) *First*, retrieve the tube of **CRM** from the 37°C water bath, sanitize the outside with a 70% ethanol swab;

Second, retrieve **Reporter Cells** from -80°C storage and immerse in dry ice to transport the tube to a laminar flow hood. Perform a *rapid thaw* of the frozen cells by transferring a **6.5 ml** volume of 37°C CRM into the tube of frozen cells. Recap the tube of cells and place it in a 37°C water bath for 5 - 10 minutes. The resulting volume of cell suspension will be 7.5 ml.

5.) Retrieve the tube of cell suspension from the water bath. Sanitize the outside surface of the tube with a 70% alcohol swab. Add an additional **7.5 ml** of CSM to the tube. The resulting volume of cell suspension will be 15 ml.

6.) *Gently* invert the tube of cells several times to gain a homogenous cell suspension.

a. for Agonist-mode assays: Dispense **30 µl / well** of cell suspension into the Assay Plate that has been pre-dispensed with test compounds.

~ or ~

b. for Antagonist-mode assays: First supplement the bulk volume of Reporter Cell suspension with the challenge agonist Vasopressin to achieve an EC₅₀ – EC₈₀ concentration (refer to "A word about antagonist-mode assay setup", pg. 8). Then dispense **30 µl / well** of the supplemented cell suspension into the assay plate that has been pre-dispensed with test compounds.

(continued ...)

NOTE: Take special care to prevent cells from settling during the dispensing period. Allowing cells to settle during the transfer process, and/or lack of precision in dispensing uniform volumes across the assay plate *will* cause well-to-well variation (= increased Standard Deviation) in the assay.

NOTE: Following the dispensing of Reporter Cells and test compounds INDIGO recommends performing a *low-speed* spin of the assay plate (with lid) for ≤ 1 minute using a room temperature centrifuge fitted with counter-balanced plate carriers.

7.) Transfer the assay plate into a 37°C, humidified, 5% CO₂ incubator for 22 - 24 hours.

NOTE: Ensure a high-humidity ($\geq 70\%$) environment within the cell culture incubator. This is critical to prevent the onset of deleterious "edge-effects" in the assay plate.

8.) For greater convenience on *Day 2*, retrieve **Detection Substrate** from freezer storage and place in a dark refrigerator (4°C) to thaw overnight.

DAY 2 Assay Protocol:

Subsequent manipulations do *not* require special regard for aseptic technique and may be performed on a bench top or in a **fume hood**.

9.) Approximately 30 minutes before intending to quantify receptor activity remove **Detection Substrate** from the refrigerator and place it in a low-light area so that it may equilibrate to room temperature. Gently invert the tube several times to ensure a homogenous solution.

NOTE: Do NOT actively warm Detection Substrate above room temperature. If this solution was not allowed to thaw overnight at 4°C, a room temperature water bath may be used to expedite thawing.

10.) Set the plate-reader to "luminescence" mode. Program the instrument to perform a single 5 second "plate shake" prior to reading the first assay well. Set read-time to 0.5 second (500 mSec) per well, *or less*.

11.) Following 22 - 24 hours of incubation dispense **15 µl / well** of **Detection Substrate** into the assay plate.

NOTE: 'Detection Substrate' contains a high concentration of DTT, which produces a strong odor that some users may find objectionable. It is advised to work in a **fume hood** when dispensing it into the assay plate followed by a 'plate rest' period.

NOTE: Perform this reagent transfer carefully to avoid bubble formation! Scattered micro-bubbles will not pose a problem. However, bubbles covering the surface of the reaction mix, or large bubbles clinging to the side walls of the well, will cause lens-effects that will degrade the accuracy and precision of the assay data. It is recommended to perform a final *low-speed* spin of the assay plate (with lid) for ≤ 1 minute using a room temperature centrifuge fitted with counter-balanced plate carriers.

12.) Allow the plate(s) to rest at room temperature for 30 minutes. Do not shake the assay plate(s) during this period.

NOTE: the 30-minute rest period allows the luminescence signal to achieve stable emission output.

13.) Quantify luminescence.

14.) Data analyses.

V. Related Products

<i>Product No.</i>	<i>Product Descriptions</i>
Human AVPR1A Assay Products	
IB37001	Human AVPR1A Reporter Assay System 1x 96-well format assay
IB37002	Human AVPR1A Reporter Assay System 1x 384-well format assays
Bulk volumes of assay reagents may be custom manufactured to accommodate any scale of HTS. Please Inquire.	
Human OXTR Assay Products	
IB35001	Human OXTR Reporter Assay System 1x 96-well format assay
IB35002	Human OXTR Reporter Assay System 1x 384-well format assays
NFAT Assays (recommended for receptor specificity screening)	
IB18001	NFAT Reporter Assay System 1x 96-well format assay
LIVE Cell Multiplex (LCM) Assay	
LCM-01	Reagent volumes sufficient to perform 96 Live Cell Assays
LCM-05	Reagent in 5x bulk volume to perform 480 Live Cell Assays contained in 5 x 96-well assay plates
LCM-10	Reagent in 10x bulk volume to perform 960 Live Cell Assays contained in 10 x 96-well assay plates
INDIGlo Luciferase Detection Reagent	
LDR-10, -25, -50, -500	INDIGlo Luciferase Detection Reagents 10 mL, 25 mL, 50 mL, and 500 mL; custom volumes available

Please refer to INDIGO Biosciences website for updated product offerings.

www.indigobiosciences.com

VI. Citations

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$$Z' = 1 - [3*(SD^{Ref EC100} + SD^{Untreated}) / (RLU^{Ref EC100} - RLU^{Untreated})]$$

VII. Limited Use Disclosures

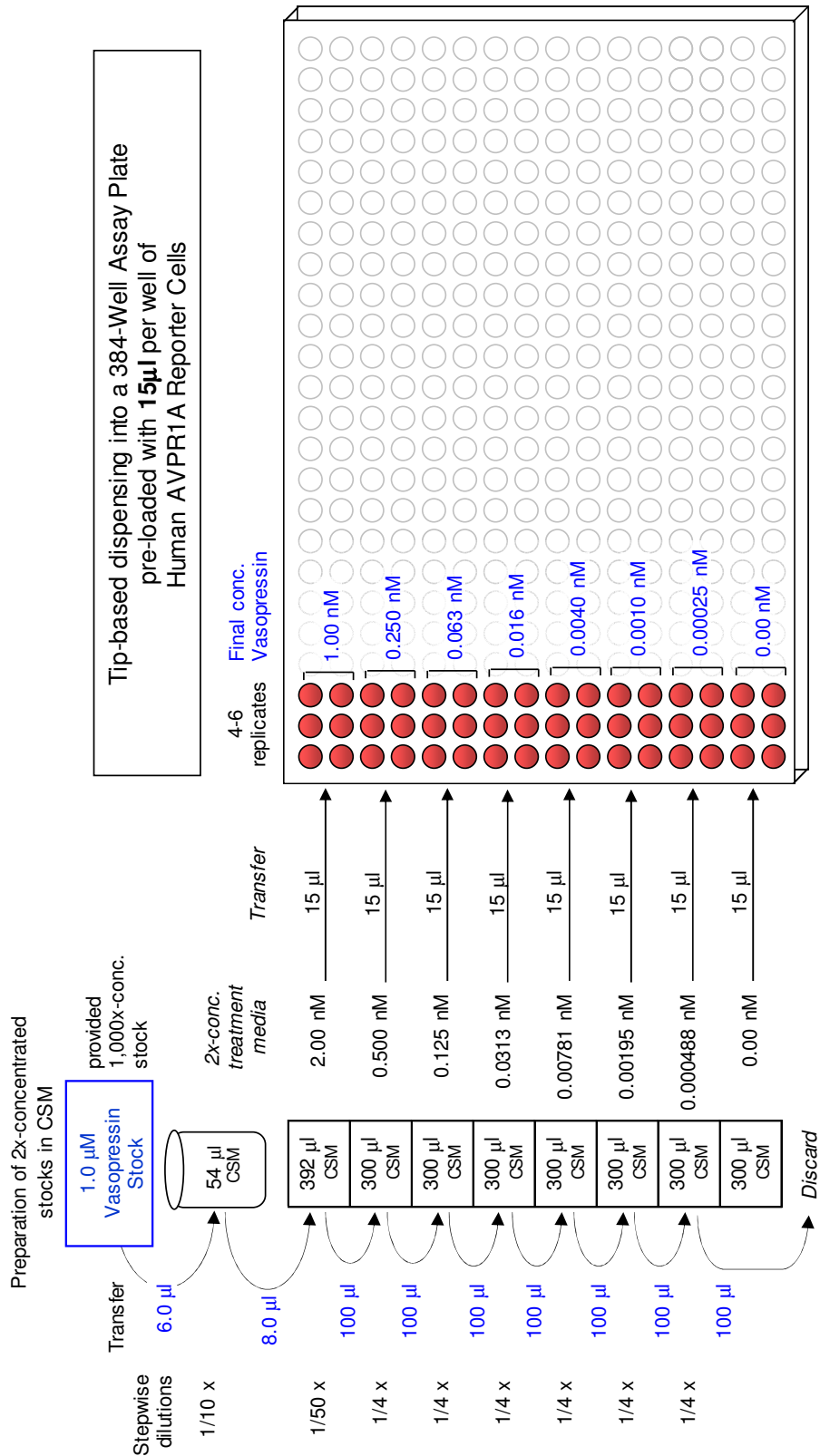
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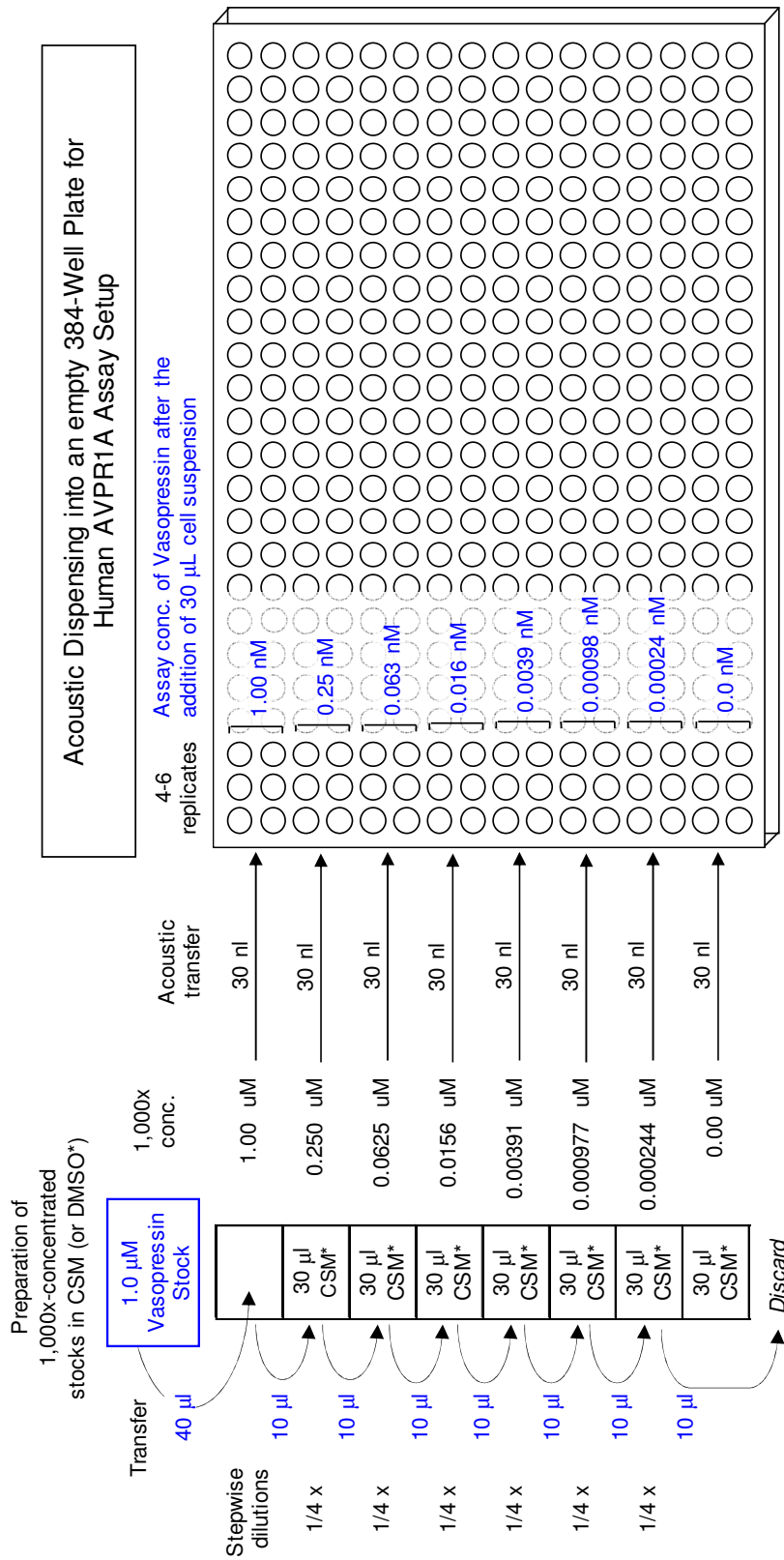
Product prices, availability, specifications, claims and technical protocols are subject to change without prior notice. The printed Technical Manual provided in the kit box will always be the most recently updated version available.

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APPENDIX 1a for tip-based dispensing. Example scheme for the serial dilution of the reference agonist vasopressin into CSM to generate **2x-concentrated** treatment media. A *tip-based* instrument is used to dispense 15 µl / well into an assay plate that has been *pre-dispensed* with 15 µl / well of AVPR1A Reporter Cells suspension.



APPENDIX 1b for acoustic dispensing. Example scheme for the serial dilution of the reference agonist vasopressin to generate **1,000x-concentrated** stocks. 30 nl / well are pre-dispensed into an empty assay plate using an acoustic transfer device.



* Stocks of protein ligands, such as Vasopressin in the above example, that are solvated in aqueous solution should be further diluted using CSM. However, stocks of test materials that are originally solvated in DMSO, as is typical for small molecule chemicals, should be further diluted using DMSO.