Human
Transforming Growth Factor Beta Receptors I/II
Reporter Assay System

(TGFβR)

384-well Format Assays
Product # IB12002

▪

Technical Manual
(version 8.0c)

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Human Transforming Growth Factor Beta Receptors I/II 384-well Format Assays

I. Description

▪ The Assay System ▪

This TGFβR assay utilizes proprietary human cells that provide constitutive expression of the **Human type I** and **type II Transforming Growth Factor beta Receptors (TGFβR I/II),** both of which are transmembrane serine/threonine kinase receptors. Receptor activation results when TGF-β binds to RII, which then phosphorylates and forms a heterodimer complex with RI. The mechanisms of TGFβ–RI/RII activation and ensuing signal transduction cascade have been well studied and involve the phosphorylation and interplay of a variety of Smad regulatory proteins and transcription factors.[1] Additionally, cross-talk between the activated TGFβR and NF-κB signal transduction pathways have been characterized.[2]

INDIGO's Reporter Cells include the luciferase reporter gene functionally linked to tandem TGF-β Response Sequences (TRS) derived from the human plasminogen activator inhibitor-1 (PAI-1) promoter, a well characterized TGF-β responsive target gene[3]. The TRS sequences are readily bound by activated dimeric $Smad3^{PP}$/Smad4 to initiate formation of a transcription complex. Quantifying changes in luciferase activity in drug treated cells *vs.* untreated (or vehicle treated) reporter cells provides a sensitive surrogate measure of drug-induced changes in TGFβR activity.

Considering its role in cell proliferation and the progression of many types of cancers, the TGFβ Receptors continues to command much interest as targets for the development of novel, specific, and predominantly inhibitory drugs and antibodies. Accordingly, the primary application of this assay is in the screening of drug candidates to quantify any functional activity, either agonistic or inhibitory, that they may exert against the human TGFβR complex.

Reporter Cells are transiently transfected and prepared as frozen stocks using INDIGO's 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 cumbersome intermediate treatment steps such as spin-and-rinse of cells, viability determinations or cell titer adjustments prior to assay setup.

INDIGO's TGFβR assay kit provides the convenience of an all-inclusive cell-based assay system. In addition to TGFβR Reporter Cells, provided are two optimized media for use in recovering the cryopreserved cells and for diluting test samples. Also included is the reference agonist TGF-β1, 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 ▪

It is recommended that test materials that are **protein ligands** or **antibodies** be solvated in aqueous buffered solutions with carrier protein (*e.g.,* PBS + 0.1% BSA) at concentrations *no less* than 10x-concentrated relative to the highest desired treatment concentration.

Small molecule compounds are typically solvated at high concentration (ideally 1,000x-concentrated) in DMSO and stored frozen as master stocks. For **384-well format assays** these master stocks will be diluted by one of two alternative methods, the selection of which will be dictated by the type of dispensing instrument that is to 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 test compounds into assay wells (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, and as depicted in Appendix 1a.

b.) The final concentration of DMSO carried over into assay reactions should never 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,

c.) Assay setups in which an **acoustic transfer** device is used to dispense test compounds into assay wells (text highlighted in blue). Use DMSO to make a series of **1,000x-concentrated** test compound stocks that correspond to each desired final assay concentrations, as described in *Step 2b* of the Assay Protocol, and as depicted in Appendix 1b.

▪ 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**
when using tip dispensing of test cmpds **Reporter Cell Suspension** 7.5 ml	15 µl / well 5.8 ml / plate	~ 1.7 ml
when using acoustic dispensing of test cmpds **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 hr 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.

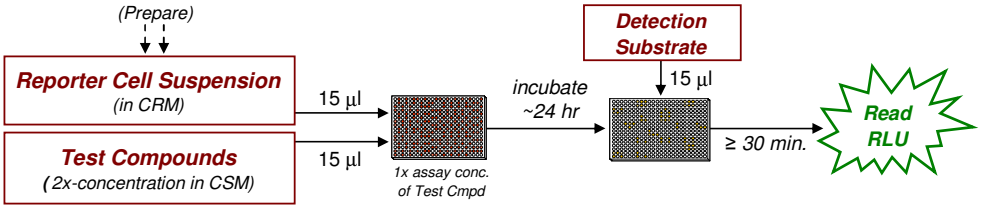
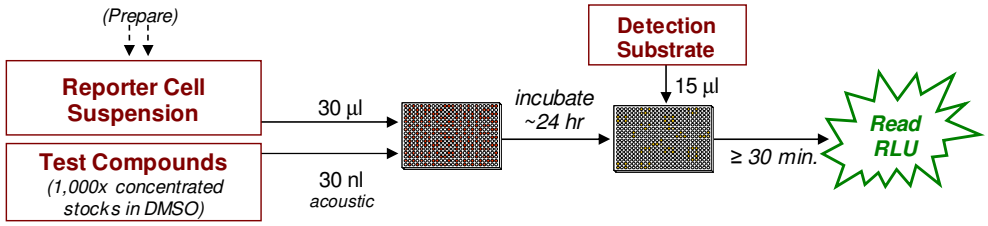


Figure 1b. Assay workflow if using **acoustic** dispensing of test compounds.



▪ Assay Performance ▪

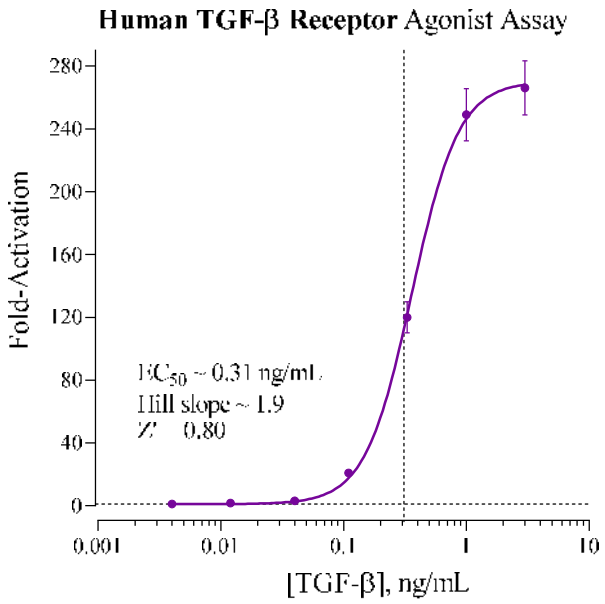


Figure 2a. Agonist dose-response of the TGFβR.
Dose-response analyses of TGFβR Reporter Cells were performed according to the protocol provided in this Technical Manual. TGFβR Reporter Cells were treated with TGF-β1 using a range of 7 concentrations (n = 4/conc.) generated in 3-fold decrements: 3.0, 1.0, .33, .11, .037, .012 and 0.0041 ng/mL, and including 'untreated' (*i.e.*, 'vehicle only') control wells, as described in **Appendix 1**. Luminescence/well was quantified and the average relative light units (RLU) and corresponding standard deviation (SD), percent coefficient of variation (%CV) and Fold-Activation values were determined for each treatment concentration. Z' values were calculated as described by Zhang, *et al.* (1999)[4]. Non-linear regression analyses and IC_{50} calculations were performed using GraphPad Prism software.

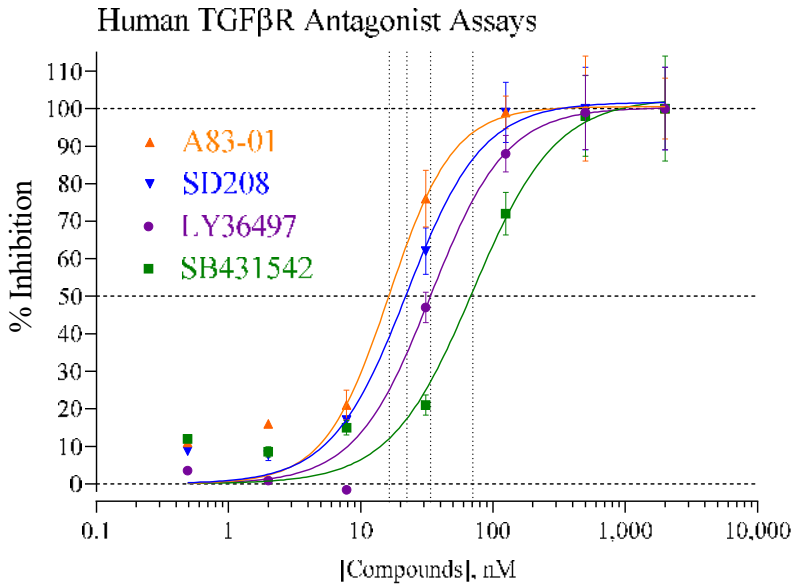


Figure 2b. Antagonist dose-response of the TGFβR.
200 µl / well of TGFβR Reporter Cell suspension was dispensed into the 96-well assay plate, which was then placed in a cell culture incubator for four hours. Approximately 30 minutes before the end of the 4 hr pre-culture period, treatment media were prepared by first supplementing CSM with TGF-β1 to a final concentration of 0.6 ng / ml (an approximate EC_{80} concentration), then using that medium to prepare serial dilutions of the reference antagonists A83-01, SD208, LY36497 and SB431542 (all from Tocris). For each drug, seven treatment concentrations were prepared in 4-fold decrements: 2000, 500, 125, 31.3, 7.81, 1.95 and 0.488 nM. At the end of the pre-culture period media were discarded from the assay wells and 200 µl /well of respective treatment media were dispensed (n = 4/conc.), including 'vehicle only' control wells. Residual DMSO was ≤ 0.1% per well in the assay plate. Following a 22 hr incubation period media were discarded, Luciferase Detection Reagent was added, and Luminescence per well was quantified. Values of average relative light units (RLU) and corresponding standard deviation (SD), percent coefficient of variation (%CV), Fold-Inhibition, and % Inhibition were determined for each treatment concentration. Depicted is a plot of % Inhibition of TGFβR *vs.* Log_{10}[nM] concentration of the various drugs. Non-linear regression analyses and IC_{50} calculations were performed using GraphPad Prism software.

[4] Zhang JH, Chung TD, Oldenburg KR. (1999) A Simple Statistical Parameter for Use in Evaluation and Validation of High Throughput Screening Assays. J Biomol Screen.:**4**(2), 67-73.

$$Z' = 1 - [3*(SD^{Reference} + SD^{Vehicle\ Bkg}) / (RLU^{Reference} - RLU^{Vehicle\ Bkg})]$$

II. Product Components & Storage Conditions

This 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.

Kit Components	*Amount*	*Storage Temp.*
▪ TGFβR Reporter Cells	1 x 2.0 mL	**-80°C**
▪ Cell Recovery Medium (CRM)	1 x 7 mL	-20°C
▪ Compound Screening Medium (CSM)	1 x 35 mL	-20°C
▪ TGF-β1, 3.0 µg/mL (in PBS/0.1% BSA) (reference agonist)	1 x 80 µL	-20°C
▪ Detection Substrate	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.

▪ 37°C, humidified 5% CO_2 incubator for mammalian cell culture.

▪ 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 / antibody (*e.g.,* Fig. 2b.)

▪ *Optional:* clear 96-well assay plate, cell culture treated, for viewing cells on Day 2.

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 Inhibition-mode assay setups ▪

Receptor inhibition assays expose the Reporter Cells to a constant, sub-maximal concentration (typically between EC_{50} – EC_{85}) of a known agonist AND varying concentrations of the test compound(s) to be evaluated for antagonist activity. This TGFβR Assay kit includes a 3.0 µg/mL stock solution of **TGF-β1**, a potent physiological agonist of TGFβR, that may be used to setup antagonist-mode assays. 0.6 ng/mL TGF-β1 typically approximates EC_{80} in this assay. Hence, it presents a reasonable *final assay concentration* of agonist to be used when screening test compounds for inhibitory activity.

Adding the reference activator TGF-β1 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 of the challenge activator.

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 of the challenge activator.

DAY 1 Assay Protocol:

All steps should 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 test and reference compounds will be prepared differently when using tip-dispensing *vs.* acoustic dispensing. Regardless of the method, the total DMSO carried over into assay reactions should never exceed 0.4%.

a. *Tip dispensing method*: In *Step 6*, 15 µl / well of the prepared treatment media is added to the assay that has 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 35 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 proteins (*e.g.*, TGF-β1), should be further diluted using CSM (not DMSO).

Preparing the positive control: This TGFβR Assay kit includes a concentrated stock of TGF-β1, 3.0 µg/mL solvated in PBS/0.1%BSA. The following 7-point series of treatment concentrations, with concentrations generated using serial 3-fold decrements, provides a complete dose-response: 3.0, 1.0, .33, .11, .037, .012 and 0.0041 ng/mL. Always include 'no treatment' (or 'vehicle') controls.

APPENDIX 1a provides an example for generating such a dilution series to be used when *tip-dispensing* compound solutions 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 samples prepared in aqueous solutions (*e.g.*, TGF-β1) and DMSO to further dilute samples 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 5.5 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 cell suspension several times to disperse cell aggregates and gain a homogenous suspension.

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

~ or ~

b. **for Inhibition-mode assays**: Supplement the bulk volume of Reporter Cells suspension with a 2x-concentration of the challenge agonist (refer to "*A word about Inhibition-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 (in DMSO solutions, 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 **5.5 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.

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 disperse cell aggregates and 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 *Inhibition*-mode assays:** First supplement the bulk volume of TGFβR Reporter Cells suspension with the challenge activator **TGF-β1** to achieve an EC_{50} – EC_{80} concentration (refer to "*A word about inhibition-mode assay setups*", pg. 8). Then dispense **30 µl / well** of the supplemented cell suspension into the assay plate that has been pre-dispensed with test compounds.

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 1-2 minutes using a room temperature centrifuge fitted with counter-balanced plate carriers.

7.) Transfer the assay plate into a 37°C, humidified, 5% CO_2 incubator for 22 - 24 hours.

NOTE: Ensure a high-humidity (≥ 85%) 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.

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. Set the instrument to perform a single 5 second "plate shake" prior to reading the first assay well. Read time may be set 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 all wells of the assay plate.

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. INDIGO recommends performing a final *low-speed* spin of the assay plate (with lid) for 1-2 minutes 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 luminescent signal is unstable during the first 30 minutes of the luciferase reaction, however, after the initial 30 minute reaction period the luminescence signal achieves a stable emission output.

13.) Quantify luminescence.

V. Related Products

Human TGFβR Assay Products	
Product No.	***Product Descriptions***
IB12001-32	Human TGFβR Reporter Assay System 3x 32 assays in 8-well strips (96-well plate format)
IB12001	Human TGFβR Reporter Assay System 1x 96-well format assay
IB12002	Human TGFβR Reporter Assay System 1x 384-well format assays
Bulk volumes of TGFβR Assay Reagents may be custom manufactured to accommodate any scale of HTS. Please Inquire.	

Please refer to INDIGO Biosciences website for updated product offerings.

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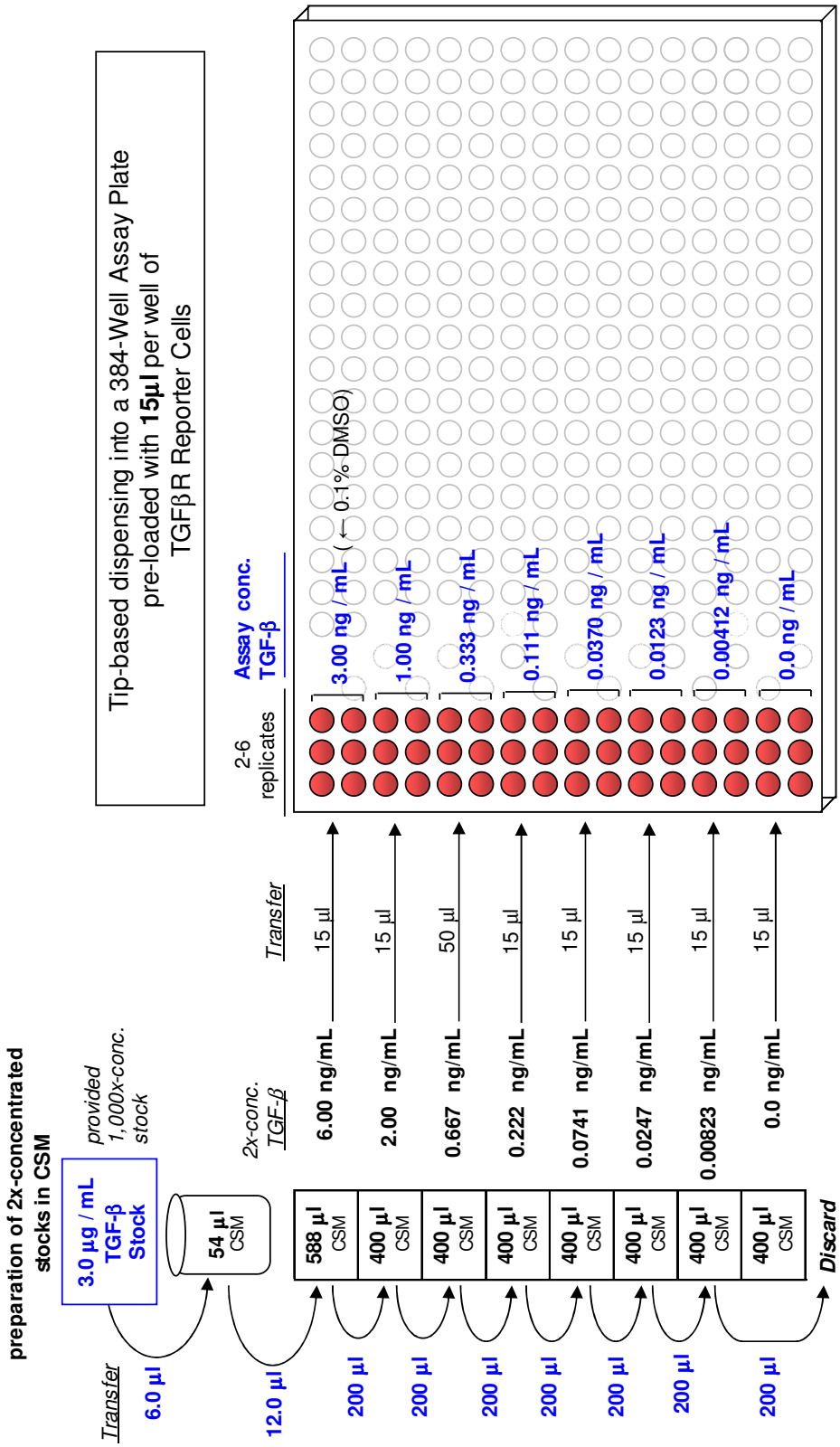
VI. Limited Use Disclosures

Products commercialized by INDIGO Biosciences, Inc. are for RESEARCH PURPOSES ONLY – not for therapeutic, diagnostic, or contact use in humans or animals.

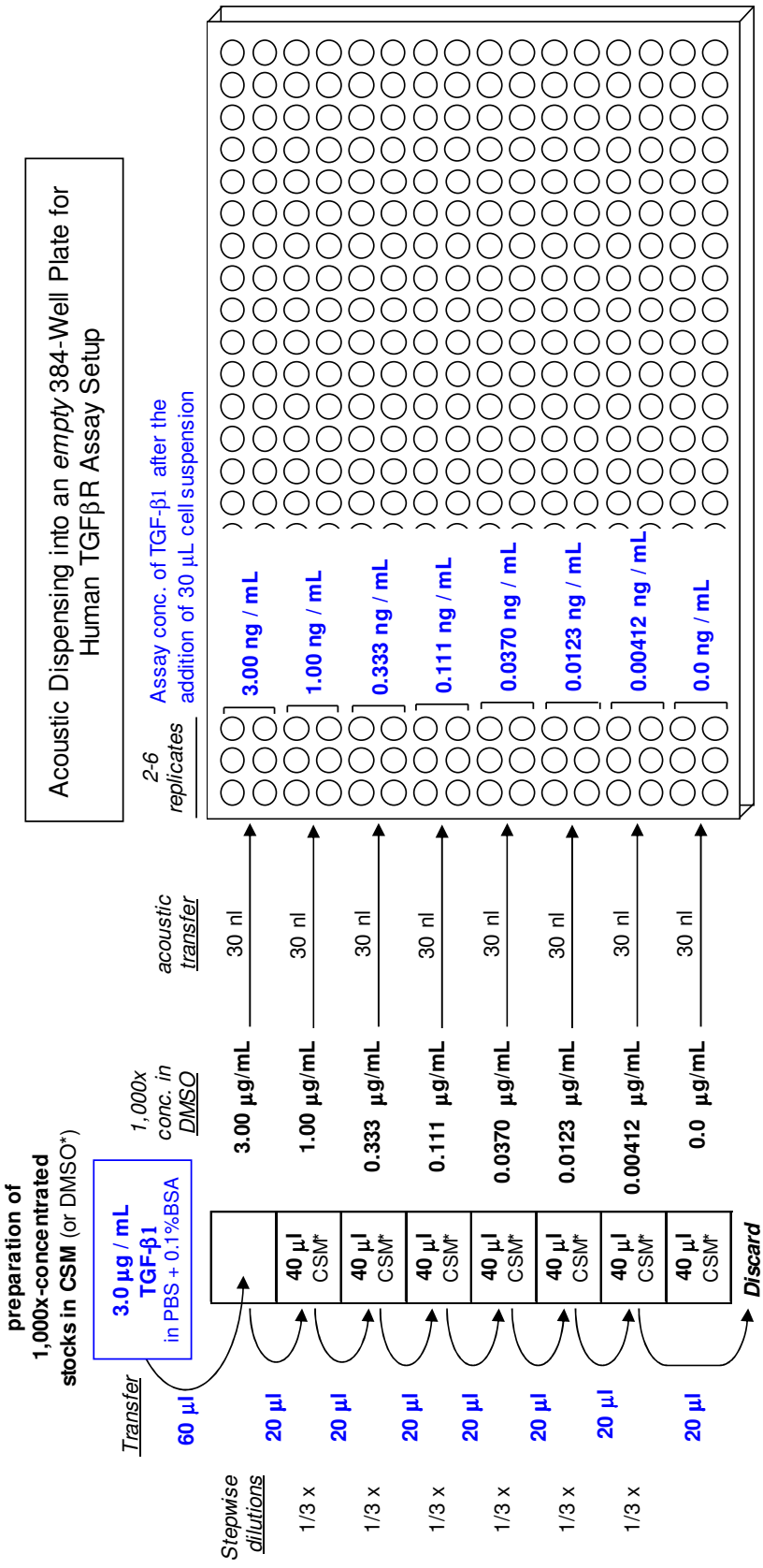
"CryoMite" is a Trademark ™ of INDIGO Biosciences, Inc. (State College, PA, USA).

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 current version available.

APPENDIX 1a for tip-based dispensing. Example scheme for the serial dilution of the reference agonist TGF-β into CSM to generate **2x-concentrated** treatment media. 15 µl / well are dispensed into assay plates using a *tip-based* instrument.



APPENDIX 1b for acoustic dispensing. Example scheme for the serial dilution of the reference agonist TGF-β1 (a protein) into CSM to generate **1,000x-concentrated** stocks. 30 nl / well are pre-dispensed into assay plates using an acoustic transfer device. **NOTE:* Stocks of small-molecule test drugs are typically prepared in DMSO, and **DMSO** (*not* CSM) should be further used to generate the desired series of 1,000x-treatment concentrations.



* Stocks of protein ligands, such as TGF-β1 in the above example, or other test materials that are solvated in aqueous solution should be further diluted using CSM. However, any stocks of test materials that are solvated in DMSO, as is typical for small molecule chemicals, should be further diluted using DMSO.