

**Human Aryl Hydrocarbon Receptor (AhR)  
Reporter Assay System**

**3x 32 Assays in 96-well Format**  
Product # IB06001-32

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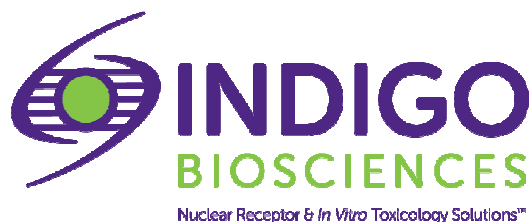
**Technical Manual**  
*(version 7.2i)*

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## Human AhR Reporter Assay System 3x 32 Assays in 96-well Format

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## I. Description

### ▪ Background ▪

While technically not a nuclear receptor, the AhR is mechanistically and functionally similar to members of that super-family, being both a receptor and a ligand-activated transcription factor. More formally, the AhR is a member of the basic helix-loop-helix, Per-Arnt-Sim family of transcription factors.

AhR is a xenobiotic-sensing receptor that is responsive to polycyclic aromatic hydrocarbons found in the environment as industrial pollutants, perhaps the most infamous being 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The basic mechanism of action of dioxin and related compounds has been extensively studied, in particular as it relates to the regulation of Cytochrome P450 gene expression.

The AhR is present in the cytosol of most cell types where, in the non-active state, it is complexed with chaperone proteins such as Hsp90. Binding of a polycyclic aromatic hydrocarbon to AhR leads to nuclear translocation and hetero-dimerization with its partner protein ARNT. The AhR-ARNT hetero-dimer binds to specific cognate DNA sequence elements known as dioxin/xenobiotic response elements (DRE/XRE) present in the regulatory region of target genes. Binding of AhR:ARNT to these elements, and subsequent recruitment of transcription co-activator complexes, induces the transcription of a battery of target genes, including xenobiotic-metabolizing enzymes such as CYP1A1, CYP1A2, CYP2B1 and UGT1A6. In addition, genes affected directly and indirectly by the TCDD/AhR-complex encode both inhibitory and stimulatory growth factors, and their gene products affect cellular growth and differentiation leading to tumor promotion and carcinogenicity in addition to induced toxic responses.

### ▪ The Assay System ▪

INDIGO's **Aryl Hydrocarbon Receptor (AhR) Reporter Cells** include the luciferase reporter gene functionally linked to an AhR-responsive promoter. Thus, quantifying changes in luciferase expression in the treated reporter cells provides a sensitive surrogate measure of the changes in AhR activity. The principal application of this assay is in the screening of test samples to quantify any functional activity, either agonist or antagonist, that they may exert against human AhR.

AhR Reporter Cells are prepared using INDIGO's proprietary **CryoMite™** process. This cryo-preservation method yields exceptional cell viability post-thaw, and provides the convenience of immediately dispensing 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 Human AhR assay kit is an all-inclusive system. In addition to AhR Reporter Cells, this kit provides two optimized media for use during cell culture and in diluting the user's test samples, a reference agonist, Luciferase Detection Reagent, and a cell culture-ready assay plate.

### ▪ The Assay Chemistry ▪

INDIGO's cell-based assay formats 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<sup>+2</sup>-dependent reaction that consumes O<sub>2</sub> and ATP as co-substrates, and yields as products oxyluciferin, AMP, PP<sub>i</sub>, CO<sub>2</sub>, 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 assay kits feature a luciferase detection reagent specially formulated to provide stable light emission between 5 and 90+ minutes after initiating the luciferase reaction. Incorporating a 5 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.

### ▪ Preparation of Test Compounds ▪

Test compounds are typically solvated at high-concentration in DMSO and stored frozen as master stocks. Immediately prior to setting up an assay, the master stocks are serially diluted using one of two alternative strategies:

1.) As described in *Step 7* and depicted in Appendix 1 for the reference agonist MeBIO, **Compound Screening Medium (CSM)** may be used as the diluent to make serial dilutions of test compounds to achieve the desired final assay concentration series.

Alternatively, if test compound solubility is expected to be problematic,

2.) DMSO may be used to make serial dilutions, thereby generating 1,000x-concentrated stocks for each independent test concentration. Treatment media are then prepared using CSM to make final 1,000-fold dilutions of the prepared DMSO dilution series.

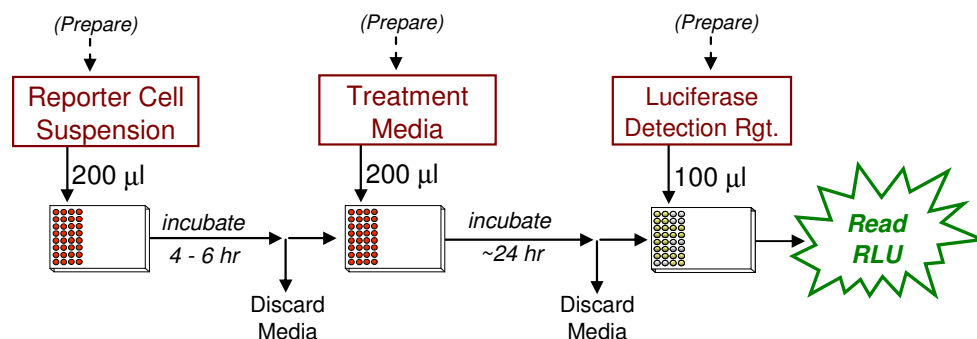
Regardless of the dilution method used, the final concentration of total DMSO carried over into assay wells should *never* exceed 0.4%. Significant DMSO-induced cytotoxicity can be expected above 0.4%.

*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.

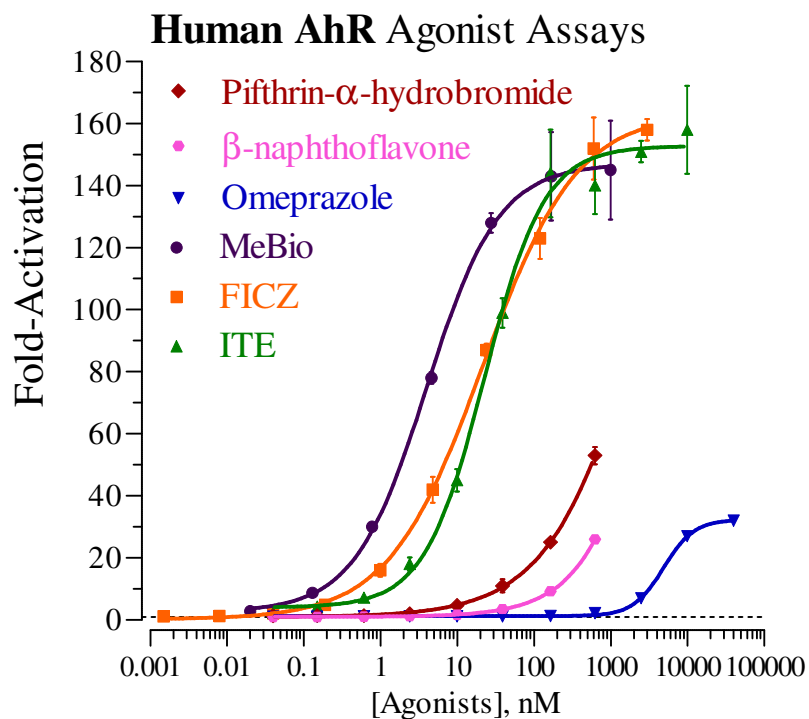
### ▪ Assay Scheme ▪

**Figure 1.** Assay workflow.

*In brief*, 200  $\mu$ l of Reporter Cells is dispensed into wells of the assay plate and pre-incubated for 4-6 hours. Following the pre-incubation period, culture media are discarded and 200  $\mu$ l/well of the prepared 1x-concentration treatment media are added. Following 22-24 hr incubation, discard the treatment media and add Luciferase Detection Reagent. The intensity of light emission (in units of 'Relative Light Units'; RLU) from each assay well is quantified using a plate-reading luminometer.



▪ Assay Performance ▪



**Figure 2. Agonist dose-response analyses of Human AhR.**

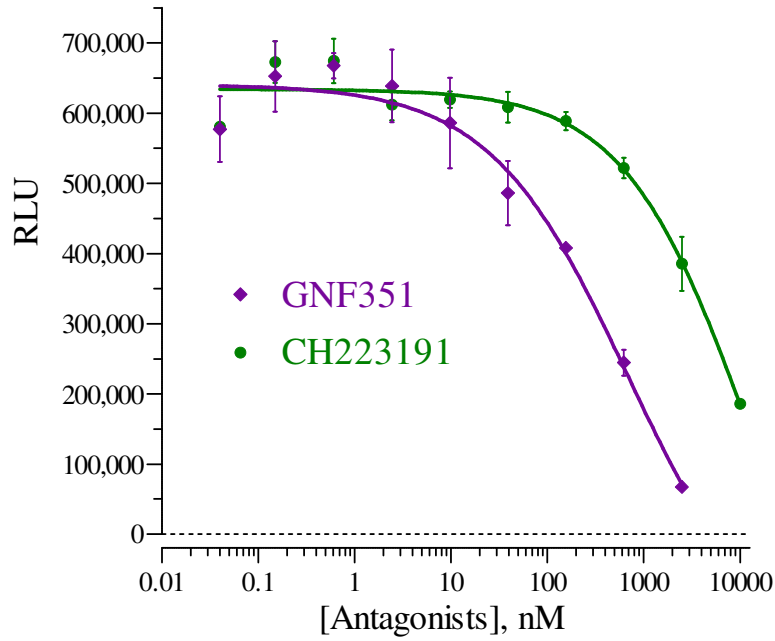
Agonist analyses of Human AhR Reporter Cells were performed according to the protocol described in this Technical manual, using the reference agonists MeBIO (provided), FICZ (6-Formylindolo(3,2-b)carbazole; Enzo), ITE (2-(1H-indole-3-ylcarbonyl)-4-thiazolecarboxylic methyl ester; Tocris), β-Naphthoflavone (Sigma), Omeprazole and Pifthrin-α-hydrobromide (each from Tocris). Luminescence was quantified using a GloMax-Multi+ luminometer (Promega). Average relative light units (RLU) and corresponding standard deviation (SD) values were determined for each treatment concentration ( $n \geq 6$ ). Fold-activation (*i.e.*, S/B) and Z' values were calculated as described by Zhang, *et al.* (1999)<sup>1</sup>. Non-linear regression and EC<sub>50</sub> analyses were performed using GraphPad Prism software.

The reference agonist MeBIO yielded an EC<sub>50</sub> = 4 nM, and a Z' value of 0.69, confirming the robust performance of this assay, and its suitability for HTS<sup>1</sup>.

<sup>1</sup> 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.

$$Z' = 1 - [3 * (SD^{Control} + SD^{Background}) / (RLU^{Control} - RLU^{Background})]$$

### Human AhR Antagonist Assays



**Figure 3. Antagonist dose-response analyses of Human AhR.**

Antagonist analyses of Human AhR Reporter Cells were performed according to the protocol described in this Technical manual, using the reference antagonists GNF351 (Calbiochem) and CH 223191 (Tocris).

## II. Product Components & Storage Conditions

This Human AhR Assay kit contains materials to perform three distinct groups of assays in a 96-well plate format. Reagents are configured so that each group will comprise 32 assays. If desired, however, reagents may be combined to perform either 64 or 96 assays.

The individual aliquots of Reporter Cells are provided as single-use reagents. Once thawed, reporter cells can NOT be refrozen or maintained in extended culture with any hope of retaining downstream assay performance. Therefore, extra volumes of these reagents should be discarded after assay setup.

Assay kits are shipped on dry ice. Upon receipt, individual kit components may be stored at the temperatures indicated on their respective labels. Alternatively, the entire kit may be further stored at -80°C.

To ensure maximal viability, Reporter Cells must be maintained at -80°C until immediately prior to use.

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>
▪ AhR Reporter Cells	3 x 0.60 mL	<b>-80°C</b>
▪ Cell Recovery Medium (CRM)	2 x 10.5 mL	-20°C
▪ Compound Screening Medium (CSM)	1 x 45 mL	-20°C
▪ MeBio, 1.0 mM (in DMSO) (positive control for AhR activation)	1 x 30 µL	-20°C
▪ Detection Substrate	3 x 2.0 mL	<b>-80°C</b>
▪ Detection Buffer	3 x 2.0 mL	-20°C
▪ Plate frame	1	ambient
▪ Snap-in, 8-well strips (white, sterile, cell-culture ready)	12	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

- container of dry ice (see *Step 2*)
- cell culture-rated laminar flow hood.
- 37°C, humidified 5% CO<sub>2</sub> incubator for mammalian cell culture.
- 37°C water bath.
- 70% alcohol wipes
- 8-channel electronic, repeat-dispensing pipettes & sterile tips
- disposable media basins, sterile.
- sterile multi-channel media basins (such as the Heathrow Scientific "Dual-Function Solution Basin"), *or* sterilized 96 deep-well blocks (*e.g.*, Axygen Scientific, #P-2ML-SQ-C-S), *or* appropriate similar vessel for generating dilution series of reference and test compound(s).
- *Optional*: Antagonist reference compound (see Figure 3).
- *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 1-11* are performed on **Day 1**, requiring less than 2 hours of bench work and a 4 hr incubation step to complete. *Steps 12-18* 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 EC<sub>50</sub> – EC<sub>85</sub>) of a known agonist AND the test compound(s) to be evaluated for antagonist activity. This AhR assay kit includes a 1.0 mM stock solution of **MeBio**, an activator of AhR that may be used to setup antagonist-mode assays. 28 nM MeBio typically approximates EC<sub>85</sub> in this cell-based assay (see **Figure 2**). Hence, it presents a reasonable assay concentration of agonist to be used when screening test compounds for inhibitory activity to AhR.

We find that adding the challenge agonist to a bulk volume of CSM, at the desired final assay concentration, is the most efficient and precise method of setting up antagonist assays, and it is the method presented in *Step 7b* of the following protocol.

**DAY 1 Assay Protocol:** All steps must be performed using aseptic technique.

**1.)** Remove the **2 tubes** of **Cell Recovery Medium (CRM)** from freezer storage, thaw and equilibrate to 37°C using a water bath.

**2.) Rapid Thaw of the Reporter Cells:** *First*, retrieve one or two tubes of **CRM** from the 37°C water bath and sanitize the outside surface(s) with a 70% ethanol swab.

*Second*, retrieve **Reporter Cells** from -80°C storage and place them directly into dry ice to transport them to the laminar flow hood: 1 tube for 32 assay wells, 2 tubes for 64 assay wells, or 3 tubes for 96 assay wells. When ready to begin, transfer the tube(s) of reporter cells into a rack and, *without delay*, perform a rapid thaw of the frozen cells by transferring **6.4 ml** of pre-warmed CRM into each tube of frozen cells. Recap the tube of Reporter Cells and immediately place it in a 37°C water bath for 5 - 10 minutes. The resulting volume of cell suspension will be 7.0 ml per tube.

*Third*, during the 5 - 10 minutes incubation period, work in the cell culture hood to *carefully* mount four sterile 8-well strips into the blank assay plate frame. Strip-wells are fragile. Note that they have keyed ends (square and round), hence, they will fit into the plate frame in only one orientation.

**3.)** Retrieve the tube of Reporter Cell Suspension from the water bath and sanitize the outside surface with a 70% alcohol swab.

**4.)** Gently invert the tube of Reporter Cells several times to gain a homogenous cell suspension. Dispense **200 µl / well** of cell suspension into the Assay Plate.

*NOTE 4.1:* If INDIGO's Live Cell Multiplex Assay is to be incorporated, a minimum of 3 'blank' wells (meaning cell-free but containing 'CSM') must be included in the assay plate to allow quantification of fluorescence background (refer to the LCMA Technical Manual).

*NOTE 4.2:* Increased well-to-well variation will occur if care is not taken to prevent cells from settling in the reservoir during the dispensing period. Likewise, take care to ensure precision in dispensing exact volumes across the assay plate.

*NOTE 4.3:* Users sometimes wish to examine the reporter cells using a microscope. If so, the extra volume of cell suspension provided with each kit may be dispensed into a clear, collagen-coated 96-well assay plate. Continue to process the assay plate in identical manner to the white assay plate.



**5.) Pre-incubate reporter cells:** Place the assay plate into a 37°C, ≥ 70% humidity, 5% CO<sub>2</sub> incubator for 4 - 6 hours.

**6.)** Near the end of the pre-culture period remove Compound Screening Medium (CSM) from freezer storage and thaw in a 37°C water bath.

**7.) Prepare the Test Compound and Reference Compound treatment media at the desired final assay concentrations:** Use CSM to prepare an appropriate dilution series of the reference and test compound stocks. Prepare treatment media at the desired **final assay concentrations**. In *Step 9*, the prepared treatment media are dispensed at **200 µl / well** into the assay plate. Manage dilution volumes carefully; this assay kit provides **45 ml** of CSM.

NOTE: Total DMSO carried over into assay reactions should never exceed 0.4%.

**a. Agonist-mode assays.** This AhR Assay kit includes a 1.0 mM stock solution of **MeBio**, a potent activator of AhR. The following 7-point treatment series, prepared in serial 5-fold decrements, provides a suitable dose-response: 1000, 200, 40, 8.0, 1.6, 0.32, and 0.064 nM (final assay concentrations), and including a 'no treatment' control. **APPENDIX 1** provides an example for generating such a dilution series.

~ or ~

**b. Antagonist-mode assays.** When setting antagonist assays, first supplement a bulk volume of CSM with the challenge agonist to achieve the desired final assay concentration (refer to "*A word about antagonist-mode assay setup*", pg. 8). The agonist-supplemented CSM is then used to generate dilutions of test compound samples to achieve the desired final assay concentrations.

**8.)** At the end of the cell pre-culture period discard the culture media.

Because the assay plate is composed of a frame with snap-in strip-wells, the practice of physically ejecting media is NOT advised. Complete removal of the media is efficiently performed by tilting the plate on edge and aspirating media using an 8-pin manifold (*e.g.*, Wheaton Science Microtest Syringe Manifold, # 851381) affixed to a vacuum-trap apparatus. Do *not* touch the well bottom or run the tip of the aspiration device around the bottom circumference of the assay well. Such practices will result in destruction of the cells and greatly increased well-to-well variability.

**9.)** Dispense **200 µl** of each treatment media into appropriate wells of the assay plate.

**10.)** Transfer the assay plate into a 37°C, humidified 5% CO<sub>2</sub> incubator for 22 - 24 hours.

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

**11.)** For greater convenience on *Day 2*, retrieve the appropriate number of vials of **Detection Substrate and Detection Buffer** from freezer storage and place them 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.

12.) 30 minutes before intending to quantify receptor activity, remove **Detection Substrate** and **Detection Buffer** from the refrigerator and place them in a low-light area so that they may equilibrate to room temperature. Once at room temperature, gently invert each tube several times to ensure homogenous solutions.

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

13.) 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*.

14.) *Immediately before proceeding to Step 15:* To read 32 assay wells, transfer the entire volume of 1 vial of Detection Buffer into 1 vial of Detection Substrate, thereby generating a 4 ml volume of **Luciferase Detection Reagent (LDR)**. Mix gently to avoid foaming.

15.) Following 22 - 24 hours of incubation, retrieve the assay plate from the incubator and discard all media contents (as before in *Step 8*).

16.) Add 100 µl of **LDR** to each well of the assay plate.

17.) Allow the assay plate to rest at room temperature for at least 5 minutes following the addition of LDR. Do not shake the assay plate during this period.

18.) Quantify luminescence.

## V. Related Products

<i>Product No.</i>	<i>Product Descriptions</i>
<b>Human AhR Assay Kit Products</b>	
IB06001-32	Human AhR Reporter Assay System 3x 32 assays; 8-well strips in 96-well format plate frame
IB06001	Human AhR Reporter Assay System 1x 96-well format assay
IB06002	Human AhR Reporter Assay System 1x 384-well format assay
<b>Mouse AhR Assay Kit Products</b>	
M06001-32	Mouse AhR Reporter Assay System 3x 32 assays; 8-well strips in 96-well format plate frame
M06001	Mouse AhR Reporter Assay System 1x 96-well format assay
<b>Rat AhR Assay Kit Products</b>	
R06001-32	Rat AhR Reporter Assay System 3x 32 assays; 8-well strips in 96-well format plate frame
R06001	Rat AhR Reporter Assay System 1x 96-well format assay
Bulk assay reagents may be custom manufactured to accommodate any scale of HTS. Please Inquire.	
<b>LIVE Cell Multiplex (LCM) Assay Products</b>	
LCM-01	Reagent volumes sufficient to perform <b>96</b> Live Cell Assays in 1x96-well, or 2x48-well, or 3x32-well assay plate formats
LCM-05	Reagent in <b>5x bulk volume</b> to perform <b>480</b> Live Cell Assays contained in 5 x 96-well assay plates
LCM-10	Reagent in <b>10x bulk volume</b> to perform <b>960</b> Live Cell Assays contained in 10 x 96-well assay plates
<b>INDIGlo Luciferase Detection Reagent</b>	
LDR-10, -25, -50, -500	INDIGlo Luciferase Detection Reagents in 10 mL, 25 mL, 50 mL, and 500 mL volumes

Please refer to INDIGO Biosciences website for updated product offerings.

[www.indigobiosciences.com](http://www.indigobiosciences.com)

## VI. 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 currently updated version.

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### APPENDIX 1

Example scheme for the serial dilution of MeBio reference agonist using CSM, and the setup of a Human AhR dose-response assay.

