INSTRUCTIONS

CXCR4 Redistribution® Assay

For High-Content Analysis

018-01.03

Number	Description
R04-018-01	Recombinant U2OS cells stably expressing human CXCR4 receptor (GenBank Acc. NM_003467) fused to the N-terminus of enhanced green fluorescent protein (EGFP). U2OS cells are adherent epithelial cells derived from human osteosarcoma. Expression of CXCR4-EGFP is controlled by a standard CMV promoter and continuous expression is maintained by addition of G418 to the culture medium.

Quantity: 2 cryo-vials each containing 1.0 x 10^6 cells in a volume of 1.0 ml Cell Freezing Medium.

Storage: Immediately upon receipt store cells in liquid nitrogen (vapor phase).

Warning: Please completely read these instructions and the material safety data sheet for DMSO before using this product. This product is for research use only. Not intended for human or animal diagnostic or therapeutic uses. Handle as potentially biohazardous material under at least Biosafety Level 1 containment. Safety procedures and waste handling are in accordance with the local laboratory regulations.

CAUTION: This product contains Dimethyl Sulfoxide (DMSO), a hazardous material. Please review Material Safety Data Sheet before using this product.

Introduction

The Redistribution® Technology

The Redistribution® technology monitors the cellular translocation of GFP-tagged proteins in response to drug compounds or other stimuli and allows easy acquisition of multiple readouts from the same cell in a single assay run. In addition to the primary readout, high content assays provide supplementary information about cell morphology, compound fluorescence, and cellular toxicity.

The CXCR4 Redistribution® Assay

The CXCR4 receptor is a chemokine receptor and belongs to the family of G protein coupled receptors (GPCRs). Its only known endogenous ligand is stromal cell-derived factor 1 (SDF-1), which exists in two forms originating from alternative splicing, i.e. SDF-1α and SDF-1β. SDF-1 and CXCR4 form an important chemokine ligand/receptor pair, that plays a crucial role in numerous biological processes including hematopoiesis, cardiogenesis, vasculogenesis, neuronal development, immune cell trafficking, malignant cell growth, and metastasis. Binding of SDF-1 to the CXCR4 receptor activates G- proteins and induces signaling through downstream pathways involving Ras and the PI3 kinase. CXCR4 signaling results in the activation of JAK2 and transcription factors such as AP-1 and STATs [1,2].

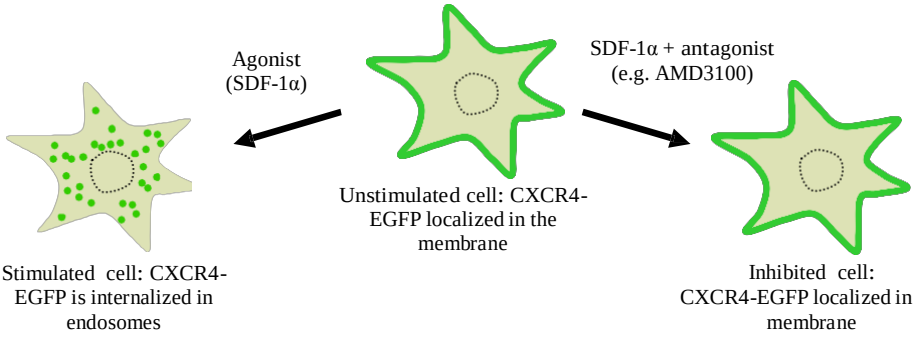

Figure 1. Illustration of CXCR4 internalization.

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The CXCR4 Redistribution® assay can be run in either agonist or antagonist format. The agonist format is designed to screen for agonists of CXCR4 translocation by monitoring the internalization of a membrane-localized CXCR4-EGFP fusion protein to endosomes. SDFla is used as reference compound. The CXCR4 antagonist Redistribution® assay is designed to screen for antagonists of CXCR4 translocation by monitoring the degree of inhibition of SDF-1a-induced internalization of membrane-localized CXCR4-EGFP fusion protein to endosomes. In this assay SDF-la is used as the agonist [3,4] and the CXCR4 specific inhibitor, AMD3100, is used as reference antagonist [5,6].

Additional materials required

The following reagents and materials need to be supplied by the user.

- Dulbecco's Modified Eagle Medium (DMEM), high glucose, without L-Glutamine, Sodium Pyruvate (Thermo Scientific, Fisher Scientific cat.# SH30081)
- L-Glutamine supplement, 200 mM (Thermo Scientific, Fisher Scientific cat.# SH30034)
- Fetal Bovine Serum (FBS) (Thermo Scientific, Fisher Scientific cat.# SH30071)
- Penicillin/Streptomycin, 100X solution (Thermo Scientific, Fisher Scientific cat.# SV30010),
- Trypsin-EDTA, 0.05% (Thermo Scientific, Fisher Scientific cat.# SH30236)
- G418, 50mg/ml (Thermo Scientific, Fisher Scientific cat.# SC30069)
- Dimethylsulfoxide (DMSO) (Fisher Scientific, cat.# BP231)
- Dulbecco´s Phosphate-Buffered Saline (PBS), w/o calcium, magnesium, or Phenol Red (Thermo Scientific, Fisher Scientific cat.# SH30028)
- Hepes Buffer, 1 M, Free Acid (liquid) (Thermo Scientific, Fisher Scientific cat.# SH30237)
- Bovine Serum Albumin (BSA) Cohn Fraction V (MP Biomedicals, cat.# ICN841032)
- Stromal Cell-Derived Factor 1a (SDF1α), Human, Recombinant, E. coli (EMD Chemicals, cat.# 572300)
- AMD3100 octahydrochloride hydrate (Sigma-Aldrich, cat.# A5602)
  Note: AMD3100 is only used in the antagonist mode of the assay.
- Hoechst 33258 (Fisher Scientific, cat.# AC22989)
- Triton X-100 (Fisher Scientific, cat.# AC21568)
- 10% formalin, neutral-buffered solution (approximately 4% formaldehyde) (Fisher Scientific, cat.# 23-305-510)
  Note: is not recommended to prepare this solution by diluting from a 37% formaldehyde solution.
- 96-well microplate with lid (cell plate) (e.g. Nunc 96-Well Optical Bottom Microplates, Thermo Scientific cat.# 165306)
- Black plate sealer
- Nunc EasYFlasks with Nunclon Delta Surface, T-25, T-75, T-175 (Thermo Scientific, cat.# 156367, 156499, 159910

Reagent preparation

The following reagents are required to be prepared by the user.

- Cell Culture Medium: DMEM supplemented with 2mM L-Glutamine, 1% Penicillin-Streptomycin, 0.5 mg/ml G418 and 10% FBS.
- Cell Freezing Medium: 90% Cell Culture Medium without G418 + 10% DMSO.
- Plate Seeding Medium: DMEM supplemented with 2mM L-Glutamine, 1% Penicillin-Streptomycin, 0.5 mg/ml G418 and 10% FBS.
- 10% BSA: 1 g BSA dissolved in purified water to a final volume of 10 ml.
- Assay Buffer: DMEM supplemented with 2mM L-Glutamine, 1% Penicillin-Streptomycin, 1% FBS and 10 mM Hepes Buffer.
- Control Compound Stock (agonist mode): 40 µg/ml (5.1 µM) SDF-1α stock solution in PBS + 0.1% BSA. Prepare by dissolving 10 µg SDF-1α (MW = 7800) in 250 µl PBS containing 0.1% BSA. Store at -70°C.
- Control Compound Stock (antagonist mode): 1 mM AMD3100 stock solution in deionized water. Prepare by dissolving 5 mg AMD3100 (MW = 794.5) in 6293 µl deionized water. Store at -20°C.
  Note: AMD3100 is only used in the antagonist mode of the assay.
- Fixing Solution: 10% formalin, neutral-buffered solution (approximately 4% formaldehyde).
  Note: It is not recommended to prepare this solution by diluting from a 37% formaldehyde solution.
- Hoechst Stock: 10 mM stock solution is prepared in DMSO.

- **Hoechst Staining Solution:** 111M Hoechst in PBS containing 0.5% Triton X-100. Prepare by dissolving 2.5 ml Triton X-100 with 500 ml PBS. Mix thoroughly on a magnetic stirrer. When Triton X-100 is dissolved add 5011110 mM Hoechst 33258. Store at 4°C for up to 1 month.

The following procedures have been optimized for this cell line. It is strongly recommended that an adequately sized cell bank is created containing cells at a low passage number.

Cell thawing procedure

1. Rapidly thaw frozen cells by holding the cryovial in a 37°C water bath for 1-2 minutes. Do not thaw cells by hand, at room temperature, or for longer than 3 minutes, as this decreases viability.
2. Wipe the cryovial with 70% ethanol.
3. Transfer the vial content into a T75 tissue culture flask containing 25 ml Cell Culture Medium and place flask in a 37ºC, 5% CO_2, 95% humidity incubator.
4. Change the Cell Culture Medium the next day.

Cell harvest and culturing procedure

For normal cell line maintenance, split 1:8 every 3-4 days. Maintain cells between 5% and 95% confluence. Passage cells when they reach 80-95% confluence. All reagents should be pre-warmed to 37ºC.

1. Remove medium and wash cells once with PBS (10 ml per T75 flask and 12 ml per T175 flask).
2. Add trypsin-EDTA (2 ml per T75 flask and 4 ml per T175 flask) and swirl to ensure all cells are covered.
3. Incubate at 37ºC for 3-5 minutes or until cells round up and begin to detach.
4. Tap the flask gently 1-2 times to dislodge the cells. Add Cell Culture Medium (6 ml per T75 flask and 8 ml per T175 flask) to inactivate trypsin and resuspend cells by gently pipetting to achieve a homogenous suspension.
5. Count cells using a cell counter or hemocytometer.
6. Transfer the desired number of cells into a new flask containing sufficient fresh Cell Culture Medium (total of 20 ml per T75 flask and 40 ml per T175 flask).
7. Incubate the culture flask in a 37ºC, 5% CO_2, 95% humidity incubator.

Cell freezing procedure

1. Harvest the cells as described in the “Cell harvest and culturing procedure”, step 1 – 5.
2. Prepare a cell suspension containing 1 x 10^6 cells per ml (5 cryogenic vials = 5 x 10^6 cells).
3. Centrifuge the cells at 250g (approximately 1100 rpm) for 5 minutes. Aspirate the medium from the cells.
4. Resuspend the cells in Cell Freezing Medium at 1 x 10^6 cells per ml until no cell aggregates remain in the suspension.
5. Dispense 1 ml of the cell suspension into cryogenic vials.
6. Place the vials in an insulated container or a cryo-freezing device (e.g. Nalgene "Mr. Frosty" Freezing Container, Thermo Scientific, Fisher Scientific cat.# 15-350-50) and store at -80ºC for 16-24 hours.
7. Transfer the vials for long term storage in liquid nitrogen.

Cell plating procedure

The cells should be seeded into 96-well plates 18-24 hours prior to running the assay. Do not allow the cells to reach over 95% confluence prior to seeding for an assay run. The assay has been validated with cells up to passage 25, split as described in the “Cell harvest and culturing procedure”.

1. Harvest the cells as described in the “Cell harvest and culturing procedure”, step 1-5 using Plate Seeding Medium instead of Cell Culture Medium.
2. Dilute the cell suspension to 40,000 cells/ml in Plate Seeding Medium.
3. Transfer 200 µl of the cell suspension to each well in a 96-well tissue culture plate (cell plate). This gives a cell density of 8000 cells/well.
   Note: At this step, be careful to keep the cells in a uniform suspension.
4. Incubate the cell plate on a level vibration-free table for 1 hour at room temperature (20-25°C). This ensures that the cells attach evenly within each well.
5. Incubate the cell plate for 18-24 hours in a 37ºC, 5% CO_2, 95% humidity incubator prior to starting the assay.

Assay protocol - agonist mode

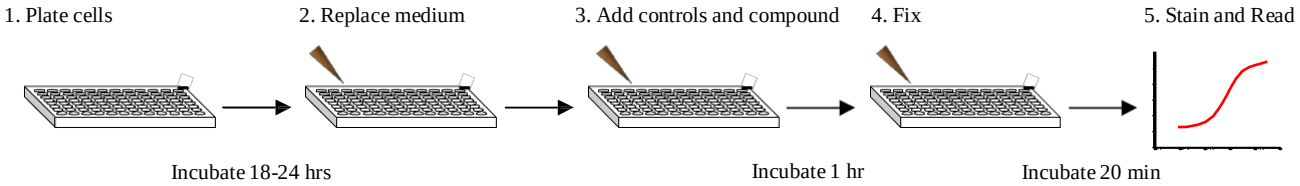


Figure 2: Quick assay workflow overview.

The following protocol is based on 1x 96-well plate.

1. Before initiating the assay:
    - Prepare Assay Buffer. Ensure Assay Buffer is pre-warmed to 20-37ºC.
2. Gently remove Plate Seeding Medium and wash cell plate twice with 100 µl Assay Buffer per well.
3. Add 100 µl Assay Buffer per well.
4. Prepare controls and test compounds:
    - Dilute controls and test compounds in Assay Buffer to a 2X final concentration. (Volumes and concentrations are indicated below). A final DMSO concentration of 0.25% is recommended, but the assay can tolerate up to 2% DMSO final concentration.
    - Mix controls for 1x 96–well plate as indicated below:

	Assay Buffer	Control Stock	DMSO	2X concentration	Final assay concentration	Final DMSO concentration
Negative control	12 ml	----	60 µl	0.5% DMSO	----	0.25%
Positive control	12 ml	47 µl SDF-1α	60 µl	20 nM SDF-1α	10 nM SDF-1α	0.25%

5. Add 100 µl 2X concentrated control or compound solution in Assay Buffer to appropriate wells of the cell plate.
6. Incubate cell plate for 1 hour in a 37ºC, 5% CO_2, 95% humidity incubator.
7. Fix cells by gently decanting the buffer and add 150 µl Fixing Solution per well.
8. Incubate cell plate at room temperature for 20 minutes.
9. Wash the cells 4 times with 200 µl PBS per well per wash.
10. Decant PBS from last wash and add 100 µl 1 µM Hoechst Staining Solution.
11. Seal plate with a black plate sealer. Incubate at room temperature for at least 30 minutes before imaging. The plate can be stored at 4ºC for up to 3 days in the dark.

Assay protocol - antagonist mode

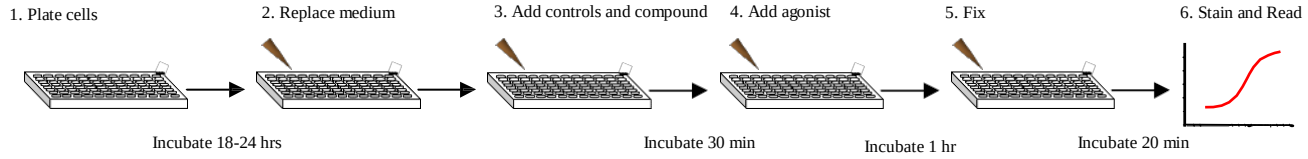


Figure 3: Quick assay workflow overview.

The following protocol is based on 1x 96-well plate.

1. Before initiating the assay:
    - Prepare Assay Buffer. Ensure Assay Buffer is pre-warmed to 20-37ºC.
2. Gently remove Plate Seeding Medium and wash cell plate twice with 100 µl Assay Buffer per well.
3. Add 100 µl Assay Buffer per well.
4. Prepare controls and test compounds:
    - Dilute controls and test compounds in Assay Buffer to a 4X final concentration. (Volumes and concentrations are indicated below). A final DMSO concentration of 0.25% is recommended, but the assay can tolerate up to 2% DMSO final concentration.
    - Mix controls for 1x 96–well plate as indicated below:

	Assay Buffer	Control Stock	DMSO	4X concentration	Final assay concentration	Final DMSO concentration
Negative control	6 ml	----	60 µl	1% DMSO	----	0.25%
Positive control	6 ml	7.2 µl AMD3100	60 µl	1.2 µM AMD3100	300 nM AMD3100	0.25%

5. Add 50 µl 4X concentrated control or compound solution in Assay Buffer to appropriate wells of the cell plate
6. Incubate cell plate for 30 minutes in a 37ºC, 5% CO_2, 95% humidity incubator.
7. Prepare 4X SDF-1α Agonist Solution (40 nM):
    - Prepare fresh by mixing 47 µl 5.1 µM SDF-1α Stock with 6 ml Assay Buffer. Use the SDF-1α Agonist Solution within 20 min after preparation.
8. Add 50 µl 4X SDF-1α Agonist Solution to appropriate wells of the cell plate.
9. Incubate cell plate for 1 hour in a 37ºC, 5% CO_2, 95% humidity incubator.
10. Fix cells by gently decanting the buffer and add 150 µl Fixing Solution per well.
11. Incubate cell plate at room temperature for 20 minutes.
12. Wash the cells 4 times with 200 µl PBS per well per wash.
13. Decant PBS from last wash and add 100 µl 1 µM Hoechst Staining Solution.
14. Seal plate with a black plate sealer. Incubate at room temperature for at least 30 minutes before imaging. The plate can be stored at 4ºC for up to 3 days in the dark.

Imaging

The translocation of CXCR4-EGFP can be imaged on most HCS platforms and fluorescence microscopes. The filters should be set for Hoechst (350/461 nm) and GFP/FITC (488/509 nm) (wavelength for excitation and emission maxima). Consult the instrument manual for the correct filter settings.

The translocation can typically be analyzed on images taken with a 10x objective or higher magnification.

The primary output in the CXCR4 Redistribution® assay is the formation of spots in the cytoplasm. The data analysis should therefore report an output that corresponds to number, area, or intensity of spots in the cytoplasm.

Imaging on Thermo Scientific Arrayscan HCS Reader
This assay has been developed on the Thermo Scientific Arrayscan HCS Reader using a 10x objective (0.63X coupler), High Resolution images, XF100 filter sets for Hoechst and FITC, and the SpotDetectorV3 BioApplication. The output parameter used was SpotTotalAreaPerObject. The minimally acceptable number of cells used for image analysis in each well was set to 150 cells.

Other BioApplications that can be used for this assay include CompartmentalAnalysisV2 and ColocalizationV3.

High Content Outputs
In addition to the primary readout, it is possible to extract secondary high content readouts from the Redistribution® assays. Such secondary readouts may be used to identify unwanted toxic effects of test compounds or false positives. In order to acquire this type of information, the cells should be stained with a whole cell dye which allows for a second analysis of the images for determination of secondary cell characteristics.

Examples of useful secondary high content outputs:

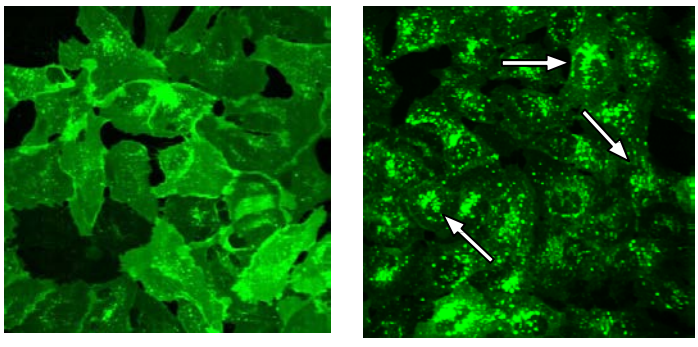
Nucleus size, shape, intensity:	Parameter used to identify DNA damage, effects on cell cycle and apoptosis.
Cell number, size, and shape:	Parameter for acute cytotoxicity and apoptosis.
Cell fluorescence intensity:	Parameter for compound cytotoxicity and fluorescence.

The thresholds for determining compound cytotoxicity or fluorescence must be determined empirically. Note that the primary translocation readout in some cases may affect the secondary outputs mentioned above.

Representative Data Examples

The CXCR4 Redistribution® assay monitors internalization of CXCR4-EGFP. SDF-1α is used as a reference ligand, and compounds are assayed for their ability to induce internalization of CXCR4. In antagonist format, compounds are tested for their ability to inhibit SDF-1α-induced internalization. AMD3100 is used as the reference antagonist.

Representative images of CXCR4 Redistribution® cells treated with SDF-1α are shown in figure 4.



DMSO-treated cells SDF1α-treated cells

Figure 4. Internalization of CXCR4-EGFP. Cells were treated with 10 nM SDF-1α for 1 hr. Arrow indicates the CXCR4 internalization detected by the image analysis algorithm.

Figure 5 shows a representative concentration response curve of the reference compound SDF-1α in the CXCR-4 agonist assay and the reference compound AMD3100 in the CXCR4 antagonist assay. The EC_{50} of SDF-1α is ~3 nM and the EC_{50} of AMD3100 is ~4 nM .

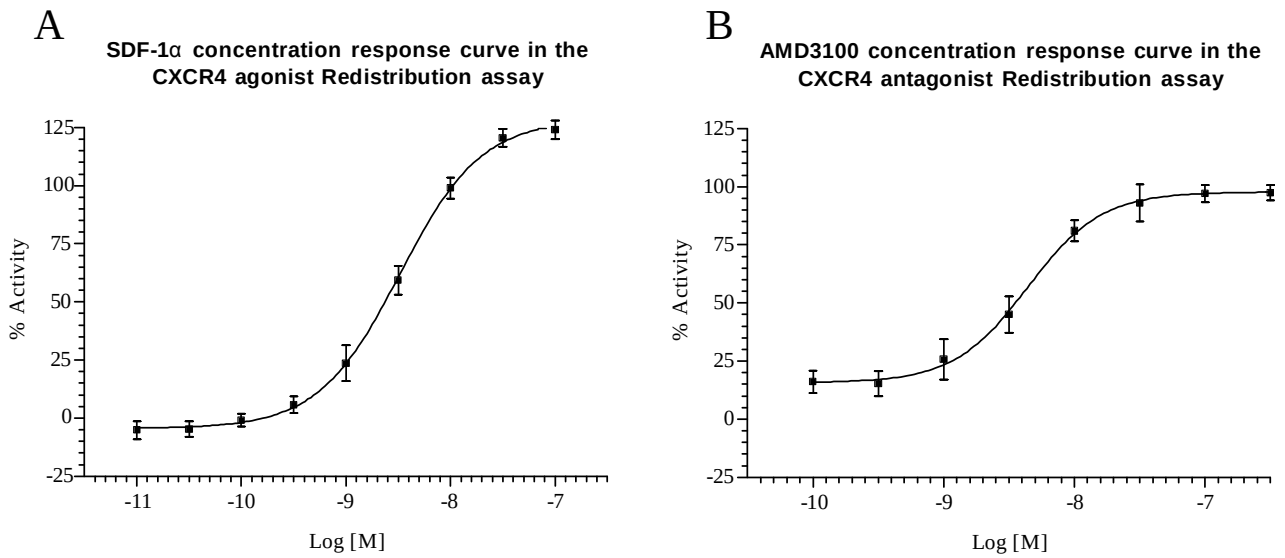


Figure 5. Concentration response curves in the CXCR4 assay: A) SDF-1α concentration response in the CXCR4 agonist assay (n=8). The EC_{50} is approximately 3 nM. Concentration response was measured in 9 point half log dilution series. Cells were treated with SDF-1α for 1 hr. Cells were then fixed and receptor internalization was measured using the Cellomics ArrayScan V^{TI} Reader and the SpotDetectorV3 BioApplication. % activity was calculated relative to the positive (10 nM SDF-1α) and negative control (0.25% DMSO). B) AMD3100 concentration response in the CXCR4 antagonist assay (n=8). The EC_{50} is approximately 4 nM. Cells were treated with SDF-1α in the presence of a half log dilution series of AMD3100. Cells were then fixed and receptor internalization was measured using the Cellomics ArrayScan V^{TI} Reader and the SpotDetectorV3 BioApplication. % activity was calculated relative to the positive (300 nM AMD3100) and negative control (0.25% DMSO)

Product qualification

Assay performance has been validated with an average Z'=0.74±0.07 in agonist mode and Z'=0.71±0.08 in antagonist mode. The cells have been tested for viability. The cells have been tested negative for mycoplasma and authenticated to be U2OS cells by DNA fingerprint STR analysis.

Related Products

Product #	Type	Product description	Cell line
R04-094-01	Profiling & Screening	GRPR Redistribution® Assay	U2OS
R04-054-01	Profiling	MCH1 Redistribution® Assay	U2OS
R04-039-01	Profiling & Screening	$S1P_1$ Redistribution® Assay	U2OS
R04-095-01	Profiling	$S1P_3$ Redistribution® Assay	U2OS
R04-086-01	Profiling	M1 Redistribution® Assay	U2OS
R04-075-01	Profiling & Screening	M2 Redistribution® Assay	U2OS
R04-076-01	Profiling & Screening	M3 Redistribution® Assay	U2OS
R04-057-01	Profiling	MC4 Redistribution® Assay	U2OS
R04-053-01	Profiling	FSHR Redistribution® Assay	U2OS
R04-093-01	Profiling & Screening	CRTH2 Redistribution® Assay	U2OS
R04-051-01	Profiling & Screening	CB1 Redistribution® Assay	U2OS
R04-061-01	Profiling & Screening	CB2 Redistribution® Assay	U2OS
R04-097-02	Profiling & Screening	GLP1R Redistribution® Assay	U2OS
R04-017-02	Profiling & Screening	Gq-coupled GPCRs – NFATc1 Redistribution® Assay	U2OS
R04-045-02	Profiling & Screening	Gs/Gi-coupled GPCRs – PKA Redistribution® Assay	CHO-K1
R04-088-01	Profiling & Screening	M1:NFATc1 Redistribution® Assay	U2OS
R04-072-01	Profiling & Screening	M2:PKA Redistribution® Assay	CHO-K1
R04-073-01	Profiling & Screening	M3:NFATc1 Redistribution® Assay	U2OS

References

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This product and/or its use is subject of patent nos. US 6,518,021; EP 1,199,564; EP 0,986,753; US 6,172,188; EP 0,851,874 including continuations, divisions, reissues, extensions, and substitutions with respect thereto, and all United States and foreign patents issuing therefrom to Fisher BioImage ApS, and the patents assigned to Aurora/ The Regents of the University of California (US5,625,048, US6,066,476, US5,777,079, US6,054,321, EP0804457B1) and the patents assigned to Stanford (US5,968,738, US5,804,387) including continuations, divisions, reissues, extensions, and substitutions with respect thereto, and all United States and foreign patents issuing therefrom.

For European customers:
The CXCR4 Redistribution cell line is genetically modified with a vector expressing CXCR4 fused to EGFP. As a condition of sale, use of this product must be in accordance with all applicable local legislation and guidelines including EC Directive 90/219/EEC on the contained use of genetically modified organisms.

The Thermo Scientific Redistribution assays are part of the Thermo Scientific High Content Platform which also includes Thermo Scientific HCS Reagent Kits, Thermo Scientific Arrayscan HCS Reader, Thermo Scientific CellInsight Personal Cell Imager, Thermo Scientific ToxInsight IVT platform, BioApplication image analysis software and high-content informatics. For more information on Thermo Scientific products for high content and Cellomics, visit www.thermoscientific.com/cellomics, or call 800-432-4091 (toll free) or 412-770-2500. LC06483402

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