INSTRUCTIONS

Beta-catenin Redistribution® Assay

For High-Content Analysis

040-01.04

Number	Description
R04-040-01	Recombinant U2OS cells stably expressing human β-catenin (GenBank Acc. NM_001904) fused to the C-terminus of enhanced green fluorescent protein (EGFP). U2OS cells are adherent epithelial cells derived from human osteosarcoma. Expression of EGFP-β-catenin 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 β-catenin Redistribution® Assay

The Wnt signaling pathway regulates key biological processes including cell motility, differentiation, and tumorigenesis. Wnt acts in a paracrine fashion on cells expressing Frizzled receptors, which recruit and activate the cytoplasmic phosphoprotein Dishevelled (DSH).

In normal cells, β-catenin associates with cadherins at the intracellular side of the plasma membrane to promote cell adhesion. The level of cytoplasmic β-catenin is normally controlled by formation of a degradation complex between the scaffold protein axin, the tumor suppressor APC, Ser/Thr kinase GSK3β, and β-catenin. This leads to phosphorylation of β- catenin and subsequently to degradation mediated by the E3 ubiquitin ligase β-TrCP [1]. Activated DSH is thought to inhibit the formation of this degradation complex leading to stabilization of β-catenin. Stabilized β-catenin translocates to the nucleus where it interacts with TCF/LEF transcription factors resulting in activation of Wnt pathway target genes [2,3].

The β-catenin Redistribution® assay is designed to assay for antagonists of β-catenin translocation by monitoring the translocation of a GFP-β-catenin fusion protein from the membrane to the nucleus. The GSK3 inhibitor X ((2′Z,3′E)-6-Bromoindirubin-3′-acetoxime) [4,5,6] is used as agonist and compounds are assayed for their ability to inhibit GSK3 inhibitor X-induced membrane-to-nucleus translocation of β-catenin. Compounds inhibiting GSK3 inhibitor X-induced membrane-to-nucleus translocation of β-catenin could be interfering with nuclear translocation of β-catenin or perhaps directly block the effect of the GSK inhibitor.

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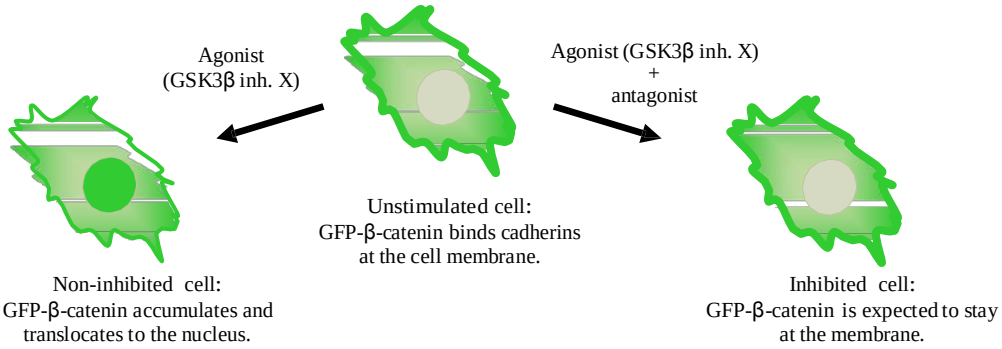


Figure 1. Illustration of the β-catenin translocation event.

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)
- GSK-3 inhibitor X (EMD Chemicals, cat.# 361551)
- 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.
- Assay Buffer: DMEM supplemented with 2mM L-Glutamine, 1% Penicillin-Streptomycin.
- Control Compound Stock: 10 mM GSK-3 inhibitor X stock solution in DMSO. Prepare by dissolving 1 mg GSK-3 inhibitor X (MW=398.2) in 251 µl DMSO. Store at -20°C.
- 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: 1 µM 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 50 µl 10 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 in up to passage 26 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 100 µl of the cell suspension to each well in a 96-well tissue culture plate (cell plate). This gives a cell density of 4000 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

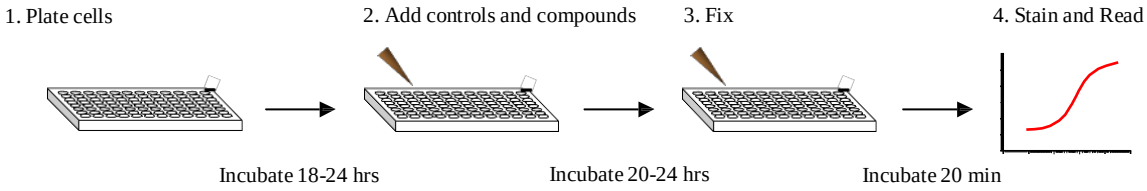


Figure 2: Quick assay workflow overview

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.
   - 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 0.5% 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	12 µl GSK-3 inhibitor X	48 µl	10 µM GSK-3 inhibitor X	5 µM GSK-3 inhibitor X	0.25%

2. Add 100 µl 2X concentrated control or compound solution in Assay Buffer to appropriate wells of the cell plate.
3. Incubate cell plate for 20-24 hours in a 37ºC, 5% CO_2, 95% humidity incubator.
4. Fix cells by gently decanting the buffer and add 150 µl Fixing Solution per well.
5. Incubate cell plate at room temperature for 20 minutes.
6. Wash the cells 4 times with 200 µl PBS per well per wash.
7. Decant PBS from last wash and add 100 µl 1 µM Hoechst Staining Solution.
8. 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

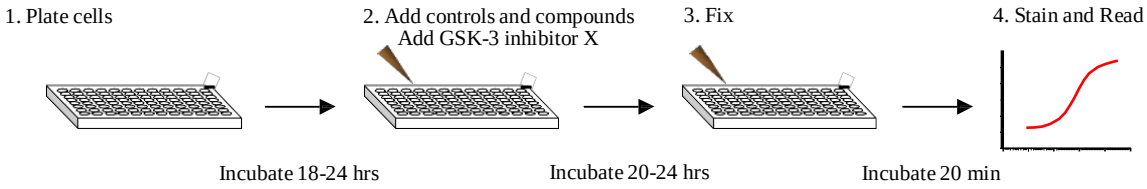


Figure 3: Quick assay workflow overview

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.
   - 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 0.5% 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	----*	60 µl	1% DMSO	----*	0.25%

* Note: Because there is no known antagonist the positive control is run with no agonist activation.

2. Prepare 4X GSK-3 inhibitor X Agonist Solution (20 µM):
   - Prepare fresh by mixing 12 µl 10 mM GSK-3 inhibitor Stock with 6 ml Assay Buffer. Final assay concentration is 5 µM GSK-3 inhibitor X.
3. Add 50 µl 4X concentrated control or compound solution in Assay Buffer to appropriate wells of the cell plate.
4. Add 50 µl 4X GSK-3 inhibitor X Agonist Solution to appropriate wells of the cell plate.
   Note: Do not add 4X GSK-3 inhibitor X Agonist Solution to the “Positive control” wells.
5. Incubate cell plate for 20-24 hours in a 37ºC, 5% CO_2, 95% humidity incubator.
6. Fix cells by gently decanting the buffer and add 150 µl Fixing Solution per well.
7. Incubate cell plate at room temperature for 20 minutes.
8. Wash the cells 4 times with 200 µl PBS per well per wash.
9. Decant PBS from last wash and add 100 µl 1 µM Hoechst Staining Solution.
10. 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

Imaging in general

The translocation of Beta-catenin 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 Beta-catenin Redistribution® assay is the translocation from cytoplasm to nucleus of beta-catenin. The data analysis should therefore report an output relating to the GFP fluorescence intensities in the nucleus and 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), XF100 filter sets for Hoechst and FITC and the Redistribution V3 BioApplication. The output used was MEAN_CircRingAvgIntenRatioLog (Log of the ratio of average fluorescence intensities of nucleus and cytoplasm (well average)). The minimally acceptable number of cells used for image analysis in each well was set to 400 cells.

Other BioApplications that can be used for this assay include Molecular TranslocationV2, CompartmentalAnalysisV2, NucTransV2 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.

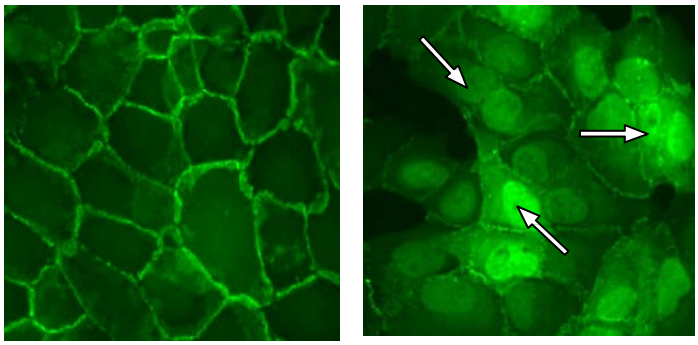
Examples of useful secondary high content outputs:

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 β-catenin Redistribution® Assay may be set up to either monitor test compound induced activation of β-catenin or inhibition of activated β-catenin through rescue of GSK3 inhibition. Example images of the β-catenin Redistribution® Assay are illustrated in Figure 4. Figure 5 shows a concentration response curve of the reference compound GSK3 inhibitor X in the β-catenin Redistribution® assay. The EC_{50} value of GSK3 inhibitor X is approximately 2.5 µM.



DMSO-treated cells GSK3 inhibitor X treated cells

Figure 4. Translocation of β-catenin stimulated withGSK3 inhibitor X. Cells were treated with DMSO or 5 µM GSK3 inhibitor X in. Arrows indicate GSK3 inhibitor X mediated nuclear accumulation of EGFP-β-catenin detected by the image analysis algorithm.

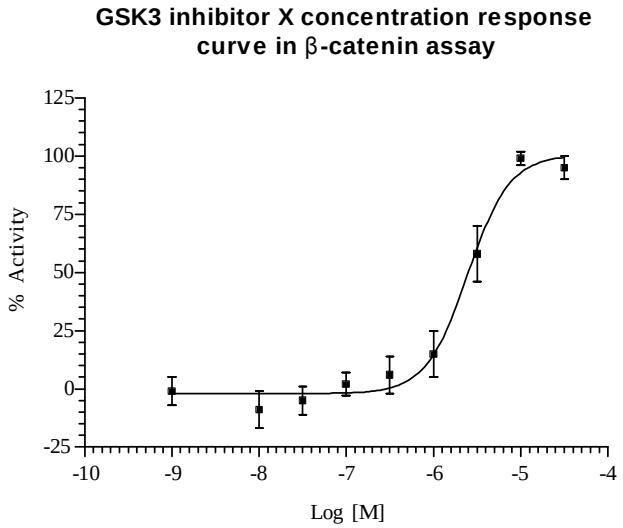


Figure 5: GSK3 inhibitor X concentration response curve in the β-catenin Redistribution® assay (n=4). Concentration response was measured in 9 point half log dilution series of GSK3 inhibitor X. Cells were then fixed and the nuclear accumulation of EGFP-β-catenin was measured using the Cellomics ArrayScan V^{TI} Reader and the RedistributionV3 BioApplication. % activity was calculated relative to the positive (GSK3 inhibitor X) and negative control (0.25% DMSO). The EC_{50} value of GSK3 inhibitor X is approximately 2.5 µM.

Product qualification

Assay performance has been validated with an average Z'=0.65±0.06 (agonist mode) and 0.37±0.13 (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
R04-040-01	CryoRedi	Beta-catenin Redistribution® Assay	U2OS
8403601	HCS Reagent Kit	Beta-catenin Activation Kit	

References

1. Rosen H & Goetzl EJ, Nature Rev Immunol., 5, 560-570, 2005.
2. Kostenis E, J Cell Biochem., 92, 923-936, 2004.
3. Okamoto H et al., J Biol Chem., 273, 27104-27110, 1998.
4. Jo E et al., Chem Biol., 12, 703-715, 2005.
5. Polychronopoulos P et al., J Med Chem., 47, 935-946, 2004.
6. Meijer L et al., Chem Biol., 10, 1255-1266, 2003.

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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 β-catenin Redistribution cell line is genetically modified with a vector expressing β-catenin 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. LC06593403

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