Cellular Dynamics international

iCell® Neurons
User's Guide

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CDI does not in any way guarantee or represent that you will obtain satisfactory results from using iCell Neurons as described herein. The only warranties provided to you are included in the Limited Warranty enclosed with this guide. You assume all risk in connection with your use of iCell Neurons.

Conditions of Use

iCell Neurons are for life science research use only and subject to the use restrictions as contained in Appendix A. You are responsible for understanding and performing the protocols described within. CDI does not guarantee any results you may achieve. These protocols are provided as CDI's recommendations based on its use and experience with iCell Neurons.

Origin

iCell Neurons are manufactured in the United States of America.

Copyright Notice

Revision History

Version 1.2: August 2014
Version 1.1.1: November 2013
Version 1.1: October 2013
Version 1.0.1: November 2012
Version 1.0: December 2011

Table of Contents

Before You Begin

Notes

- Immediately transfer the frozen vials to liquid nitrogen storage.
- Read this entire iCell® Neurons User's Guide before handling or using iCell Neurons.
- iCell Neurons are for life science research use only. See Appendix A for more information and other restrictions.
- A Safety Data Sheet (SDS) for dimethyl sulfoxide (DMSO), in which iCell Neurons are frozen, is available online at www.cellulardynamics.com/lit/ or on request from Cellular Dynamics International. Only technically qualified individuals experienced in handling DMSO and human biological materials should access, use, or handle iCell Neurons.

Notes

Chapter 1. Introduction

Cellular Dynamics International's (CDI) iCell Neurons are a highly pure population of human neurons derived from induced pluripotent stem (iPS) cells using CDI's proprietary differentiation and purification protocols. iCell Neurons are a mixture of post-mitotic neural subtypes, comprised primarily of GABAergic and glutamatergic neurons (Figure 1), with typical physiological characteristics and responses. These cells provide a reliable source of human neurons suitable for use in targeted drug discovery, toxicity testing, and other life science research.

When handled and maintained as recommended in this User's Guide, iCell Neurons quickly assume a typical neuronal morphology with branching neurites (Figure 2). In addition, these cells display a stable adherent single-cell morphology and remain viable for an extended culture period (≥14 days), making them amenable to a variety of electrophysiology, neurotoxicity, and neurotransmission assays.

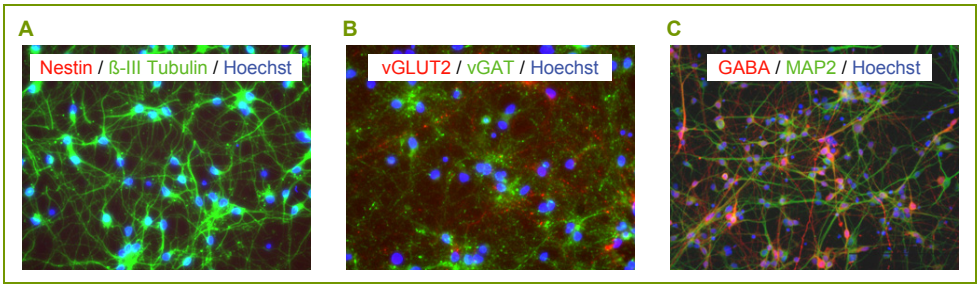

Figure 1: iCell Neurons Represent a Highly Pure Population of Human Neurons
iCell Neurons represent a highly pure population comprised primarily of GABAergic and glutamatergic neurons with low levels of nestin (neuronal progenitor marker) as demonstrated by immunocytochemistry: (A) ß-III tubulin (neuronal marker, green) and nestin (red), 7 days post-plating; (B) punctate staining pattern for the vesicular glutamate transporter 2 (vGLUT2, red) and vesicular GABA transporter (vGAT, green), 14 days post-plating, indicative of glutamatergic and GABAergic neuronal subtypes, respectively; and (C) gamma-aminobutyric acid (GABA, red) and microtubule-associated protein 2 (MAP2, green), 14 days post-plating.

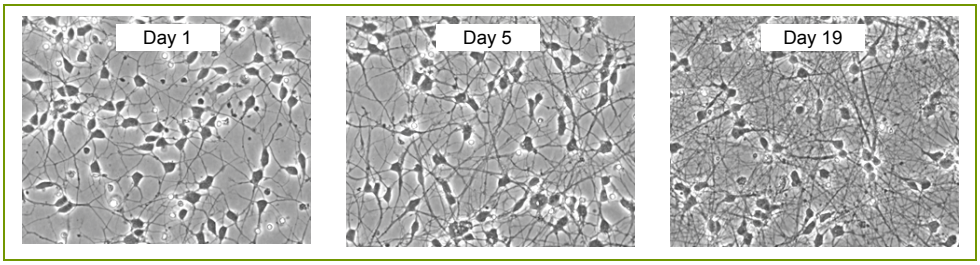

Figure 2: iCell Neurons Exhibit Typical Neuronal Morphology
These images show iCell Neurons at days 1, 5, and 19 post-plating. Re-animated neurons develop branched networks within 24 hours and remain viable and adherent for an extended period in culture (≥14 days).

Components Supplied by Cellular Dynamics

Item	Catalog Number
iCell Neurons[1]	NRC-100-010-001
iCell Neurons Maintenance Medium[1]	NRM-100-121-001
iCell Neurons Medium Supplement[1]	NRM-100-031-001
iCell Neurons User's Guide[1]	
Certificate of Analysis[2]	
Certificate of Origin If required for shipping purposes	

1 Safety Data Sheets and User's Guide available online at www.cellulardynamics.com/lit/

2 Available online at www.cellulardynamics.com/coa/

Required Equipment and Consumables

Item	Vendor	Catalog Number
Equipment		
37°C Water Bath	Multiple Vendors	
Biological Safety Cabinet with UV Lamp	Multiple Vendors	
Cell Culture Incubator	Multiple Vendors	
Hemocytometer or Automated Cell Counter	Multiple Vendors	
Liquid Nitrogen Storage Unit	Multiple Vendors	
Pipettors	Multiple Vendors	
Tabletop Centrifuge	Multiple Vendors	
Consumables		
384-well Cell Culture Plates	Corning	3707
50 ml Centrifuge Tubes	Multiple Vendors	
6-well Cell Culture Plates	Nunc	140675
96-well Cell Culture Plates	Corning	3603
Laminin	Sigma	L2020
Pipettes	Multiple Vendors	
Poly-L-Ornithine	Sigma	P4957
Trypan Blue	Gibco	15250

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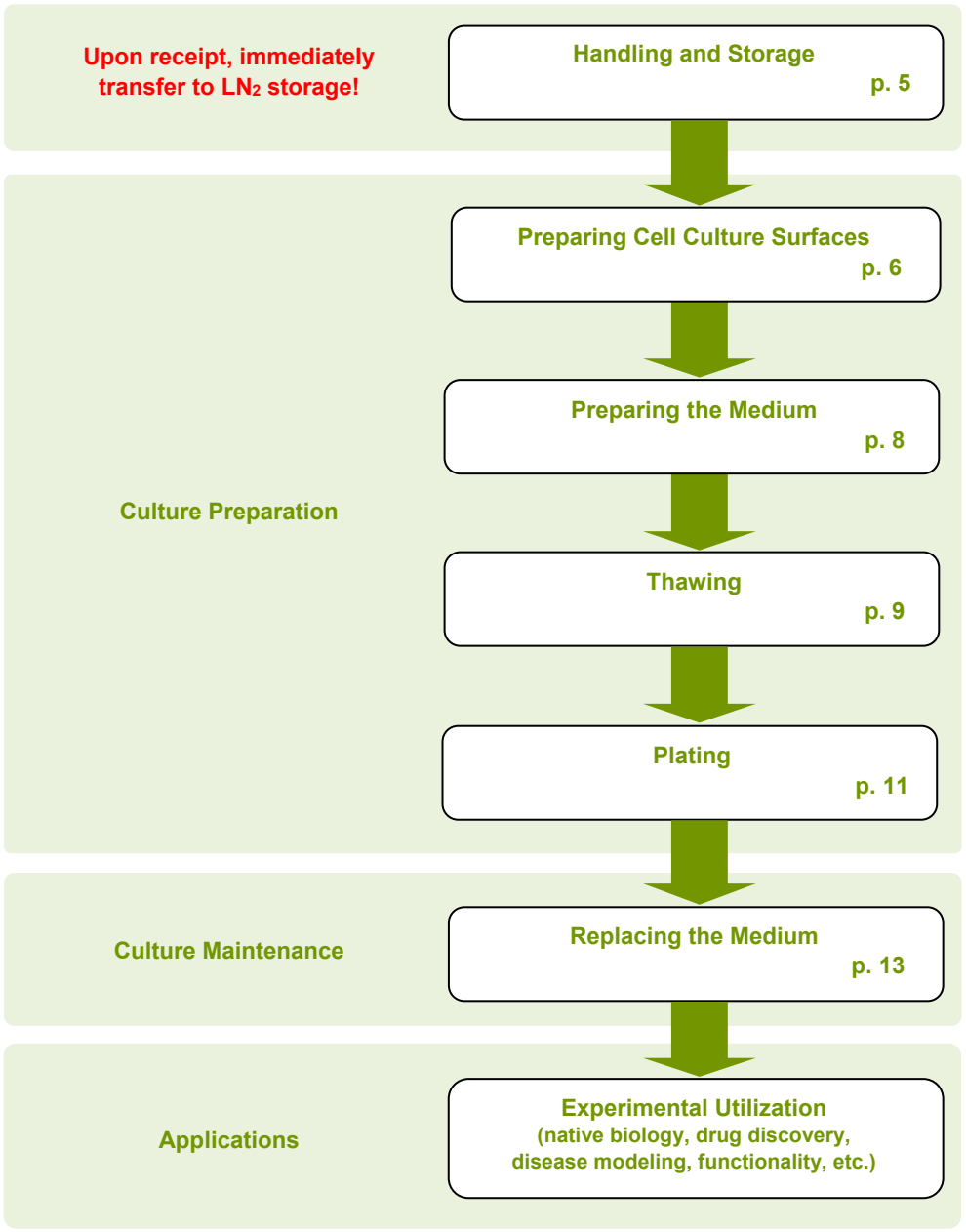
Technical Support and Training

CDI's Technical Support Scientists have the necessary laboratory and analytical experience to respond to your inquiries. In addition, in-lab training may be available upon request.

Telephone	(877) 320-6688 (US toll-free) / (608) 310-5100 x5 Monday - Friday, 8:30 am - 5:00 pm US Central Time
Fax	(608) 310-5101
Email	support@cellulardynamics.com

Workflow Diagram



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Chapter 2. Handling and Storage

Handling iCell Neurons

iCell Neurons are provided as cryopreserved single-cell suspensions in 1.5 ml cryovials. Upon receipt, directly transfer the cryobox containing iCell Neurons to the vapor phase of a liquid nitrogen storage dewar. CDI strongly recommends transferring the entire cryobox into the storage rack to avoid transferring individual vials.

It is critical to maintain cryopreserved iCell Neurons at a stable temperature. Minimize exposure of cryopreserved iCell Neurons to ambient temperature when transferring vials to liquid nitrogen storage.

Handling iCell Neurons Maintenance Medium and Supplement

iCell Neurons media are shipped as two components. iCell Neurons Maintenance Medium is shipped at ambient temperature, and iCell Neurons Medium Supplement is shipped frozen on dry ice. Upon receipt, store iCell Neurons Maintenance Medium at 4°C and iCell Neurons Medium Supplement at -20°C until ready for use.

Chapter 3. Preparing Cell Culture Surfaces

Notes

iCell Neurons will plate and function on the following substrates:

- A freshly prepared plate with a base layer of poly-L-ornithine (PLO) and a top coating of laminin is recommended to promote iCell Neurons attachment, viability, and function. See the Preparing the PLO/Laminin Cell Culture Vessel section.
- Commercially available pre-coated poly-D-lysine plates with a top coating of fresh laminin can also be used. See the Alternate Substrate Options section.

Regardless of the substrate of choice, prepare plating surfaces before thawing iCell Neurons.

Preparing the PLO/Laminin Cell Culture Vessel

1. Thaw 1 mg/ml laminin solution at room temperature or overnight at 4°C. Do not thaw the laminin solution in a 37°C water bath. Do not vortex the laminin solution.
2. Select the cell culture vessel appropriate for your experimental use. Use the volumes specified in the table below in the following coating procedure. Scale volumes appropriately for other vessel formats.

Culture Vessel	Volume of 0.01% PLO Solution (ml)	Volume of Water Rinse (ml)	Volume of 3.3 µg/ml Laminin Solution (ml)
6-well Cell Culture Plate	1	2	3
96-well Cell Culture Plate	0.1	0.2	0.1
384-well Cell Culture Plate	0.025	0.05	0.025

Table 1: Summary of Useful Volumes
*All volumes are **per well**.*

***Note:** For glass coverslips and additional 384-well cell culture plate options, see the Alternate Substrate Options section.*

***Note:** For plating cells into a 1536-well format, see the iCell Neurons Application Protocol: Plating into 1536-well Cell Culture Plates available online at www.cellulardynamics.com/lit/.*

3. Add 0.01% PLO solution to each well of the vessel(s).
4. Incubate the vessel(s) at room temperature for at least 1 hour.
5. Dilute 1 mg/ml laminin solution 1:300 in sterile-filtered Milli-Q (or equivalent) water to a final concentration of 3.3 µg/ml immediately before use. Do not vortex the laminin solution.
6. After incubation, completely aspirate the PLO solution from each well. Rinse each well twice with sterile Milli-Q water and aspirate completely.

Rinsing each well thoroughly is critical to avoid PLO-induced cell toxicity.

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7. Add 3.3 µg/ml laminin solution to each well and incubate the vessel(s) in a 37°C cell culture incubator for at least 1 hour.

   Note: *Alternatively, add the laminin solution to each well, wrap the vessel(s) in parafilm, and store overnight at 4°C. Equilibrate the vessel(s) in a 37°C cell culture incubator before use.*

   Note: *Aliquot any remaining 1 mg/ml laminin solution into small working volumes and store at -20°C.*

8. Aspirate the laminin solution immediately before the addition of the cell suspension.

   Do not allow the laminin-coated surface to dry. Drying the surface can lead to cell clumping and migration.

Alternate Substrate Options

iCell Neurons can be plated onto the following substrates:

- CELLCOAT Poly-D-Lysine Multiwell Plates (Greiner Bio-One, Cat. No. 655946 (96WP), or Cat. No. 781946 (384WP)) or BD BioCoat Poly-D-Lysine Plates (BD Biosciences, Cat. No. 354413 (6WP), or Cat. No. 354640 (96WP)) coated with fresh laminin as described in steps 5, 7, and 8 in the previous section.
- BD BioCoat Poly-D-Lysine/Laminin Coated Glass Coverslips (BD Biosciences, Cat. No. 354087 (round 12 mm)).

Additionally, iCell Neurons have been plated onto other substrates for specific applications. Contact CDI's Technical Support for more information.

Chapter 4. Preparing the Medium

Notes

The Complete iCell Neurons Maintenance Medium (Complete Maintenance Medium) is comprised of iCell Neurons Maintenance Medium and iCell Neurons Medium Supplement. Complete Maintenance Medium is serum- and antibiotic-free and has been specially formulated to maintain the health and function of iCell Neurons while limiting the proliferation of progenitor or non-neuronal cells. iCell Neurons therefore can be maintained in culture for at least 2 weeks in this medium without appreciable loss of viability or purity.

1. Thaw the iCell Neurons Medium Supplement overnight at 4°C (or in a 37°C water bath just until thawed).
2. Spray the iCell Neurons Maintenance Medium bottle and iCell Neurons Medium Supplement vial with 70% ethanol and place in a biological safety cabinet.
3. Using sterile technique, add the entire contents of the iCell Neurons Medium Supplement (~2 ml) to the iCell Neurons Maintenance Medium (~100 ml) to make Complete Maintenance Medium.
4. Store the Complete Maintenance Medium at 4°C, protected from light, for up to 3 weeks.

   Note: *CDI recommends using room temperature Complete Maintenance Medium to thaw iCell Neurons.*

   Note: *Do not refreeze the Complete Maintenance Medium.*

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Chapter 5. Thawing iCell Neurons

Maintain iCell Neurons in liquid nitrogen until immediately before thawing to ensure maximal performance of the cells. Complete the following steps of the thawing procedure in a time-efficient manner to facilitate optimal iCell Neurons viability and performance.

Note: *Thaw no more than 1 vial of iCell Neurons at one time.*

1. Equilibrate the Complete Maintenance Medium at room temperature before thawing iCell Neurons.
2. Remove the iCell Neurons cryovial from the liquid nitrogen storage tank.

   Note: *If necessary, place cryovials on dry ice for up to 10 minutes before thawing.*
3. Immerse the cryovial in a 37°C water bath for **exactly 3 minutes** (avoid submerging the cap) holding the tube stationary (no swirling). Use of a floating microcentrifuge tube rack is recommended.

   

   Precise timing is critical to maximizing viable cell recovery.
4. Immediately remove the cryovial from the water bath, spray with 70% ethanol, and place in a biological safety cabinet.
5. Gently transfer the iCell Neurons cryovial contents to a sterile 50 ml centrifuge tube using a 1 ml pipettor.

   Note: *Use of a 50 ml centrifuge tube facilitates suitable mixing to minimize osmotic shock and increase neuron viability.*

   

   Avoid repeated pipetting of the thawed iCell Neurons cell suspension.
6. Rinse the empty iCell Neurons cryovial with 1 ml of room temperature Complete Maintenance Medium to recover any residual cells from the vial. Transfer the 1 ml of Complete Maintenance Medium rinse from the cryovial drop-wise (~1 drop/sec) to the 50 ml centrifuge tube containing the iCell Neurons cell suspension. Gently swirl the tube while adding the medium to mix the solution completely and minimize the osmotic shock on the thawed cells.

   

   Drop-wise addition of the Complete Maintenance Medium to the cell suspension is critical to minimize osmotic shock and ensure maximum viability and subsequent attachment of the cells to the plating substrate.
7. Slowly add 8 ml of room temperature Complete Maintenance Medium to the 50 ml centrifuge tube drop-wise (~1 - 2 drops/sec). Gently swirl the centrifuge tube while adding the medium.

   

   It is critical to add the 8 ml of Complete Maintenance Medium slowly to ensure maximum viability and attachment of the cells once plated.

8. Gently mix the contents of the 50 ml centrifuge tube by swirling or inverting 2 - 3 times. Gentle mixing is critical to ensure maximum viability. Avoid vigorous shaking or vortexing of the cell suspension.

   Note: *Thaw no more than 1 vial of iCell Neurons at one time. However, once thawed and diluted to the desired density, you can pool the cell suspensions from multiple vials for plating.*

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Chapter 6. Plating iCell Neurons

The recommended plating density for iCell Neurons is 125,000 viable cells/cm^2. See Figure 3 for images showing cells plated at alternative plating densities.

1. Remove a sample of cells to perform a cell count using a hemocytometer (using trypan blue exclusion to identify viable cells) or an automated cell counter.
2. Dilute the cell suspension using room temperature Complete Maintenance Medium to obtain a desired cell plating density.
3. Aspirate the laminin solution from the pre-coated cell culture vessel(s).
4. Immediately dispense the cell suspension into the pre-coated cell culture vessel(s).

   Note: *Plating iCell Neurons at less than 67,500 cells/cm^2 could result in reduced viability over time.*
5. Culture iCell Neurons in a cell culture incubator at 37°C, 5% CO_2.

Expected Cell Density

iCell Neurons can be plated at various densities to accommodate different application needs (Figure 3). 125,000 viable cells/cm^2 is the recommended starting density for most cell-based assays. However, the optimal density of iCell Neurons per unit of surface area can be assay dependent and must be determined empirically based on the intended use. The following table provides the desired cell number and plating volume for several common cell culture vessels.

Note: *This table provides a guide for a healthy neuronal culture. See the application protocols and notes available online at www.cellulardynamics.com/lit/ for recommended densities and plating volumes for various cell-based assays as well as electrophysiological techniques.*

Culture Vessel	Surface Area (cm^2)	Plating Volume (ml)	Cell Number (1.25 x 10^5 cells/cm^2)
6-well Cell Culture Plate	9.6	3	1,200 x 10^3
96-well Cell Culture Plate	0.32	0.2	40 x 10^3
384-well Cell Culture Plate	0.06	0.04	7.5 x 10^3

Table 2: Summary of Recommended Volumes and Measures
*All volumes and measures are **per well**.*

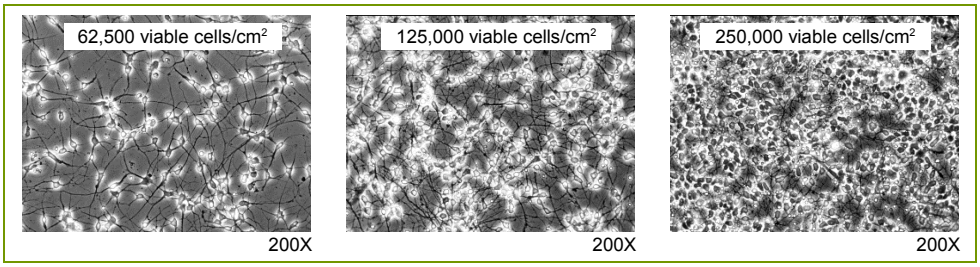

Figure 3: iCell Neurons Plated at Various Densities
These images show iCell Neurons at 48 hours post-plating when plated at 62,500, 125,000, and 250,000 viable cells/cm^2 into a PLO/laminin-coated 96-well cell culture plate.

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Chapter 7. Maintaining iCell Neurons

iCell Neurons are shipped cryopreserved at high purity. The neurons preserve a high purity for at least 2 weeks after thawing if plated and maintained in Complete Maintenance Medium as recommended.

Complete Maintenance Medium is stable for 3 weeks when stored at 4°C.

1. Immediately before use, equilibrate the Complete Maintenance Medium in a 37°C water bath.
2. 24 hours post-plating iCell Neurons, aspirate the spent medium and replace (100% exchange) with the appropriate volume of Complete Maintenance Medium. Recommended volumes are as follows:
   - **6-well cell culture plate:** 2 ml/well
   - **96-well cell culture plate:** 200 µl/well
   - **384-well cell culture plate:** 40 µl/well

   It is critical to gently dispense the Complete Maintenance Medium to the side of the well to avoid cell detachment.
3. Replace 50 - 75% of the medium every 3 - 5 days.
4. Culture iCell Neurons in a cell culture incubator at 37°C, 5% CO_2.

Appendices

Notes

Appendix A. Intellectual Property Rights, Use Restrictions, and Limited License

A. **OWNERSHIP.** The Products are covered by pending patents and patents: www.cellulardynamics.com/patents. Customer has a limited license to use the Products for internal research purposes for the sole benefit of the Customer, subject to the use restrictions included in subsection B of this Appendix A. Customer acknowledges and agrees that the receipt or purchase of the Products by Customer shall not be construed as a transfer of any title or the grant of any rights in or to the intellectual property embodied in the Products owned or licensed by Cellular Dynamics. In particular, no right or license to make, have made, offer to sell, or sell the Products, to modify or reproduce the Product or any part thereof, or to use the Products in combination with any other product(s), except product(s) provided or expressly licensed to Customer by Cellular Dynamics for such use, is implied or conveyed by the sale or transfer of Products to Customer.

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A. During the Warranty Period (as defined below) and subject to subsection F of this Appendix B, Cellular Dynamics warrants that its Products conform to the specifications contained in the Certificate of Analysis for the Product shipped to Customer. Customer's sole and exclusive remedy (and Cellular Dynamics' sole and exclusive liability) with respect to any defective Products shall be replacement of the defective Products by Cellular Dynamics pursuant to this Appendix B.

B. Under no circumstances shall Cellular Dynamics' liability to Customer exceed the amount paid by Customer for the Products to Cellular Dynamics. Cellular Dynamics will bear all reasonable shipping costs if the Products are replaced pursuant to this warranty. For clarity, this warranty automatically shall be void, and any claims under it invalid, (i) if Customer's use of the Products is other than solely in accordance with this User's Guide and Cellular Dynamics' Terms and Conditions (or such other written agreement between Cellular Dynamics and Customer under which the Products are sold or transferred to Customer) or for a purpose or in a manner other than that for which the Products were designed; or (ii) if Customer fails to follow this User's Guide for the use, storage, and handling of the Products

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however such failure is caused; or (iii) if Customer fails to comply with any of the provisions of Appendix A in this User's Guide; or (iv) if there is any abuse, other misuse or neglect of the Products by Customer or to the extent of any damage or loss of the Products by events or occurrences beyond a person's (e.g., Cellular Dynamics') control including without limitation, accident, fire, vandalism and natural disasters (acts of God). This warranty applies only to Customer and not to third parties. This warranty is not assignable.

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D. Within five (5) business days of thawing the Product but prior to the expiration date of the Product as listed on the Certificate of Analysis and/or Product's label (the "Warranty Period"), Customer must notify Cellular Dynamics in writing of any nonconformity of the Products, describing the nonconformity in detail. Customer's failure to properly notify Cellular Dynamics in the Warranty Period voids the limited warranty set forth above in this Appendix B.

E. Customers who believe they have a warranty claim should call Cellular Dynamics' Technical Support line at (608) 310-5100 ext. 5 or email at support@cellulardynamics.com to request a replacement Product based on a breach of the limited warranty set forth above in this Appendix B. Any action by Customer for Cellular Dynamics' breach of this limited warranty, for which Customer has given timely and proper notice of such breach during the Warranty Period and otherwise in accordance with this Appendix B, must be commenced by Customer within 18 months following the date of such breach.

F. Cellular Dynamics makes no warranty of any kind or nature, neither express nor implied, for any product sold together with, or as a part of, the Products (e.g., an accessory accompanying a Product or a discrete component part of a Product that is a kit) that is not manufactured by Cellular Dynamics. Any such accessory to or part of the Products shall have the warranty, if any, that is offered and granted (and, for clarity, extended by its terms to Customer) by the manufacturer of such other accessory or component product accessories.

G. Customer acknowledges and agrees that Cellular Dynamics may fill Customer's order with any number of units of Products. Such units may be more units than Customer ordered. Customer will not be charged extra for any adjustments made by Cellular Dynamics. The number of cells in a unit is determined by the Product's Certificate of Analysis. The number of cells that are contained in a unit accounts for both viability and plating efficiency percentages. Because this may vary from lot to lot, Cellular Dynamics reserves the right to fill the order with that number of units which is sufficient to fill Customer's order and such adjustments shall not constitute a breach of the limited warranty set forth herein.

Appendix C. Limited Liability

TO THE FULLEST EXTENT PERMITTED UNDER APPLICABLE LAW, CELLULAR DYNAMICS SHALL NOT HAVE ANY LIABILITY FOR INCIDENTAL, COMPENSATORY, PUNITIVE, CONSEQUENTIAL, INDIRECT, SPECIAL OR OTHER SIMILAR DAMAGES, HOWEVER CAUSED AND REGARDLESS OF FORM OF ACTION WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT PRODUCT LIABILITY OR OTHERWISE, EVEN IF CELLULAR DYNAMICS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. NOTWITHSTANDING ANY OTHER TERM OR IMPLICATION TO THE CONTRARY, UNDER NO CIRCUMSTANCES SHALL CELLULAR DYNAMICS' LIABILITY TO CUSTOMER EXCEED THE AMOUNT PAID BY CUSTOMER FOR THE PRODUCTS TO CELLULAR DYNAMICS.

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