

---

Product Manual

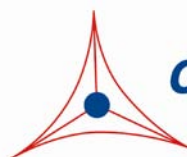
# AAV- DJ/8 Helper Free Packaging System

Catalog Number

VPK- 400- DJ- 8      1 kit

**FOR RESEARCH USE ONLY**  
**Not for use in diagnostic procedures**

---



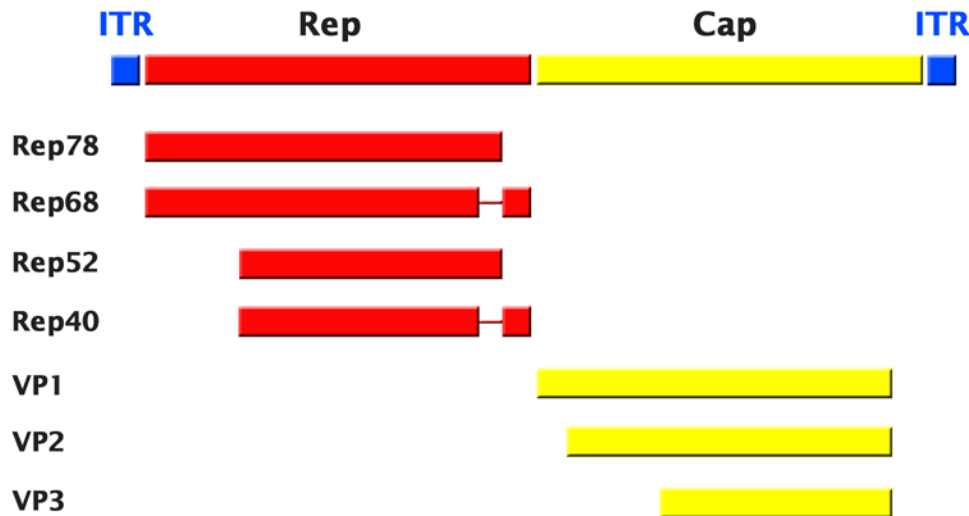
**CELL BIOLABS, INC.**

*Creating Solutions for Life Science Research*

## Introduction

Adeno-associated viruses (AAVs) are derived from defective parvoviruses, which depend on essential helper functions provided by other viruses, such as adenovirus and herpes virus, for efficient viral replication and propagation. AAV has no etiologic association with any known diseases and has been successfully used to establish efficient and long-term gene expression *in vivo* in a variety of tissues without significant cellular immune responses or toxicity.

AAV has a single-stranded DNA genome which consists of approximately 4.7 kb. All characterized AAV serotypes share three key features, including two copies of AAV terminal repeats (ITRs), one *rep* region and one *cap* region. The ITRs are capable of forming T-shape secondary structure and are the only *cis* elements that are required for AAV replication, packaging, integration, and rescue. The *rep* region encodes four overlapping proteins designated as Rep78, Rep68, Rep52, and Rep40, according to the apparent molecular mass of the protein. In addition to their well-defined roles in AAV replication, Rep proteins also regulate AAV packaging and site-specific integration. The *cap* region encodes three structural proteins, VP1, VP2, and VP3. These three proteins share the same reading frame (see Figure 1).



**Figure 1. Schematic Map of AAV Genome.** Rep: involved in genome replication; VP1/2/3: capsid proteins.

Cell Biolabs' AAV Helper-Free System allows the production of infectious recombinant human adeno-associated virus (rAAV) virions without the use of a helper virus (Figure 2). In the AAV Helper-Free System, most of the adenovirus gene products required for the production of infective AAV particles are supplied on the plasmid pHelper (i.e. E2A, E4, and VA RNA genes) that is co-transfected into cells with human AAV vector DNA. The remaining adenoviral gene product is supplied by the 293 host cells, which stably express the adenovirus E1 gene. By eliminating the requirement for live helper virus the AAV Helper-Free System provides a safer and more convenient gene delivery system. In the AAV Helper-Free System, the *rep* and *cap* genes have been removed from the viral vector that contains AAV-2 ITRs and are supplied *in trans* on the plasmid pAAV-RC. The removal of the AAV *rep* and *cap* genes allows for insertion of a gene of interest in the viral genome. Cell Biolabs' AAV Helper-Free System can accommodate inserts of up to 3 kb, depending on the expression vector used (see Table 1 for detail).

Adeno-associated virus (AAV) serotypes differ broadly in transduction efficacies and tissue tropisms. DNA family shuffling technology was used to create a complex library of hybrid capsids from eight different wild-type viruses (Figure 3). Stringent selection of AAV variants on human liver cells and with human anti-AAV antisera result in AAV-DJ (a clone named after the first two authors, see ref. 11), and AAV-DJ/8 (a heparin binding domain mutant of AAV-DJ). Recombinant AAV-DJ vectors mediate superior in vitro transduction efficacies in comparison with any other wild type serotypes. Transduction on cell types from different species and tissues, including primary human hepatocytes, melanoma cells, and embryonic stem cells, showed that AAV-DJ vectors were not only superior to all HBD-negative wild-type viruses (up to 100,000-fold better than AAV-8 or AAV-9), but also substantially better than AAV-2. (See Table 2 for detail). The heparin binding domain (HBD) plays important role for in vivo viral infection as demonstrated by comparing AAV-DJ to the DJ/8 mutant: HBD deletion alleviated the liver restriction and expanded transduction to all nonhepatic tissues, including the brain, identical to the transduction patterns of AAV-8 and AAV-9.

Recombinant adeno-associated viruses are important tools for gene delivery and expression. AAV has not been reported to cause any diseases. Together with its replication defective nature, AAV has good safety profile to be used in gene transfer in vivo, and as potential gene therapy vehicles. Recombinant AAV is capable of infecting a broad range of cell types including non-dividing cells and remaining as concatemers for long-term expression. Compared with other viral vectors such as adenovirus, AAV elicits very mild immune response in animal models.

<b>Catalog #</b>	<b>Product Name</b>	<b>Capacity (kb)</b>
VPK-410	pAAV-MCS	3
VPK-415	pAAV-IRES-Puro	1.8
VPK-416	pAAV-IRES-Neo	1.6
VPK-417	pAAV-IRES-Hygro	1.4
VPK-418	pAAV-IRES-GFP	1.7
VPK-419	pAAV-IRES-Bsd	2

**Table 1. Packaging capacity of AAV shuttle vectors.**

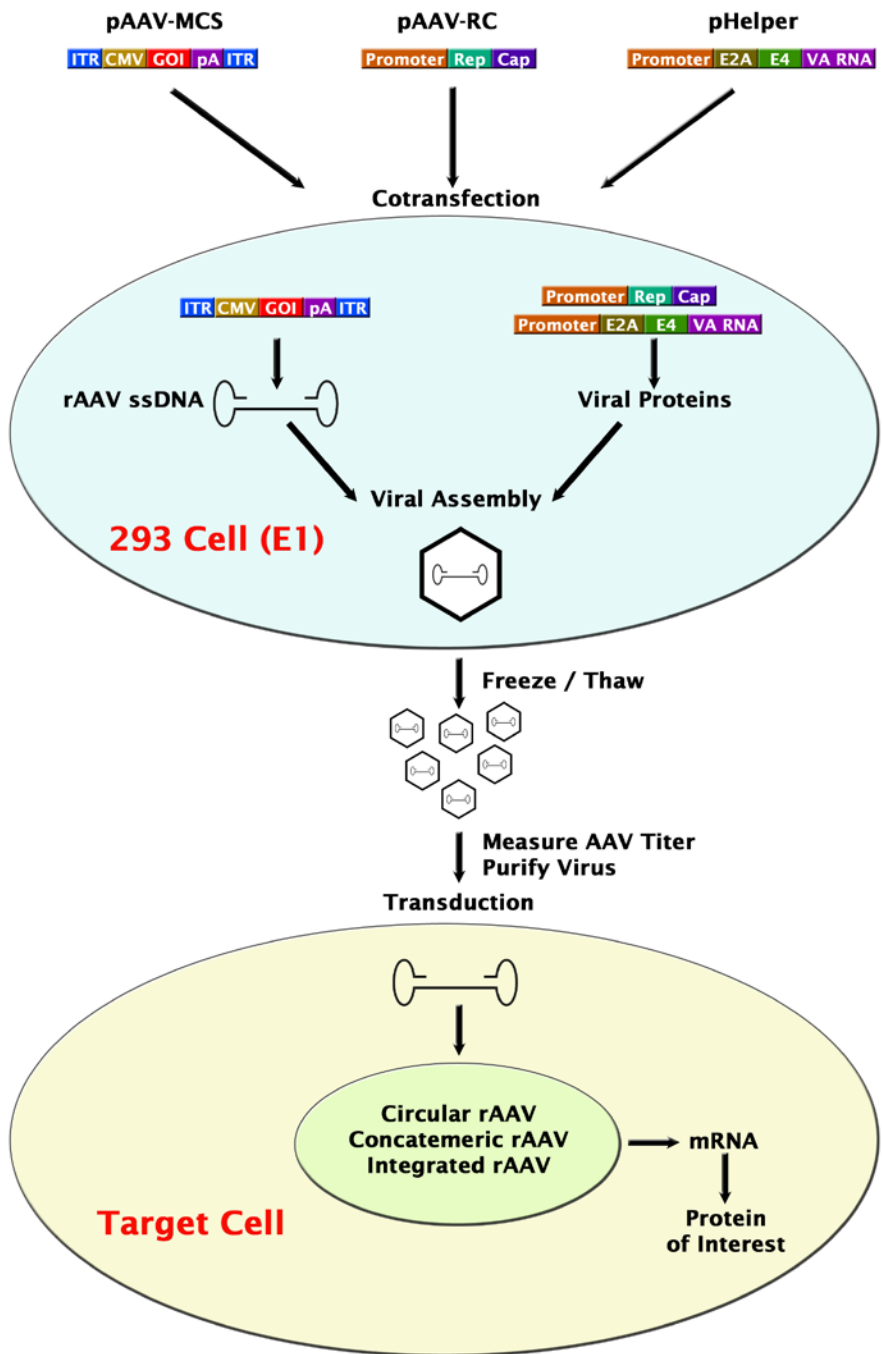
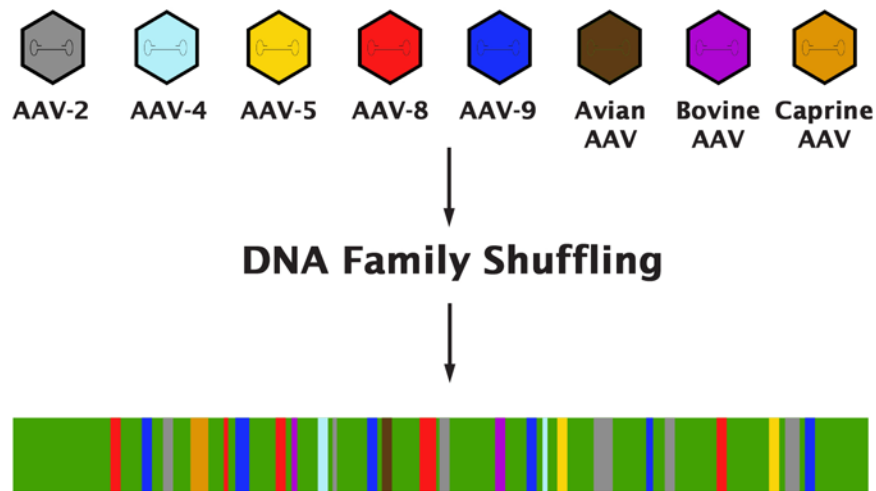


Figure 2. AAV Helper-Free System.



**Figure 3. Generation of AAV-DJ through capsid DNA family shuffling.**

Cell Line	Tissue or Cell Type	AAV-1	AAV-2	AAV-3	AAV-4	AAV-5	AAV-6	AAV-8	AAV-9	AAV-DJ	AAV-DJ/8
Huh-7	Hu Liver	13	100	2.5	0.0	0.1	10	0.7	0.0	500	0.2
HEK293	Hu Kidney	25	100	2.5	0.1	0.1	5	0.7	0.1	500	0.3
HeLa	Hu Cervix	3	100	2.0	0.1	6.7	1	0.2	0.1	667	0.2
HepG2	Hu Liver	3	100	16.7	0.3	1.7	5	0.3	ND	1250	0.5
Hep1A	Ms Liver	20	100	0.2	1.0	0.1	1	0.2	0.0	400	0.1
911	Hu Retina	17	100	11.1	0.2	0.1	17	0.1	ND	500	0.0
CHO	Hm Ovary	100	100	14.3	1.4	333	50	10.0	1.0	25000	5.0
COS	Si Kidney	33	100	33.3	3.3	5.0	14	2.0	0.5	500	0.3
MeWo	Hu Skin	10	100	20.0	0.3	6.7	10	1.0	0.2	2857	1.0
NIH3T3	Ms Fibroblasts	10	100	2.9	2.9	0.3	10	0.3	ND	500	0.1
A549	Hu Lung	14	100	20.0	ND	0.5	10	0.5	0.1	1000	0.1
HT1180	Hu Fibroblasts	20	100	10.0	0.1	0.3	33	0.5	0.1	333	0.2
Monocytes	Hu Primary Monocytes	1111	100	ND	ND	125	1429	ND	ND	100	ND
Immature DC	Hu Monocyte-derived DC	2500	100	ND	ND	222	2857	ND	ND	200	ND
Mature DC	Hu Monocyte-derived DC	2222	100	ND	ND	333	3333	ND	ND	100	ND

**Table 2. In vitro relative infectivity of AAV vectors.**

## **Related Products**

1. VPK-410: pAAV-MCS Expression Vector
2. VPK-418: pAAV-IRES-GFP Expression Vector
3. VPK-410-DJ-8: AAV-DJ Helper Free Expression System
4. VPK-418-DJ-8: AAV-DJ Helper Free Bicistronic Expression System (GFP)
5. AAV-100: 293AAV Cell Line
6. VPK-140: ViraBind™ AAV Purification Kit
7. VPK-141: ViraBind™ AAV Purification Mega Kit
8. VPK-145: QuickTiter™ AAV Quantitation Kit
9. AAV-200: ViraDuctin™ AAV Transduction Kit

## **Kit Components**

1. pAAV-DJ/8 Vector (Part No. VPK-420-DJ-8): One 40 µL vial at 0.25 mg/mL.
2. pHelper Vector (Part No. 340202): One 40 µL vial at 0.25 mg/mL.
3. pAAV-GFP Control Vector (Part No. AAV-400): One 40 µL vial at 0.25 mg/mL.

## **Materials Not Supplied**

1. 293 cells: we recommend 293AAV Cell Line (Cat. # AAV-100) for high titer production of AAV.
2. Cell Culture Medium
3. Transfection Reagents
4. 0.5 M EDTA

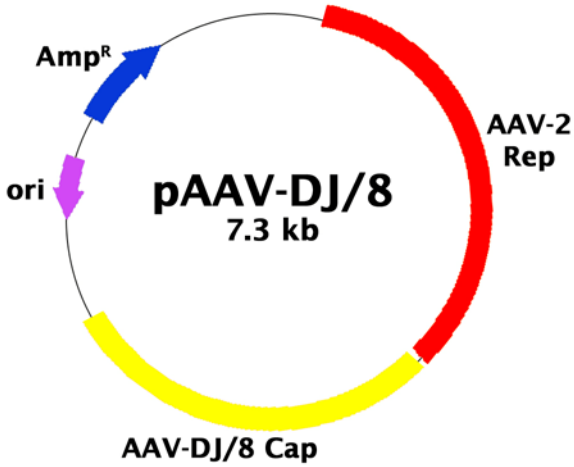
## **Storage**

Store all components at -20°C.

## **Safety Considerations**

Remember that you will be working with samples containing infectious virus. Follow the recommended NIH guidelines for all materials containing BSL-2 organisms. The AAV Helper-Free system is designed to minimize the chance of generating wild type AAV, but precautions should still be taken to avoid direct contact with viral supernatants.

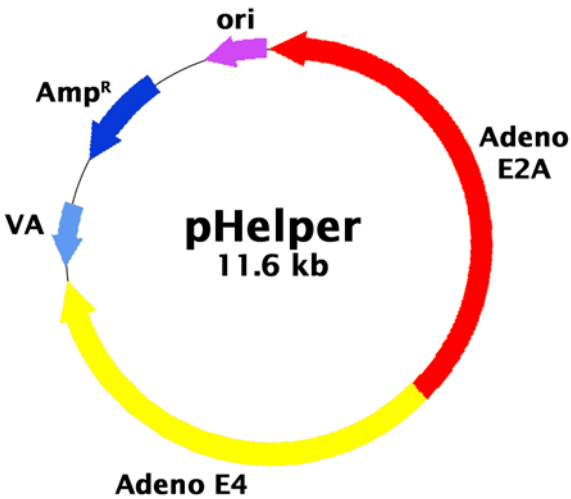
## Vector Features



**Figure 4. pAAV-DJ/8 Vector**

**Vector Features:**

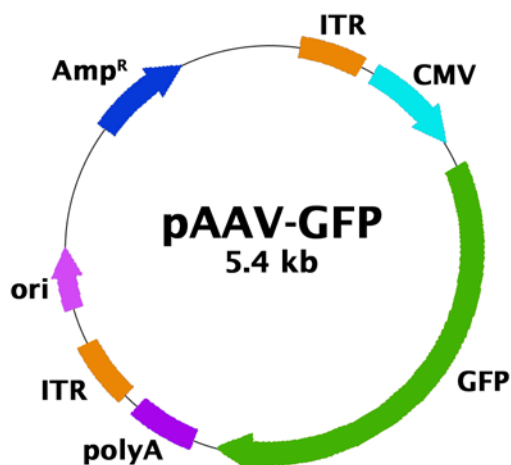
6 ~ 1871: AAV-2 Rep  
1888 ~ 4101: AAV-DJ/8 Cap  
5606 ~ 6466: Ampicillin Resistance



**Figure 5. pHelper Vector**

**Vector Features:**

1 ~ 5336: Adeno E2A  
5337 ~ 8537: Adeno E4  
8535 ~ 9280: Adeno VA  
10182 ~ 11042: Ampicillin Resistance



**Figure 6. pAAV-GFP Vector**

**Vector Features:**

1 ~ 141:	Left ITR
150 ~ 812:	CMV Promoter
820 ~ 1312:	human $\beta$ -globin intron
1335 ~ 2075:	GFP
2134 ~ 2612:	PolyA
2652 ~ 2792:	Right ITR
3709 ~ 4566:	Ampicillin Resistance

**rAAV Production**

1. One day before transfection, plate sufficient 293 cells or 293AAV cells (Cat. # AAV-100) to achieve 70-80% confluence on the day of transfection.
2. Cotransfect cells with pAAV Expression vector, pAAV-DJ/8 and pHelper.  
*Notes:*
  - We recommend the ratio of vectors at 1:1:1 (pAAV Expression Vector:pAAV-DJ/8:pHelper).
  - Calcium Phosphate transfection method is preferred for AAV production. For lipid-based transfection reagents, we only suggest FuGENE® 6 (Roche Applied Science) or Lipofectamine™ LTX (Invitrogen).
3. 48-72 hours after transfection, add 0.5 M EDTA to a final of 10 mM to the plate and incubate for 3 min at room temperature. Gently shake the culture plate several times and harvest all media, including cells, in a sterile tube.  
*Notes:*
  - As viral production proceeds, some of the cells will round up and detach from the plate, and can be seen as floating in the medium.
  - Viruses are present in both intact cells and the growth medium. For more concentrated virus stock, we only recommend proceeding with cell pellet.
4. Centrifuge the cell suspension at 1000 RPM for 5 min. Remove the supernatant and resuspend the cell pellet in desired amount of DMEM or sterile PBS.
5. Freeze and thaw the cell suspension four times by placing it alternately in a dry ice/ethanol bath and a water bath of 37°C. Remove cell debris by centrifugation at 10,000 g for 10 min and collect the supernatant as AAV crude lysate.
6. AAV crude lysate can be used directly or purified/concentrated if needed. For long term storage, store supernatant at -80°C in aliquots.



## **Post-Packaging Considerations**

The quality of rAAV vector preparations is a key element in obtaining reliable and reproducible data. Purification of rAAV from crude cell lysate is usually required before transduction of your target cells. rAAV is usually quantified by genome copy (GC) number. These genome-containing particles are functional vectors that infect target cells. Besides these "full" AAV, empty viral particles are also produced. Measurement of GC rather than total particle number is thus more relevant.

- 1. Concentration and purification of your rAAV:** Recombinant AAV vector can be purified by CsCl gradient ultracentrifugation, iodixanol discontinuous gradient ultracentrifugation, and high-performance liquid chromatography (HPLC).
- 2. Measure titer of your rAAV:**
  - a. Genome Copy (GC) Number:** This is an important step to ensure consistent viral transduction into your host cell. However, QPCR or dot blot of viral DNA can take as much as 1-4 days to complete. An ELISA method has been developed by using antibody that only reacts with AAV intact particles; however, this method measures all AAV particles including the ones lacking genomic DNA. Cell Biolabs' QuickTiter™ AAV Quantitation Kit (Catalog # VPK-145) does not involve cell infection; instead it specifically measures the viral nucleic acid content of purified virus. The entire procedure takes about 30 minutes for purified AAV.
  - b. Infectious Titer:** For AAV vector containing reporter, the rAAV infectious titer can be determined using either green fluorescent protein (GFP) or LacZ as the reporter gene. For rAAV-LacZ, each blue cell after X-Gal staining represents one infectious unit (IU). For rAAV-GFP, each green cell under fluorescence microscopy represents one IU.
- 3. Use transduction reagents to increase infection efficiency:** The AAV transduction process includes viral binding and entry, intracellular trafficking, nuclear transport, and viral second strand DNA synthesis. The viral second strand DNA synthesis has been shown to be the rate limiting step, which leads to inefficient transduction by AAV vectors. Cell Biolabs' ViraDuctin™ AAV Transduction Kit (Catalog # AAV-200) is designed to increase transduction efficiencies by AAV on both dividing and non-dividing cells.

## **References**

1. Auricchio, A., Hildinger, M., O'Connor, E., Gao, G. P. and Wilson, J. M. (2001) *Hum Gene Ther* **12**:71–6.
2. Brument, N., Morenweiser, R., Blouin, V., Toubanc, E., Raimbaud, I. et al. (2002) *Mol Ther* **6**:678–86.
3. Clark, K., Liu, X., McGrath, J., and Johnson, P. (1999) *Hum. Gene Ther.*, **10**:1031-1039.
4. Graham, F. L., Smiley, J., Russell, W. C. and Nairn, R. (1977) *J Gen Virol* **36**:59-74.
5. Grimm, D. and Kleinschmidt, J. A. (1999) *Hum Gene Ther* **10**:2445-50.
6. Matsushita, T., Elliger, S., Elliger, C., Podsakoff, G., Villarreal, L. et al. (1998) *Gene Ther* **5**:938-45.
7. McCarty, D. M., Monahan, P. E. and Sumulski, R. J. (2001) *Gene Therapy* **8**:1248-1254.

8. Rabinowitz, J, and Samulski, R. J. (1998) *Curr. Opin. Biotechnol.*, **9**:470-475.
9. Russell, D. W., Alexander, I. E. and Miller, A. D. (1995) *Proc Natl Acad Sci U S A* **92**:5719-23.
10. Summerford, C., and Samulski, R. J. (1999) *Nat. Med.*, **5**:587-588.
11. Grimm, D., Lee, J.S., Wang, L., Desai, T., Akache, B., Storm, T.A., and Kay, M.A. (2008) *J. Virol.* **82**:5887-5911.

### **Recent Product Citations**

1. Wang, P. et al. (2017). Tau interactome mapping based identification of Otub1 as Tau deubiquitinase involved in accumulation of pathological Tau forms in vitro and in vivo. *Acta Neuropathol.* doi:10.1007/s00401-016-1663-9
2. Luo, W. et al. (2016). Supernova: A versatile vector system for single-cell labeling and gene function studies in vivo. *Sci. Reports* **6**:35747.
3. Iwata, R. et al. (2015). Developmental RacGAP  $\alpha$ 2-chimaerin signaling is a determinant of the morphological features of dendritic spines in adulthood. *J Neurosci.* **35**:13728-13744.

### **Notice to Purchaser #1**

Cell Biolabs, Inc. agrees to sell, and Customer agrees to purchase Cell Biolabs' AAV vectors provided herewith (referred to as the "Products") on the following terms and conditions. (For purposes of this Notice, "Customer" shall include any person or entity which ordered the Products or at any time uses the Products). Customer's acceptance of delivery and/or use of the Products shall constitute Customer's binding agreement to the following terms and conditions. If Customer is unwilling to accept such terms and conditions, Customer must return the Products prior to any use of the Products and shall be entitled to a full refund.

1. The Products provided herewith are covered by issued U.S. and/or foreign patents and/or pending U.S. and foreign patent applications owned by Genzyme Corporation ("Licensor"). Cell Biolabs has the right to sell the Products for use by Customer for internal *in vitro* or *in vivo* research purposes only, wherein said right specifically excludes, without limitation, (i) any use of Products and/or materials made using Products in humans and (ii) any transfer of Product or materials made using Products to a third party. No other rights are conveyed with the sale of Products hereunder. Purchase of the Products does not convey any rights to modify the Products, offer the Products or any derivatives thereof for resale, or distribute or transfer the Products or any derivatives thereof to any third parties.

2. The Products shall be used solely on the premises of and under the control of Customer, and in compliance with all laws, regulations, rules and guidelines applicable to the Products and their use, testing, handling, or other dispositions thereof, or otherwise applicable to Customer's activities hereunder.

3. THE PRODUCTS ARE EXPERIMENTAL IN NATURE AND IS PROVIDED WITHOUT WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Customer hereby waives, releases and renounces any and all warranties, guarantees, obligations, liabilities, rights and remedies, express or implied, arising by law or otherwise, with

respect to the usefulness or freedom from defects of the Products, including, but not limited to, (a) any implied warranty of merchantability or fitness for a particular purpose, (b) any implied warranty arising from course of performance, course of dealing or usage in the trade, and (c) any claim or remedy for (1) loss of use, revenue or profit, or any other damages, (2) infringement of third party intangible property rights, and (3) incidental or consequential damages.

4. Customer agrees to bear all risks associated with the Products and their use, testing, handling or other disposition thereof. Customer hereby assumes all risks of damage or injury to Customer's facilities, employees or agents and to any third party arising from possession or use of the Products. Genzyme Corporation shall have no liability to Customer, its employees or agents or to any third party, regardless of the form or theory of action (whether contract, tort or otherwise, including but not limited to, negligence and strict liability), for any direct, indirect, consequential, incidental or other damages arising out of or relating to the Products or this Agreement.

5. Customer shall indemnify, defend and hold Cell Biolabs, Genzyme, and their licensors, affiliates, distributors, suppliers, directors, officers, employees and agents, harmless from and against any and all claims, actions, demands, liabilities, damages and expenses (including attorneys' fees) relating to or arising out of any damage or injury, including, but not limited to, personal injury and death, alleged to have been caused by the Products or the use, testing, handling or other disposition thereof or Customer's activities hereunder.

6. Customer may at any time properly dispose of the Products in a manner which ensures their prompt destruction and is consistent with all applicable laws, regulations, rules and guidelines.

7. No modification or waiver of any terms or conditions of this Notice shall be effective unless in a writing signed by Customer and an authorized representative of Genzyme. For information on purchasing a license to use the Products for non-research purposes, including commercial manufacturing, clinical manufacturing, commercial sale, or use in clinical trials, please contact: Sr. Vice President of Corporate Development, Genzyme Corporation, 500 Kendall Street, Cambridge, MA 02142.

8. Customer acknowledges and agrees that Genzyme Corporation is an intended third-party beneficiary of this Notice, with the right to enforce the foregoing restrictions.

### **Notice to Purchaser #2**

This product is covered by U.S. Patent # 7,588,772. This licensed product is intended for ACADEMIC, GOVERNMENT AND NON-PROFIT RESEARCH USE ONLY; not for use in diagnostic or therapeutic procedures. The product may not be transferred, sold, or otherwise provided to another laboratory except by an authorized distributor of Cell Biolabs, Inc.

Use of this product by any other entity including for-profit companies requires a license for all fields of use including research. Please contact:

Office of Technology Licensing  
Stanford University  
[info@otlmail.stanford.edu](mailto:info@otlmail.stanford.edu)  
Subject Line: S06-098

## **Warranty**

These products are warranted to perform as described in their labeling and in Cell Biolabs literature when used in accordance with their instructions. THERE ARE NO WARRANTIES THAT EXTEND BEYOND THIS EXPRESSED WARRANTY AND CELL BIOLABS DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR PARTICULAR PURPOSE. CELL BIOLABS' sole obligation and purchaser's exclusive remedy for breach of this warranty shall be, at the option of CELL BIOLABS, to repair or replace the products. In no event shall CELL BIOLABS be liable for any proximate, incidental or consequential damages in connection with the products.

## **Contact Information**

Cell Biolabs, Inc.  
7758 Arjons Drive  
San Diego, CA 92126  
Worldwide: +1 858-271-6500  
USA Toll-Free: 1-888-CBL-0505  
E-mail: [tech@cellbiolabs.com](mailto:tech@cellbiolabs.com)  
[www.cellbiolabs.com](http://www.cellbiolabs.com)

©2011-2017: Cell Biolabs, Inc. - All rights reserved. No part of these works may be reproduced in any form without permissions in writing.