SIGMA-ALDRICH®

sigma-aldrich.com

3050 Spruce Street, St. Louis, MO 63103 USA
Tel: (800) 521-8956 (314) 771-5765 Fax: (800) 325-5052 (314) 771-5757
email: techservice@sial.com sigma-aldrich.com

Product Information

MISSION® shRNA Human Gene Family Sets, Bacterial Glycerol Stocks

Catalog Numbers: **SH0111, SH0211, SH0411, SH0511, SH0711, SH0811, SH1011, SH1111, SH1311, SH1811, SH1911, SH2111, SH2211, SH2311, SH2411, SH2511, SH2611, SH2711, SH2811, SH2911, and SH3011**

Storage Temperature –70 °C

TECHNICAL BULLETIN

Product Description

Small interfering RNAs (siRNAs) generated from short hairpin RNAs (shRNAs) are a powerful way to mediate gene specific RNA interference (RNAi) for extended periods of time in mammalian cells. The MISSION® product line is a viral-vector-based RNAi library against annotated mouse and human genes. MISSION shRNAs are expressed intracellularly after transduction with amphotropic lentivirus particles, allowing screening in a wide range of mammalian cell lines. In these cell lines, MISSION shRNA clones permit rapid, cost efficient loss-of-function and genetic interaction screens. We have collected a list of reviews that highlight the importance of each gene family set.

The MISSION shRNA Gene Family Sets allow for high throughput loss-of-function and genetic interaction screens. The glycerol stock format consists of bacterial glycerol stocks harboring sequence-verified shRNA lentiviral plasmid vectors. Each MISSION shRNA clone is constructed within the lentivirus plasmid vector pLKO.1-puro.[1] The pLKO.1–puro vector contains the ampicillin and puromycin antibiotic resistance genes for selection of inserts in bacterial or mammalian cells, respectively. The sets consist of sequence-verified shRNA lentiviral plasmid DNA. For each gene target, there are 3 or more constructs that have been designed against each target gene using a proprietary algorithm. Therefore, a range of gene silencing efficiencies, with at least one construct from each gene set being >70%, can be expected when using these clones. This allows one to examine the effect of loss of gene function over a large range of gene knockdown efficiencies. Each shRNA construct has been cloned and sequence verified to ensure a match to the target gene.

Bacterial cultures may be amplified from the glycerol stocks for use in purification of the shRNA plasmid DNA. Subsequently, target cell lines may be transfected with the purified plasmid for transient or stable gene silencing (puromycin selection). In addition, self-inactivating replication incompetent viral particles can be produced in packaging cells (HEK293T) by co-transfection with compatible packaging plasmids.[4-5] Unlike murine-based MMLV or MSCV retroviral systems, lentiviral-based particles permit efficient infection and integration of the specific shRNA construct into differentiated and non-dividing cells, such as neurons and dendritic cells,[6] overcoming low transfection and integration difficulties when using these cell lines.

Please see the **Cell Type Table** for those cell types that have been successfully infected by pLKO.1-puro based shRNA constructs.

Each MISSION shRNA clone is constructed within the lentiviral plasmid vector pLKO.1-puro[6] followed by transformation into *Escherichia coli*. The pLKO.1–puro vector contains bacterial (ampicillin) and mammalian (puromycin) antibiotic resistance genes for selection of inserts in either bacterial or mammalian cell lines.

Components/Reagents

The individual clones are provided as a 50 μl bacterial glycerol stock containing Terrific Broth (TB), carbenicillin at 100 μg/ml, and 15% glycerol. The sets are provided in 96-well barcoded plates, along with a CD containing gene description, symbol, RefSeq, locus link, clone ID, hairpin sequence, and plate map position for each clone. The number of plates will vary between gene families; we will not break up a target set between plates.

The hairpin sequence and other unique clone information may be obtained by searching the MISSION search database at: www.sigma.com/yfg using RefSeq accession numbers, e.g. NM_027088, unique clone identification numbers, e.g. NM_027088.1-989s1c1, or TRC numbers, e.g. TRCN0000030720.

Genotype of host *E. coli* strain

F^- Φ80*lac*ZΔM15 Δ(*lac*ZYA-*arg*F)U169 *end*A1 *rec*A1 *rel*A1 *gyr*A96 *hsd*R17 (r_k^-, m_k^+) *pho*A *sup*E44 *thi*-1 *ton*A

Precautions and Disclaimer

These products are for R&D use only, not for drug, household, or other uses. Please consult the Material Safety Data Sheet for information regarding hazards and safe handling practices.

Storage/Stability

Stable for at least six months after receipt when stored at –70 °C. Avoid repeated freeze/thaw cycles, which will severely reduce culture viability.

Catalog Number	Human Gene Family Set	Gene Count *	Clone Count *	Average Number Clones/Gene *
SH1911	Apoptosis Pathway	443	3512	7.9
SH2911	B-Cell Activation	99	661	6.7
SH2211	Cell Adhesion Genes	368	2396	6.5
SH0811	Cytokine and Chemokine	106	538	5.1
SH1311	Cytokine and Chemokine Receptors	93	584	6.3
SH2311	Cytoskeleton Genes	275	1991	7.2
SH3011	Epigenetic Regulators	10	59	5.9
SH1811	DNA Repair Pathway	117	837	7.2
SH0711	Ubiquitin Hydrolases (DUBS)	127	830	6.5
SH2511	Extracellular Matrix Genes	331	1968	5.9
SH0211	G-Protein Coupled Receptors (GPCRs)	541	2864	5.3
SH2611	Helicase	136	909	6.7
SH1011	Ion Channel	277	1479	5.3
SH2711	JAK-STAT Pathway	190	1358	7.1
SH0111	Kinases, complete	678	7607	11.2
SH1111	Nuclear Hormone Receptors	218	1448	6.6
SH2411	p53 Pathway	242	1865	7.7
SH0411	Phosphatases	320	2099	6.6
SH2811	T-Cell Activation	242	1469	6.1
SH0511	Tumor Supressors	73	575	7.9
SH2111	Ubiquitin Ligases (E1, E2, E3)	349	2151	6.2

*The MISSION production and bio-informatics team constantly reviews and quality controls clones available for a gene family set. These numbers are very close to the actual number that will be shipped, but each researcher will receive a final plate map indicating the location and exact TRCN clone numbers.

References

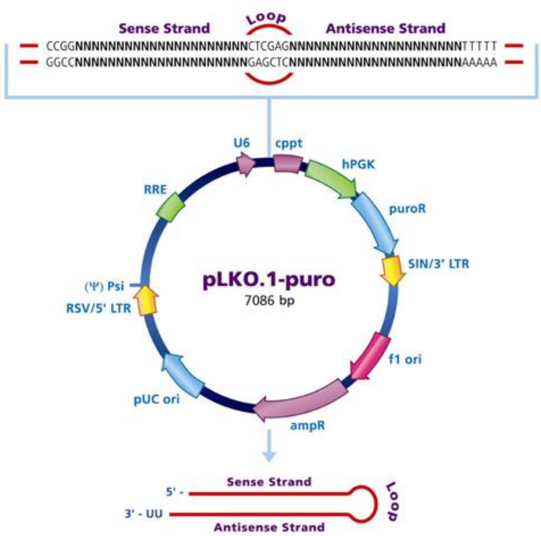
1. Demedts, I.K. *et al.*, Role of apoptosis in the pathogenesis of COPD and pulmonary emphysema. *Respiratory Research*, **7**, 53 (2006).
2. Fink, S.K. *et al.*, Apoptosis, Pyroptosis, and Necrosis: Mechanistic Description of Dead and Dying Eukaryotic Cells. *Infection and Immunity*, **73**(4), 1907-1916 (2005).
3. Miller, M.A. *et al.*, Caspase 8L, a novel inhibitory isoform of caspase 8, is associated with undifferentiated neuroblastoma. *Apoptosis*, **11**, 15-24 (2006).
4. Zufferey, R. *et al.*, Multiply attenuated lentiviral vector achieves efficient gene delivery *in vivo*. *Nat. Biotechnol.*, **15**, 871-85 (1997).
5. Zufferey, R. *et al.*, Self-inactivating lentivirus vector for safe and efficient *in vivo* gene delivery. *J. Virol*., **72**, 9873-80 (1998).
6. Stewart, S.A. *et al.*, Lentivirus-delivered stable gene silencing by RNAi in primary cells. *RNA*, **9**, 493-501 (2003).
7. Whither RNAi? *Nature Cell Biology*, **5**, 489-490 (2003).

Lentiviral Plasmid Vector pLKO.1-puro Features

Name	Description
U6	U6 Promoter
cppt	Central polypurine tract
hPGK	Human phosphoglycerate kinase eukaryotic promoter
puroR	Puromycin resistance gene for mammalian selection
SIN/3′ LTR	3′ self inactivating long terminal repeat
f1 ori	f1 origin of replication
ampR	Ampicillin resistance gene for bacterial selection
pUC ori	pUC origin of replication
5′ LTR	5′ long terminal repeat
Psi	RNA packaging signal
RRE	Rev response element

Procedure for Culturing Clonal Cell Lines

1. Remove ice splinters (50-100 μL) from the frozen bacterial glycerol stock using a sterile loop and place them into a sterile culture tube containing 0.5 ml of LB without antibiotics.
2. Incubate the culture at 37 °C with shaking for 15–30 minutes.
3. Using a sterile loop, streak 25-50 μL of the incubated culture onto freshly prepared plates containing LB agar and carbenicillin (Catalog No. C2113, 100 μg/ml). Carbenicillin, an ampicillin analog, is recommended over ampicillin due to its increased stability in cultures.
4. Incubate plates in a humidified atmosphere for 15–20 hours at 37 °C.
5. Isolate a single colony from the plate and use as a source inoculum for downstream applications (e.g., plasmid DNA preparation).



Troubleshooting Guide

Problem	Cause	Solution
No growth of bacterial culture on selection plates	Incorrect carbenicillin concentration	Re-check the carbenicillin concentration or pour fresh plates containing 100 μg/ml of carbenicillin.
	Insufficient inoculum volume from frozen culture	Remove a larger volume of culture from the frozen glycerol.
	Insufficient storage temperature of frozen culture	Storage temperature must be –70 °C or lower. Obtain new stock.
	Multiple freeze-thaw cycles	Avoid freeze thawing the culture more than 2 times.
Low plasmid yield	Difficult construct	Perform larger purifications (midi or maxi preps) on constructs that produce low yields.
	Failure to use a single colony for inoculation	Use an isolated colony for inoculation of cultures for DNA preps

Control Selection Table

The recommended controls for any shRNA experiment are described in the **Control Selection Table** and are closely aligned with the controls suggested in the *Nature Cell Biology* editorial.[7]

Recommended Control	Objective
Negative Control: Untreated Cells	Untreated cells will provide a reference point for comparing all other samples.
Negative Control: Transfection with empty vector, containing no shRNA insert	MISSION pLKO.1-puro Control Vector, Catalog Number SHC001 The empty vector, pLKO.1-puro, is a useful negative control that will not activate the RNAi pathway because it does not contain an shRNA insert. It will allow for observation of cellular effects of the transfection process and the delivery of the lentiviral vector. Cells transfected with the empty vector provide a useful reference point for comparing specific knockdown.
Negative Control: Transfection with non-targeting shRNA	MISSION Non-Target shRNA Control Vector, Catalog Number SHC002 This non-targeting shRNA vector is a useful negative control that will activate RISC and the RNAi pathway, but does not target any human or mouse genes. The short-hairpin sequence contains 5 base pair mismatches to any known human or mouse gene. This allows for examination of the effects of shRNA transfection on gene expression. Cells transfected with the non-target shRNA vector will also provide a useful reference for interpretation of knockdown.
Positive Control: Transfection with positive reporter vector	MISSION TurboGFP™ Control Vector, Catalog Number SHC003 This vector is a useful positive control for measuring transfection efficiency and optimizing shRNA delivery. The TurboGFP Control Vector consists of the lentiviral backbone vector, pLKO.1-puro, containing a gene encoding TurboGFP, driven by the CMV promoter. Transfection of this vector provides fast visual confirmation of successful transfection and delivery.
Positive Control: Transfection with shRNA targeting reporter vector	MISSION TurboGFP shRNA Control Vector, Catalog Number SHC004 The TurboGFP shRNA vector consists of the pLKO.1–puro vector, containing shRNA that targets TurboGFP, and can be used as a positive control to quickly visualize knockdown. This TurboGFP shRNA Control Vector has been experimentally shown to reduce GFP expression by 99.6% in HEK 293T cells after 24 hours. Because this vector targets TurboGFP, and it does not target any human or mouse genes, it can also be used as a negative non-target control in shRNA experiments

Cell Type Table

The cell types listed below have been successfully infected by pLKO.1-puro based shRNA constructs

Cell lines, human	**Cell Type**		**Cell lines, human**	**Cell Type**		**Primary cells human**	**Cell Type**
HEK293	embryonic kidney cells		A431	epidermal carcinoma		dendritic	immature dendritic
HeLa	cervical adenocarcinoma		THP1	monocytic		T-cells	lymphocytes
A549	lung adenocarcinoma		RAW264.7	macrophage		epithelial	prostate
H1299	lung carcinoma		SH-SY5Y	brain neuroblastoma		fibroblasts	primary mammary
HT29-D4	colon carcinoma		HCN-1A	brain cortical neuron		**Primary cells, other species**	**Cell Type**
HepG2	hepatocellular carcinoma		SupT1	T-cells		ECS	mouse embryonic stem cells
HCT116	colon carcinoma		BJ-TERT	diploid fibroblasts		fibroblasts	mouse embryonic fibroblasts
MCF7	breast carcinoma		**Cell lines, mouse**	**Cell Type**		MC3T3-E1	mouse bone marrow derived
MCF10A	breast carcinoma		NIH3T3	fibroblast		molar mesenchymal	mouse embryonic mesenchymal
Panc-1	pancreatic epithelioid carcinoma		**Primary cells, human**	**Cell Type**		cardiomyocytes	rat neonatal cardiomyocytes
PC3	prostate carcinoma		astrocytes	normal			
DU145	prostate carcinoma		C3H10T1/2	mesenchymal			

Reviews Indicating the Importance of Each of the Gene Family Sets-

Apoptosis Pathway

1. Krysko, D.V. *et al*., Apoptosis and necrosis: detection, discrimination and phagocytosis. *Methods*, **44**, 205-21 (2008).
2. Howley, B., and Fearnhead, H.O., Caspases as therapeutic targets. *J. Cell Mol. Med.*, Feb 24 [Epub ahead of print] (2008)
3. Logue, S.E., and Martin, S.J., Caspase activation cascades in apoptosis. *Biochem. Soc. Trans.* **36 (Pt 1)**, 1-9 (2008).

B Cell Activation

1. Tolar, P. *et al*., Viewing the antigen-induced initiation of B-cell activation in living cells. *Immunol Rev*., **221**, 64-76 (2008).
2. Youinou, P., B cell conducts the lymphocyte orchestra. *J. Autoimmun*., **28**, 143-51. (2007).

Cell Adhesion

1. Ebnet, K., Organization of multiprotein complexes at cell-cell junctions. *Histochem. Cell Biol.,* Mar 26 [Epub ahead of print] (2008).
2. Basson, M.D., An intracellular signal pathway that regulates cancer cell adhesion in response to extracellular forces. *Cancer Res*., **68**, 2-4 (2008).
3. Mousa, S.A., Cell adhesion molecules: potential therapeutic & diagnostic implications. *Mol. Biotechnol*., **38**, 33-40. (2008).

Cytokine and Chemokine Receptors

1. Callewaere, C. *et al*., Chemokines and chemokine receptors in the brain: implication in neuroendocrine regulation. *J. Mol. Endocrinol.*, **38**, 355-63 (2007)
2. Allen, S.J. *et al*., Chemokine: receptor structure, interactions, and antagonism. *Annu. Rev. Immunol*.; **25**, 787-820 (2007).
3. Zlotnik, A. *et al*., The chemokine and chemokine receptor superfamilies and their molecular evolution. *Genome Biol*.; **7**, 243 (2006).
4. Mantovani, A. *et al*., Regulatory pathways in inflammation. *Autoimmun. Rev*., **7**, 8-11 (2007).

Cytokines and Chemokines

1. Anderson, P. Post-transcriptional control of cytokine production. *Nat. Immunol.,* **9**, 353-9 (2008).
2. Tayal, V., and Kalra, B.S., Cytokines and anti-cytokines as therapeutics--an update. *Eur. J. Pharmacol*., **579**,1-12 (2008).

Cytoskeleton

1. Dalby, M.J., and Yarwood, S.J., Analysis of focal adhesions and cytoskeleton by custom microarray. *Methods Mol. Biol*., **370**, 121-34 (2007).
2. Dustin, M.L., Cell adhesion molecules and actin cytoskeleton at immune synapses and kinapses. *Curr. Opin. Cell Biol*., **19**, 529-33 (2007).

DNA Repair Pathway

1. Hinkal, G., and Donehower, L.A., How does suppression of IGF-1 signaling by DNA damage affect aging and longevity? *Mech. Ageing Dev*., **129**, 243-53 (2008).
2. Hakem, R., DNA-damage repair; the good, the bad, and the ugly. *EMBO J*., **27**, 589-605 (2008).
3. Harper, J.W., and Elledge, S.J., The DNA damage response: ten years after. *Mol. Cell*., **28**, 739-45 (2007).

DUBS - Ubiquitin Hydrolyases

1. Nicholson, B. *et al*., Deubiquitinating enzymes as novel anticancer targets. *Future Oncol*., **3**, 191-9 (2007).
2. Millard, S.M., and Wood, S.A., Riding the DUBway: regulation of protein trafficking by deubiquitylating enzymes. *J. Cell Biol*., **173**, 463-8 (2006).
3. Amerik, A.Y., and Hochstrasser, M., Mechanism and function of deubiquitinating enzymes. *Biochim. Biophys. Acta*, **1695**, 189-207 (2004).

Epigenetic Regulators

1. Esteller, M., Epigenetics in cancer. *N. Engl. J. Med*., **358**, 1148-59. Review (2008).
2. Grønbaek, K. *et al*., Epigenetic changes in cancer. *APMIS,* **115**, 1039-59 (2007).

Extracellular Matrix

1. Rees, M.D. *et al*., Oxidative damage to extracellular matrix and its role in human pathologies. *Free Radic. Biol. Med.,* Apr 8 (2008). [Epub ahead of print}
2. Adair-Kirk, T.L., and Senior, R.M., Fragments of extracellular matrix as mediators of inflammation. *Int. J. Biochem. Cell Biol*., **40**, 1101-10 (2008).
3. Daley, W.P. *et al*., Extracellular matrix dynamics in development and regenerative medicine. *J. Cell Sci.,* **121(Pt 3)**, 255-64 (2008).

G-Protein-Coupled Receptors:

1. Thompson, M.D. *et al*., G protein-coupled receptors disrupted in human genetic disease. *Methods Mol. Biol.*; **448**, 109-37 (2008).
2. Milligan, G., New aspects of G-protein-coupled receptor signalling and regulation. *Trends Endocrinol. Metab*., **9**, 13-9 (1998).

Helicases

1. Ha, T., Need for speed: mechanical regulation of a replicative helicase. *Cell,* **129**, 1249-50 (2007).
2. Singleton, M.R. *et al*., Structure and mechanism of helicases and nucleic acid translocases. *Annu. Rev. Biochem.,* **76**, 23-50 (2007).
3. Xi, X.G., Helicases as antiviral and anticancer drug targets. *Curr. Med. Chem*., **14**, 883-915 (2007).

Ion Channels

1. Cannon, S.C., Physiologic principles underlying ion channelopathies. *Neurotherapeutics*, **4**, 174-83 (2007).

JAK-STAT Pathway

1. Murray, P.J., The JAK-STAT signaling pathway: input and output integration. *J. Immunol*., **178**, 2623-9 (2007).
2. O'Sullivan, L.A. *et al*., Cytokine receptor signaling through the Jak-Stat-Socs pathway in disease. *Mol. Immunol*., **44**, 2497-506 (2007).

Kinases

1. Gomase, V.S. *et al*., *Curr. Drug Metab*., **9**, 255-8 (2008).

Nuclear Hormone Receptors

1. Kininis, M., and Kraus, W.L., A global view of transcriptional regulation by nuclear receptors: gene expression, factor localization, and DNA sequence analysis. *Nucl. Recept. Signal*, **6**, e005 (2008).

p53 Pathway

1. Bose, I., and Ghosh, B., The p53-MDM2 network: from oscillations to apoptosis. *J. Biosci*., **32**, 991-7 (2007).
2. Efeyan, A., and Serrano, M., p53: guardian of the genome and policeman of the oncogenes. *Cell Cycle*, **6**, 1006-10 (2007).
3. Kastan, M.B., Wild-type p53: tumors can't stand it. *Cell*, **128**, 837-40 (2007).

Phosphatases

1. Hendriks, W.J. *et al*., Protein tyrosine phosphatases: functional inferences from mouse models and human diseases. *FEBS J*., **275**, 816-30 (2008).
2. Tremblay, M.L., and Giguère, V., Phosphatases at the heart of FoxO metabolic control. *Cell Metab.,* **7**, 101-3 (2008).
3. Heideker, J. *et al*., Phosphatases, DNA damage checkpoints and checkpoint deactivation. *Cell Cycle*, **6**, 3058-64 (2007).
4. Sawyer, T.K. *et al*., Protein phosphorylation and signal transduction modulation: chemistry perspectives for small-molecule drug discovery. *Med. Chem*., **1**, 293-319 (2005).

T Cell Activation

1. Won. J., and Lee, G.H., T-cell-targeted signaling inhibitors. *Int. Rev. Immunol*., **27**, 19-41 (2008).
2. Brenner, D. *et al*., Concepts of activated T cell death. *Crit. Rev. Oncol. Hematol.,* **66**, 52-64 (2008).
3. Seminario, M.C., and Bunnell, S.C., Signal initiation in T-cell receptor microclusters. *Immunol. Rev.,* **221**, 90-106 (2008).
4. Lämmermann, T, and Sixt, M., The microanatomy of T-cell responses. *Immunol. Rev*., **221**, 26-43 (2008).

Tumor Suppressors

1. Vattemi, E., and Claudio, P.P., Tumor suppressor genes as cancer therapeutics. *Drug News Perspect,* **20**, 511-20 (2007).
2. Berger, J.C. *et al*., Metastasis suppressor genes: from gene identification to protein function and regulation. *Cancer Biol. Ther*., **4**, 805-12 (2005).

Ubiquitin Ligases (E1, E2, E3)

1. Cardozo, T., and Pagano, M., Wrenches in the works: drug discovery targeting the SCF ubiquitin ligase and APC/C complexes. *BMC Biochem*., **8 Suppl 1,** S9 (2007).
2. Newton, K., and Vucic, D., Ubiquitin ligases in cancer: ushers for degradation. *Cancer Invest*., **25**, 502-13 (2007).
3. Sun, Y., Overview of approaches for screening for ubiquitin ligase inhibitors. *Methods Enzymol*., **399**, 654-63 (2005).
4. Hershko, A., The ubiquitin system for protein degradation and some of its roles in the control of the cell division cycle. *Cell Death Differ*., **12**, 1191-7 (2005).

This product (based upon the lentikat system) is sub-licensed from Invitrogen Corporation under U.S. Patent Nos. 5,686,279, 5,834,256, 5,858,740; 5,994,136; 6,013,516; 6,051,427, 6,165,782, and 6,218,187 and corresponding patents and applications in other countries for internal research purposes only. Use of this technology for gene therapy applications or bioprocessing other than for nonhuman research use requires a license from Cell Genesys, Inc. Please contact Cell Genesys, Inc. at 342 Lakeside Drive, Foster City, California 94404. Use of this technology to make or sell products or offer services for consideration in the research market requires a license from Invitrogen Corporation, 1600 Faraday Ave., Carlsbad, CA 92008.

This product is for non-clinical research use only. It is not to be used for commercial purposes. Use of this product to produce products for sale or for diagnostic, therapeutic or high throughput drug discovery purposes (the screening of more than 10,000 compounds per day) is prohibited. This product is sold under license from Invitrogen Corporation. In order to obtain a license to use this product for these commercial purposes, contact The Regents of the University of California. This product or the use of this product is covered by U.S. Patent No. 5,624,803 owned by The Regents of the University of California.

This Product is covered by US and foreign patent applications or patents and other proprietary intellectual property rights owned by CSHL ("CSHL shRNA IP Rights"), including U.S. Patent Nos. 8,153,776, 8,202,846, 8,383,599, 8,829,264, and EP1546174.

Subject to acceptance and all terms and conditions of this License, sale of the Product to Buyer by Sigma-Aldrich, Co. (acting under its license, an "Authorized Sale") conveys to Buyer only the nonexclusive, nontransferable right (with no right to sublicense) under the shRNA IP Rights to use the Product solely for Customer's internal research purposes, and only at its facility where the Product is delivered by Sigma-Aldrich, Co.

The Product is for research use only and may not be used *in vitro* or *in vivo* for any diagnostic, preventative, therapeutic or vaccine application, or used (directly or indirectly) in humans for any purpose.

Non-Profit Buyers. If Buyer is a Non-Profit Entity, then the following additional restrictions will apply:

Customer obtains no right to use, develop or otherwise exploit the product for any commercial purpose.

Commercial Buyers. If Buyer is a Commercial Entity, then the following additional restrictions will apply:

A Product sale is an Authorized Sale only if Buyer has already entered into a separate written agreement that has been executed by CSHL or Hairpin Technologies, that covers the CSHL shRNA IP Rights, and that is then currently in effect. Any delivery or transfer of Product to Customer outside of an Authorized Sale is void, conveys no implied or express right under this license and Customer will immediately return Product to Sigma-Aldrich for a refund.

"Commercial Entity" means any entity or organization other than a Non-Profit Entity.

"CSHL" means Cold Spring Harbor Laboratory.

“Hairpin Technologies” means Hairpin Technologies, Inc. located at 2200 Smithtown Avenue, Ronkonkoma, NY 11779, www.hairpintechnologies.com.

"Non-Profit Entity" means any college, university or governmental entity (including without limitation, governmental and quasi-governmental institutes and research laboratories), or any non-profit scientific, research or educational organization of the type described in section 501(c)(3) of the Internal Revenue Code or qualified under a state non-profit organization statute.

"Product" means a product (including, without limitation, expression vectors encoding a shRNA, the design, manufacture or use of which (in whole or in part) is the subject of the shRNA IP Rights, and is deemed to include all components, progeny, reproductions, modified versions and other derivatives thereof.

This license is subject to a license from CSHL or Hairpin Technologies, and CSHL and Hairpin Technologies reserves all other rights under its license. For information on licensing rights for Commercial Entities, including use of this product for purposes other than research and trial licenses, please contact Hairpin Technologies, Inc. at info@hairpintechnologies.com or call (631) 881-0844.

MISSION is a registered trademark of Sigma-Aldrich Co. LLC.
TurboGFP is a trademark of Evrogen Co.

PHC,MAM 08/17-1