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Product Manual

# QuickTiter™ AAV Quantitation Kit

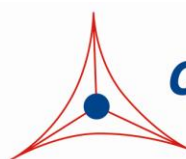
Catalog Number

VPK-145

20 assays

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

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*Creating Solutions for Life Science Research*

## **Introduction**

Viral gene delivery systems include vectors developed from retrovirus (RV), adenovirus (AdV), adeno-associated virus (AAV), lentivirus (LV), and herpes simplex virus (HSV). AAV belongs to the family of Parvoviridae, a group of viruses among the smallest of single-stranded and non-enveloped DNA viruses. There are eight different AAV serotypes reported to date.

Recombinant AAV-2 is the most common serotype used in gene delivery, and it can be produced at high titers with a helper virus or Cell Biolabs' AAV Helper-Free System. AAV-2 can infect both dividing and non-dividing cells and can be maintained in the human host cell, creating the potential for long-term gene transfer. Because AAV-2 is a naturally defective virus, requiring provision of several factors in *trans* configuration for productive infection, it is considered the safest viral vector to use. Recently a new vector, AAV-DJ, was developed using DNA family shuffling to create a hybrid capsid from 8 different AAV serotypes, resulting in a vector with significantly higher *in vitro* infection rates across a variety of cells and tissues.

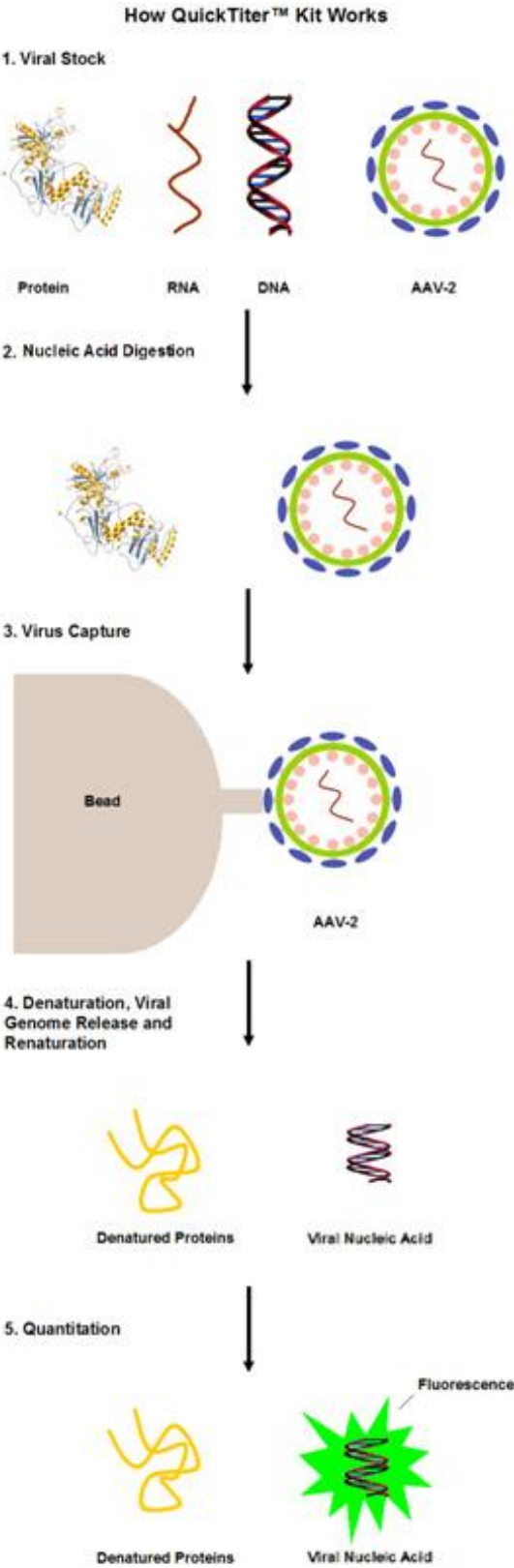
Recombinant AAV-2 and AAV-DJ vectors can be purified by CsCl gradient ultracentrifugation, iodixanol discontinuous gradient ultracentrifugation, or Cell Biolabs' ViraBind™ AAV Purification Kit.

A particular challenge in the delivery of a gene by a viral vector is the accurate measurement of virus titer. Traditionally, AAV particles are measured by DNA dot blot or similar approaches. These methods are time-consuming and suffer from a high degree of inter-assay variability. For highly purified virus samples, an optical absorbance at 260 nm has been used to estimate the total number of virus particles. However this method cannot be used in an unpurified viral supernatant, because other components it contains can contribute to the optical absorbance of 260 nm. 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' proprietary QuickTiter™ AAV Quantitation Kit does not involve cell infection; instead it specifically measures the viral nucleic acid content of purified viruses or unpurified viral supernatant sample (See Assay Principle). The kit is especially useful for determining the supernatant titer before the purification step. The kit has a detection sensitivity limit of  $1 \times 10^9$  GC/mL (genome copy/mL) for unpurified AAV-2 or AAV-DJ supernatants, or  $5 \times 10^{10}$  GC/mL for purified AAV sample from any serotype, which is sufficient for mid or high-titer AAV samples. The entire procedure takes about 4 hours for unpurified supernatant or about 30 minutes for purified AAV. Each kit provides sufficient quantities to perform up to 20 tests for unpurified AAV-2 or AAV-DJ samples generated from the AAV Helper-Free System.

QuickTiter™ AAV Quantitation Kit provides an efficient system for rapid quantitation of AAV titer for both viral supernatant and purified virus.

# Assay Principle



## **Related Products**

1. AAV-100: 293AAV Cell Line
2. VPK-140: ViraBind™ AAV Purification Kit
3. VPK-141: ViraBind™ AAV Purification Mega Kit
4. AAV-200: ViraDuctin™ AAV Transduction Kit
5. VPK-109: QuickTiter™ Adenovirus Titer Immunoassay Kit
6. VPK-110: QuickTiter™ Adenovirus Titer ELISA Kit
7. VPK-106: QuickTiter™ Adenovirus Quantitation Kit
8. VPK-112: QuickTiter™ Lentivirus Quantitation Kit
9. VPK-120: QuickTiter™ Retrovirus Quantitation Kit

## **Kit Components**

1. ViraBind™ AAV Reagent A (Part No. 314001): One 0.3 mL tube.
2. ViraBind™ AAV Reagent B (Part No. 314002): One 1.5 mL tube.
3. QuickTiter™ AAV Capture Matrix (Part No. 314501): One 1 mL tube.
4. QuickTiter™ AAV Wash Solution (5X) (Part No. 314502): One 10 mL bottle.
5. QuickTiter™ Solution C (10X) (Part No. 314503): One 5 mL bottle.
6. CyQuant® GR Dye (400X) (Part No. 105101): One 50 µL tube.
7. QuickTiter™ AAV DNA Standard (Part No. 314504): One 500 µL tube containing 100 µg/mL AAV DNA Standard.

## **Materials Not Supplied**

1. AAV Helper-Free System
2. HEK 293 cells and cell culture growth medium
3. Cell culture centrifuge
4. 1X TE (10 mM Tris, pH 7.5, 1 mM EDTA)
5. Fluorescence Plate Reader

## **Storage**

Store ViraBind™ AAV Reagent B at room temperature and all other kit components at 4°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.

## Preparation of Reagents

- 1X QuickTiter™ AAV Wash Solution: Prepare a 1X QuickTiter™ AAV Wash Solution by diluting the provided 5X stock 1:5 in deionized water. Store the diluted solution at room temperature.
- 1X QuickTiter™ Solution C: Prepare a 1X QuickTiter™ Solution C by diluting the provided 10X stock to 1X with 1X TE. Store the diluted solution at room temperature.

*Note: Only dilute the amount of QuickTiter™ Solution C needed to prepare the Standard Curve and **unpurified** samples. If **purified** AAV samples will be tested, the 10X QuickTiter™ Solution C will be used undiluted.*

- 1X CyQuant® GR Dye: Estimate the amount of 1X CyQuant® GR Dye needed based on the number of assays including AAV DNA standard samples. Immediately before use, prepare a 1X CyQuant® GR Dye by diluting the provided 400X stock 1:400 in 1X TE. For best results, the diluted solution should be used within 2 hrs of its preparation.

## Preparation of Standard Curve

1. Create AAV DNA standards from 10 µg/mL, 5 µg/mL, 2.5 µg/mL, 1.25 µg/mL,... 0 µg/mL (using 1:2 serial dilutions).

Standard Tubes	100 µg/mL AAV DNA Standard (µL)	1X QuickTiter™ Solution C (µL)	AAV DNA Standard (µg/mL)
1	10	90	10
2	50 of Tube #1	50	5
3	50 of Tube #2	50	2.5
4	50 of Tube #3	50	1.25
5	50 of Tube #4	50	0.625
6	50 of Tube #5	50	0.313
7	50 of Tube #6	50	0.156
8	50 of Tube #7	50	0.078
9	50 of Tube #8	50	0.039
10	50 of Tube #9	50	0.020
11	50 of Tube #10	50	0.010
12	0	50	0

2. Transfer 10 µL of each dilution including blank to a microtiter plate suitable for reading on a fluorometer. Add 90 µL of 1X CyQuant® GR Dye to each of the wells containing the 10 µL sample. Read the plate with a fluorescence plate reader using a 480/520 nm filter set.

## Preparation of rAAV Samples

The following procedure is suggested for one 15 cm dish or two 10 cm dishes and may be optimized to suit individual needs. For best results please refer to your user manual for Cell Biolabs' AAV Helper-

Free System or other system you are using. In general, each cell produces about 20,000 to 100,000 viral particles under optimized conditions.

1. Use HEK 293 cells that have been passaged 2-3 times prior to transfection. Culture these cells until the monolayer is 70-80% confluent.
2. Cotransfect cells with the pAAV-RC, pHelper and your expression construct according to manufacturer's manual.
3. After 48-72 hrs, harvest the transfected cells plus culture medium in a conical tube and centrifuge for 5 min at 3000 rpm to pellet the transfected cells. Resuspend the cell pellet in 2.5 mL of serum-free DMEM.
4. Subject the cell suspension to four rounds of freeze/thaw cycles by alternating the tubes between the dry ice-ethanol bath and the 37°C water bath.
5. Collect the AAV supernatant by centrifugation at 10,000 x g for 10 minutes. Discard the pellet.
6. The viral supernatant can be stored at -80°C or immediately titered or purified.

## **Assay Protocol**

### **I. Unpurified AAV-2 or AAV-DJ Samples**

*Note: The following procedure is written for quantitation of 1.0 mL of unpurified AAV-2 or AAV-DJ supernatant. For AAV samples that are less than 1.0 mL, add serum-free DMEM to the final volume of 1.0 mL.*

1. Add 10 µL of ViraBind™ AAV Reagent A to 1.0 mL of viral supernatant, mixing well.
2. Incubate for 30 minutes at 37°C.
3. Incubate ViraBind™ AAV Reagent B for 30-60 minutes at 37°C to ensure Reagent B is dissolved. Add 50 µL of ViraBind™ AAV Reagent B to the viral supernatant pre-treated with ViraBind™ AAV Reagent A, mixing well.
4. Incubate for 30 minutes at 37°C.
5. Resuspend the QuickTiter™ AAV Capture Matrix by inverting and shaking. Add 50 µL of matrix to the virus supernatant.
6. Mix the supernatant/matrix suspension at room temperature for 30 minutes on a shaker.
7. Pellet the AAV Capture Matrix by centrifugation for 10 minutes at 1,000 rpm.
8. Carefully remove the supernatant and wash the AAV Capture Matrix with 1.0 mL of 1X QuickTiter™ AAV Wash Solution. Pellet the AAV Capture Matrix by centrifugation for 5 minutes at 1,000 rpm and carefully remove the supernatant.
9. Repeat the wash step once and aspirate the final wash. To remove the last bit of liquid, centrifuge the tube again at 2000 rpm for 30 seconds, and remove remaining supernatant with a small bore pipette tip to avoid disturbing the beads.
10. Add 20 µL of 1X QuickTiter™ Solution C and mix with the beads by vortexing for 30 seconds. Incubate 1 hr at 75°C. Spin down the beads at 12,000 rpm for 30 seconds.

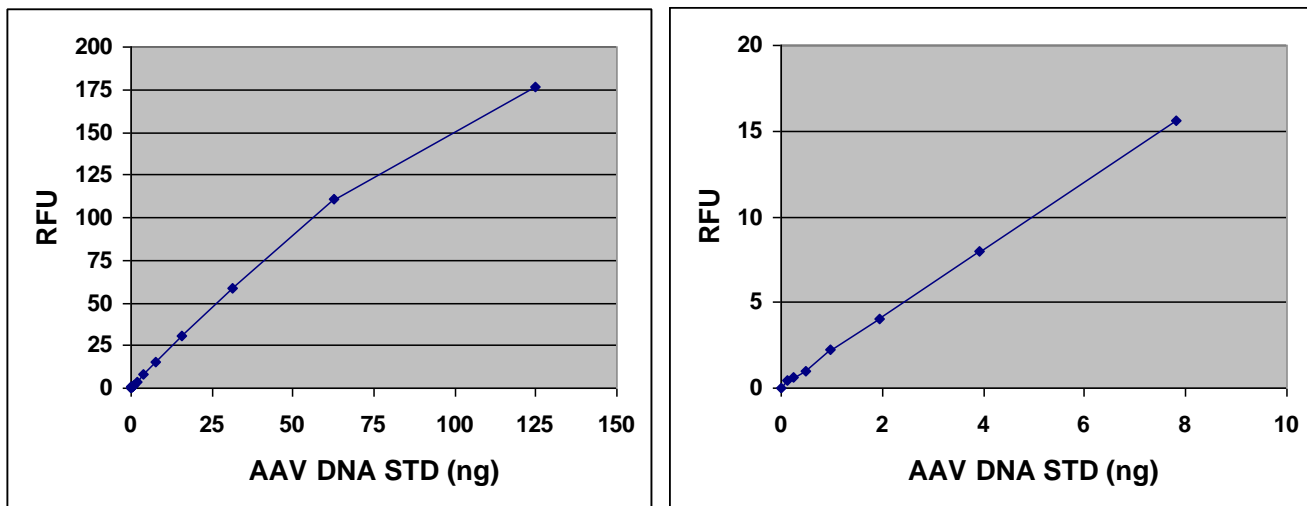
- Transfer 10  $\mu\text{L}$  supernatant to a microtiter plate suitable for fluorometer. Add 90  $\mu\text{L}$  of freshly prepared 1X CyQuant® GR Dye to well(s) containing the 10  $\mu\text{L}$  supernatant. Read the plate with a fluorescence plate reader using a 480/520 nm filter set.
- Calculate AAV titer based on the standard curve.

## II. Purified AAV Sample

- Mix 13.5  $\mu\text{L}$  of purified AAV sample and 1.5  $\mu\text{L}$  of 10X QuickTiter™ Solution C in a tube and incubate 1 hr at 75°C. Spin briefly to collect condensation. Incubate 20 minutes at room temperature.
- Prepare a non-heated control sample by mixing 13.5  $\mu\text{L}$  of the same purified AAV sample and 1.5  $\mu\text{L}$  of 10X QuickTiter™ Solution C in a tube.
- Transfer 10  $\mu\text{L}$  of the mixtures including the non-heated control sample to a microtiter plate suitable for reading in a fluorometer. Add 90  $\mu\text{L}$  of freshly prepared 1X CyQuant® GR Dye to each well containing the 10  $\mu\text{L}$  supernatant. Read the plate with a fluorescence plate reader using a 480/520 nm filter set.
- Calculate AAV titer based on the standard curve.

### Example of Results

The following figures demonstrate typical quantitation results. One should use the data below for reference only. This data should not be used to interpret actual results.



**Figure 1: AAV-2 DNA Standard Curve.** The QuickTiter™ AAV-2 DNA Standard was diluted as described in the Assay Protocol. Fluorescence measurement was performed on a SpectraMax Gemini XS Fluorometer (Molecular Devices) with a 485/538 nm filter set and 530 nm cutoff.

### Calculation of AAV-2 Titer (Genome Copy (GC)/mL)

- Determine AAV-2 DNA amount:

- 1) Calculate Net RFU (Relative Fluorescence Unit):  

$$\text{Net RFU} = \text{RFU (viral sample)} - \text{RFU (negative control corresponding to viral sample)}$$
- 2) Use the standard curve to determine the viral DNA amount of each unknown sample.

## 2. Calculate Viral Titer:

The average genome size of an AAV-2 is 5000 base, therefore:

$$1 \text{ ng AAV-2 DNA} = (1 \times 10^{-9}) \text{ g} / (5000 \text{ base} \times 330 \text{ g/base}) \times 6 \times 10^{23} = 3.6 \times 10^8 \text{ GC}$$

(a) For unpurified AAV-2 sample:

Net RFU = RFU (viral sample) – RFU (0 ng/mL standard)

$$\text{Titer (GC/mL)} = \frac{\text{Dilution Factor} \times \text{AAV-2 DNA (ng)} \times (3.6 \times 10^8 \text{ GC/ng}) \times (20 \mu\text{L}/10 \mu\text{L})}{1.0 \text{ mL}}$$

(b) For purified AAV-2 sample:

Net RFU = RFU (viral sample) – RFU (non-heated control sample)

$$\text{Titer (GC/mL)} = \frac{\text{Dilution Factor} \times \text{AAV-2 DNA (ng)} \times (3.6 \times 10^8 \text{ GC/ng}) \times (15 \mu\text{L}/13.5 \mu\text{L})}{0.010 \text{ mL}}$$

## Calculation Example

Purified AAV-2-GFP (ViraBind™ AAV Purification Kit): undiluted purified AAV-2-GFP was used as described in Assay Protocol

Net RFU = 54.6 – 3.3 = 51.3 or 28 ng of viral DNA

$$\text{Titer (GC/mL)} = \frac{\text{Dilution Factor} \times \text{AAV-2 DNA (ng)} \times (3.6 \times 10^8 \text{ GC/ng}) \times (15 \mu\text{L}/13.5 \mu\text{L})}{0.010 \text{ mL}}$$

$$\text{Titer (GC/mL)} = \frac{1 \times 28 \text{ (ng)} \times (3.6 \times 10^8 \text{ GC/ng}) \times (15 \mu\text{L}/13.5 \mu\text{L})}{0.010 \text{ mL}} = 1.12 \times 10^{12} \text{ GC/mL}$$

## References

1. Rabinowitz, J, and Samulski, R. J. (1998) *Curr. Opin. Biotechnol.*, **9**, 470-475.
2. Summerford, C., and Samulski, R. J. (1999) *Nat. Med.*, **5**, 587-588.
3. Clark, K., Liu, X., McGrath, J., and Johnson, P. (1999) *Hum. Gene Ther.*, **10**, 1031-1039.

## Recent Product Citations

1. Rai, R. et al. (2020). Targeted gene correction of human hematopoietic stem cells for the treatment of Wiskott - Aldrich Syndrome. *Nat Commun.* **11**(1):4034. doi: 10.1038/s41467-020-17626-2.
2. Zeng, J. et al (2020). The Zika Virus Capsid Disrupts Corticogenesis by Suppressing Dicer Activity and miRNA Biogenesis. *Cell Stem Cell.* S1934-5909(20)30350-7. doi: 10.1016/j.stem.2020.07.012.
3. Tang, Y. et al. (2020). Social touch promotes interfemale communication via activation of parvocellular oxytocin neurons. *Nat Neurosci.* doi: 10.1038/s41593-020-0674-y.



4. Zhu, J. et al. (2020). Preparation of a Bacteriophage T4-based Prokaryotic-eukaryotic Hybrid Viral Vector for Delivery of Large Cargos of Genes and Proteins into Human Cells. *Bio-protocol*. **10**(07): e3573. doi: 10.21769/BioProtoc.3573.
5. Wu, Z. et al. (2020). Gene therapy conversion of striatal astrocytes into GABAergic neurons in mouse models of Huntington's disease. *Nat Commun*. **11**(1):1105. doi: 10.1038/s41467-020-14855-3.
6. Zhang, H. et al. (2020). Vitamin D receptor targets hepatocyte nuclear factor 4 $\alpha$  and mediates protective effects of vitamin D in nonalcoholic fatty liver disease. *J Biol Chem*. pii: jbc.RA119.011487. doi: 10.1074/jbc.RA119.011487.
7. Xu, Y. et al. (2020). Diabetic nephropathy exacerbates epithelial-to-mesenchymal transition (EMT) via miR-2467-3p/Twist1 pathway. *Biomed Pharmacother*. **125**:109920. doi: 10.1016/j.biopha.2020.109920.
8. Oser, M.G. et al. (2019). The KDM5A/RBP2 histone demethylase represses NOTCH signaling to sustain neuroendocrine differentiation and promote small cell lung cancer tumorigenesis. *Genes Dev*. doi: 10.1101/gad.328336.119.
9. Niranjana, N. et al. (2019). Sarcolipin overexpression impairs myogenic differentiation in Duchenne muscular dystrophy. *Am J Physiol Cell Physiol*. doi: 10.1152/ajpcell.00146.2019.
10. Ferretti, V. et al. (2019). Oxytocin Signaling in the Central Amygdala Modulates Emotion Discrimination in Mice. *Curr Biol*. pii: S0960-9822(19)30499-3. doi: 10.1016/j.cub.2019.04.070.
11. Hasan, M.T. et al. (2019). A Fear Memory Engram and Its Plasticity in the Hypothalamic Oxytocin System. *Neuron*. pii: S0896-6273(19)30386-1. doi: 10.1016/j.neuron.2019.04.029.
12. Lee, S. et al. (2019). Anti-EpCAM-conjugated adeno-associated virus serotype 2 for systemic delivery of EGFR shRNA: Its retargeting and antitumor effects on OVCAR3 ovarian cancer in vivo. *Acta Biomater*. pii: S1742-7061(19)30287-9. doi: 10.1016/j.actbio.2019.04.044.
13. Nakamura, M. et al. (2019). Glycogen Synthase Kinase-3 $\alpha$  Promotes Fatty Acid Uptake and Lipotoxic Cardiomyopathy. *Cell Metab*. pii: S1550-4131(19)30005-1. doi: 10.1016/j.cmet.2019.01.005.
14. Tseng, S.J. et al. (2018). Targeting Tumor Microenvironment by Bioreduction-Activated Nanoparticles for Light-Triggered Virotherapy. *ACS Nano*. **12**(10):9894-9902. doi: 10.1021/acsnano.8b02813.
15. Ikegami, R. et al. (2018). Gamma-Aminobutyric Acid Signaling in Brown Adipose Tissue Promotes Systemic Metabolic Derangement in Obesity. *Cell Rep*. **24**(11):2827-2837.e5. doi: 10.1016/j.celrep.2018.08.024.
16. Menon, R. et al. (2018). Oxytocin Signaling in the Lateral Septum Prevents Social Fear during Lactation. *Curr Biol*. **28**(7):1066-1078.e6. doi: 10.1016/j.cub.2018.02.044.
17. Wen, L. et al. (2018). Transient High Pressure in Pancreatic Ducts Promotes Inflammation and Alters Tight Junctions via Calcineurin Signaling in Mice. *Gastroenterology*. **155**(4):1250-1263.e5. doi: 10.1053/j.gastro.2018.06.036.
18. McGrady, N.R. et al. (2017). Upregulation of the endothelin A (ETA) receptor and its association with neurodegeneration in a rodent model of glaucoma. *BMC Neurosci*. **18**(1):27. doi: 10.1186/s12868-017-0346-3.
19. 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.
20. Tseng, S.J. et al. (2016). Remote control of light-triggered virotherapy. *ACS Nano* **10**:10339-10346.

21. Eliava, M. et al. (2016). A new population of parvocellular oxytocin neurons controlling magnocellular neuron activity and inflammatory pain processing. *Neuron* **89**:1291-1304.
22. Madroñal, N. et al. (2016). Rapid erasure of hippocampal memory following inhibition of dentate gyrus granule cells. *Nat Commun.* doi:10.1038/ncomms10923.
23. Park, H. Y. et al. (2016). Gadd45 $\beta$  ameliorates L-DOPA-induced dyskinesia in a Parkinson's disease mouse model. *Neurobiol Dis.* **89**:169-179.
24. Tran, L. & Keele, N. B. (2016). CaMKII $\alpha$  knockdown decreases anxiety in the open field and low serotonin-induced upregulation of GluA1 in the basolateral amygdala. *Behav Brain Res.* **303**:152-159.
25. Chen, W. et al. (2016). The silencing of cathepsin K used in gene therapy for periodontal disease reveals the role of cathepsin K in chronic infection and inflammation. *J Periodontal Res.* doi:10.1111/jre.12345.
26. Orabi, A. I. et al. (2015). Dynamic imaging of pancreatic NF- $\kappa$ B activation in live mice using AAV infusion and bioluminescence. *J Biol Chem.* doi:10.1074/jbc.M115.647933.
27. Oh, S. M. et al. (2015). Combined Nurr1 and Foxa2 roles in the therapy of Parkinson's disease. *EMBO Mol Med.* doi: 10.15252/emmm.201404610.
28. Stankowska, D. L. et al. (2015). Neuroprotective effects of transcription factor Brn3b in an ocular hypertension rat model of glaucoma. *Invest Ophthalmol Vis Sci.* **56**:893-907.
29. Li, Y. et al. (2014). Assembly and validation of versatile transcription activator-like effector libraries. *Sci Rep.* 4:4857.
30. Paydar, A. et al. (2014). Extrasynaptic GABAA receptors in mediodorsal thalamic nucleus modulate fear extinction learning. *Mol Brain.* **7**:39.

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