

Graveley Lab shRNA knockdown followed by RNA-seq Biosample Preparation and Characterization Document

Wet Lab: Sara Olson and Lijun Zhan
Computational Lab: Xintao Wei and Michael Duff
PI: Brenton Graveley

Department of Genetics and Genome Sciences
UConn Institute for Systems Genomics
UConn Health
400 Farmington Avenue
Farmington, CT 06030 USA

March 30, 2016

Project: ENCODE3
Grant: U54HG007005
Sample Description: shRNA Knockdown of DDX3X in K562 cells
Cell Line: K562
RNA ID: DDX3X-LV08-15
ENCODE BIOSAMPLE ACCESSION: ENCBS406BAI

This document contains the protocols used to generate shRNA expressing lentiviral particles, transduction of K562 cells, harvesting of RNA, characterization of the RNA integrity and measurement of target knockdown efficiency by both qRT-PCR and Western blotting.

Protocol for producing shRNA lentiviral particles

In this portion of the protocol we will generate lentiviral particles expressing either an shRNA targeting an RNA binding protein mRNA or a non-target control shRNA.

| Item | Info |
|-----------------|-----------------------|
| Target | DDX3X-human |
| shRNA Source | The RNAi Consortium |
| Product ID | TRCN0000000003 |
| Target sequence | CGTAGAATAGTCGAACAAGAT |
| Vector backbone | pLKO.1 |

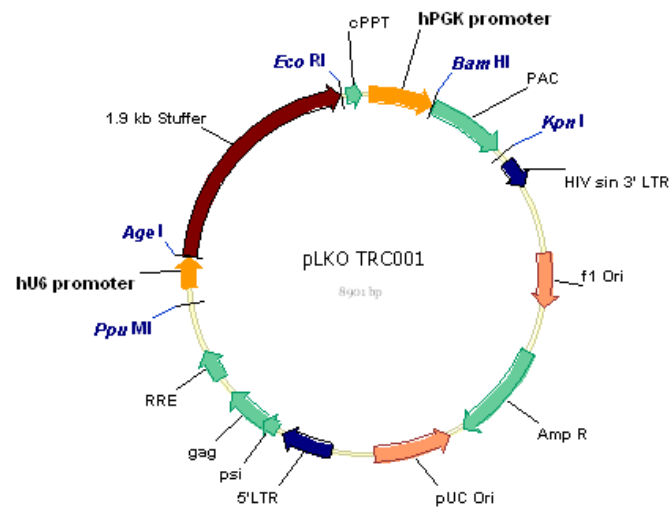


Figure 1: Schematic depiction of backbone of the pLKO.1 plasmid encoding the shRNA.

Day 1

1. Plate $0.8-1 \times 10^6$ 293 T cells (catalog number: CRL-11268, ATCC) in each well of 6-well plate with 10 % FBS (catalog number: 30-2020, ATCC) DMEM (catalog number: 11995-065, Life technologies) medium without penicillin and streptomycin.
2. Incubate overnight. Cells should be 70-80% confluent.

Day 2

1. In polypropylene tubes, make a cocktail for each transfection as follows:

| Reagent | Quantity |
|----------------------|----------------|
| pLKO-shRNA | 500 ng |
| psPAX2 Packaging DNA | 500 ng |
| PMD2.G Envelope DNA | 50 ng |
| serum-free OPTI-MEM | to 100 μ l |

2. Add 3.1 μ l of FuGENE HD Transfection reagent (Catalog number: E2311, Promega) to the tube (FuGENE:DNA=3:1)
3. Incubate for 20 minutes at room temperature.
4. Gently add the DNA mix dropwise to cells.
5. Incubate the cells at 37 °C for 12-15 hr.

Day 3

1. In the morning, change the media to remove the transfection reagent, wash with PBS once and add 1.5 ml fresh media +10% FBS + penicillin/streptomycin.

Day 4

1. Harvest media from cells, store at 4 °C.
2. Add 1.5 ml fresh media.

Day 5

1. Harvest the media from the cells and pool with the media collected on Day 4.
2. Spin the media at 1250 rpm for 5 min to remove cells.
3. Freeze the virus stock at -40°C .

qPCR Lentivirus Titration Assay

Lentiviral titrations are performed using the qPCR Lentivirus Titration kit from Applied Biological Materials Inc. (Catalog Number LV900).

1. Add 2 μ l of the viral supernatant to 18 μ l of Virus Lysis buffer and incubate at RT for 3 mins. This is now referred to as viral lysate.
2. qRT-PCR set up:

| Component | Viral lysate | Positive Control (STD1) | Positive Control (STD2) | Negative control (NTC) |
|-------------------|--------------|-------------------------|-------------------------|------------------------|
| 2x qPCR Mastermix | 12.5 μ l | 12.5 μ l | 12.5 μ l | 12.5 μ l |
| Viral Lysate | 2.5 μ l | | | |
| STD1 | | 2.5 μ l | | |
| STD2 | | | 2.5 μ l | |
| Reagent-mix | 10 μ l | 10 μ l | 10 μ l | 10 μ l |
| Final vol. | 25 μ l | 25 μ l | 25 μ l | 25 μ l |

3. qRT-PCR program:

| STEP | TEMP | TIME |
|-----------------------|-------|------------|
| Reverse Transcription | 42 °C | 20 minutes |
| Enzyme Activation | 95 °C | 10 minutes |
| 40 Cycles | 95 °C | 15 seconds |
| | 60 °C | 1 minute |

4. Calculate the titer from Ct values by using abm's on-line lentiviral titer calculator at <http://www.abmgood.com/High-Titer-Lentivirus-Calculation.html> or by using the formula: $\text{IU/ml} = \text{Dilution factor} \times 5 \times 10^7 / 2^{3(\text{Ct sample} - \text{Ct STD1}) / (\text{CtSTD2} - \text{CtSTD1})}$

Lentiviral Transduction Protocol

For K562 cells

Source: ATCC CCL-243 (lot 59300853)

Growth Media for K562 cells:

500 ml RPMI-1640 with glutamine medium (Hyclone, SH30027.01)
50 ml Fetal Bovine Serum (FBS) (10% Final Concentration) (Hyclone, SH30071.03)
5 ml Pen-Strep (1% Final Concentration) (Invitrogen, 15140-163)

Culturing

1. Remove a frozen stock vial of K562 cells from liquid nitrogen.
2. Thaw it in a 37 °C water bath.
3. As soon as it thawed, transfer the cells into the growth medium.
4. Centrifuge at 1000 rpm for 5 minutes.
5. Resuspend the cells in the growth medium such that the final cell density is about 1×10^5 cells/ml.
6. Split the cells every 2 to 3 days.
7. Grow the cells to required numbers.

Prepare cells for transduction

Day 0

1. Plate $5-7 \times 10^5$ cells in each well of 12-well plates.
2. Add $8 \mu\text{g/ml}$ of polybrene (Catalog Number H9268, Sigma-Aldrich) to the cells.
3. Add lentiviral particles ($\text{MOI} \sim 10$) to appropriate wells.

Day 1

1. After 24 hrs, change to fresh media (2 ml) with $3 \mu\text{g/ml}$ of puromycin.

Day 3

1. Change to fresh media (2 ml) with $3 \mu\text{g/ml}$ of puromycin.

Day 5

1. Change to fresh media (2 ml) with $3 \mu\text{g/ml}$ of puromycin.

Day 6

1. Harvest half of the cells to prepare RNA and half of the cells to prepare a protein lysate for western blotting.

RNA Isolation

RNA isolation is performed using a Promega Maxwell®16 Instrument and the Maxwell®16 LEV simplyRNA Cells Kits (Catlog Number AS1270).

1. Pellet cells at $300 \times g$ for 3 minutes and remove medium.
2. Add $200 \mu\text{l}$ of chilled 1-Thioglycerol/Homogenization solution to the cell pellet and vortex until the pellet is dispersed.
3. Add $200 \mu\text{l}$ of lysis buffer and vortex vigorously for 15 sec to mix.
4. Transfer all $400 \mu\text{l}$ lysate to well 1 of the Maxwell 16 LEV cartridge.
5. Add $5 \mu\text{l}$ of DNase I solution to well 4 of the cartridge.
6. Put elution tubes with $40-50 \mu\text{l}$ of nuclease-free water and LEV plungers in the cartridge.
7. Transfer the Maxwell 16 LEV cartridge rack containing prepared cartridges on the Maxwell 16 Instrument.
8. Push Run/Stop button to start run.

RNA Quality Control

The quality of the RNA is measured using an Agilent TapeStation Instrument with the RNA screen tape (Catlog Number 5067-5576).

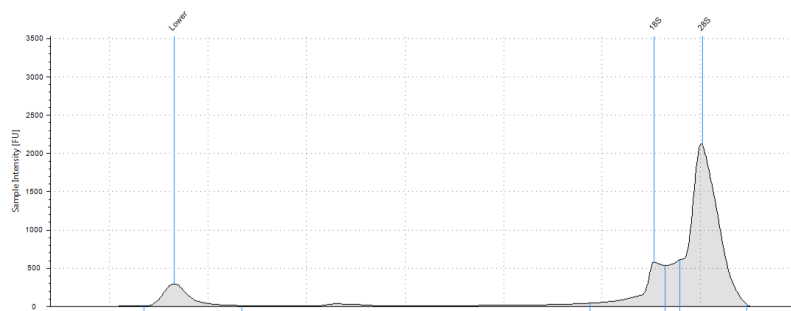


Figure 2: Agilent TapeStation image of 1 μ l of total RNA sample.

qRT-PCR Assay to Monitor mRNA Target Knock-down Efficiency

cDNA Synthesis

This assay uses the iScript cDNA Synthesis Kit from BIO-RAD (Catalog number: 170-8891)

1. Reaction Setup:

| Reagent | Quantity |
|-------------------------------|-------------|
| 5x iScript reaction mix | 2 μ l |
| iScript reverse transcriptase | 0.5 μ l |
| Nuclease-free water | x μ l |
| RNA template (200 ng) | x μ l |
| Total volume | 10 μ l |

2. Reaction Protocol:

| Time | Temperature |
|------------|-------------|
| 5 minutes | 25 °C |
| 30 minutes | 42 °C |
| 5 minutes | 85 °C |
| Hold | 4 °C |

qPCR Assay

This assay uses Phusion High-Fidelity DNA Polymerase from NEB (Catalog number: M0530L) and SYBR Green from Invitrogen (Catalog number: S7563)

1. Reaction setup:

| Reagent | Quantity |
|----------------------------------|---------------|
| 5X Phusion HF Buffer | 4 μ l |
| 10 mM dNTPs | 0.4 μ l |
| 10 μ M Forward Primer | 1 μ l |
| 10 μ M Reverse Primer | 1 μ l |
| Template (1:20 of cDNA reaction) | 1 μ l |
| Phusion DNA Polymerase | 0.2 μ l |
| SYBR Green (10,000 X) | 0.1 μ l |
| Nuclease-free water | to 20 μ l |
| Total volume | 20 μ l |

2. Reaction Protocol:

| STEP | TEMP | TIME |
|----------------------|------------|------------|
| Initial Denaturation | 98 °C | 30 seconds |
| 35 Cycles | 98 °C | 10 seconds |
| | 58 – 66 °C | 15 seconds |
| | 72 °C | 10 seconds |

3. Data Analysis:

Data analysis is performed using the $2^{-\Delta\Delta C_t}$ Method.

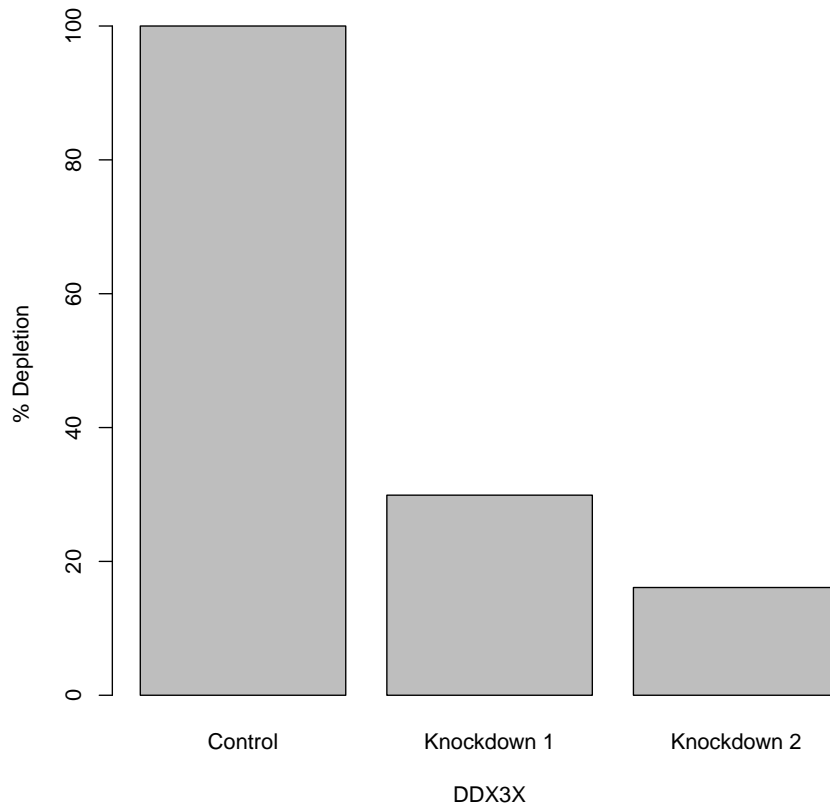


Figure 3: qRT-PCR analysis of depletion level of the target RNA binding protein in control and knockdown cells. The percent depletion was calculated in the RNA sample isolated from K562s transduced with an shRNA targeting DDX3X (ENCODE Biosample ENCBS406BAI) in comparison to K562 cells transduced with a control non-target shRNA (ENCODE Biosample ENCBS366CLP). The efficiency of depletion is normalized using GAPDH as a control.

Western Blot Assay to Monitor Protein Target Knockdown Efficiency

A western blot is performed to determine the knockdown efficiency of the target RNA binding protein. For this biosample, the following antibodies were used:

RNA binding protein primary antibody: DDX3X

Loading control primary antibody: Tubulin

1. Purify protein by resuspending cell pellets in 100 μ l Lysis buffer (50 mM Tris-HCl, pH 7.4; 100 mM NaCl; 1% NP-40; 0.1% SDS; 0.5% sodium deoxycholate) with protease inhibitor (Roche cocktail).

2. Vortex vigorously and leave tubes on ice at least 30 min.
3. Spin 18,000g, 20 min, 4 °C. Recover the supernatant in a new tube on ice. Discard the pellet.
4. Quantitate the protein concentration using the Pierce BCA kit.
5. Load 30–60 μ g of protein per sample depending on expression levels of the protein of interest in the cell type.
6. Dilute the protein samples with 4X sample buffer and 10X reducing agent (Invitrogen NuPage reagents) and heat at 70 °C for 10 min.
7. While samples are heating, prepare the gel: 4–12% Bis–Tris gel for proteins 10–220 kDa, or 8% Tris–glycine for proteins over 220 kDa. Dilute MOPS running buffer to 1X and pour into buffer tank. Add 500 μ l of antioxidant to the inner chamber of the buffer tank. Wash out all wells of the gel with buffer.
8. Load 3 μ l of Licor Odyssey prestained molecular weight marker (928–4000) and protein samples. Run the gel at 200 V for about an hour, until the dye just runs off the gel (less for small molecular weight proteins).
9. Transfer to PVDF for 30 min in transfer buffer, with methanol and antioxidant, using BioRad Semi–dry transfer apparatus.
10. After transfer, block membrane in 5–10 mls of Licor Blocking buffer for 1 hour at room temperature.
11. Incubate with the RNA binding protein primary antibody (0.2 μ g/ml) and the loading control primary antibody (mfg recommended dilution) diluted in Licor block with 0.1% tween 20 on a rocker at 4 °C overnight.
12. The next day, wash the blot 4 x 5 min each in TBST.
13. Prepare the secondary antibody (Rockland Fluorescent TrueBlot anti-rabbit IgG IRDye800 (Catalog number 18–3216–32) for the RBP and Licor IRDye680 secondary antibody for the loading control). Dilute the antibodies according to the mfg instructions in Licor blocking buffer with 0.1% Tween 20 and 0.01% SDS. Incubate on a rocker for 30–60 min, at room temperature.
14. Wash 4 x 5 min each in TBST. Rinse 1x in TBS (no T) and scan on the Licor Odyssey instrument.

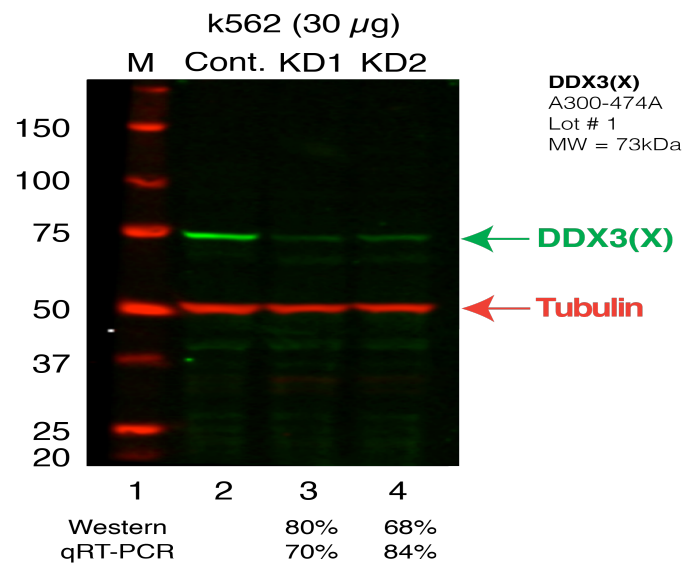


Figure 4: Western Blot Analysis of depletion level of the target RNA binding protein in control and knockdown cells. Lane 1: Molecular weight marker. Lane 2: 30 μ g of protein from K562 transduced with a control, non-target shRNA (ENCODE Biosample ENCBS366CLP and ENCBS746YXR). Lane 3: 30 μ g of protein from K562 transduced with an shRNA targeting DDX3X (ENCODE Biosample ENCBS406BAI). Lane 4: 30 μ g of protein from K562 transduced with an shRNA targeting DDX3X (ENCODE Biosample ENCBS441PSF). Samples were separated by SDS-PAGE, transferred to a membrane and blotted using antibodies against DDX3X (ENCODE Antibody ENCAB173JTT) and Tubulin as controls.