Supplemental Table 1. Cellular proteins identified in this study bound by retroviral 5' UTRs and their previously described activity in retrovirus biology

5' UTR binding protein	Activity in retrovirus biology
ACTA1, ACTB, ACTG1	Actin modulation by different host proteins may be important for HIV-1 particle release and cell- cell transmission (Wen et al., 2014) Perturbation of actin cytoskeleton influences release of HIV-1 virions sequestered in intracellular plasma membrane-connected compartments in human monocyte-derived macrophages (Mlcochova et al., 2013)
ATP5B	Mediates transfer of HIV-1 from APCs to CD4 (+) target cells (Yavlovich et al., 2012) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
DBN1	Identified in a cDNA screen in HIV infected cells to identify potential therapeutic targets (Nguyen et al., 2007) Actin binding protein that regulates HIV-1 triggered actin polymerizations and viral infection (Gordon-Alonso et al., 2013) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
DDX17	Overexpression of wild-type DDX17 increases HIV-1 RNA packaging and infectivity, transfection of a DDX17 mutant decreases Gag-Pol frameshift efficiency (Lorgeoux et al., 2013). Binds to Rev and co-localizes with Rev in nucleolus (Naji et al., 2012; Yasuda-Inoue et al., 2013b) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
DDX21	Binds to rev and co-localizes with rev in nucleolus (Naji et al., 2012; Yasuda-Inoue et al., 2013b); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
DDX3X (DDX3)	Directly interacts with CRM1 in a Ran-independent manner. Binds Rev and increases Rev/RRE-mediated nuclear export of incompletely spliced HIV-1 RNA and replication (Ishaq et al., 2008; Yedavalli and Jeang, 2011) HIV-1 and SNV translation are sensitive to DDX3 knockdown (Soto-Rifo et al., 2012) Co-localizes with Rev in nucleolus (Lai et al., 2013; Yasuda-Inoue et al., 2013b) Required for Tat function (Yasuda-Inoue et al., 2013a) Interacts with Tat to facilitate mRNA translation (Lai et al., 2013) Replaces eIF4E to promote compartmentalized translation initiation of HIV-1 gRNA (Soto-Rifo et al., 2012)
DDX5	Cofactor of HIV-1 Rev (Zhou et al., 2013) Co-localizes with Rev in nucleolus (Naji et al., 2012; Yasuda-Inoue et al., 2013a, b) Interacts with TAR RNA-binding protein (Chi et al., 2011)
DHX30	Over-expression of DHX30 increases HIV-1 transcription, Gag expression and virus release but leads to a decrease in packaging and infectivity (Zhou et al., 2008a) Involved in the ZAP protein anti-viral function against multiple viruses including MLV (Lee et al., 2013; Ye et al., 2010)
DHX9	Modulates HIV-1 translation and infectivity (Bolinger et al., 2010; Hartman et al., 2006) Phosphorylated by PKR as an HIV-1 antiviral response (Sadler et al., 2009) Interacts with HIV Gag (Roy et al., 2006) Activates CTE mediated export of type D retroviruses (Tang and Wong-Staal, 2000; Westberg et al., 2000; Yang et al., 2001) Regulates HIV-1 transcription (Fujii et al., 2001)
EEF1A1	Relocalized by HIV-1 Nef to inhibit ER stress-mediated apoptosis in macrophages (Abbas et al., 2012)
EIF2AK2 (PKR)	Activation caused by Alpha-interferon restricts HTLV-1 and 2 de novo infection (Cachat et al., 2013); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
EIF2S1	Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
ELAVL1 (HuR)	Conflicting data regarding interaction with HIV-1 RT (Ahn et al., 2010; Lemay et al., 2008) Repressor of HIV-1 IRES activity (Rivas-Aravena et al., 2009) Increases the expression of TNF-α and IL-6 in response to HIV-1 protease inhibitor drugs (Zhou et al., 2007)
FLNA	Interacts with HIV-1 Gag and contributes to particle assembly (Cooper et al., 2011) Regulates actin-dependent clustering of HIV receptors (Jimenez-Baranda et al., 2007)
FN1	Down regulated in MMTV-induced tumors (Popken-Harris et al., 2006)
GNL3	Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)

GRSF1	Regulates balance of HIV-1 mRNA species (Jablonski and Caputi, 2009)
HNRNPA1	Overexpression counters the effect of the instability RNA element found in the HIV-1 *gag* coding region that inhibits IRES and cap dependent translation (Valiente-Echeverria et al., 2013) Critical for HTLV-1 replication in transformed T lymphocytes (Kress et al., 2005) Regulates balance of HIV-1 mRNA species and the expression of their protein products (Hallay et al., 2006; Jablonski and Caputi, 2009; Lund et al., 2012) Interacts with HIV-1 Rev (Hadian et al., 2009) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
HNRNPA2B1, HNRNPAB, HNRNPM, NSUN2, RPLP0, RPLP1, RPL7, RPL7A, RPL12, RPL15, RPL22, RPL23A, RPL24, RPL27, RPL27A, RPL29, RPL3, RPL31, RPL35, RPS2, RPS7, RPS8, RPS13, RPS14, RPS15A, RPS16, RPS18, RPS26, U2AF1	Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
HNRNPA3	Regulates balance of HIV-1 mRNA species (Jablonski and Caputi, 2009)
HNRNPD	Knock down leads to a decrease in accumulation of unspliced and singly spliced HIV-1 RNAs in the cytoplasm (Lund et al., 2012)
HNRNPF	Regulates balance of HIV-1 mRNA species (Jablonski and Caputi, 2009) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
HNRNPH1	Interacts with HTLV-2 p28 (Doueiri et al., 2012); Regulates balance of HIV-1 mRNA species (Jablonski and Caputi, 2009)
HNRNPH3	Regulates balance of HIV-1 RNA species (Jablonski and Caputi, 2009)
HNRNPK	Interacts with HTLV p28 and p30 (Doueiri et al., 2012); Interacts with HIV-1 Rev (Hadian et al., 2009)
HNRNPR	Interacts with HIV-1 Rev (Hadian et al., 2009)
HNRNPU	An N-terminal fragment binds the 3'LTR of all species of HIV-1 RNA to prevent their nuclear export, implying a role for HNRNPU in HIV RNA nuclear export (Valente and Goff, 2006) Interacts with HIV-1 Rev (Hadian et al., 2009)
HSP90AB1	Rescues infectivity of defective or ritonavir resistant HIV (Joshi et al., 2013; Joshi and Stoddart, 2011)
HSPA8	Enhances syncytium formation induced by HTLV-1 (Fang et al., 1999; Sagara et al., 1998)
IGF2BP1 (ZBP1, IMP1)	Binds to HIV-1 Gag NC domain, and overexpression leads to a decrease in infectivity through decreased RNA packaging, defective Gag processing on cellular membranes, and inhibition of virus particle maturation (Zhou et al., 2008b) Ectopic expression leads to Rev translocation from the nucleus to cytoplasm causing an accumulation of multiply spliced viral RNAs (Zhou et al., 2009) Found in HIV-1 RNP containing Gag and STAU1 (Milev et al., 2010) Overexpression enhances stability and packaging of MLV based retroviral vectors (Mai and Gao, 2010) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
ILF3 (NF90)	Binds to HIV-1 Rev and RRE RNA to inhibit Rev mediated nuclear export (Urcuqui-Inchima et al., 2006)
IQGAP1	Binds to MA of MLV Gag to play a role in early and late steps of viral replication and assembly (Leung et al., 2006)
KARS	Packaged into HIV-1 VP (Cen et al., 2002); Interacts with CA domain of HIV Gag *in vivo* (Javanbakht et al., 2003) May be involved in tRNA packaging (Saadatmand et al., 2008)
KIF3B	KIF3B associates KIF3A (Yamazaki et al., 1995), and KIF3 is required for HIV-1 release from infected macrophages (Gaudin et al., 2012)

LRPPRC	Interacts with HIV nucleic acids and knockdown attenuates HIV-1 infection (Schweitzer et al., 2012)
MATR3	Interacts with HIV-1 Rev in an RNA-dependent manner, and is required for Rev mediated nuclear export of unspliced HIV-1 RNAs (Kula et al., 2011) HIV-1 pre-mRNA bound to PSF and MATR3 is committed to Rev mediated nuclear export (Kula et al., 2013) Co-factor of HIV-1 for regulating post-transcriptional gene expression (Yedavalli and Jeang, 2011) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
MYH9	Renal MYH9 is downregulated in HIV-1 patients with HIV-associated nephropathy (Hays et al., 2012)
NCL	Interacts with MuLV Gag via NC to inhibit assembly (Bacharach et al., 2000) May be important in HIV-1 host cell entry (Nisole et al., 2002) May promote HIV-1 budding (Ueno et al., 2004)
NONO (p54nrb)	Binds instability element in HIV-1 Gag RNA in the cytoplasm and may play a role in late stages of HIV-1 mRNA metabolism (Zolotukhin et al., 2003)
NOP2	Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
NPM1	Interacts with HIV-1 Tat and HIV-1 infection results in the acetylation of NPM1 which is critical for Tat nuclear localization and Tat-mediated transcription activation (Gadad et al., 2011a; Gadad et al., 2011b)
PABPC1	Cleaved by MMTV, HIV-1, and HIV-2 Protease, and not MoMLV, HTLV-1, and SIV proteases (Alvarez et al., 2006) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
POLR2B	Synthesizes retroviral RNA from integrated provirus retroviruses (Rabson and Graves, 1997)
PRPF8	Constituent of U5 snRNP, does not bind to RSV negative regulator of splicing (NRS) element; hypothesized as mechanism to explain lack of splicing (Giles and Beemon, 2005); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
PTBP1	Identified in previous proteomics studies as interacting with HIV RNA (Black et al., 1996; Kula et al., 2011) TAR-RNA binding protein (Chi et al., 2011);
RAN	Numerous retroviral Gag proteins and accessory proteins enter the nucleus during infection, reviewed in (Stake et al., 2013)
RBMX	Reduced levels in the nucleoli of HIV-1 Tat expressing Jurkat T-cells (Jarboui et al., 2012)
RPL4	Overexpression of RPL4 in certain cell types increases readthrough of *gag* stop codons to produce *gag-pol* transcripts for MoMLV and HIV-1 and impairs virus replication (Green et al., 2012) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPL6	Interacts with HTLV-1 Tax protein (Boxus et al., 2008) HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPL8	Upregulated in B-cells of SIV-infected monkeys with B-cell non-Hodgkin's lymphomas (Tarantul et al., 2000)
RPL9	Interacts with MMTV Gag; knockdown impairs virus release, but not Gag expression (Beyer et al., 2013) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPS10	Interacts with HIV-1 Nef, and Nef decreases translation in a dose-dependent manner (Abbas et al., 2012) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPS23	Upregulated in HIV-1 patients undergoing ART (Massanella et al., 2013); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPS25	Required for HTLV-1 IRES function (Olivares et al., 2014); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPS3A	Upregulated in B-cells of SIV-infected monkeys with B-cell non-Hodgkin's lymphomas (Tarantul et al., 2000); Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RPS6	Antiretroviral drugs indinavir, nelfinavir, and zidovudine decrease translation, partly through impairing phosphorylation of RPS6 (Hong-Brown et al., 2004, 2005) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
RUVBL1	Identified as HIV-1 Tat interaction partner via *in vitro* proteomics study (Gautier et al., 2009) Downregulated in THP-1 cells infected with HIV-1 (Pathak et al., 2009)
SFPQ/PSF	The unspliced HIV-1 RNA contains cis-acting instability (INS) elements located in gag and env open reading frames that impair RNA stability, nucleocytoplasmic transport and translation. INS

	activity counteracts Rev/RRE SFPQ and NONO/p54nrb assemble INS in gag and over-expression of PSF correlates with degradation of INS-containing RNA (Zolotukhin, 2003)
SFRS1	Binds the RRE in a Rev-dependent fashion and overexpression can influence HIV RNA splicing and virus production (Jacquenet et al., 2005; Powell et al., 1997; Ropers et al., 2004) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
SFRS6	Identified in siRNA screen as playing a role in early events of HIV-1 infection (Konig et al., 2008)
SMC3	Identified as HIV-1 Tat interaction partner by an *in vitro* proteomics approach (Gautier et al., 2009)
SNRNP200	Packaged into HIV-1 particles from human lymphoma T cells; function unknown (Santos 2012)
SNRNP70	Component of the U1 snRNP (Wu and Maniatis, 1993) that interacts with HIV-1 major splice donor (Ashe et al., 1997)
SNRPA	Component of the U1 snRNP (Wu and Maniatis, 1993) that interacts with HIV-1 major splice donor (Ashe et al., 1997) SNRPA specifically upregulated by HIV-1 Nef (Simmons et al., 2001) Highly reduced in the nucleoli of HIV-1 Tat expressing Jurkat T-cells (Jarboui et al., 2012)
SNRPD1	Interacts with HIV-1 Tar RNA-binding protein (Chi et al., 2011) identified in siRNA screen of factors involved in HIV-1 replication (Genovesio et al., 2011)
SNRPD3	Interacts with HIV-1 TAR RNA-binding protein (Chi et al., 2011) Interacts with HIV Tat (Fu et al., 2009; Pinney et al., 2009; Ptak et al., 2008)
SPTAN1	Originally identified in siRNA screen for factors required for HIV-1 infection (Brass et al., 2008), however susceptibility of HIV-1 to knockdown is dependent on the envelope used for the assay with authentic HIV env conferring more susceptibility than VSV-G (Gallo and Hope, 2012)
SPTBN1	Originally identified in siRNA screen for factors required for HIV-1 infection (Brass et al., 2008); notably, susceptibility of HIV-1 to knockdown is dependent on the envelope used for the assay with authentic HIV env conferring more susceptibility than VSV-G (Gallo and Hope, 2012) Associates with HIV-1 Gag protein and knockdown confers resistance to HIV-1 infection in macrophages (Dai et al., 2013)
SSB	Addition of purified *E. coli* SSB increased strand displacement synthesis of HIV-1 RT *in vitro* (Fuentes et al., 1996)
SSRP1	Identified as HIV-1 Tat interaction partner via *in vitro* proteomics study (Gautier et al., 2009) Addition of purified *E. coli* SSB increased strand displacement synthesis of HIV-1 RT *in vitro* (Fuentes et al., 1996)
STAU1	Influences HIV-1 Gag multimerization for virus particle assembly (Chatel-Chaix, 2007) Present in the HIV genomic RNP (Chatel-Chaix, 2004; Milev, 2010) Staufen interacts with HIV Gag via zinc fingers in NC (Chatel-Chaix, 2008) Staufen is packaged into HIV virions (Mouland, 2000)
SUB1	Associated with LEDGF, postulated to be involved in retroviral integration site selection (Desfarges and Ciuffi, 2010)
SYNCRIP/HNRNPQ	SYNCRIP (HNRNPQ) interacts directly with HIV-1 Rev and influences translation of Rev-dependent transcripts (Hadian et al., 2009; Vincendeau et al., 2013) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
TARDBP	A transcriptional repressor that binds to HIV proviral DNA at pyrimidine-rich elements in corresponding to TAR; represses HIV-1 transcription irrespective of the presence of Tat *in vitro*; does not bind TAR RNA (Ou et al., 1995)
THRAP3	Interacts with acylated HIV-1 integrase in a yeast-two hybrid screen and IP (Allouch and Cereseto, 2011)
TOP1	Interacts with HIV-1 NC domain of Gag and augments reverse transcriptase activity (Takahashi et al., 1995) May be packaged into HIV-1 particles, although conflicting evidence exists (Jardine et al., 1993; Priel et al., 1990) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
TOP2A	Evidence for HIV-1 integration at TOP2A locus in resting CD4+ T-cells,; however integration did not appear to induce TOP2A expression (Han et al., 2004) Interacts with HIV TAR RNA-Binding Protein (Chi et al., 2011)
TPM1	Downregulated in dorsal root ganglia of a neuropathic rat model treated with HIV-1 gp120 and the reverse transcriptase inhibitor ddC (Maratou et al., 2009)
TRA2B	Overexpression of TRA2B resulted in a decrease in all species of HIV-1 RNA and Gag production (Wong et al., 2013)
TUBA1B, TUBA3E, TUBB, TUBB2C,	HIV-1 Rev causes depolymerization of microtubules *in vitro* and *Xenopus* egg extracts (Watts et al., 2000) and HIV-1 Tat binds tubulin and can result in cell apoptosis through a microtubule-

TUBB6	dependent mechanism (Chen et al., 2002)
TUBBP1	No identified role in retrovirus replication
UPF1	Component of HIV-1 RNP and positively regulates gag mRNA translation (Ajamian et al., 2008)
XRCC5 (Ku80) and XRCC6	Member of the Ku DNA damage response complex (Errami et al., 1996; Polo and Jackson, 2011) and shown to bind to the HIV-LTR and modulate transcription (Manic et al., 2013) Tat expression increases nucleolar accumulation (Jarboui et al., 2012) Ribozyme-mediated knockdown of XRCC5 inhibited HIV-1 transcription and integration (Waninger et al., 2004)
YBX1	Overexpression of YBX1 increases virus particle production of HIV-1 and an MLV-based vector by stabilizing viral genomic RNA (Li et al., 2012; Mu et al., 2013) Involved in MMTV virus particle production (Bann et al., 2014)
YY1	Decreases transcription from the HIV-1 LTR and production of virus particles through regulating chromatin modification (He and Margolis, 2002; Margolis et al., 1994)
Proteins identified in this study with role in retroviral replication not known: ACLY, ACTN1, AIMP2, CABP4, CIRBP, COL6A1, COL6A2, CPS1, DHX36, EIF2S3, EPRS, FARSA, FLNB, FUBP3, GTPBP1, H1F0, H1FX, H2AFX, H2AFZ, H2A-IX, H3F3C, H4-VII (HIST1H47), HDLBP, HIST1H1C, HIST2H2AA4, HIST2H2BE, HNRNPUL2, HNRPDL, HP1BP3, HSPA5, HSPB1, KHSRP, IGF2BP3, ILF2, LMNB2, LMO7, MYBBP1A, MYL4, MYL12B, NACA, NOLC1, NOP58, NUP210L, RARS, RPL10L, RPL11, RPL13, RPL14, RPL19, RPL36A, RPS3, RPS4X, RPSA, SARS2, SF3B1, SF3B3, SFRS13A, SLC25A3, SLC25A31, THOC4/ALYREF, URP, VIMURP, WDR3	

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