

VISDB User Manual

[V1.0]

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Notes: Words with blue color mean they are hyperlinks, clicking on the words will navigate to another next page or pop out another page.

1 Homepage

1.1 Menu Bar

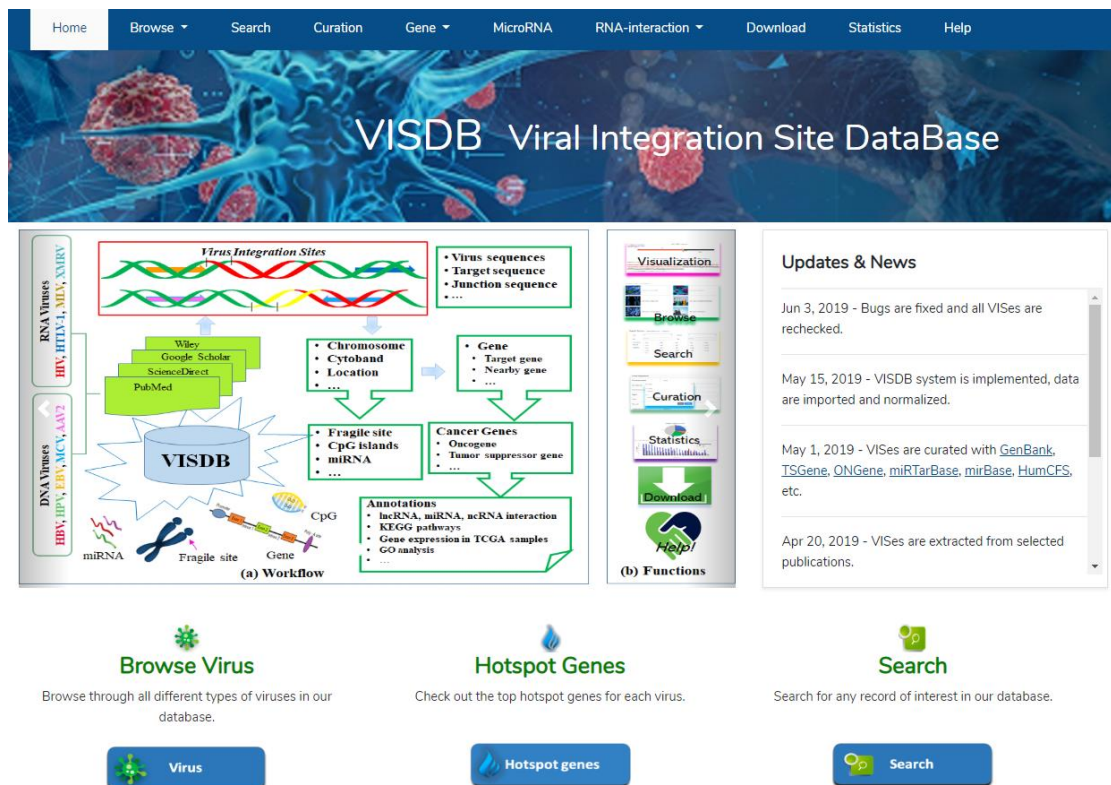


Figure 1. Homepage of VISDB

The homepage of VISDB (Figure 1) gives a summary of our knowledgebase, lists the functions of VISDB in the menu bar and provides some quick entries for accessing VISDB. Functions in VISDB consist of browse, search, curation, gene, miRNA, RNA-interaction, download, statistics and help.

1.2 Hotspot genes button

When clicking blue "Hotspot genes" button (Figure 2), a window pops out, listing the most 5 frequential genes targeted by HBV, HPV, EBV, MCV, AAV2, HIV and HTLV-1 respectively (Figure 3). Clicking on the "Close" button turns off the window while clicking on the hyperlinks of each gene name will create a new page to display all VISs targeting the gene (Figure 4).



Hotspot Genes

Check out the top hits across the hotspot gene of the each virus.



Figure 2. Hotspot gene button

Hotspot genes

- HBV: [TERT](#) [FN1](#) [KMT2B](#) [ALB](#) [LOC110806263](#)
- HPV: [FHIT](#) [LRP1B](#) [RAD51B](#) [CDK13](#) [KLF12](#)
- EBV: [BACH2](#) [DPP6](#) [LOC100132154](#) [CNTN4](#) [KHDRBS2](#)
- MCV: [ECH1](#) [CDKAL1](#) [PTP4A2](#) [PTPRG](#)
- AAV2: [CCNA2](#) [CCNE1](#) [KMT2B](#) [TNFSF10](#)
- HIV: [MKL2](#) [BACH2](#) [HORMAD2](#) [PACS1](#) [STAT5B](#)
- HTLV-1: [ROBO2](#) [LRP1B](#) [EYS](#) [MACROD2](#)



Figure 3. All hotspot genes

Gene Information	
Gene ID	7015
Name	TERT
Alias	CMM9, DKCA2, DKCB4, EST2, PFBMFT1, TCS1, TP2, TRT, HEST2, HTRT
Description	telomerase reverse transcriptase
Location	5p15.33
Chromosome	chr5
Start	1253167
End	1295047
MicroRNAs	hsa-mir-138-5p; hsa-mir-498; hsa-mir-193b-3p; hsa-mir-335-5p; hsa-mir-512-5p; hsa-mir-1207-5p; hsa-mir-126-6-5p; hsa-mir-1182; hsa-mir-181a-5p; hsa-mir-6776-3p; hsa-mir-197-3p; hsa-mir-6740-3p; hsa-mir-6760-3p; hsa-mir-532-5p; hsa-mir-3064-5p; hsa-mir-422a; hsa-mir-346; hsa-mir-1226-3p; hsa-mir-1255a; hsa-mir-1255b-5p; hsa-mir-143-3p; hsa-mir-3161; hsa-mir-3605-5p; hsa-mir-3620-3p; hsa-mir-3682-3p; hsa-mir-4323; hsa-mir-4712-3p; hsa-mir-4733-3p; hsa-mir-4758-3p; hsa-mir-4770; hsa-mir-6088; hsa-mir-7112-3p
Annotations	ENCODE; GeneCards; KEGG; NCBI

VIS ID	Virus genome	Human genome									
		Virus Name	Subtype	Reference	Start	End	Chromosome	Locl	Reference	Start	End
TVIS10000434	AAV2		AF043303.1	4390	4597	chr5	p15.33	hg19	1295308	1295308	
TVIS10000457	HBV		AF090842.1;AB033554.1;AB014381.1;M32138.1;AB032431			chr5	p15.33	hg19	1295776	1295776	
TVIS10000519	HBV		AF090842.1;AB033554.1;AB014381.1;M32138.1;AB032431			chr5	p15.33	hg19	1293411	1293411	
TVIS10000524	HBV		AF090842.1;AB033554.1;AB014381.1;M32138.1;AB032431			chr5	p15.33	hg19	1272746	1272746	

Figure 4. VISs related to hotspot gene

1.3 Virus button

Clicking on the blue “Virus” button (Figure 5) lists 9 viruses curated in our knowledgebase. When clicking on virus name, the table on the bottom of the page change, listing the summary of 9 viruses (Figure 6).

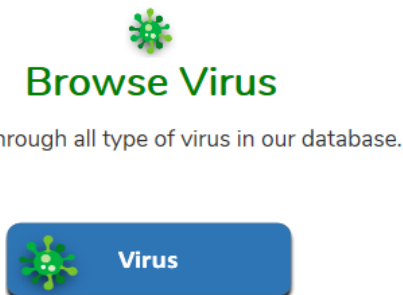


Figure 5. Virus button

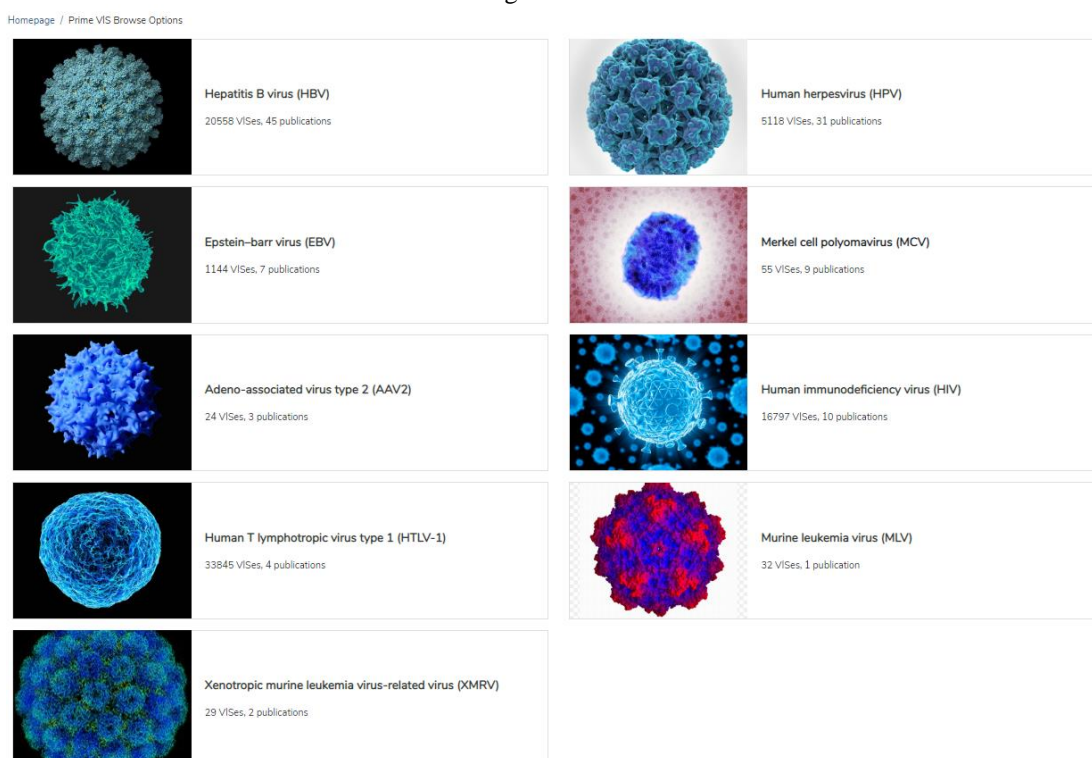


Figure 6. VIS summary of 9 viruses

Clicking on the icon of each virus activates virus-related pathway, GO analysis and VISs list (Figure 7). For HBV, HPV, HIV, HTLV-1 and EBV, virus pathway information is provided. GO analysis is available for HBV, HIV, HTLV-1 and HPV, other viruses have VISs list only.

Homepage / Prime VIS Browse Options / Browse by virus - HBV

Virus pathway

GO summary

Virus genome				Human genome												
VIS ID	Virus Name	Subtype	Reference	Start	End	Chromosome	Loc	Reference	Start	End	Target gene	Sample	Disease	Method	Pubmed ID	Curated way
TVIS10000001	HBV		F1562281.1	1782		chr9	q31.1	hg19	100940295	100940295	CORO2A	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000002	HBV		GQ377546.1	1820		chr9	q31.1	hg19	101030026	101030026		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000003	HBV		KC792890.1	1471		chr3	p26.3	hg19	2002381	2002381		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000004	HBV		KR014001.1	689		chr2	q35	hg19	216291034	216291034		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000005	HBV		MH818373.1	1807		chr16	q12.1	hg19	51320015	51320015		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000006	HBV		MG571337.1	1908		chr16	q12.1	hg19	51320070	51320070		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000007	HBV		GU815714.1	2360		chr10	p11.21	hg19	34836578	34836578	PAR3	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000008	HBV		GU815645.1	1651		chr14	q11.2	hg19	19828316	19828316		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated

Figure 7. Browse by virus

Clicking on the Virus pathway unfolds virus metabolic pathway (Figure 8). Pathway information was downloaded from KEGG, we only retained the networks and genes of pathway entries.

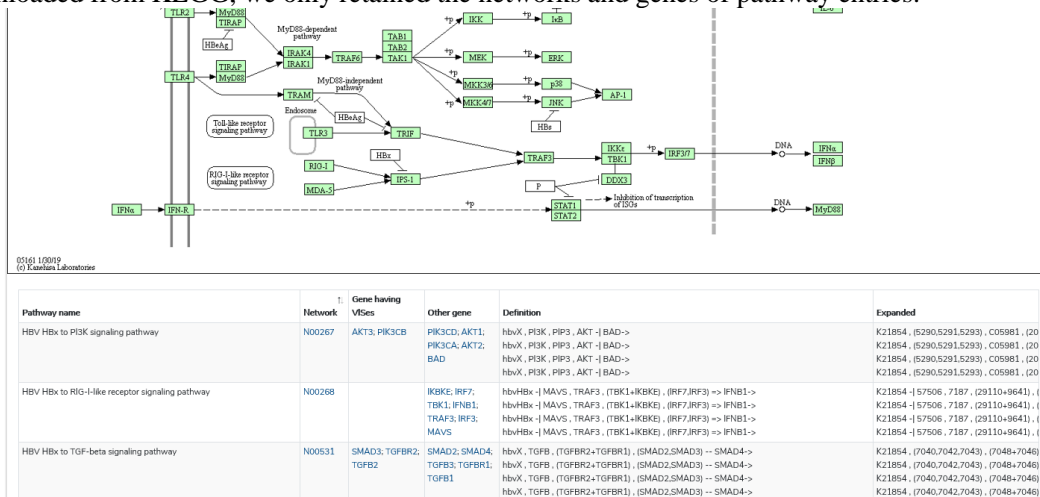


Figure 8. Virus pathway and its details

We divide pathway genes into two subsets, one is the set of genes targeted by VIS, the other is gene set of not being targeted by VISs. Clicking on the target gene name activates a new page displaying VISs in a table, clicking on non-target gene create a page display the gene information in KEGG. Clicking on the network code creates a new page displaying the sub pathway in KEGG.

Clicking on the “GO summary” link in Figure 7 unfolds the GO analysis result including BP table, BP bar chart, MF table and MF bar chart (Figure 9). Each part can unfold or fold independently.



Figure 9. GO analysis result

1.4 Search button

The blue “Search” button (Figure 10) is an entrance of searching all VISs in our database as well the menu item “Search” in the menu bar. The webpage will be navigated to the basic search page (Figure 11) when clicking on “Search” button.



Search the interested records in our database.



Figure 10. Search button

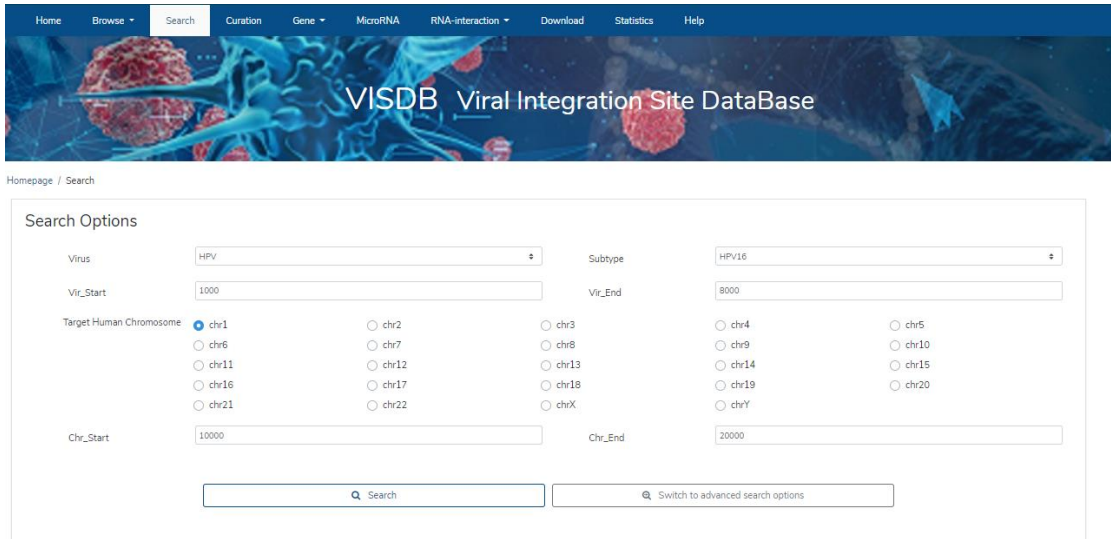


Figure 11. Basic search page

The basic search function provides user searching of specific virus and the integration sites on the chromosome.

Tips:

- 1) For virus with subtype, the default option is ignoring subtype and the user can click the dropdown box to choose the specific subtype. For virus without subtype, no other choice is provided. The “Start” and “End” mean the breakpoint in virus reference genome, their value must be integers.
- 2) User can search for multiple chromosomes at the same time by checking the chromosome checkbox. Clicking “[Select all](#)” link on the left of checkbox chooses all chromosomes, while “[Deselect all](#)” cancels all check.
- 3) “[Advanced search options](#)” link provides an entrance for using more complex query conditions, please refer to [3.2](#).
- 4) “[Example option](#)” link give users an example to fill in the search item.

2 VIS information

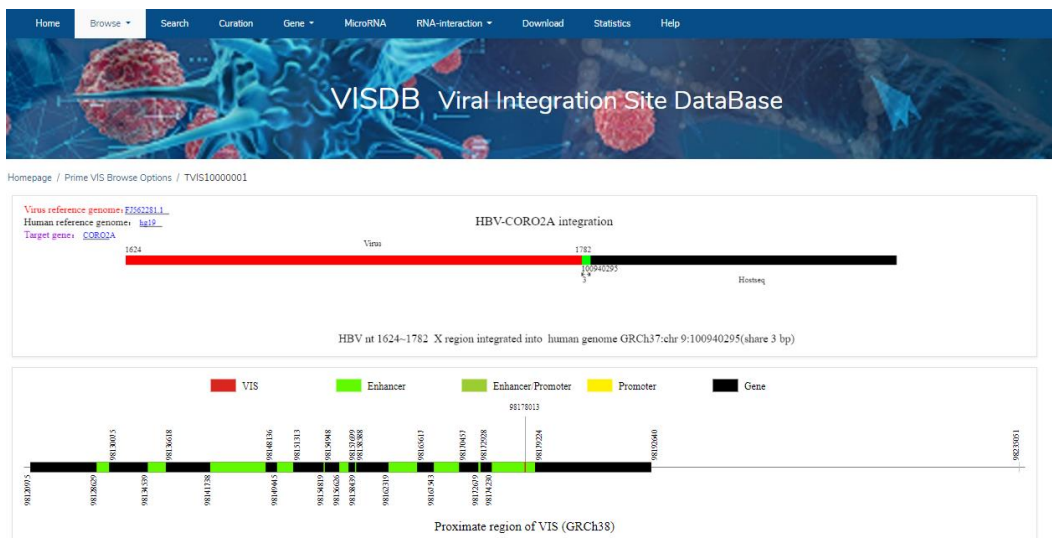


Figure 12. VIS information page

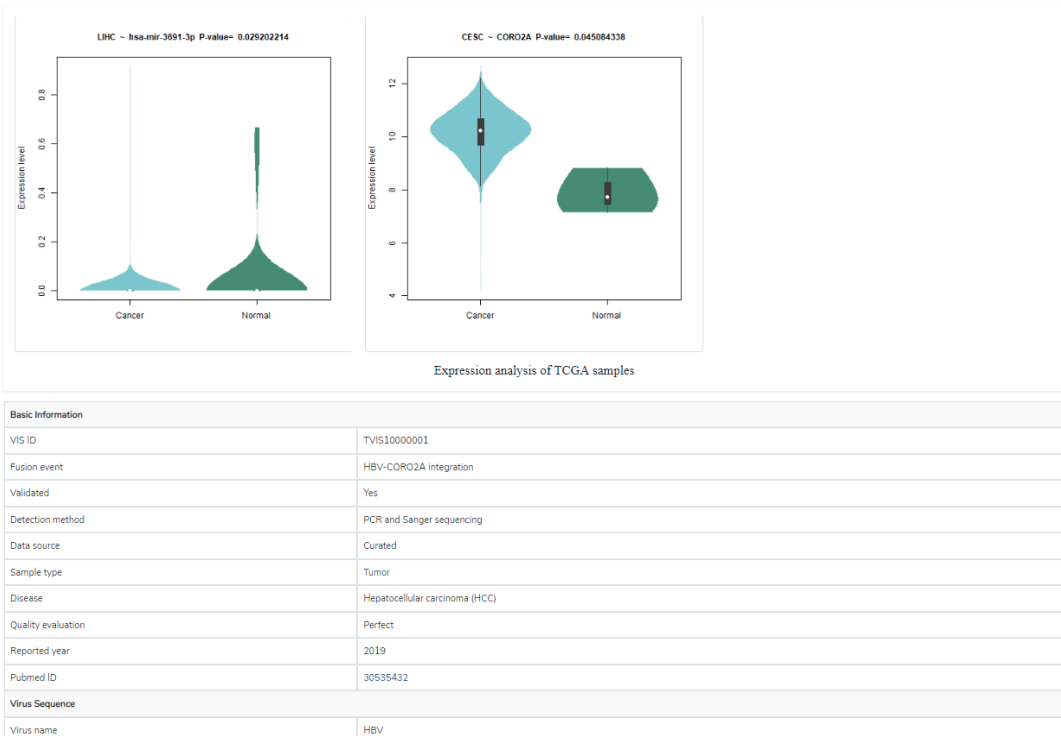


Figure 13. VIS information page

Disease	Hepatocellular carcinoma (HCC)
Quality evaluation	Perfect
Reported year	2019
Pubmed ID	30535432
Virus Sequence	
Virus name	HBV
Reference genome	FJ562281.1
Region type	X
Start	1782
Integrated sequence	TCAACGACCGACCTTGAGGCATCTCAAGACTGTTTGTAAAGGACTGGGAGGAGTTGGGGAGGAGATTAGGTTAATGATCTTGTACTAGGAGGCTTIGTAGGCATAAATTGGCTCTTCCACGACACCATGCAACTTTTTCACCTCGCTAAATCATCTCATGTTTCATGCTCTCAAGCCTCAAGCTGTGC
Host Sequence	
Chromosome	chr9
Cytoband	q31.1
Reference genome	GRCh37/hg19
Start	100940295/98178013 (Hg38)
End	100940295/98178013 (Hg38)
Location type	Intronic
Target gene	CORO2A
miRNAs that regulate target gene	hsa-mir-124-3p; hsa-mir-21-5p; hsa-mir-6778-3p; hsa-mir-6128; hsa-mir-1976; hsa-mir-3653-5p; hsa-mir-150-5p; hsa-mir-6747-3p; hsa-mir-6727-3p; hsa-mir-4722-3p; hsa-mir-6814-5p; hsa-mir-3691-3p; hsa-mir-4279; hsa-mir-8081; hsa-mir-1231; hsa-mir-627-5p; hsa-mir-937-5p; hsa-mir-516b-5p; hsa-mir-7977; hsa-mir-3120-5p; hsa-mir-5699-3p; hsa-mir-4421; hsa-mir-6748-3p; hsa-mir-4267; hsa-mir-6736-3p; hsa-mir-5588-3p; hsa-mir-29b-2-5p; hsa-mir-3187-3p; hsa-mir-588; hsa-mir-4701-5p; hsa-mir-548s; hsa-mir-4755-3p; hsa-mir-29b-1-5p; hsa-mir-4507; hsa-mir-3940-5p
Nearest miRNA	hsa-let-7a-1/Upstream/614332; hsa-mir-12126/Downstream/51136;
Nearest TSS	ENST00000422679/Upstream/5129; ENST00000610463/Downstream/14627;
Nearest CpG islands	None/Target; chr9-CpG: 64/Upstream/58635; chr9-CpG: 24/Downstream/13991
Downstream sequence	GCTCTCTCACTTTTTTTTCTTTTAAATTTTATTTTATTTTAAACATTTTTTTAGAGACAGAGTCTCGCTCTGTCACCTAGGCTGGAGTGCAAGTGGTCCATCATAA
Junction sequence	ACGCCACTGGAACTGCCAAGGCTTACATAAAAGGACTCTGGACTCTCAGCAATGCAACGACCGACCTTGAGGCATCTCAAGACTGTTGTTTAAAGACTGGAGGAGTTGGGGGAGGAGATTAGGTTAATGATCTTTGTACTAGGAGGCTCTCCTCACTTTTTTCTTTTTTAAATTTATTTTATTTTAAACATTTTTTTAGAGACAGAGTCTCGCTCTGTCACCTAGGCTGCCAGTGCAGTGGTCCATCATAA
Reference	* Color: Human Sequence / Virus Sequence / Overlapped sequence / Unknown sequence

Figure 14. VIS information page

Figure 12-14 is the detailed description of VIS, the introduction of our VIS expressing model please refer to the online help page. For VIS downloaded from other databases, VISDB will navigate to the source website such as RID and HPVbase. The “Curate” button provides the user with the function of correcting or perfecting VIS for VISDB, and its usage is referred to “Curation” page. Here we just list the tips of using this page.

The detailed page is divided into 4 zones, zone one shows the visualization of single integration event, zone two shows the visualization of DNA elements proximate to VIS, zone three shows the gene and miRNA

expression of target gene targeted by current VIS, zone four is the description of VIS.

2.1 VIS visualizing zone

The uppermost of this page is the visualization of virus integration site.

(1) The title such as “HBV-CORO2A integration” implies the integration is an event of HBV integrated into CORO2A gene.

(2) The title such as “HBV-chr14: q22.3 integration” implies that the integration is an event of HBV integrated into cytoband 14q22.3.

(3) The description of the demo briefly introduces the specific breakpoints and locations of this integration event.

(4) Red block, black block, green block and gray block means the region belonging to virus sequence, human sequence block, both human sequence and virus sequence and unknown sequence separately.

(5) Coordinates above the red block mean they are the start and stop breakpoints of virus sequence.

(6) Coordinates below the black block mean they are the start and end locations on the human sequence.

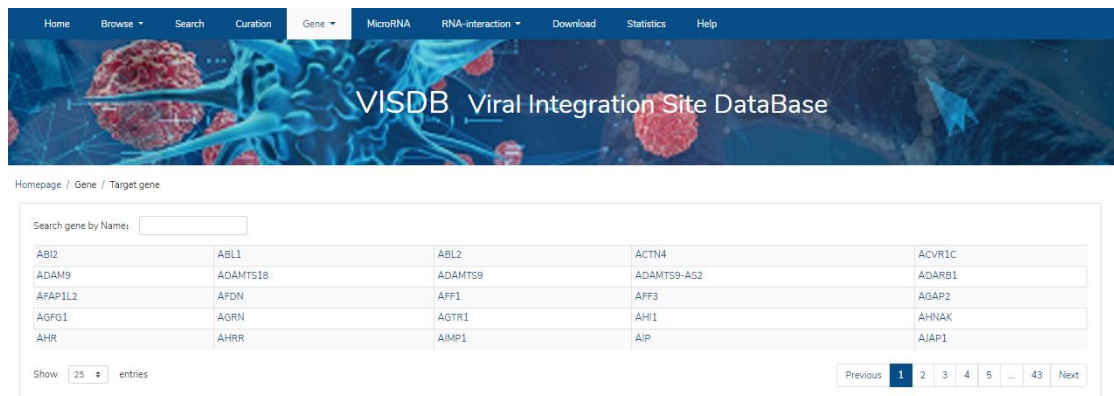
(7) The reference virus genome and human genome are displayed in the upper left corner if they are provided in the original publications.

(8) Clicking on the link of Virus reference genome or red block navigates to the virus reference genome used in the original navigates.

(9) Clicking on the link of Human reference genome navigates to the human reference genome used in the original publication.

(10) Clicking on the link of gene name will open a new page describing the relation between gene, fragile site and miRNA (Figure 15).

(11) Clicking on the black navigates to the precise region of the NCBI human reference genome with corresponding assembly and location (Figure 16).



The screenshot shows the VISDB (Viral Integration Site DataBase) website interface. The top navigation bar includes links for Home, Browse, Search, Curation, Gene, MicroRNA, RNA-interaction, Download, Statistics, and Help. The main header features a blue background with a molecular structure and the text "VISDB Viral Integration Site DataBase". Below the header, the breadcrumb "Homepage / Gene / Target gene" is visible. A search bar labeled "Search gene by Name:" is present. The main content area displays a grid of 20 gene names in a 4x5 layout. At the bottom left, there is a "Show 25 entries" option. At the bottom right, there is a pagination control showing "Previous 1 2 3 4 5 ... 43 Next", with "1" highlighted as the current page.

ABL2	ABL1	ABL2	ACTN4	ACVR1C
ADAM9	ADAMTS1B	ADAMTS9	ADAMTS9-AS2	ADARB1
AFAP1L2	AFDN	AFF1	AFF3	AGAP2
AGFG1	AGRN	AGTR1	AH1	AHNAK
AHR	AHRR	AIMP1	AIP	AJAP1

Figure 15. Target gene-correlated entries

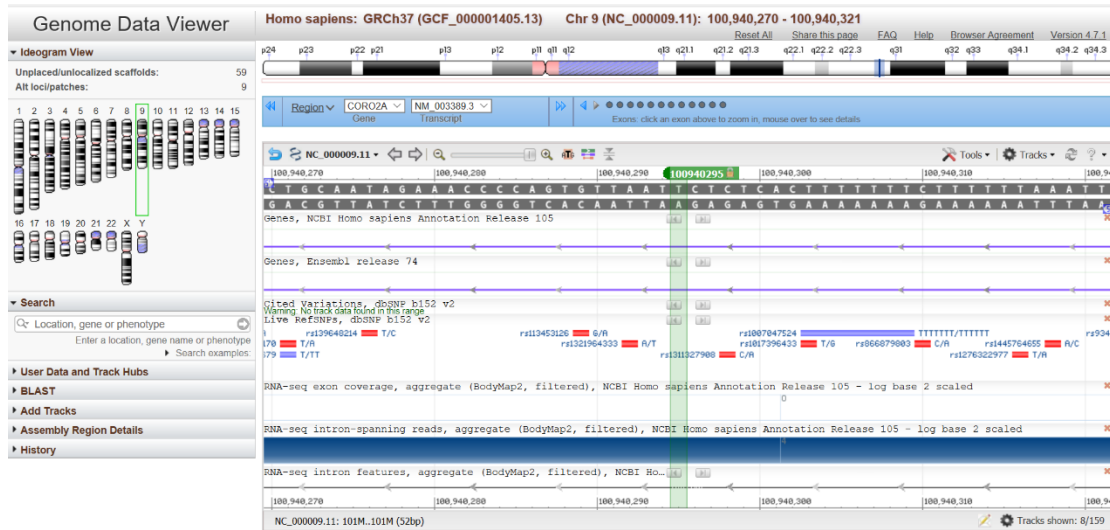


Figure 16. Displaying the precise location of “HBV-CORO2A integration” with NCBI Genome Data Viewer

2.2 Proximate DNA elements visualizing zone

The figure shows the relationship between VIS and other gene elements. On the top of the figure, there are five color blocks representing five different elements. Clicking the region on the gene will display the detail information about this region, such as the name of this region, the location in this chromosome and the score from the GeneHancer database (Figure 17).

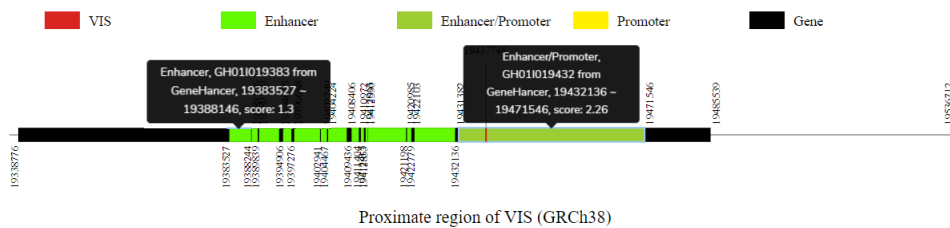


Figure 17. Proximate DNA elements visualizing zone

2.3 Gene and miRNA expression zone

This part shows the expression level of the target genes and miRNAs that regulate the target gene in The Cancer Genome Atlas (TCGA) dataset. The title of each figure shows the type of cancer in TCGA dataset, the symbol of the gene or miRNA and P-value. For miRNAs, only miRNAs with P-value less than 0.05 are shown (Figure 18).

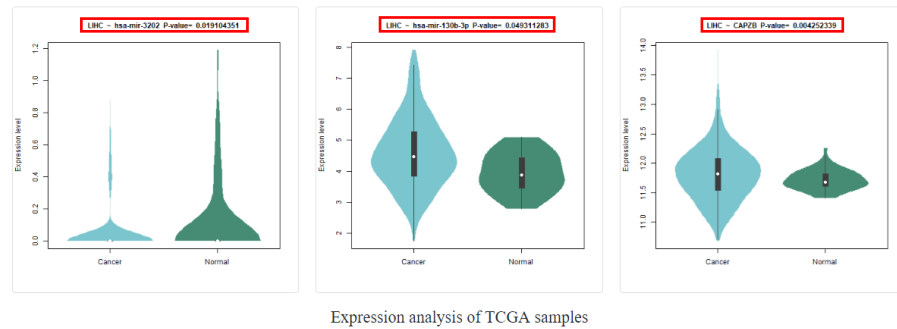


Figure 18. Expression of genes and miRNAs in TCGA dataset.

2.4 Text information region

- (1) Clicking on the “PubMed ID” link navigates to the online download page in the NCBI PubMed database.
- (2) Clicking on the “Reference Genome” link navigates to virus genome or human genome.
- (3) Clicking on the “microRNA” link navigates to the corresponding microRNA introduction page in miRTarBase.
- (4) Clicking on the “Target gene” or “Nearby gene” or “Nearest cancer gene” (TSG means tumor suppressor gene, OG means oncogene) link navigate to the gene homepage in NCBI GenBank.
- (5) Clicking on the “Fragile site” link navigates to the corresponding chromosome fragile site/region in HumCFS database.
- (6) Clicking on the “Start” or “End” link of host sequence navigate to the precise region of NCBI human reference genome with corresponding assembly and locations (Figure 16).
- (7) For virus sequence, if the begin breakpoint, stop breakpoint and reference genome exists, the “integrated sequence” is the sequence between “begin breakpoint” and “stop breakpoint”. Otherwise, the upstream 100bp of “begin breakpoint” or “stop breakpoint” is extracted and isolated by “|”.
- (8) For target sequence, we try to provide the upstream 100bp of “begin location”, the sequence between “begin location” and “end location” (denoted as “target sequence”), and the downstream 100bp of “end location” if the detailed locations and reference human genome are provided in the original publications. If only one location is provided, then the upstream 100bp and downstream 100bp of the point are extracted.

2.5 Gene, fragile site, miRNA and pathway

For the VIS-targeted gene, we also provide:

- 1) Fragile site the target gene located.
- 2) miRNAs that have influences on the target gene.
- 3) Pathways that target gene involved in KEGG database.
- 4) Carcinogenesis in ONGene database if the target gene is identified as an oncogene.
- 5) Cancer suppressor in TSGene database if the target gene is identified as a tumor suppressor gene.
- 6) Common gene database such as GenBank, Encode, GeneCards.

In the target gene-correlated page:

- (1) Clicking on the “microRNA” link navigates to the corresponding microRNA introduction page in miRTarBase.
- (2) Clicking on the “Fragile site” link navigates to the corresponding chromosome fragile site/region in HumCFS database.
- (3) Clicking on the “Reference” link navigates to ENCODE, KEGG, Genecards page about the target.

3 Browse

In VISDB, we provide six kinds of different ways to browse all virus integration sites (VIS), you may browse the VIS based on your rules, such as fragile sites, chromosome, disease, experiment and literature.

Choose the Browse module (Figure 19). You will see six options below and you can select one based on your interest.

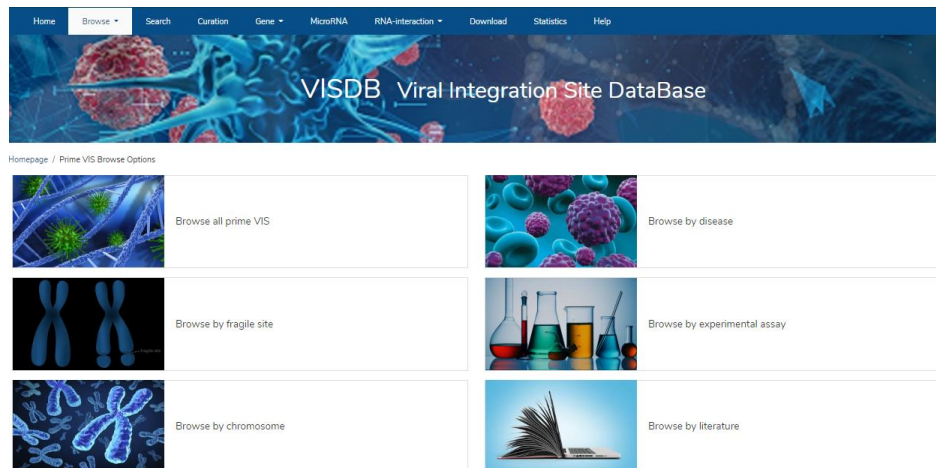


Figure 19. Browse the main menu.

3.1 Browse all

Click Browse all Prime VIS menu, you will see all VISs in VISDB (Figure 20).

The screenshot shows the 'Browse all Prime VIS' page with a table of virus integration sites. The table has columns for Virus ID, Virus genome (Name, Subtype, Reference, Start, End), Human genome (Chromosome, Loci, Reference, Start, End), Target gene, Sample, Disease, Method, Pubmed ID, and Curated way. Annotations include 'Click the title to sort' pointing to the 'Title' column, 'Click to see more detail about this VIS' pointing to the first row, and 'Title' pointing to the 'Title' column header.

Virus ID	Virus genome	Human genome	Target gene	Sample	Disease	Method	Pubmed ID	Curated way								
t	Virus Name	Subtype	Reference	Start	End	Chromosome	Loci	Reference	Start	End						
TVIS10000001	HBV		F1962281.1	1782		chr9	q11.1	hg19	100940295	100940295	CORO2A	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000002	HBV		GQ377546.1	1820		chr9	q11.1	hg19	101030026	101030026		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000003	HBV		KC792890.1	1471		chr3	p26.3	hg19	2002381	2002381		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000004	HBV		KR014001.1	689		chr2	q35	hg19	216281034	216281034		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000005	HBV		MH818373.1	1807		chr16	q12.1	hg19	51320015	51320015		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000006	HBV		MG571337.1	1908		chr16	q12.1	hg19	51320070	51320070		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000007	HBV		GU815714.1	2360		chr10	p11.21	hg19	34836578	34836578	PARD3	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000008	HBV		GU815645.1	1651		chr14	q11.2	hg19	19828316	19828316		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000009	HBV		JN827419.1	1754		chr14	q22.3	hg19	57417625	57417625		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000010	HBV	B2	JQ688405	1831		chr14	q22.3	hg19	57417636	57417636		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000011	HBV		JX026886.1	1760		chr16	p11.2	hg19	34990970	34990970		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000012	HBV		AB713529.1	1546		chr9	q22.33	hg19	98928137	98928137		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000013	HBV		MG571336.1	1465		chrX	p21.1	hg19	96919408	96919408		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000014	HBV		JX507212.1	1513		chr5	p13.1	hg19	42009760	42009760		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	30535432	Curated
TVIS10000035	HBV		U95551.1	1708		chr13	q13.1	GRCh38.p7	31729164	31729164		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000036	HBV		U95551.1	1733		chr8	q11.23	GRCh38.p7	52471135	52471135		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000037	HBV		U95551.1	1806		chr3	p23	GRCh38.p7	31775388	31775388	OSBPL10	Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000039	HBV		U95551.1	1811		chr2	p12	GRCh38.p7	82212254	82212254		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000040	HBV		U95551.1	1822		chr4	q35.2	GRCh38.p7	190113319	190113319		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000042	HBV		U95551.1	1800		chr11	q13.3	GRCh38.p7	70090784	70090784	ANCL	Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000043	HBV		U95551.1	1829		chr8	p22	GRCh38.p7	14930823	14930823	SGC2	Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000044	HBV		U95551.1	1776		chr6	q23.3	GRCh38.p7	136048040	136048040	PRPF8	Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000045	HBV		U95551.1	1810		chr8	q22.1	GRCh38.p7	93745853	93745853		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000046	HBV		U95551.1	1770		chr22	q12.3	GRCh38.p7	34066380	34066380	LINC01643	Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated
TVIS10000047	HBV		U95551.1	1828		chr5	q11.1	GRCh38.p7	49902408	49902408		Cell line	Hepatocellular carcinoma	invPCR	29437961	Curated

Figure 20. All VIS in VISDB

3.2 Browse by fragile site

Clicking Browse by fragile site, the page will display the name of each fragile site (Figure 21).

[Homepage](#) / [Prime VIS Browse Options](#) / [Browse by fragile site](#)

FRA10A	FRA10B	FRA10C	FRA10D	FRA10E
FRA10F	FRA10G	FRA11A	FRA11B	FRA11C
FRA11D	FRA11E	FRA11F	FRA11G	FRA11H
FRA11I	FRA12A	FRA12B	FRA12C	FRA12D
FRA12E	FRA13A	FRA13B	FRA13C	FRA13D

Show 25 entries

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Figure 21. All fragile site name in VISDB.

You may select one of the interested fragile to see the detail information of this fragile site (Figure 22) and also the VIS which is located within this fragile site (Figure 23).

Fragile Site Information	
Name	FRA10A
Type	Folic acid
Chromosome	chr10
Cytoband	10q23.3
Start	97000000
End	1089500001
Frequency	Rare
Reference	HumCFS

Figure 22. Detail information of one fragile site.

VIS ID	Virus genome				Human genome				Target gene	Sample	Disease			
	Virus Name	Subtype	Reference		Start	End	Chromosome	Loc				Reference	Start	End
TVS10000058	HBV		U9551.1		1775		chr10	q25.1	GRCh38.p7	105717410	105717410	LINC02627	Cell line	Hepatocellular carcinoma
TVS10000198	HBV		U9551.1		1906		chr10	q26.12	GRCh38.p7	121374033	121374033		Cell line	Hepatocellular carcinoma
TVS10000199	HBV		U9551.1		1811		chr10	q26.3	GRCh38.p7	131236464	131236464	TCERG1L	Cell line	Hepatocellular carcinoma
TVS10000200	HBV		U9551.1		1706		chr10	q26.3	GRCh38.p7	132184576	132184576	PRPF31	Cell line	Hepatocellular carcinoma
TVS10000367	HBV	A	X70185.1		1647	1720	chr10	q21.2	hg19	111339527	111339567	ANK3	Cell line	Hepatocellular carcinoma
TVS10000403	HBV	C	Not given			1869	chr10	q24.32	hg19	102723937	102723937	SLF2	Nontumor	Hepatocellular carcinoma
TVS10000581	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.13	hg19	126262824	126262824	LHPP	Tumor	Hepatocellular carcinoma
TVS10000877	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524675	135524675		Tumor	Hepatocellular carcinoma
TVS10000883	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524715	135524715		Tumor	Hepatocellular carcinoma
TVS10000884	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524737	135524737		Tumor	Hepatocellular carcinoma
TVS10000909	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524466	135524466		Tumor	Hepatocellular carcinoma
TVS10001030	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524730	135524730		Tumor	Hepatocellular carcinoma
TVS10001031	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524748	135524748		Tumor	Hepatocellular carcinoma
TVS10001051	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q24.2	hg19	100116305	100116305		Tumor	Hepatocellular carcinoma
TVS10001133	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524741	135524741		Tumor	Hepatocellular carcinoma
TVS10001381	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524695	135524695		Tumor	Hepatocellular carcinoma
TVS10001382	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524713	135524713		Tumor	Hepatocellular carcinoma
TVS10001383	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524749	135524749		Tumor	Hepatocellular carcinoma
TVS10001487	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q25.1	hg19	106508859	106508859	SORCS3	Tumor	Hepatocellular carcinoma
TVS10001523	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	135524236	135524236		Tumor	Hepatocellular carcinoma
TVS10001659	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q24.32	hg19	103178795	103178795	BTRC	Tumor	Hepatocellular carcinoma
TVS10001797	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	130791308	130791308		Tumor	Hepatocellular carcinoma
TVS10001799	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.3	hg19	134744574	134744574	CFAP46	Tumor	Hepatocellular carcinoma
TVS10001893	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q26.13	hg19	126787260	126787260	CTBP2	Tumor	Hepatocellular carcinoma
TVS10001990	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431				chr10	q24.2	hg19	100726692	100726692	HPSE2	Tumor	Hepatocellular carcinoma

Show 25 entries

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Figure 23. VIS located within this fragile site.

3.3 Browse by disease

Click Browse by disease menu, the page will display all the diseases in VISDB (Figure 24).

Adenocarcinoma	Adenosquamous carcinoma	Adult T-cell leukemia	AIDS dementia	AIDS-associated lymphoma
Angioimmunoblastic lymphadenopathy	B-cell lymphoma	Cervical carcinoma	Cervical intraepithelial neoplasia	Clear cell carcinoma
Extranodal natural killer T-cell lymphoma	Gastric carcinoma	Head and neck squamous cell carcinoma	Hepatocellular carcinoma	HIV-infected disease
Hodgkin lymphoma	HTLV-1 associated myelopathy/tropical spastic paraparesis	Merkel cell carcinoma	Nasopharyngeal carcinoma	Neuroendocrine carcinoma
NKT cell lymphoma	Not given	Oropharyngeal squamous cell carcinoma	Prostate cancer	Squamous-cell carcinoma

Figure 24. All diseases in VISDB.

You can click the interested disease name to see all VISs associated with this kind of disease (Figure 25).

VIS ID	Virus genome					Human genome					Target gene	Sample	Disease	Method	Pubmed ID	Curated w	
	Virus Name	Subtype	Reference	Start	End	Chromosome	Loc	Reference	Start	End							
TVIS20004791	HPV	HPV16	Not given			chr6	q22.31	hg19					Tumor	Adenocarcinoma	APOT and sequencing	22815898	Curated
TVIS20005055	HPV	HPV18	Not given			chr9	q22.31	hg19	94912835	94913715	LINC00475		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005056	HPV	HPV18	Not given			chr17	q23.1	hg19	57918880	58007502			Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005063	HPV	HPV18	Not given			chr17	q21.2	hg19	39101544	39132008	KRT39		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005064	HPV	HPV18	Not given			chr9	q22.32	hg19	97764551	97823107	AOPEP		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005068	HPV	HPV16	HQ644271.1			chr19	q13.2	hg19	42224737	42233185	CEACAM5		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005079	HPV	HPV18	Not given			chr7	q36.1	hg19	14888555	148886074			Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005080	HPV	HPV18	Not given			chr3	q26.32	hg19	176741962	176754943	TBL1XR1		Tumor	Adenocarcinoma	WGS	24390348	Curated
TVIS20005093	HPV	HPV18	Not given			chr3	q25.2	hg19	152937087	152937321	LOC105374164		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005096	HPV	HPV18	Not given			chr9	q34.3	hg19	139543325	139562753	EGFL7		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005097	HPV	HPV16	HQ644271.1			chr14	q24.1	hg19	68596826	68607359	RAD51B		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005099	HPV	HPV18	Not given			chr8	q24.3	hg19	144502066	144510443	MAFA		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005100	HPV	HPV18	Not given			chr8	q24.3	hg19	144501850	144502166			Tumor	Adenocarcinoma	WGS	24390348	Curated
TVIS20005115	HPV	HPV18	Not given			chr2	q22.3	hg19	146400095	146485051			Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005117	HPV	HPV16	HQ644271.1			chr2	q22.3	hg19	146478434	146574722			Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005121	HPV	HPV16	HQ644271.1			chr19	q13.2	hg19	42215341	42223935	CEACAM5		Tumor	Adenocarcinoma	RNA-Seq+RT-PCR	24390348	Curated
TVIS20005144	HPV	HPV18	Not given			chr11	q23.3	hg19			ARCN1		Tumor	Adenocarcinoma	APOT and sequencing	22815898	Curated
TVIS20005232	HPV	HPV18	Not given			chr15	q21.3	Unknown	53423030				Cell line	Adenocarcinoma	DIPS-PCR	16682952	Curated
TVIS20005233	HPV	HPV18	Not given			chr8	q24.21	Unknown	128424413		MYC		Cell line	Adenocarcinoma	DIPS-PCR	16682952	Curated
TVIS20005234	HPV	HPV18	Not given			chr8	q24.21	Unknown	128503231				Cell line	Adenocarcinoma	APOT-PCR	16682952	Curated
TVIS20005235	HPV	HPV18	Not given			chr8	q24.21	Unknown	128417091				Cell line	Adenocarcinoma	APOT-PCR	16682952	Curated
TVIS20005236	HPV	HPV18	Not given			chr8	q24.21	Unknown	128430753				Cell line	Adenocarcinoma	DIPS-PCR	16682952	Curated
TVIS20005239	HPV	HPV16	Not given			chr8	q24.21	Unknown	127905623				Cell line	Adenocarcinoma	DIPS-PCR	16682952	Curated
TVIS20005247	HPV	HPV16	Not given			chr1	q32.2	Unknown	206166879				Cell line	Adenocarcinoma	FISH, DIPS, APOT assay	16682952	Curated
TVIS20005248	HPV	HPV18	Not given			chr19	p13.2	Unknown	12984638		NFX		Cell line	Adenocarcinoma	DIPS-PCR	16682952	Curated

Figure 25. All VISs associated with one kind of disease.

3.4 Browse by experimental assay

Click Browse by experiment assay, the page will display all of the experiment assays in VISDB (Figure 26). It includes wet and dry lab assays that used to detect the virus integration on human genome.

ABI310 automatic sequencer	Alu PCR	Alu PCR and sequencing	APOT and sequencing	APOT-PCR
Capture-NGS platform	dd-PCR+WGA	DIPS-PCR	DTS+PCR	FISH, WGS, RNA-seq, qPCR
GenCap Enrichment+NGS	HIVD	HTS	invPCR	invPCR +Sequencing
invPCR+NAH	invPCR+RT-PCR	Linker ligation-mediated PCR	LM PCR	MAPS
Multiplex RT-PCR, APOT assay	Nested PCR, nested RT-PCR, or quantitative RT-PCR	NG-SGS	NGS	PCR Ion Torrent Sequencing
PCR and Sanger sequencing	PCR and Ultra-deep sequencing	QiaQuick PCR and Sequencing	RACE	RNA-Seq
RNA-Seq+RT-PCR	Roche NGS	RT-PCR	RT-PCR+Long-range PCR	Sanger sequencing
Splinkerette-PCR	TaME-seq	TS	VirusFinder	VirusScan
WES	WGS	WGS&RNA-Seq	WGS, RNA-seq, Whole-Exome sequencing, PCR	

Figure 26. All experiment assay in VISDB

You can click the interested experiment assay to check the VIS that was detected by this experiment assay (Figure 27).

VIS ID	Virus genome					Human genome					Target gene	Sample	Disease	Method	Pubmed ID	Curated
	Virus Name	Subtype	Reference	Start	End	Chromosome	Loc	Reference	Start	End						
TVIS10020020	HBV		D50519.1	2112		chr13	q34	Unknown			CHAMP1	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020021	HBV		D50519.1	1779		chr13	q34	Unknown			CHAMP1	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020022	HBV		D50519.1	1580		chr19	q13.1	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020023	HBV		D50519.1	188		chr3	p14-p21	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020024	HBV		D50519.1	1096		chr11	q13	Unknown			FCHSD2	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020025	HBV		D50519.1	1798		chr11	q13	Unknown			FCHSD2	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020026	HBV		D50519.1	1343		chr8	p12	Unknown			GTF2E2	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020027	HBV		D50519.1	1643		chr3	p23	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020028	HBV		D50519.1	2390		chr6	q16	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020029	HBV		D50519.1	1769		chr1	q42	Unknown			DNAH14	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020030	HBV		D50519.1	543		chr10	q21.3	Unknown			LOC256328	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020031	HBV		D50519.1	68		chr10	q21.3	Unknown			LOC256328	Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020032	HBV		D50519.1	1610		chr20	p13	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020033	HBV		D50519.1	1715		chr20	p13	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020034	HBV		D50519.1	1816		chr4	p15.1	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020035	HBV		D50519.1	2716		chr4	p15.1	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020036	HBV		D50519.1	2954		chr18	q12	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020037	HBV		D50519.1	1695		chr5	q21	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020038	HBV		D50519.1	1308		chr7	q35	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020039	HBV		D50519.1	975		chr3	q25	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020040	HBV		D50519.1	2722		chr8	q23	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated
TVIS10020041	HBV		D50519.1	2507		chr5	p13	Unknown				Tumor	Hepatocellular carcinoma	ABI310 automatic sequencer	14712219	Curated

Show 25 entries

Figure 27. All VIS detected by the experiment assay.

3.5 Browse by chromosome

Click Browse by chromosome, the page will display all chromosome in VISDB (Figure 28).

[Homepage](#) / [Prime VIS Browse Options](#) / [Browse by chromosome](#)

chr1	chr2	chr3	chr4	chr5
chr6	chr7	chr8	chr9	chr10
chr11	chr12	chr13	chr14	chr15
chr16	chr17	chr18	chr19	chr20
chr21	chr22	chrX	chrY	

Figure 28. All chromosome in VISDB.

You may click the interested chromosome on this page, it will display all VISs located on this chromosome (Figure 29).

VIS ID	Virus genome					Human genome					Target gene	Sample	Disease	Method	Pubmed ID	Cu	
	Virus Name	Subtype	Reference	Start	End	Chromosome	Loc	Reference	Start	End							
TVIS10000026	HBV		Not given			chr1	p36.23	hg16					Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	15806150	Cu
TVIS10000031	HBV		Not given			chr1	p35.3	hg16				EYA3	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	15806150	Cu
TVIS10000049	HBV		U95551.1	1829		chr1	q21.1	GRCh38.p7	143264454	143264454			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000062	HBV		U95551.1	1815		chr1	p36.13	GRCh38.p7	19437744	19437744		CAP2B	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000063	HBV		U95551.1	1827		chr1	p34.1	GRCh38.p7	44395472	44395472			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000064	HBV		U95551.1	1812		chr1	p32.3	GRCh38.p7	52219974	52219974		ZFYVE9	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000065	HBV		U95551.1	1838		chr1	p31.1	GRCh38.p7	80793604	80793604			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000066	HBV		U95551.1	1816		chr1	p22.2	GRCh38.p7	88665227	88665227		PKN2-AS1	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000067	HBV		U95551.1	1733		chr1	p21.1	GRCh38.p7	106305730	106305730			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000068	HBV		U95551.1	1828		chr1	q21.1	GRCh38.p7	143213532	143213532			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000069	HBV		U95551.1	1828		chr1	q21.1	GRCh38.p7	143214000	143214000			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000070	HBV		U95551.1	1824		chr1	q21.3	GRCh38.p7	154135816	154135816		NUP210L	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000071	HBV		U95551.1	1824		chr1	q31.1	GRCh38.p7	186392640	186392640		ODR4	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000072	HBV		U95551.1	1799		chr1	q31.1	GRCh38.p7	187050002	187050002			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000073	HBV		U95551.1	1677		chr1	q32.1	GRCh38.p7	199527139	199527139			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000074	HBV		U95551.1	1739		chr1	q32.1	GRCh38.p7	199824110	199824110			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000075	HBV		U95551.1	1797		chr1	q32.1	GRCh38.p7	201619049	201619049		NAV1	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000076	HBV		U95551.1	1838		chr1	q32.2	GRCh38.p7	210272394	210272394			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000077	HBV		U95551.1	1828		chr1	q32.2	GRCh38.p7	210808383	210808383		KCNH1	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000078	HBV		U95551.1	1730		chr1	q41	GRCh38.p7	219919066	219919066		SLC30A10	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000079	HBV		U95551.1	1820		chr1	q43	GRCh38.p7	237943903	237943903		MTRNR2L11	Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000080	HBV		U95551.1	1801		chr1	q44	GRCh38.p7	244735225	244735225			Cell line	Hepatocellular carcinoma	invPCR	29437961	Cu
TVIS10000347	HBV	A	X70185.1	1720	1603	chr1	q21.1	hg19	420	437		ANP32E	Cell line	Hepatocellular carcinoma	invPCR+NAH	28414318	Cu
TVIS10000348	HBV	A	X70185.1	1246	1390	chr1	p21.3	hg19	97732056	97732056		DPYD	Cell line	Hepatocellular carcinoma	invPCR+NAH	28414318	Cu
TVIS10000349	HBV	A	X70185.1	1603	1664	chr1	q31.3	hg19	194161891	194161910		LOC107985242	Cell line	Hepatocellular carcinoma	invPCR+NAH	28414318	Cu

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Figure 29. All VIS on chr1 chromosome.

3.6 Browse by literature

Click Browse by literature, the page will display all collected literature in VISDB (Figure 30).

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Pubmed ID	Name	VISes
11593432	Identification of human cancer-related genes by naturally occurring Hepatitis B Virus DNA tagging	21
12802289	Integrations of the hepatitis B virus (HBV) and human papillomavirus (HPV) into the human telomerase reverse transcriptase (hTERT) gene in liver and cervical cancers	2
12813464	Hepatitis B virus-related insertional mutagenesis occurs frequently in human liver cancers and recurrently targets human telomerase gene	9
12843741	HIV insertions within and proximal to host cell genes are a common finding in tissues containing high levels of HIV DNA and macrophage-associated p24 antigen expression	37
14712219	Characterization of HBV integrants in 14 hepatocellular carcinomas: association of truncated X gene and hepatocellular carcinogenesis	22
14982850	Integration of Epstein-Barr virus into chromosome 6q15 of Burkitt lymphoma cell line (Raj) induces loss of BACH2 expression	1
15163705	Resting CD4+ T cells from human immunodeficiency virus type 1 (HIV-1)-infected individuals carry integrated HIV-1 genomes within actively transcribed host genes	74
15241441	Epstein-Barr virus is integrated between REL and BCL-11A in American Burkitt lymphoma cell line (NAB-2)	2
15681063	Identification of Epstein-Barr virus integrated sites in lymphoblastoid cell line [B4]	2
15806150	Hepatitis B virus-related insertional mutagenesis in chronic hepatitis B patients as an early drastic genetic change leading to hepatocarcinogenesis	20
16009689	Large scaled analysis of hepatitis B virus (HBV) DNA integration in HBV related hepatocellular carcinomas	60
16115921	Alteration of gene expression in human hepatocellular carcinoma with integrated hepatitis B virus DNA	15
17262715	Recurrent HIV-1 integration at the BACH2 locus in resting CD4+ T cell populations during effective highly active antiretroviral therapy	461
18023912	Impact of hepatitis B virus (HBV) X gene integration in liver tissue on hepatocellular carcinoma development in serologically HBV-negative chronic hepatitis C patients	19
18202256	Clonal integration of a polyomavirus in human Merkel cell carcinoma	2
18320596	Integration of hepatitis B virus DNA into the myeloid/lymphoid or mixed-lineage leukemia (MLL4) gene and rearrangements of MLL4 in human hepatocellular carcinoma	4
18684813	Integration Site Preference of Xenotropic Murine Leukemia Virus-Related Virus, a New Human Retrovirus Associated with Prostate Cancer	14
19291712	Merkel cell carcinoma of the skin: pathological and molecular evidence for a causative role of MCV in oncogenesis	10
20421928	Fidelity of Target Site Duplication and Sequence Preference during Integration of Xenotropic Murine Leukemia Virus-Related Virus	15
20519397	Clonal expansion of normal-appearing human hepatocytes during chronic hepatitis B virus infection	44
20865165	Distinct merkel cell polyomavirus molecular features in tumour and non tumour specimens from patients with merkel cell carcinoma	4
21497292	Hybrid capture and next-generation sequencing identify viral integration sites from formalin-fixed, paraffin-embedded tissue	4
22342276	Genetic variability and integration of Merkel cell polyomavirus in Merkel cell carcinom	17
22634754	Genome-wide survey of recurrent HBV integration in hepatocellular carcinoma	917
22634756	Whole-genome sequencing of liver cancers identifies etiological influences on mutation patterns and recurrent mutations in chromatin regulators	23

Show 25 entries Previous 1 2 3 4 Next

Figure 30. All literature collected in VISDB.

You can click the PubMed ID to browse all VISs collected from this literature (Figure 31).

VIS ID	Virus genome					Human genome					Target gene	Sample	Disease	Method	Pubmed ID	Curated way	
	Virus Name	Subtype	Reference	Start	End	Chromosome	Loc	Reference	Start	End							
TVIS10019988	HBV		V00866	1719	1818	chr2	p23	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019989	HBV		V00866	1726	1825			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019990	HBV		V00866	1711	1810	chr18	p11.3	NT011005	222267	222742		THOC1	Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019991	HBV		V00866	1716	1815			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019992	HBV		V00866	1722	1821	chr2	q11.2	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019993	HBV		V00866	1711	1810			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019994	HBV		V00866	1728	1827	chr9	p11	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019995	HBV		V00866	1697	1796			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019996	HBV		V00866	1728	1827	chr9	q21.1	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019997	HBV		V00866	1720	1819	chr16	p12.1	U96773	1979	2293		ATP2A1	Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019998	HBV		V00866	1686	1785	chr14	q21.1	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10019999	HBV		V00866	1725	1824			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020000	HBV		V00866	1711	1810	chr9	q22.1	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020001	HBV		V00866	1682	1781	chr5	p15.33	AF128893	240	278		TERT	Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020002	HBV		V00866	1673	1772	chr2	p24.1	AF128893					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020003	HBV		V00866	1640	1693	chr3	q11.2	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020004	HBV		V00866	1630	1708			Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020005	HBV		V00866	1628	1707	chr12	p	AC009318	112312	112971			Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020006	HBV		V00866	1796	1796	chr1	p32.3	AL360074	103283	103541		THRAP3	Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020007	HBV		V00866	1661	1760	chr3	p26	Unknown					Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated
TVIS10020008	HBV		V00866	1691	1790	chr20	p12.3	AL035461	51574	52079		MCM8	Tumor	Hepatocellular carcinoma	Alu PCR	11593432	Curated

Show 25 entries

Figure 31. All VISs collected from one literature.

4 Search

4.1 Basic search

Clicking the menu item in the menu bar acts the same as clicking the “Search” button on the homepage, please refer to [1.4 search button](#).

4.2 Advanced search



Figure 32. Advanced search page

Clicking the “Advanced search” in the basic search page will activate the advanced search page (Figure 32). As shown in Figure 32, the leftmost dropdown box provides the following searching options including:

Item	Suggested value
Virus	HBV, HPV, EBV, MCV, AAV2, HIV ,HTLV-1,MLV,XMRV
Chromosome	chr1~chr22,chrX,chrY
Paper	PubMed ID
Target gene	Official symbol of the gene in GenBank
Fragile site	Fragile site name such as FRA1A1
Disease	Adenocarcinoma, Adenosquamous carcinoma, Adult T-cell leukemia, AIDS dementia, AIDS-associated lymphoma, Anal intraepithelial neoplasia, Angioimmunoblastic lymphadenopathy, B-cell lymphoma, Cervical carcinoma, Cervical intraepithelial neoplasia, Clear cell carcinoma, Extranodal natural killer T-cell lymphoma, Gastric carcinoma, Head and neck squamous cell carcinoma, Hepatocellular carcinoma, HIV-infected disease, Hodgkin lymphoma, HTLV-1 associated myelopathy/tropical spastic paraparesis, Merkel cell carcinoma, Nasopharyngeal carcinoma, Neuroendocrine carcinoma, NK/T cell lymphoma, Oropharyngeal squamous cell carcinoma, Prostate cancer, Squamous-cell carcinoma, Vaginal cancer, Not given
Assay	Abbreviation of the assay, such as PCR, invPCR, NGS, etc. Approximate match is applied here.
Sample type	Tumor, Nontumor, PBMC, Cell line, Adjacent tissue

Users can choose any items in the above list or combine more items together to form complex searching conditions to reduce the scope of browsing. Figure 32 set “Virus” as the default searching item, users can change the item by clicking the drop-box and choose the item he or she prefers. The specific usages of advance are as follows.

Step1: choose items interested for search.

- Step2: select comparing operation: equal or unequal (IS or IS NOT).
 - Step3: choose an item value by clicking drop-box or inputting data in the text box
 - Step4: add more conditions (click the “Add” link, clicking the “remove” link will delete a querying condition), and continue step 1~3.
 - Step5: click the “search” button.
- In addition, clicking the “Back to basic search” link will navigate the page to the basic search page.

5 Curation

We provide the curation function for user to supplement or correct the VIS in our database. User uses curation function to submit their suggestion, and the final update will be validated only after checked by VISDB maintenance team.

VIS ID	Virus genome				Human genome				Target gene	Sample	Disease	Method	PubMed I		
	Virus Name	Subtype	Reference	Start	End	Chromosome	Loci	Reference						Start	End
TVIS10000001	HBV		FS62281.1	1782		chr9	q31.1	hg19	100940295	100940295	CORO2A	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000002	HBV		GQ377546.1	1820		chr9	q31.1	hg19	101030026	101030026		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000003	HBV		KC792890.1	1471		chr3	p26.3	hg19	2002381	2002381		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000004	HBV		KR014001.1	689		chr2	q35	hg19	216281034	216281034		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000005	HBV		MH818373.1	1807		chr16	q12.1	hg19	51320015	51320015		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000006	HBV		MG571337.1	1908		chr16	q12.1	hg19	51320070	51320070		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000007	HBV		GU815714.1	2360		chr10	p11.21	hg19	34836578	34836578	PARO3	Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000008	HBV		GU815645.1	1651		chr14	q11.2	hg19	19828316	19828316		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000009	HBV		JN827419.1	1754		chr14	q22.3	hg19	57417625	57417625		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000010	HBV	B2	JQ688405	1831		chr14	q22.3	hg19	57417636	57417636		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000011	HBV		JX026886.1	1760		chr16	p11.2	hg19	34990970	34990970		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000012	HBV		AB713529.1	1546		chr9	q22.33	hg19	98928137	98928137		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000013	HBV		MG571336.1	1465		chrX	p21.1	hg19	36919408	36919408		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000014	HBV		JX507212.1	1513		chr5	p13.1	hg19	42009760	42009760		Tumor	Hepatocellular carcinoma	PCR and Sanger sequencing	3053543
TVIS10000015	HBV		Not given			chr11	p12	hg16				Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000016	HBV		Not given			chr16	q13.3	hg16			AXIN1	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000017	HBV		Not given			chr7	q21.11	hg16				Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000018	HBV		Not given			chr7	q22.3	hg16			SRPK2	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000019	HBV		Not given			chr15+chr2	q13.3+q36.3	hg16			KLF13	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000020	HBV		Not given			chr6	p22.3	hg16				Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000021	HBV		Not given			chr2	q31.2	hg16			PDE11A	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000022	HBV		Not given			chr3	p22.3	hg16				Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000023	HBV		Not given			chr8	q21.11	hg16			KCNB2	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615
TVIS10000024	HBV		Not given			chr3	q13.12	hg16			BBX	Tumor	Hepatocellular carcinoma	Alu PCR and sequencing	1580615

Figure 33. Curation page

To curate a VIS, the user needs to select a VIS by inputting the VIS ID in the text box in the upper right corner or click on the VIS ID link list in the table (Figure 33). The VIS curation page is shown in Figure 34.

Basic Information	
VIS ID	TVIS10000001
Fusion name	HBV-COROZA integration
State	Validated
Fusion type	<input type="text"/>
Detection Method	PCR and Sanger sequencing
Curated Way	Curated
Sample	Tumor
Disease	Hepatocellular carcinoma
Quality evaluation	Perfect
Reported year	2019
Pubmed ID	30535432
Virus Sequence	
Virus name	HBV
Subtype	<input type="text"/>
Reference genome	FJ562281.1 Edit
Strand	<input type="text"/>
Gene	<input type="text"/>
Region type	X
Start	1782
End	<input type="text"/>

Figure 34. VIS curation page

In Figure 34, items that can be curated by user are displayed with the edit box or “Edit” link beside the value. For the former case, the user only needs to input the new value. For the latter, a small window containing the link name and URL will be popped out (Figure 35).

Edit link
×

Link name:

URL:

Close
Confirm

Figure 35. Page for editing link

In a word, the whole flow of curating a VIS for VISDB is as follows.

Step1: Choose the VIS to be curated

Step2: Edit items with accurate values.

Step3. Input a valid mailbox to get feedback from our team.

Step4. Click “Submit Curation” button to submit your update.

6 Gene

The "Gene" module provides [target gene](#), [nearby gene](#), [target oncogene](#), [nearby oncogene](#), [target tumor suppressor gene](#) and [nearby tumor suppressor gene](#) for users to browse by their interest. Here, we provide an example to show how to use the module to explore viral integration sites of each virus.

A particular gene can be specifically integrated with several viruses. How could we know the viral integration site that targets in the interested gene? Here, take "AKAP13" as an example, which has been reported associated with cancer in humans, other kinds of gene can be operated in the same way.

1. Choose the [Target Oncogene](#) sub-module under "Gene" module (Figure 36).

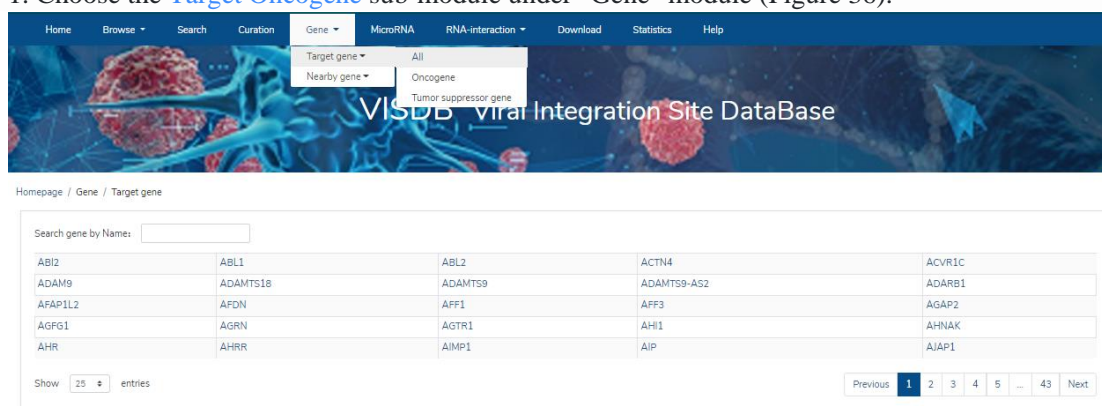


Figure 36. Target gene page

2. Enter the gene name of "AKAP13" or click the "[AKAP13](#)" button. Then it will give the information about "AKAP13" gene and all VISs which can target "AKAP13" (Figure 37, 38).

Gene Information	
Gene ID	11214
Name	AKAP13
Alias	AKAP-13, AKAP-Lbc, ARHGEF13, BRX, HA-3, Ht31, LBC, PRKA13, PROTO-LB, PROTO-LBC, c-lbc, p47
Description	A-kinase anchoring protein 13
Location	15q25.3
Chromosome	chr15
Start	85380616
End	85749358
Fragile sites	N/A
Micro RNA	hsa-mir-335-5p; hsa-mir-423-5p; hsa-mir-193b-3p; hsa-mir-484; hsa-mir-149-5p; hsa-mir-16-5p; hsa-mir-6749-3p; hsa-mir-6792-3p; hsa-mir-4691-5p; hsa-mir-211-5p; hsa-mir-204-5p; hsa-mir-8074; hsa-mir-6778-3p; hsa-mir-4287; hsa-mir-4685-3p; hsa-mir-1281; hsa-mir-3667-3p; hsa-mir-6832-3p; hsa-mir-183-5p
Reference	ENCODE; GeneCards; KEGG; NCBI; ONGene

Figure 37. Detail information of AKAP13


VIS ID	Virus genome				Human genome						Target gene	Sample	Disease
	Virus Name	Subtype	Reference		Start	End	Chromosome	Loc	Reference	Start			
TVIS10002475	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431			chr15	q25.3	hg19	86032860	86032860	AKAP13	Tumor	Hepatocellular carcinoma
TVIS10002476	HBV		AF090842.1:AB033554.1:AB014381.1:M32138.1:AB032431			chr15	q25.3	hg19	86032872	86032872	AKAP13	Tumor	Hepatocellular carcinoma
TVIS10008596	HBV		NC_003977	2511		chr15	q25.3	hg19	86173133	86173133	AKAP13	Tumor	Hepatocellular carcinoma
TVIS10010660	HBV		NC_003977	2379		chr15	q25.3	hg19	85933932	85933932	AKAP13	Nontumor	Hepatocellular carcinoma
TVIS10011517	HBV		NC_003977	1828		chr15	q25.3	hg19	86171229	86171229	AKAP13	Nontumor	Hepatocellular carcinoma
TVIS20000018	HPV	HPV16	NC_001526.4			chr15	q25.3	hg18	83735261	83735261	AKAP13	Tumor	Cervical carcinoma
TVIS20001571	HPV	HPV16	NC_001526.2			chr15	q25.3	hg19	86006171	86006171	AKAP13	Tumor	Not given
TVIS30001101	HIV		Not given			chr15	q25.3	hg19	86107553	86108447	AKAP13	PBMC	HIV-infected disease
TVIS30002372	HIV		Not given			chr15	q25.3	hg19	85943364	85943364	AKAP13	Cell line	HIV-infected disease
TVIS30002373	HIV		Not given			chr15	q25.3	hg19	86107436	86107436	AKAP13	Cell line	HIV-infected disease
TVIS30002374	HIV		Not given			chr15	q25.3	hg19	86164380	86164380	AKAP13	Cell line	HIV-infected disease
TVIS30002375	HIV		Not given			chr15	q25.3	hg19	86242366	86242366	AKAP13	Cell line	HIV-infected disease
TVIS30004525	HIV		Not given			chr15	q25.3	hg19	86100126	86100126	AKAP13	Cell line	HIV-infected disease
TVIS30006674	HIV		Not given			chr15	q25.3	hg19	86100699	86100699	AKAP13	Cell line	HIV-infected disease
TVIS30006675	HIV		Not given			chr15	q25.3	hg19	86227608	86227608	AKAP13	Cell line	HIV-infected disease
TVIS30012027	HIV		Not given			chr15	q25.3	hg19	86071954	86071954	AKAP13	Cell line	HIV-infected disease
TVIS30012028	HIV		Not given			chr15	q25.3	hg19	86092251	86092251	AKAP13	Cell line	HIV-infected disease
TVIS30012029	HIV		Not given			chr15	q25.3	hg19	86246957	86246957	AKAP13	Cell line	HIV-infected disease
TVIS30013978	HIV		Not given			chr15	q25.3	hg19	86189926	86189926	AKAP13	T cell	HIV-infected disease
TVIS4006098	HTLV-1		Not given			chr15	q25.3	hg19	86138763	86138763	AKAP13	Nontumor	Adult T-cell leukemia
TVIS44012589	HTLV-1		Not given			chr15	q25.3	hg19	85944652	85944652	AKAP13	Nontumor	Adult T-cell leukemia
TVIS44020990	HTLV-1		Not given			chr15	q25.3	hg19	86133535	86133535	AKAP13	Nontumor	HTLV-1 associated myeloid

Figure 38. AKAP13-targeted VISs

3. Click the highlighted non-zero characters to browse more details. For example, click "TVIS10002475" in the VIS ID column, you can get more details about TVIS10002475 of HBV([VIS information](#)).

7 miRNA

Clicking the menu "MiRNA" in the menu bar activate all target miRNAs curated from VISs.



miRBase ID	Accession	Chromosome	Start	End	Strand	Operations
hsa-mir-100	MI0000102	chr11	122152229	122152308	-	Browse VISes
hsa-mir-106a	MI0000113	chrX	134170278	134170278	-	Browse VISes
hsa-mir-106b	MI0000734	chr7	100093993	100094074	-	Browse VISes
hsa-mir-107	MI0000114	chr10	89592747	89592827	-	Browse VISes
hsa-mir-10a	MI0000266	chr17	48579838	48579947	-	Browse VISes
hsa-mir-10b	MI0000267	chr2	176150303	176150412	+	Browse VISes
hsa-mir-1178	MI0006271	chr12	119713634	119713724	-	Browse VISes
hsa-mir-1179	MI0006272	chr15	88608107	88608197	+	Browse VISes
hsa-mir-1180	MI0006273	chr17	19344506	19344574	-	Browse VISes
hsa-mir-1181	MI0006274	chr19	10403458	10403538	-	Browse VISes
hsa-mir-1182	MI0006275	chr1	231019828	231019924	-	Browse VISes
hsa-mir-1183	MI0006276	chr7	21471058	21471146	+	Browse VISes
hsa-mir-1193	MI0014205	chr14	101030052	101030129	+	Browse VISes
hsa-mir-1197	MI0006656	chr14	101025564	101025651	+	Browse VISes
hsa-mir-1199	MI0020340	chr19	14073361	14073479	+	Browse VISes
hsa-mir-1200	MI0006332	chr7	36919357	36919432	-	Browse VISes
hsa-mir-1202	MI0006334	chr6	155946797	155946879	+	Browse VISes
hsa-mir-1203	MI0006335	chr17	48156427	48156511	-	Browse VISes
hsa-mir-1204	MI0006337	chr8	127795962	127796028	+	Browse VISes
hsa-mir-1205	MI0006338	chr8	127960633	127960695	+	Browse VISes
hsa-mir-1206	MI0006339	chr8	128008898	128008956	+	Browse VISes
hsa-mir-1207	MI0006340	chr8	128049152	128049238	+	Browse VISes
hsa-mir-1208	MI0006341	chr8	128150116	128150188	+	Browse VISes
hsa-mir-122	MI0000442	chr18	58451074	58451158	+	Browse VISes
hsa-mir-1224	MI0003764	chr3	184241405	184241489	+	Browse VISes

Figure 39. List of miRNAs target by VISs in VISDB

Figure 39 list part of information of miRNA targeted by VIS. Clicking the miRBase ID or Accession number navigates to miRBase to see detailed information of the miRNA.

Clicking the “Browse VISs” link in the operation column navigates to the list of VISs which are shown below the list of miRNA.

8 Download

We provide http download for VISs, Target genes and other kinds of data collected in the curation process. User can click the filename with right mouse click and select “save the object as ” to save the file to local disk (Figure 40).

The screenshot shows the VISDB (Viral Integration Site DataBase) website. The navigation bar includes Home, Browse, Search, Curation, Gene, MicroRNA, RNA-interaction, Download, Statistics, and Help. The main header features a blue background with a molecular structure and the text "VISDB Viral Integration Site DataBase". Below the header, the breadcrumb "Homepage / Download" is visible. The page displays two data tables for download.

VIS Data

Name	Description	Created
VIS-AAV2.xlsx	All VISes curated from AAV2-related publications	2019-06-12
VIS-EBV.xlsx	All VISes curated from EBV-related publications	2019-06-12
VIS-HBV.xlsx	All VISes curated from HBV-related publications	2019-06-12
VIS-HIV.xlsx	All VISes curated from HIV-related publications and RID	2019-06-12
VIS-HPV.xlsx	All VISes curated from HPV-related publications and HPVbase	2019-06-12
VIS-HTLV-1.xlsx	All VISes curated from HTLV-1-related publications	2019-06-12
VIS-MCV.xlsx	All VISes curated from MCV-related publications	2019-06-12
VIS-MLV.xlsx	All VISes curated from MLV-related publications	2019-06-12
VIS-XMRV.xlsx	All VISes curated from XMRV-related publications	2019-06-12

Gene Data

Name	Description	Created
Hotspot genes.xlsx	Hotspot genes find in 5 viruses	2019-06-10
Target gene-EBV.xlsx	EBV target genes collected from publications or curated by computing	2019-06-12
Target gene-HBV.xlsx	HBV target genes collected from publications or curated by computing	2019-06-12
Target gene-HIV.xlsx	HIV target genes collected from publications or curated by computing	2019-06-12
Target gene-HPV.xlsx	HPV target genes collected from publications or curated by computing	2019-06-12
Target gene-HTLV-1.xlsx	HTLV-1 target genes collected from publications or curated by computing	2019-06-12
Target gene-MCV.xlsx	MCV target genes collected from publications or curated by computing	2019-06-12
Target gene.xlsx	Target genes collected from publications or curated by computing	2019-06-12

Figure 40. Data files for download