

Home Help

The home page provides a top-down view of representative viruses, representative species, and statistics of VThunter.

VThunter Single-cell screening of virus receptor expression in animal kingdom

Home Virus Spectrum Host Spectrum Demo Co-expression Download Help

Query viral receptor expression atlas in VThunter.

Virus Family Virus Target Gene

Representative viruses

A total of 142 viruses from 21 families were included in VThunter, covering Adenoviridae, Arenaviridae, Arteriviridae, Calciviridae, Coronaviridae, Filoviridae, Flaviviridae, Hantaviridae, Herpesviridae, Orthomyxoviridae, Papillomaviridae, Paramyxoviridae, Parvoviridae, Phenulviridae, Picornaviridae, Pneumoviridae, Polyomaviridae, Reoviridae, Retroviridae, Rhabdoviridae, Togaviridae.

Human alphaherpesvirus 1, Equid alphaherpesvirus 1, Suid alphaherpesvirus 1, Human betaherpesvirus 7, Human betaherpesvirus 6A, Human mastadenovirus B, Human alphaherpesvirus 2, Equid alphaherpesvirus 4, Human betaherpesvirus 5, Human gammaherpesvirus 4, Human betaherpesvirus 6B, Human mastadenovirus A, Bovine alphaherpesvirus 1, Human alphaherpesvirus 3, Human betaherpesvirus 6, Hepatitis E virus, Human gammaherpesvirus 8, Human mastadenovirus C

Query species in VThunter.

Classification Species

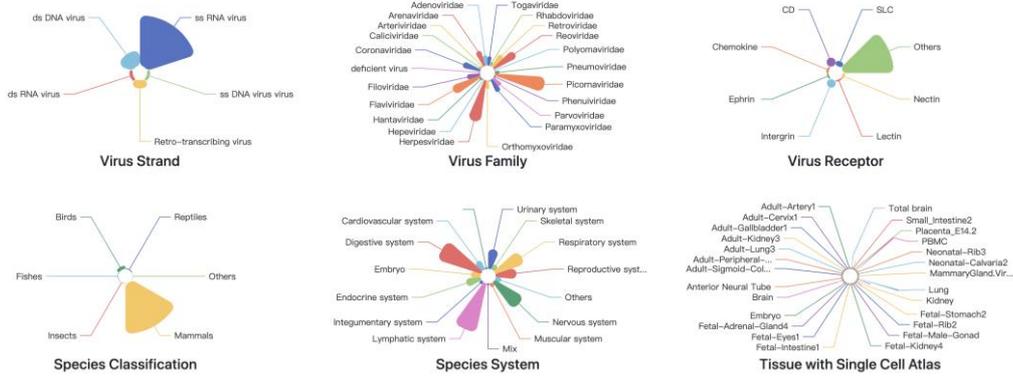
Representative species

The single cell atlas for 49 species were included in VThunter, covering mammals, reptiles, birds, fishes and insects.

Alpaca, Blue-and-yellow macaw, Chicken, Crab-eating macaque, Dog, Duck, Bat, Caenorhabditis elegans, Chinchilla, Dalmatian pelican, Domestic guinea pig, Goat, Blind mole rat, Cat, Civet, Deer, Drosophila melanogaster, Green-cheeked parakeet

Statistics of VThunter

In total, the expression of 106 receptors for 142 animal viruses were investigated.



Users can query virus receptor expression atlas through the known family of viruses (1) and query host receptor expression atlas through their classification (3). Users can also click on the graphs of representative viruses (2) or species (4) to go to the virus receptor expression atlas pages or host receptor expression atlas pages.

Besides, users can click on the statistics of VThunter (5) to jump to the pages containing the corresponding types of virus strands, virus families, virus receptors, species classifications, species systems, or tissue with single cell atlas.

Query viral receptor expression atlas in VThunter. **1**

Virus Family: Virus: Target Gene:

Representative viruses

Included in VThunter, covering Adenoviridae, Arenaviridae, Arteriviridae, Caliciviridae, Coronaviridae, Filoviridae, Flaviviridae, Hantaviridae, Herpesviridae, Parvoviridae, Phenuiviridae, Picornaviridae, Pneumoviridae, Polymoviridae, Reoviridae, Retroviridae, Rhabdoviridae, Togaviridae.

2

Human betaherpesvirus 7

Other representative viruses shown include: Bovine alphaherpesvirus 1, Human alpha herpesvirus 3, Human betaherpesvirus 5, Human gammaherpesvirus 4, Hepatitis E virus, Human betaherpesvirus 6A, Human betaherpesvirus 6B, Human mastadenovirus B, Human mastadenovirus A, and Human mastadenovirus C.

Query species in VThunter. 3

Classification
 Mammals
 Reptiles
 Birds
 Fishes
 Insects
 Others

Species

Search

Representative species

... in VThunter, covering mammals, reptiles, birds, fishes and insects.


Alpaca


Blue-and-yellow macaw


Chicken


Crab-eating macaque


Dog


Duck


Bat


Caenorhabditis elegans


Chinchilla


Dalmatian pelican


Domestic guinea pig


Goat


Blind mole rat

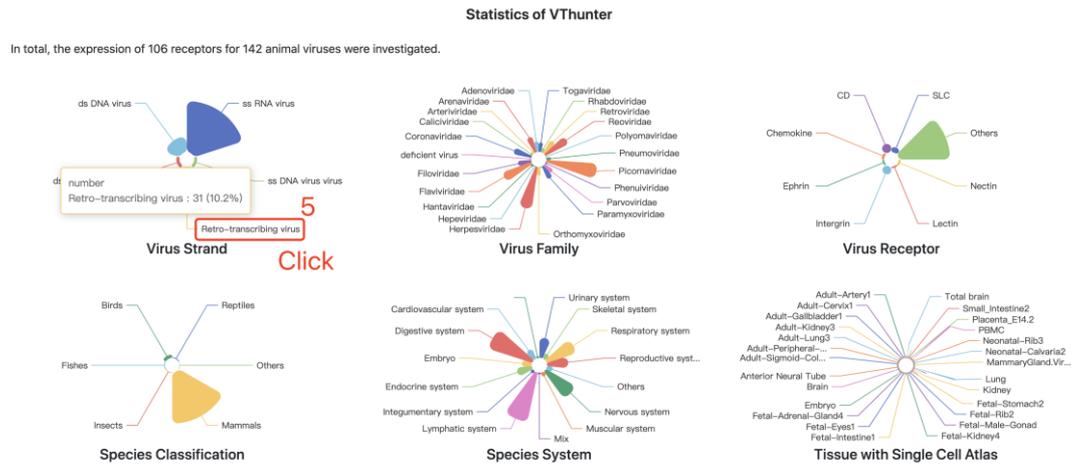

Cat 4


Civet


Deer


Drosophila melanogaster


Green-cheeked parakeet



Virus Spectrum Help

The virus spectrum page provides a list of viruses included in VThunter, covering families such as Adenoviridae, Arenaviridae, Arteriviridae, Caliciviridae, Coronaviridae, Filoviridae, Flaviviridae, Hantaviridae, Herpesviridae, Orthomyxoviridae, Papillomaviridae, Paramyxoviridae, Parvoviridae, Phenuiviridae, Picornaviridae, Pneumoviridae, Polyomaviridae, Reoviridae, Retroviridae, and Rhabdoviridae Togaviridae. Users can query a virus or receptor by selecting the family of virus (1) or browse through a list of viruses (2). The Search button (3) leads to the receptor expression atlas pages. The “Check Details” button (4) below the graph and family of virus can jump to a page displaying expression atlas of all the receptors of this virus.

List of viruses included in VThunter

A total of 142 viruses from 21 families were included in VThunter, covering Adenoviridae, Arenaviridae, Arteriviridae, Calciviridae, Coronaviridae, Filoviridae, Flaviviridae, Hantaviridae, Herpesviridae, Orthomyxoviridae, Papillomaviridae, Paramyxoviridae, Parvoviridae, Phenuiviridae, Picornaviridae, Pneumoviridae, Polyomaviridae, Reoviridae, Retroviridae, Rhabdoviridae, Togaviridae.

Query viral receptor expression atlas in VThunter.

1

Virus Family Virus Target Gene

3

Search

Browse

2

4

Virus receptor expression atlas pages help

The virus receptor expression atlas page contains a list of all species and top 5 cell types which express this receptor in our datasets. Users can click the buttons (5) to change the displayed viral receptors. Clicking on the species (6) leads to a host receptor expression atlas page. The “Check Details” buttons (7) in of each species brings the user to a result page.


Rabies lyssavirus

Family: Rhabdoviridae

5

NGFR NCAM1 GRM2

NGFR

Species Image	Species	Top 5 cell types expressing NGFR (Rabies lyssavirus)	Detail
	6 Mouse Tested tissue: PBMC / Lung / Total brain / Bladder / BoneMarrow1 / BoneMarrowKit1 / BoneMarrowKit2 / BoneMarrowKit3 / Brain1 / Brain2 / EmbryonicMesenchymeE14.5 / FetalBrain / FetalFemaleGonad / FetalIntestine / FetalLung / FetalMaleGonad / FetalStomach / Kidney2 / Liver1 / Liver2 / Lung1 / Lung2 / Lung3 / MammaryGland.Involution1 / MammaryGland.I[unfold]	Uterus1-Stromal cell_Ccl11 high : 63.92% Uterus1-Stromal cell_Has1 high : 62.11% MammaryGland.Involution2-Mast cell : 50.00% Uterus1-Stromal cell_Hsd11b2 high : 41.71% Uterus1-Stromal cell_Gm23935 high : 34.48%	7 Check Details

Results pages help

The results page shows the expression of one viral receptor in one animal host species. Detailed introductions of hosts (1) and receptors (2) are included first. Users can click on the species

and virus name to jump to the host receptor expression atlas pages and virus receptor expression atlas pages, respectively. The “NCBI” (3) and “Proteinatlas” (4) buttons lead to a description of the receptor in NCBI and the receptor’s bulk expression level in Humans in The Human Protein Atlas websites, respectively.

Civet 1
 Scientific Name: Paguma larvata
 Taxonomy: Cellular organisms-> Eukaryota-> Opisthokonta-> Metazoa-> Eumetazoa-> Bilateria-> Deuterostomia-> Chordata-> Craniata-> Vertebrata-> Gnathostomata-> Teleostomi-> Euteleostomi-> Sarcopterygii-> Dipnotetrapodomorpha-> Tetrapoda-> Amniota-> Mammalia-> Theria-> Eutheria-> Boreoeutheria-> Laurasiatheria-> Carnivora-> Feliformia

Rabies lyssavirus 2
 Family: Rhabdoviridae
 Receptor: GRM2

Receptor GRM2 information
 Summary: <https://www.proteinatlas.org/ENSG00000164082-GRM2> **3** **4**
 [NCBI] [Proteinatlas]

A “Data Source” presents the information all datasets of this species in VThunter. Each dataset contains only one tissue.

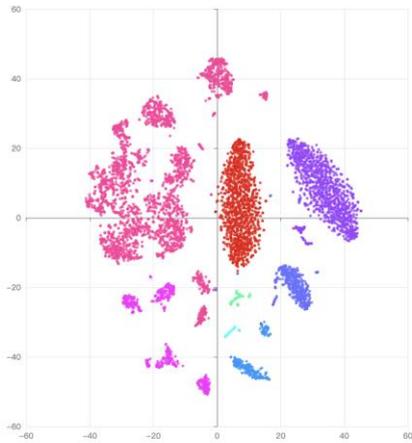
Data Source
 Data set information

Project	Date	Technology	Tissue	Condition	Cell
Vthunter_0007	2021.04	10X Genomics	Frontal	Normal	6593
Vthunter_0008	2021.04	10X Genomics	Kidney	Normal	1930
Vthunter_0009	2021.04	10X Genomics	Liver	Normal	34029
Vthunter_0010	2021.04	10X Genomics	Lung	Normal	12863
Vthunter_0011	2021.04	10X Genomics	Spleen	Normal	9682

“Featureplots of receptors” uses tSNE plots to display the cell types of each tissue in the species and the expression of the receptor. Browsing through “Vthunter_ xxxx----xxxx” options (5) from the dropdown menu displays information of various tissues. Selecting a cell type on the left alters the graph to show the cell types of interest (6). The bar of expression on the right changes the thresholds of the expression value (7). “The ratio of xxx (receptor gene name) expression in different cell type” shows the expression ratio of the receptor in the chosen tissue in a descending order. Users can drag the bar to choose cell types (9). Hovering above or clicking on the dots of the tSNE plots reveals its tSNE coordinates. The download button can be used to download the expression information in a table format (8, 10).

Featureplot of receptors

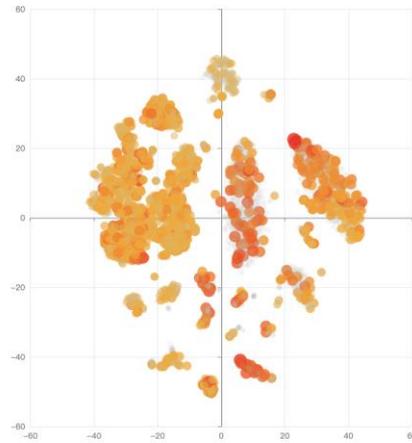
Featureplot of receptors



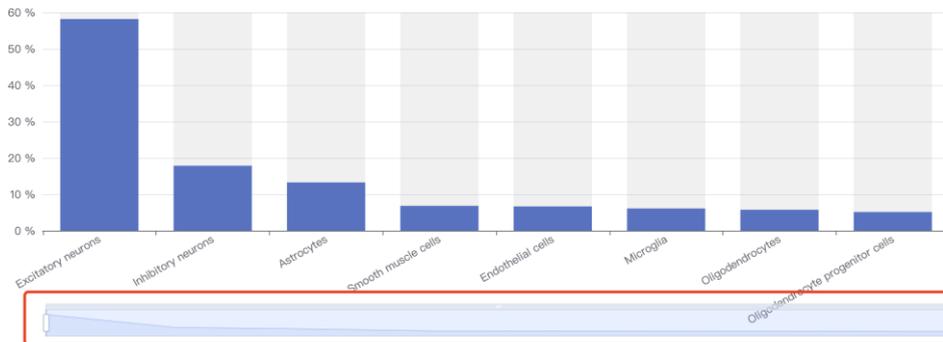
GRM2 gene expression



8



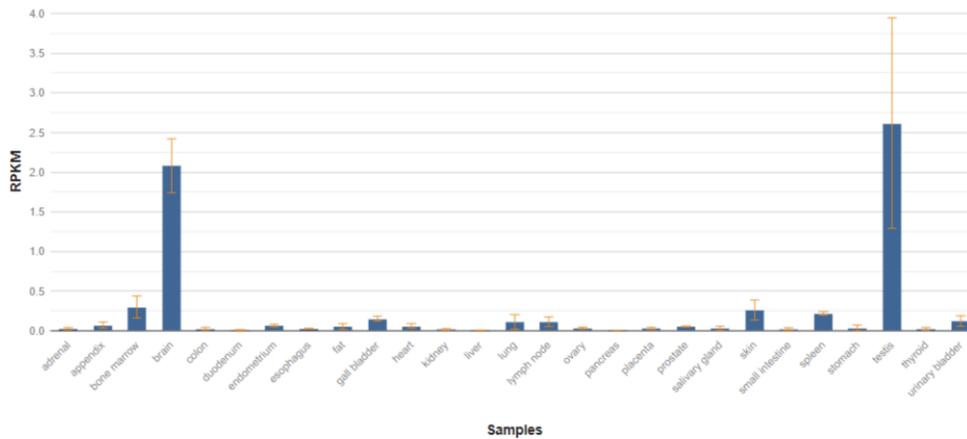
The ratio of GRM2 expression in different cell types

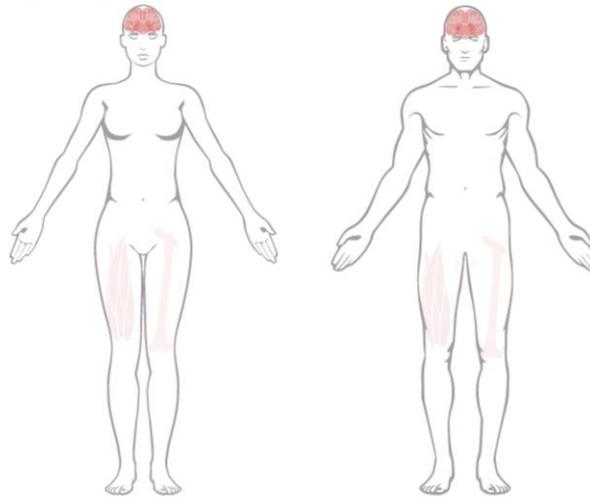


10

“mRNA expression of xxx in human tissues” and “Protein expression of xxx in human tissues” shows the expression of the receptor on a bulk mRNA level in NCBI and protein level in The Human Protein Atlas. The blue word are hyperlinked to the corresponding websites (11, 12).

mRNA expression of GRM2 in human tissues [\[NCBI\]](#) 11
 Expression: <https://www.proteinatlas.org/ENSG00000164082-GRM2>





Host Spectrum Help

The host spectrum page provides a list of species of single cell atlas included in VThunter, covering mammals, reptiles, birds, fishes and insects. Users can query a species by the classification (1) or by browse through the list of hosts (2). The Search button (3) and “Check Details” button below the host species and tested tissues of hosts (4) links to the page that consists of the expression atlas of all the receptors in the species.

The screenshot shows the VThunter website interface. At the top, there is a green navigation bar with the VThunter logo and the tagline "Single-cell screening of virus receptor expression in animal kingdom". The navigation bar includes links for Home, Virus Spectrum, Host Spectrum, Demo, Co-expression, Download, and Help. A red arrow labeled '2' points to the Host Spectrum link. Below the navigation bar, the page title is "List of species included in VThunter" with a "Browse" link on the right. A sub-header reads "The single cell atlas for 49 species were included in VThunter, covering mammals, reptiles, birds, fishes and insects." Below this, there is a search section with the text "Query species in VThunter." and a red box labeled '1' around the "Classification" dropdown menu. The dropdown menu is open, showing options: Mammals, Reptiles, Birds, Fishes, Insects, and Others. To the right of the dropdown is a "Species" input field and a green "Search" button labeled '3'. Below the search section, there is a grid of species cards. Each card includes an image of the species, its name, and the tissues tested. A red box labeled '4' highlights the "Check Details" button for the Alpaca card. The species cards shown are: Alpaca (Frontal / Liver / Lung / PBMC), Bat (Lung), Blind mole rat (Total brain), Blue-and-yellow macaw (PBMC), and Caenorhabditis elegans (Embryo).

Host receptor expression atlas pages help

The host receptor expression atlas page contains a description of the host species(5), all tissues tested in VThunter (6), and a list of all virus and receptor genes expressed in the host species. For each receptor, the top 5 cell types expressing viral receptor are ordered by expression proportion and presented on the host receptor expression atlas page (7). Users can click on the virus names (8) to go to virus receptor expression atlas pages or click on the receptor gene (9) to go to the results pages.

Cat

Taxonomy: Cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Mammalia; Theria; Eutheria; Boreoeutheria; Laurasiatheria; Carnivora; Feliformia; Felidae.

Latin Name: Felis catus

Tested tissues: Esophagus, Eyelid, Heart, Kidney, Liver, Lung, Rectum, PBMC.

Data set information

Project	Date	Technology	Tissue	Condition	Cell
Vthunter_0028	2021.04	10X Genomics	Esophagus	Normal	1928
Vthunter_0029	2021.04	10X Genomics	Eyelid	Normal	679
Vthunter_0030	2021.04	10X Genomics	Heart	Normal	8209
Vthunter_0031	2021.04	10X Genomics	Kidney	Normal	2831
Vthunter_0032	2021.04	10X Genomics	Liver	Normal	7889
Vthunter_0033	2021.04	10X Genomics	Lung	Normal	8591
Vthunter_0034	2021.04	10X Genomics	Rectum	Normal	1503
Vthunter_300003	2021.05	10X Genomics	PBMC	Normal	10214

Host description

Virus

Virus Name **Dengue virus**

Gene **CLDN1**

Top 5 cell types expressing viral receptor ordered by expression proportion

- Heart-Epicardial cells : 100.00% ;
- Liver-Hepatocytes : 85.28% ;
- Eyelid-Endothelial cells : 70.91% ;
- Liver-Hepatic stellate cells : 68.78% ;
- Lung-Secretory cells : 64.19% ;
- Kidney-Podocytes : 70.59% ;
- Heart-Epicardial cells : 100.00% ;
- Kidney-Podocytes : 97.06% ;
- Eyelid-Endothelial cells : 94.55% ;
- Heart-Fibroblasts : 93.90% ;
- Kidney-Collecting duct cells : 91.00% ;
- Heart-Epicardial cells : 100.00% ;
- Liver-Hepatocytes : 76.52% ;
- Lung-ATI : 58.13% ;
- Rectum-Enteroendocrine cells : 51.37% ;

Results pages help

The results page shows the expression of one viral receptor in one animal host species. Detailed introductions of hosts (1) and receptors (2) are included first. Users can click on the species and virus name to jump to the host receptor expression atlas pages and virus receptor expression atlas pages, respectively. The “NCBI” (3) and “Proteinatlas” (4) buttons lead to a description of the receptor in NCBI and the receptor’s bulk expression level in Humans in The Human Protein Atlas websites, respectively.

Civet **1**

Scientific Name: Paguma larvata

Taxonomy: Cellular organisms-> Eukaryota-> Opisthokonta-> Metazoa-> Eumetazoa-> Bilateria-> Deuterostomia-> Chordata-> Craniata-> Vertebrata-> Gnathostomata-> Teleostomi-> Euteleostomi-> Sarcopterygii-> Dipnotetrapodomorpha-> Tetrapoda-> Amniota-> Mammalia-> Theria-> Eutheria-> Boreoeutheria-> Laurasiatheria-> Carnivora-> Feliformia

Rabies lyssavirus **2**

Family: Rhabdoviridae

Receptor: GRM2

Receptor GRM2 information

Summary: <https://www.proteinatlas.org/ENSG00000164082-GRM2> **NCBI** **Proteinatlas**

“Data Source” presents the information all datasets of this species in VThunter. Each dataset

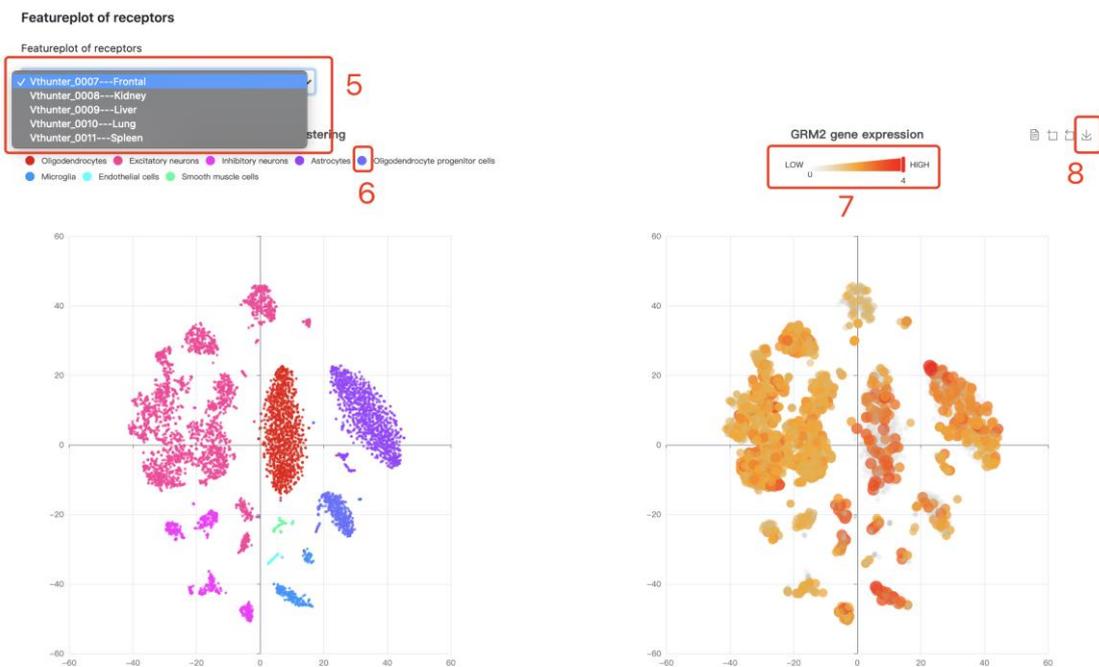
contains only one tissue.

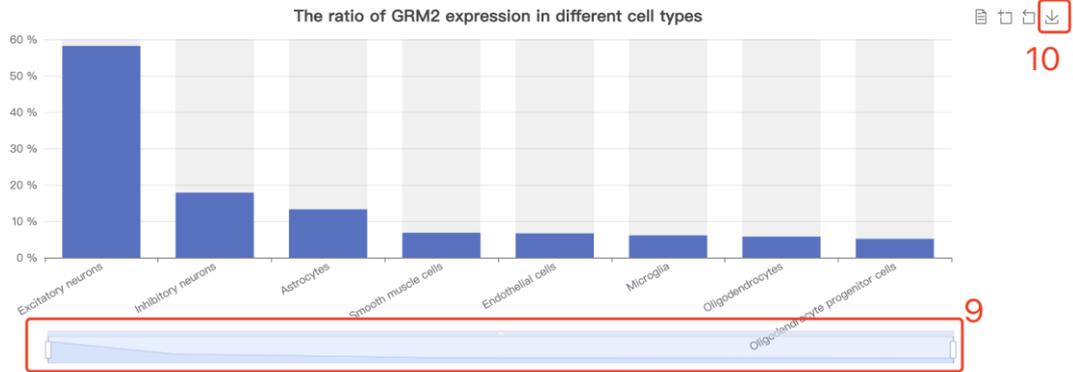
Data Source

Data set information

Project	Date	Technology	Tissue	Condition	Cell
Vthunter_0007	2021.04	10X Genomics	Frontal	Normal	6593
Vthunter_0008	2021.04	10X Genomics	Kidney	Normal	1930
Vthunter_0009	2021.04	10X Genomics	Liver	Normal	34029
Vthunter_0010	2021.04	10X Genomics	Lung	Normal	12863
Vthunter_0011	2021.04	10X Genomics	Spleen	Normal	9682

“Featureplots of receptors” uses tSNE plots to display the cell types of each tissue in the species and the expression of the receptor. Browsing through “Vthunter_XXXX---XXXX” options (5) from the dropdown menu displays information of various tissues. Selecting a cell type on the left alters the graph to show the cell types of interest (6). The bar of expression on the right changes the thresholds of the expression value (7). “The ratio of xxx (receptor gene name) expression in different cell type” shows the expression ratio of the receptor in the chosen tissue in a descending order. Users can drag the bar to choose cell types (9). Hovering above or clicking on the dots of the tSNE plots reveals its tSNE coordinates. The download button can be used to download the expression information in a table format (8, 10).

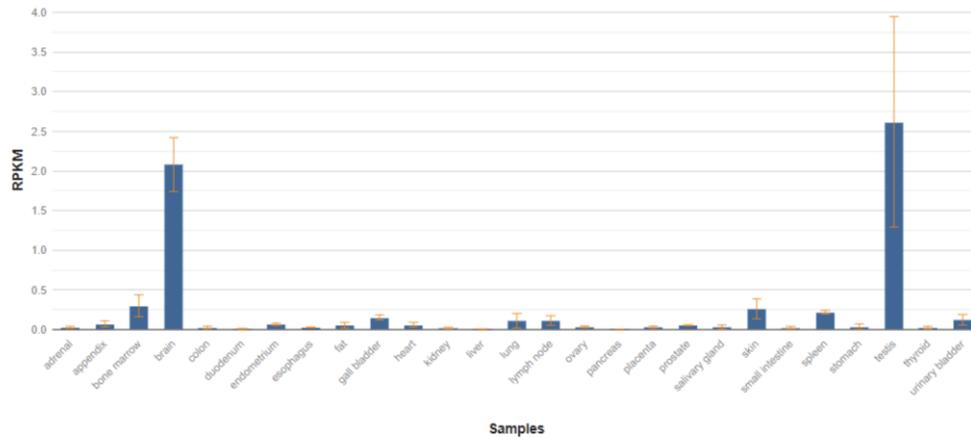




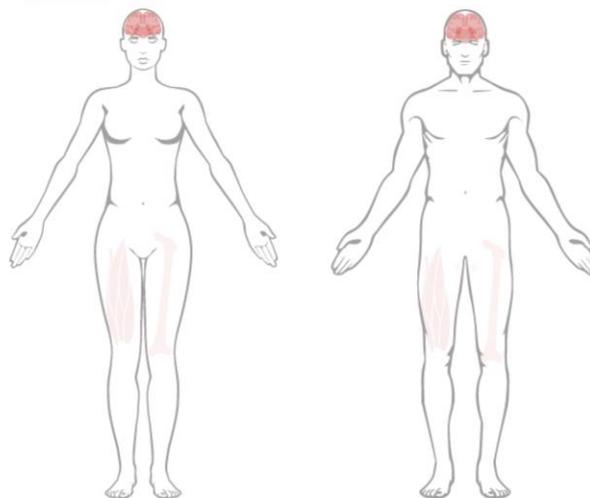
“mRNA expression of xxx in human tissues” and “Protein expression of xxx in human tissues” shows the expression of the receptor on a bulk mRNA level in NCBI and protein level in The Human Protein Atlas. The blue word are hyperlinked to the corresponding websites (11, 12).

mRNA expression of GRM2 in human tissues [\[NCBI\]](#) 11

Expression: <https://www.proteinatlas.org/ENSG00000164082-GRM2>



Protein expression of GRM2 in human tissues [\[Proteinatlas\]](#) 12



Demo Help

The Demo page shows an example of a results page of the expression of the *TYRO3* receptor of the Zika virus in the Dorsolateral prefrontal cortex of Rhesus monkeys.



Rhesus monkey

Scientific Name: *Macaca mulatta*

Taxonomy: Cellular organisms -> Eukaryota -> Opisthokonta -> Metazoa -> Eumetazoa -> Bilateria -> Deuterostomia -> Chordata -> Craniata -> Vertebrata -> Gnathostomata -> Teleostomi -> Euteleostomi -> Sarcpterygii -> Dipnotetrapodomorpha -> Tetrapoda -> Amniota -> Mammalia -> Theria -> Eutheria -> Boreoeutheria -> Euarchontoglires -> Primates -> Haplorhini -> Simiiformes -> Catarrhini -> Cercopithecoidea -> Cercopithecidae -> Cercopithecinae -> Macaca



Zika virus

Family: Flaviviridae

Receptor: TYRO3

Receptor TYRO3 information

Summary: The gene is part of a 3-member transmembrane receptor kinase receptor family with a processed pseudogene distal on chromosome 15. The encoded protein is activated by the products of the growth arrest-specific gene 6 and protein S genes and is involved in controlling cell survival and proliferation, spermatogenesis, immunoregulation and phagocytosis. The encoded protein has also been identified as a cell entry factor for Ebola and Marburg viruses. [provided by RefSeq, May 2010] [\[NCBI\]](#) [\[ProteinAtlas\]](#)

Data Source

Data set information

Project	Date	Technology	Tissue	Condition	Cell
Vthunter_110092	2018.12	10X Genomics	Dorsolateral prefrontal cortex	Normal	26933

Featureplot of receptors

Featureplot of receptors

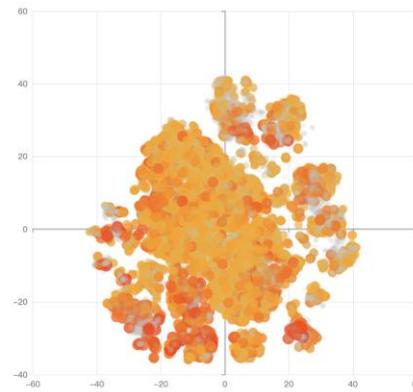
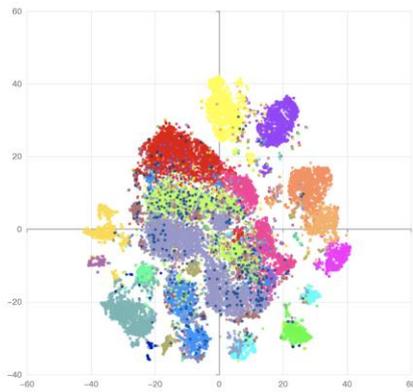
Vthunter_110092---Dorsolateral prefrontal cortex



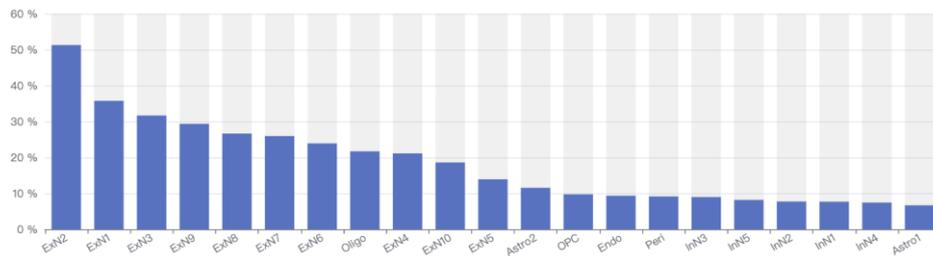
Single cell cell type clustering

- ExN2
- ExN3
- InN5
- InN2
- InN3
- ExN8
- ExN5
- ExN7
- ExN9
- OPC
- ExN4
- InN1
- Endo
- InN4
- InN3
- ExN8
- Oligo
- Astro1
- ExN1
- Peri
- Astro2
- ExN10

TYRO3 gene expression

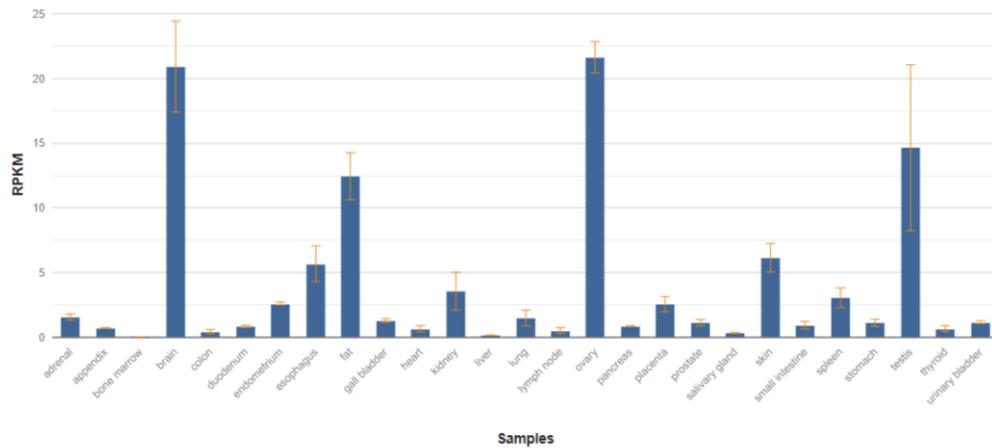


The ratio of TYRO3 expression in different cell types

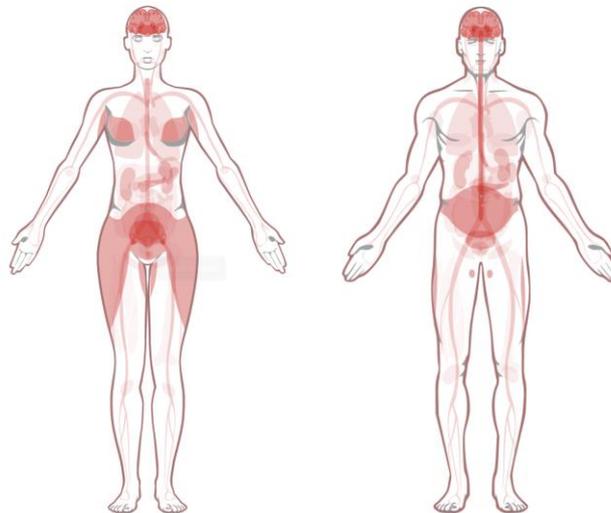


mRNA expression of TYRO3 in human tissues [\[NCBI\]](#)

Expression: Broad expression in ovary (RPKM 23.1), brain (RPKM 22.4) and 14 other tissues



Protein expression of TYRO3 in human tissues [\[ProteinAtlas\]](#)



Co-expression Help

Users can specify a species and enter multiple genes to query the co-expression ratio of chosen genes in the selected species (1). Results are presented using an interactive boxplot and that can be changed to display different cell types by dragging the bar below (2). Co-expression results can be downloaded through a download button (3).

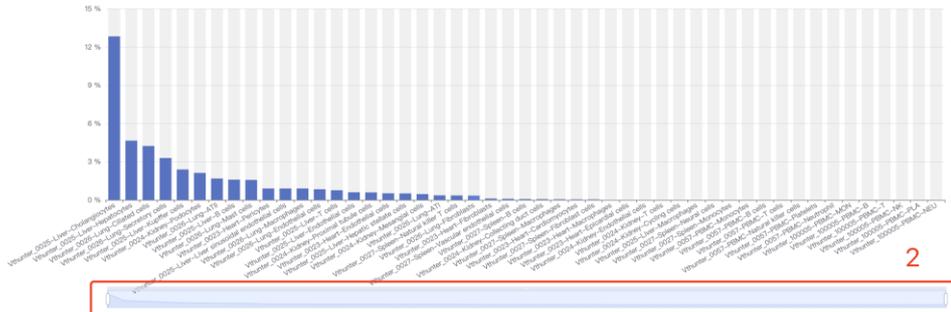
Co-expression Query

You can specify a species and choose to enter multiple genes, and we will check their co-expression in each item of the species based on your input. Supports up to 4 genes to be input at the same time, the more the number of genes, the longer the query time.

Species: Tiger Gene: ANXAS

ACE2 ANXAS

Add Query



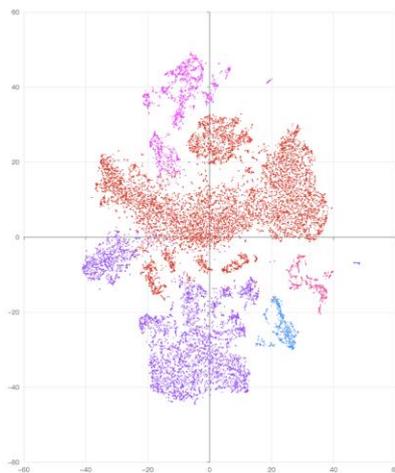
Featureplot of receptors

Featureplot of receptors

- ✓ Vthunter_0028---Heart
- Vthunter_0024---Kidney
- Vthunter_0025---Liver
- Vthunter_0028---Lung
- Vthunter_0027---Spleen

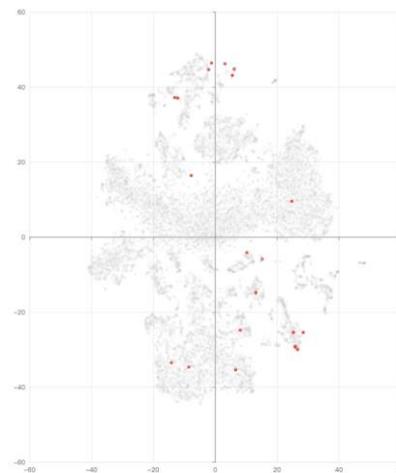
clustering

Cardiomyocytes Macrophages Endothelial cells Fibroblasts Epicardial cells Pericytes



Gene Co-expression

Non-coexpression 0 Co-expression



Download Help

Users can browse datasets by species and tissues and download the expression matrices and metadata using the download buttons on the top right of the plots.

Contact

Should you have any questions or comments regarding VThunter, please do not hesitate to contact us by emailing Dongsheng Chen (chendongsheng@genomics.cn).