

Supplementary 1. Analysis of biological processes using the Pantherdb tool.

The image shows two screenshots of the Pantherdb web interface. The top screenshot shows the initial 'Gene List Analysis' page with a search bar and navigation tabs. The bottom screenshot shows the same page after inputting gene IDs and selecting analysis options.

Page 1 (Top Screenshot):

- Browser: pantherdb.org
- Navigation: Home, About, PANTHER Data, PANTHER Tools, Workspace, Downloads, Help/Tutorial
- Message: PANTHER14.1 is generated from the 2018_04 release of ReferenceProteome dataset
- Search: All, Go
- Quick links: Whole genome function views, Genome statistics, Data Version, How to cite PANTHER, NEW! Recent publication describing PANTHER
- News: PANTHER User Interface Updates, Click for additional info.
- Newsletter subscription: Enter your Email: [input field]
- Help Tips Steps:
 - 1. Select list and list type to analyze
 - 2. Select Organism
 - 3. Select operation
- 1. Enter ids and or select file for batch upload. Else enter ids or select file or list from workspace for comparing to a reference list.
 - Enter IDs: Supported IDs [input field] separate IDs by a space or comma
 - Upload IDs: Choose File No file chosen
 - Please login to be able to select lists from your workspace.
 - Select List Type:
 - ID List
 - Previously exported text search results
 - Workspace list
 - PANTHER Generic Mapping
 - ID's from Reference Proteome Genome
 - Organism for id list: Absidia glauca (ABSGL)
 - VCF File Flanking region: 20 Kb
- 2. Select organism.

Page 2 (Bottom Screenshot):

- Browser: pantherdb.org
- Search: All, Go
- Quick links: Same as Page 1
- News: Same as Page 1
- Help Tips Steps: Same as Page 1
- 1. Enter ids and or select file for batch upload. Else enter ids or select file or list from workspace for comparing to a reference list.
 - Enter IDs: Supported IDs [input field with red border containing: PPP1R42, SNTN, PIFQ] separate IDs by a space or comma
 - Upload IDs: Choose File No file chosen
 - Please login to be able to select lists from your workspace.
 - Select List Type:
 - ID List
 - Previously exported text search results
 - Workspace list
 - PANTHER Generic Mapping
 - ID's from Reference Proteome Genome
 - Organism for id list: Absidia glauca (ABSGL)
 - VCF File Flanking region: 20 Kb
- 2. Select organism.
 - Homo sapiens
 - Mus musculus
 - Rattus norvegicus
 - Gallus gallus
 - Danio rerio
- 3. Select Analysis.
 - Functional classification viewed in gene list
 - Functional classification viewed in graphic charts
 - Bar chart
 - Pie chart
 - Statistical overrepresentation test

PANTHER BAR CHART

[Pie Chart](#) [Export](#)

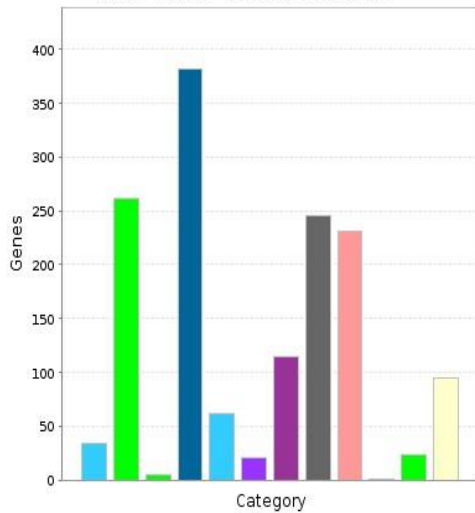
Features:

- Mouse-over bar chart category to see category name and statistics
- Click on a bar chart category to drill down to child categories
- Click on chart legend link to retrieve gene list for each category
- Click on a color key in chart legend to choose your favorite color for the category **NEW!**

Select Ontology: **Biological Process** View: 100%

PANTHER GO-Slim Biological Process

Total # Genes: 1456 Total # process hits: 1472



Click to get gene list for a category:

- [biological adhesion \(GO:0022610\)](#)
- [biological regulation \(GO:0065007\)](#)
- [cell proliferation \(GO:0008283\)](#)
- [cellular process \(GO:0009987\)](#)
- [developmental process \(GO:0032502\)](#)
- [immune system process \(GO:0002376\)](#)
- [localization \(GO:0051179\)](#)
- [metabolic process \(GO:0008152\)](#)
- [multicellular organismal process \(GO:0032501\)](#)
- [pigmentation \(GO:0043473\)](#)
- [reproduction \(GO:0000003\)](#)
- [response to stimulus \(GO:0050896\)](#)

immune system process (GO:0002376): 20, 1.4%, 1.4%

Color picker powered by



**Chart tooltips are read as: Category name (Accession): # genes; Percent of gene hit against total # genes; Percent of gene hit against total # Process hits

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Gene ID	Mapped IDs	Gene Name Gene Symbol Ortholog	PANTHER Family/Subfamily	PANTHER Protein Class	Species		
<input type="checkbox"/>	1. HUMAN HGNC=26361 UniProtKB=Q14CZ8	HEPACAM	Hepatocyte cell adhesion molecule HEPACAM ortholog	HEPATOCYTE CELL ADHESION MOLECULE (PTHR12080:SF59)	cell adhesion molecule immunoglobulin receptor superfamily protein kinase signaling molecule	Homo sapiens		
<input type="checkbox"/>	2. HUMAN HGNC=1143 UniProtKB=Q6UXE8	BTNL3	Butyrophilin-like protein 3 BTNL3 ortholog	BUTYROPHILIN-LIKE PROTEIN 3 (PTHR24100:SF109)	protease inhibitor	Homo sapiens		
<input type="checkbox"/>	3. HUMAN HGNC=8601 UniProtKB=Q06141	REG3A	Regenerating islet-derived protein 3-alpha REG3A ortholog	REGENERATING ISLET-DERIVED PROTEIN 3-ALPHA (PTHR22803:SF123)	-	Homo sapiens		
<input type="checkbox"/>	4. HUMAN HGNC=9952 UniProtKB=P48304	REG1B	Lithostathine-1-beta REG1B ortholog	LITHOSTATHINE-1-BETA (PTHR22803:SF129)	-	Homo sapiens		
<input type="checkbox"/>	5. HUMAN HGNC=3010 UniProtKB=P42658	DPP6	Dipeptidyl aminopeptidase-like protein 6 DPP6 ortholog	DIPEPTIDYL AMINOPEPTIDASE-LIKE PROTEIN 6 (PTHR11731:SF20)	enzyme modulator serine protease	Homo sapiens		
<input type="checkbox"/>	6. HUMAN HGNC=9951 UniProtKB=P05451	REG1A	Lithostathine-1-alpha REG1A ortholog	LITHOSTATHINE-1-ALPHA (PTHR22803:SF105)	-	Homo sapiens		
<input type="checkbox"/>	7. HUMAN HGNC=10638 UniProtKB=Q14625	CXCL11	C-X-C motif chemokine 11 CXCL11 ortholog	C-X-C MOTIF CHEMOKINE 11 (PTHR10179:SF28)	chemokine	Homo sapiens		
<input type="checkbox"/>	8. HUMAN HGNC=14556 UniProtKB=Q6EIG7	CLEC6A	C-type lectin domain family 6 member A CLEC6A ortholog	C-TYPE LECTIN DOMAIN FAMILY 6 MEMBER A (PTHR22802:SF249)	cell adhesion molecule immunoglobulin receptor superfamily	Homo sapiens		
<input type="checkbox"/>	9. HUMAN HGNC=4250 UniProtKB=P19440	GGT1	Glutathione hydrolase 1	GLUTATHIONE HYDROLASE 1 (PTHR10179:SF28)	acyltransferase protease	Homo sapiens		

← → ↻ ⓘ Not secure | pantherdb.org/list/list.do?chartCategoryAcc=GO:0002376&chartCategoryType=2&filterLevel=1&listType=1

<input type="checkbox"/>	9.	HUMAN HGNC=4250 UniProtKB=P19440	GGT1	Glutathione hydrolase 1 proenzyme GGT1 ortholog	GLUTATHIONE HYDROLASE 1 PROENZYME-RELATED (PTHR11686:SF56)	acyltransferase protease	Homo sapiens
<input type="checkbox"/>	10.	HUMAN HGNC=7098 UniProtKB=Q07325	CXCL9	C-X-C motif chemokine 9 CXCL9 ortholog	C-X-C MOTIF CHEMOKINE 9 (PTHR10179:SF44)	chemokine	Homo sapiens
<input type="checkbox"/>	11.	HUMAN HGNC=2389 UniProtKB=P02511	CRYAB	Alpha-crystallin B chain CRYAB ortholog	ALPHA-CRYSTALLIN B CHAIN (PTHR45640:SF5)	-	Homo sapiens
<input type="checkbox"/>	12.	HUMAN HGNC=26511 UniProtKB=Q14558	HSPB6	Heat shock protein beta-6 HSPB6 ortholog	HEAT SHOCK PROTEIN BETA-6 (PTHR45640:SF2)	-	Homo sapiens
<input type="checkbox"/>	13.	HUMAN HGNC=31791 UniProtKB=Q6ZT52	FAM43B	Protein FAM43B FAM43B ortholog	PROTEIN FAM43B (PTHR11232:SF34)	signaling molecule	Homo sapiens
<input type="checkbox"/>	14.	HUMAN HGNC=30014 UniProtKB=Q96LB9	PGLYRP3	Peptidoglycan recognition protein 3 PGLYRP3 ortholog	PEPTIDOGLYCAN RECOGNITION PROTEIN 3 (PTHR11022:SF12)	-	Homo sapiens
<input type="checkbox"/>	15.	HUMAN HGNC=30013 UniProtKB=Q96PD5	PGLYRP2	N-acetylmuramoyl-L-alanine amidase PGLYRP2 ortholog	N-ACETYLMURAMOYL-L-ALANINE AMIDASE (PTHR11022:SF66)	-	Homo sapiens
<input type="checkbox"/>	16.	HUMAN HGNC=433 UniProtKB=P16050	ALOX15	Arachidonate 15-lipoxygenase ALOX15 ortholog	ARACHIDONATE 15-LIPOXYGENASE (PTHR11771:SF33)	oxygenase	Homo sapiens
<input type="checkbox"/>	17.	HUMAN HGNC=16016 UniProtKB=Q5KU26	COLEC12	Collectin-12 COLEC12 ortholog	COLLECTIN-12 (PTHR24023:SF910)	extracellular matrix structural protein	Homo sapiens
<input type="checkbox"/>	18.	HUMAN HGNC=24954 UniProtKB=Q8WW32	HMGB4	High mobility group protein B4 HMGB4 ortholog	HIGH MOBILITY GROUP PROTEIN B4 (PTHR13711:SF152)	HMG box transcription factor chromatin/chromatin-binding protein signaling molecule	Homo sapiens
<input type="checkbox"/>	19.	HUMAN HGNC=30040 UniProtKB=Q9BZM2	PLA2G2F	Group IIF secretory phospholipase PLA2G2F ortholog	GROUP IIF SECRETORY PHOSPHOLIPASE 2 (PTHR11022:SF152)	phospholipase	Homo sapiens

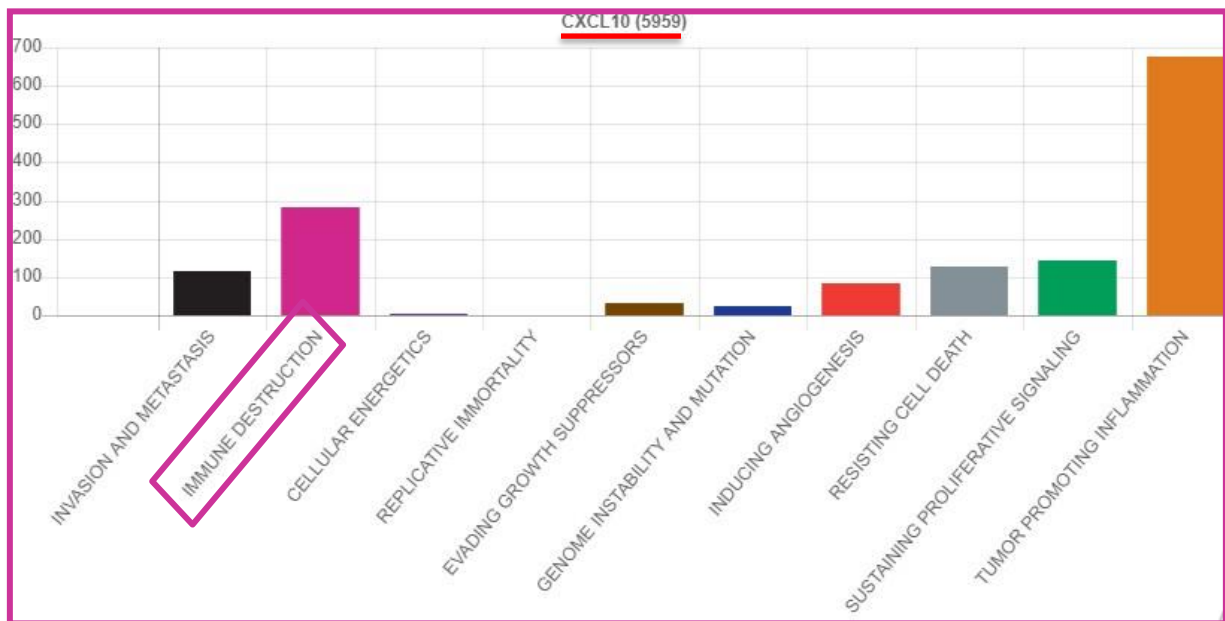
<input type="checkbox"/>	11.	HUMAN HGNC=2389 UniProtKB=P02511	CRYAB	Alpha-crystallin B chain CRYAB ortholog	ALPHA-CRYSTALLIN B CHAIN (PTHR45640:SF5)	-	Homo sapiens
<input type="checkbox"/>	12.	HUMAN HGNC=26511 UniProtKB=O14558	HSPB6	Heat shock protein beta-6 HSPB6 ortholog	HEAT SHOCK PROTEIN BETA-6 (PTHR45640:SF2)	-	Homo sapiens
<input type="checkbox"/>	13.	HUMAN HGNC=31791 UniProtKB=Q6ZT52	FAM43B	Protein FAM43B FAM43B ortholog	PROTEIN FAM43B (PTHR11232:SF34)	signaling_molecule	Homo sapiens
<input type="checkbox"/>	14.	HUMAN HGNC=30014 UniProtKB=Q96LB9	PGLYRP3	Peptidoglycan recognition protein 3 PGLYRP3 ortholog	PEPTIDOGLYCAN RECOGNITION PROTEIN 3 (PTHR11022:SF12)	-	Homo sapiens
<input type="checkbox"/>	15.	HUMAN HGNC=30013 UniProtKB=Q96PD5	PGLYRP2	N-acetylmuramoyl-L-alanine amidase PGLYRP2 ortholog	N-ACETYLMURAMOYL-L-ALANINE AMIDASE (PTHR11022:SF66)	-	Homo sapiens
<input type="checkbox"/>	16.	HUMAN HGNC=433 UniProtKB=P16050	ALOX15	Arachidonate 15-lipoxygenase ALOX15 ortholog	ARACHIDONATE 15-LIPOXYGENASE (PTHR11771:SF33)	oxygenase	Homo sapiens
<input type="checkbox"/>	17.	HUMAN HGNC=16016 UniProtKB=Q5KU26	COLEC12	Collectin-12 COLEC12 ortholog	COLLECTIN-12 (PTHR24023:SF910)	extracellular matrix structural protein	Homo sapiens
<input type="checkbox"/>	18.	HUMAN HGNC=24954 UniProtKB=Q8WW32	HMGB4	High mobility group protein B4 HMGB4 ortholog	HIGH MOBILITY GROUP PROTEIN B4 (PTHR13711:SF152)	HMG box transcription factor chromatin/chromatin-binding protein signaling_molecule	Homo sapiens
<input type="checkbox"/>	19.	HUMAN HGNC=30040 UniProtKB=Q9BZM2	PLA2G2F	Group IIF secretory phospholipase A2 PLA2G2F ortholog	GROUP IIF SECRETORY PHOSPHOLIPASE A2 (PTHR11716:SF8)	phospholipase	Homo sapiens
<input type="checkbox"/>	20.	HUMAN HGNC=10637 UniProtKB=P02778	CXCL10	C-X-C motif chemokine 10 CXCL10 ortholog	C-X-C MOTIF CHEMOKINE 10 (PTHR10179:SF47)	chemokine	Homo sapiens

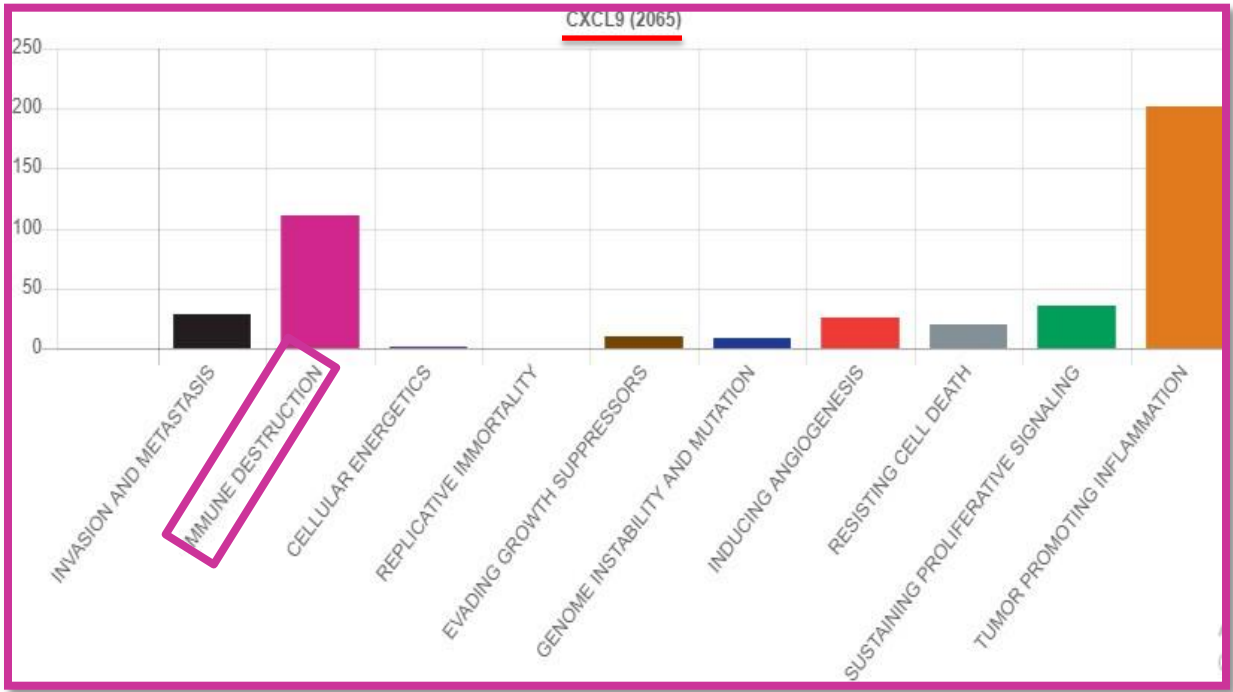
Supplementary 2. Expression of Genes, protein classes related to the Immune System Results of Pantherdb Analysis

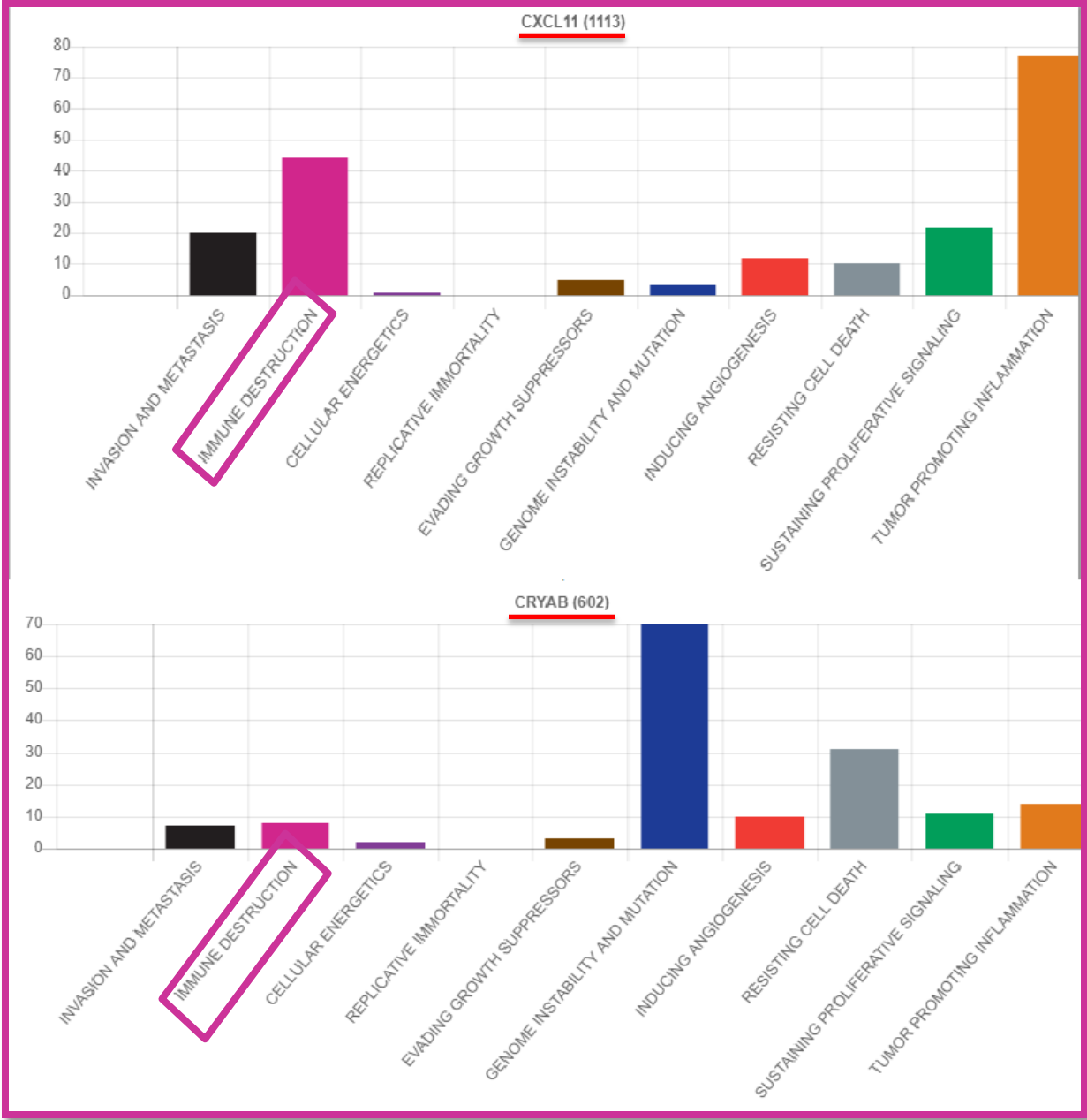
Gene symbol	Gene name	Protein classes
HEPACAM	<i>Hepatocyte cell adhesion molecule</i>	<i>cell adhesion molecule, immunoglobulin receptor superfamily, protein kinase, the signaling molecule</i>
BTNL3	<i>Butyrophilin-like protein 3</i>	<i>protease inhibitor</i>
REG3A	<i>Regenerating islet-derived protein 3-alpha</i>	
REG1B	<i>Lithostathine-1-beta</i>	
DPP6	<i>Dipeptidyl aminopeptidase-like protein 6</i>	<i>enzyme modulator, the serine protease</i>
REG1A	<i>Lithostathine-1-alpha</i>	
CXCL11	<i>C-X-C motif chemokine 11</i>	<i>Chemokine</i>
CLEC6A	<i>C-type lectin domain family 6 member A</i>	<i>cell adhesion molecule, immunoglobulin receptor superfamily</i>
GGT1	<i>Glutathione hydrolase 1 proenzyme</i>	<i>protease, acyltransferase</i>
CXCL9	<i>C-X-C motif chemokine 9</i>	<i>Chemokine</i>
CRYAB	<i>Alpha-crystallin B chain</i>	
HSPB6	<i>Heat shock protein beta-6</i>	
FAM43B	<i>Protein FAM43B</i>	<i>signaling molecule</i>
PGLYRP3	<i>Peptidoglycan recognition protein 3</i>	
PGLYRP2	<i>N-acetylmuramoyl-L-alanine amidase</i>	
ALOX15	<i>Arachidonate 15-lipoxygenase</i>	<i>Oxygenase</i>
COLEC12	<i>Collectin-12</i>	<i>extracellular matrix structural protein</i>
HMGB4	<i>High mobility group protein B4</i>	<i>HMG box transcription factor, chromatin/chromatin-binding protein, dan signaling molecule</i>
PLA2G2F	<i>Group IIF secretory phospholipase A2</i>	<i>Phospholipase</i>
CXCL10	<i>C-X-C motif chemokine 10</i>	<i>Chemokine</i>

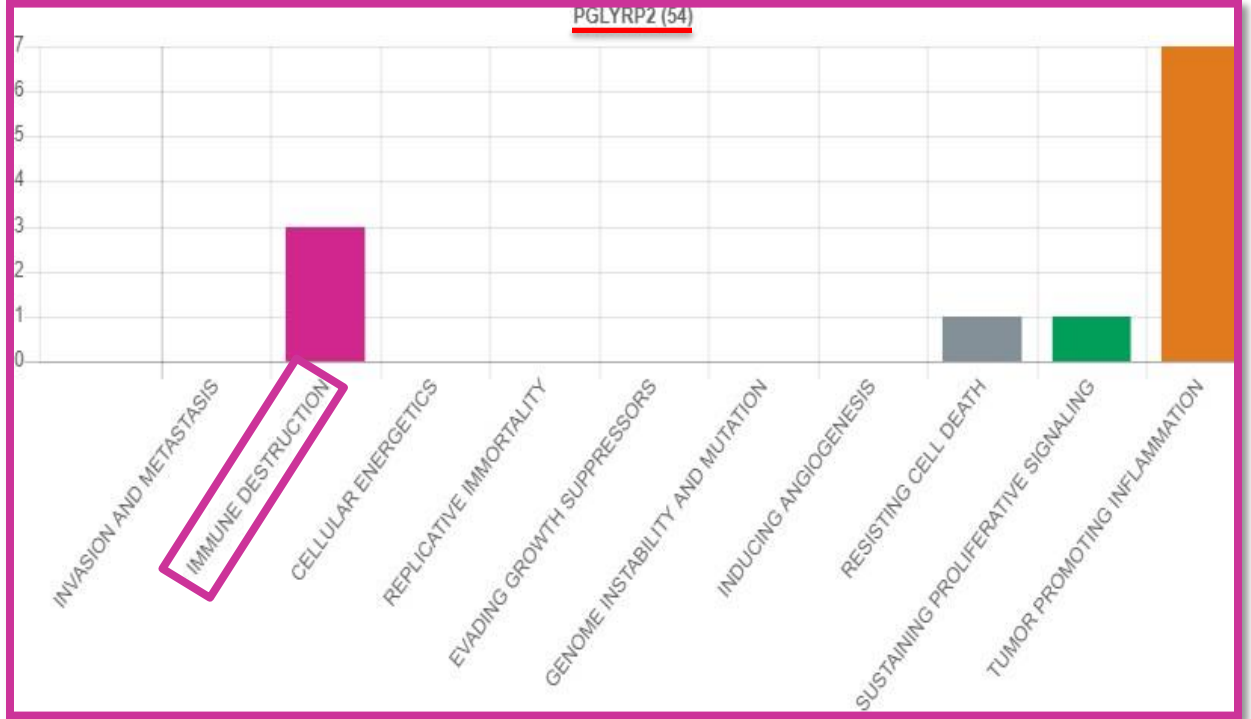
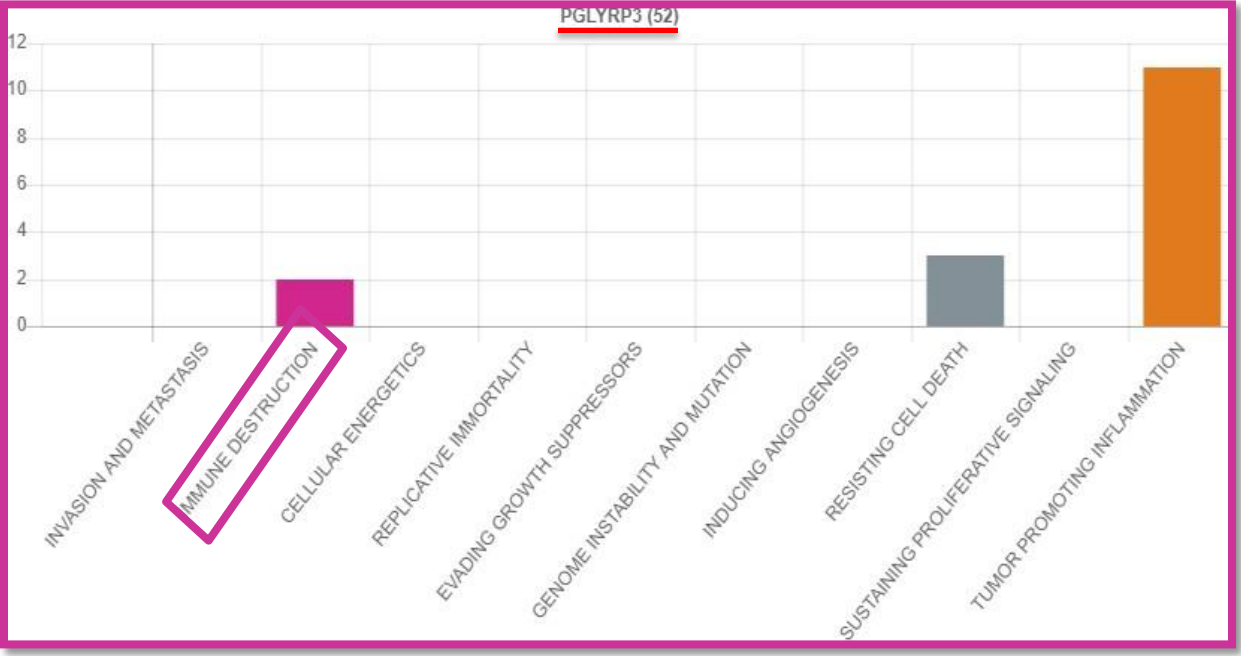
Supplementary 3. Analysis hallmark of cancer using lionproject.net tool.

The screenshot shows the web interface of the Cancer Hallmarks Analytics Tool. The browser address bar indicates the URL is chat.lionproject.net. The page title is "Cancer Hallmarks Analytics Tool". The interface includes a search bar with a "Query" input field, a "Submit" button, and dropdown menus for "Metric" (set to "npmi"), "Chart" (set to "doughnut"), and "Hallmarks" (set to "top"). Below the search bar, there are example queries: "Akt autotaxin calcineurin CCL2 Chk1 Cln2 FOXO3 HMG1A1 HMG2 Mdm2 MMP mTOR NF-kappa B P2X7 PCNA PTEN TGF-beta p16 p53". At the bottom of the page, there is a citation: "The Cancer Hallmarks Analytics Tool created in collaboration between the Language Technology Lab at University of Cambridge and the Institute of Environmental Medicine at Karolinska Institutet. Please cite our paper: Cancer Hallmarks Analytics Tool (CHAT): a text mining approach to organize and evaluate scientific literature on cancer".









Supplementary 4. Analysis of biological signaling pathway using the DAVID Bioinformatics tool.

The screenshot displays the DAVID Bioinformatics Resources 6.8 website. The top navigation bar includes links for Home, Start Analysis, Shortcut to DAVID Tools, Technical Center, Downloads & APIs, Term of Service, Why DAVID?, and About Us. A central banner reads "DAVID Bioinformatics Resources 6.8" and "Laboratory of Human Retrovirology and Immunoinformatics (LHRI)".

Below the banner, a "Shortcut to DAVID Tools" sidebar is visible on the left, with "Functional Annotation" highlighted. The main content area features a "Welcome to DAVID 6.8" message and a search bar. A "2003 - 2019" section describes the database's capabilities, including identifying enriched biological themes, discovering enriched functional-related gene groups, and visualizing genes on BioCarta & KEGG pathway maps. A bar chart titled "DAVID Citations (2003-2018)" shows an increasing trend in citations over time.

The "Functional Annotation Tool" section is highlighted with a red box. It includes an "Upload Gene List" form with the following steps:

- Step 1: Enter Gene List**: A text input field containing "PLA2G2F", "HMSGB4", and "ALOX15".
- Step 2: Select Identifier**: A dropdown menu set to "OFFICIAL_GENE_SYMBOL".
- Step 3: List Type**: A radio button selected for "Gene List".
- Step 4: Submit List**: A "Background" radio button is also visible.

Additional features include a "Key Concepts" section with sub-sections for "Term/Gene Co-Occurrence Probability", "Gene Similarity Search", and "Term Similarity Search". A "What's Important in DAVID?" section lists key features such as "Cite DAVID", "IDs of Affy Exon and Gene arrays supported", and "Enhanced calculating speed".

322 record(s)

 Download File

CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Bos taurus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Callithrix jacchus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Ursus maritimus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Macaca fascicularis
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Pan paniscus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Homo sapiens
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Macaca mulatta
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Myotis brandtii
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Lipotes vexillifer
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Equus caballus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Ovis aries
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Capra hircus
KEGG_PATHWAY	Cytokine-cytokine receptor interaction, Chemokine signaling pathway, Toll-like receptor signaling pathway, RIG-I-like receptor signaling pathway, Cytosolic DNA-sensing pathway, TNF signaling pathway, Influenza A,		
CXCL10	C-X-C motif chemokine ligand 10(CXCL10)	Related Genes	Oryctolagus cuniculus