



# QIAGEN Ingenuity Pathway Analysis (IPA): Biological Interpretation & Analysis of NGS data



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# Agenda



## Introduction to Ingenuity Pathway Analysis

### Gaining biological insights through interpretation of omic data

- Identify pathways and biological mechanism
- Discover key regulators and targets
- Study impacted biological functions and diseases

### Generating hypothesis without a dataset

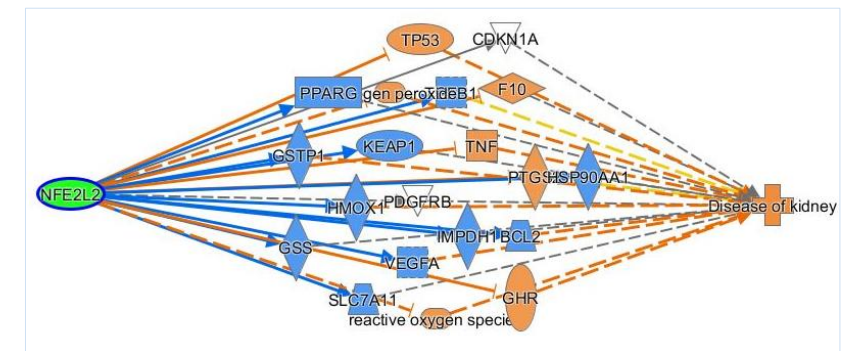
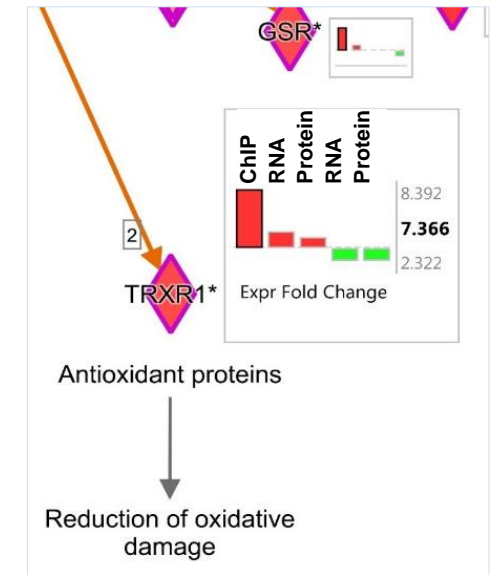
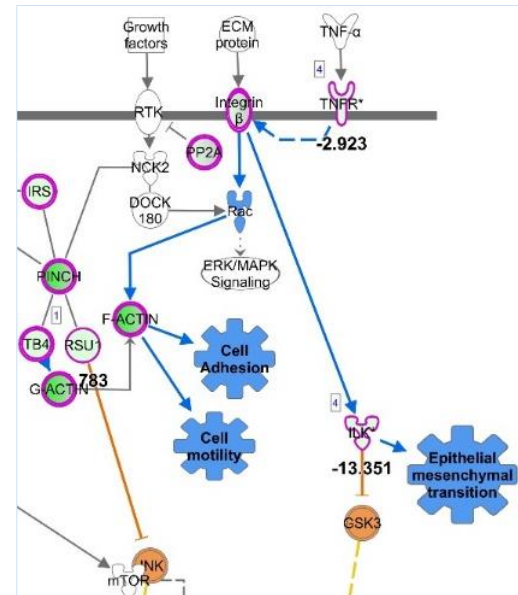
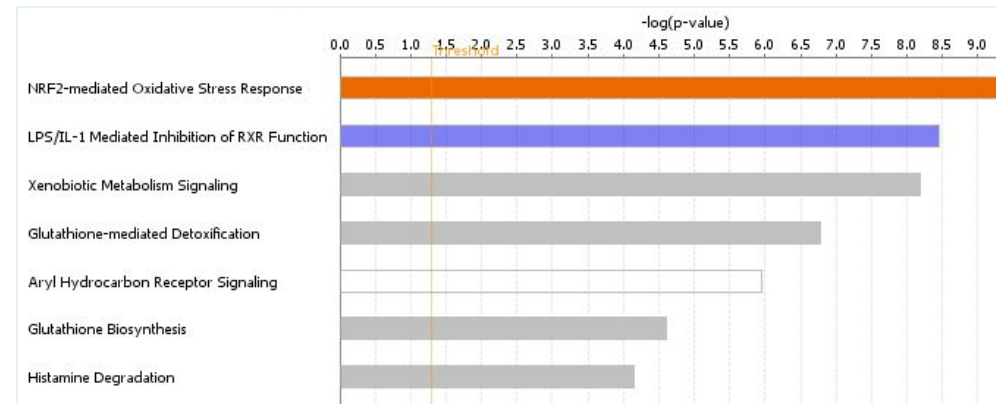
- Build custom networks and in-silico predictions

Perform analysis and interpretation of 'omics data within the context of various biological systems

Study biological mechanisms underlying disease pathology, drug treatment or cellular functions

Identify biomarkers and key regulators associated with your experimental data

Investigate gene/disease interactions by generating custom networks



# Studies using QIAGEN Ingenuity Pathway Analysis (IPA)



"ingenuity pathway analysis"

Articles

About 17,600 results (0.04 sec)

Any time

Since 2024

Since 2023

Since 2020

Custom range...

Sort by relevance

Sort by date

Any type

Review articles

☐ include patents

☐ include citations

☒ Create alert

Biomarker identification and pathway analysis of rheumatoid arthritis based on metabolomics in combination with **ingenuity pathway analysis**

Z He, Z Liu, L Gong - Proteomics, 2021 - Wiley Online Library

... The pathways involved in RA were enriched by differential metabolites using **Ingenuity Pathway Analysis** (IPA) suite. Untargeted metabolomics revealed eighteen significantly altered ...

☆ Save Cite Cited by 19 Related articles All 4 versions

[HTML] **Ingenuity pathway analysis** of differentially expressed genes involved in signaling pathways and molecular networks in RhoE gene-edited cardiomyocytes

Z Shao, K Wang, S Zhang, J Yuan... - International ..., 2020 - spandidos-publications.com

RhoE/Rnd3 is an atypical member of the Rho superfamily of proteins, However, the global biological function profile of this protein remains unsolved. In the present study, a RhoE-...

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[HTML] Gene set enrichment analysis and **ingenuity pathway analysis** to verify the impact of Wnt signaling in psoriasis treated with Taodan granules

Y Chen, Z Zhang, Y Zhang, J Jiang, Y Luo... - American Journal of ..., 2023 - ncbi.nlm.nih.gov

... Experiment validation of **Ingenuity Pathway Analysis** (IPA) upstream analysis in Wnt signaling pathway following Taodan granules (TDGs). A. IPA upstream analysis in Wnt signaling ...

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# Studies using QIAGEN Ingenuity Pathway Analysis (IPA)

> PLoS One. 2019 Jun 26;14(6):e0218674. doi: 10.1371/journal.pone.0218674. eCollection 2019.

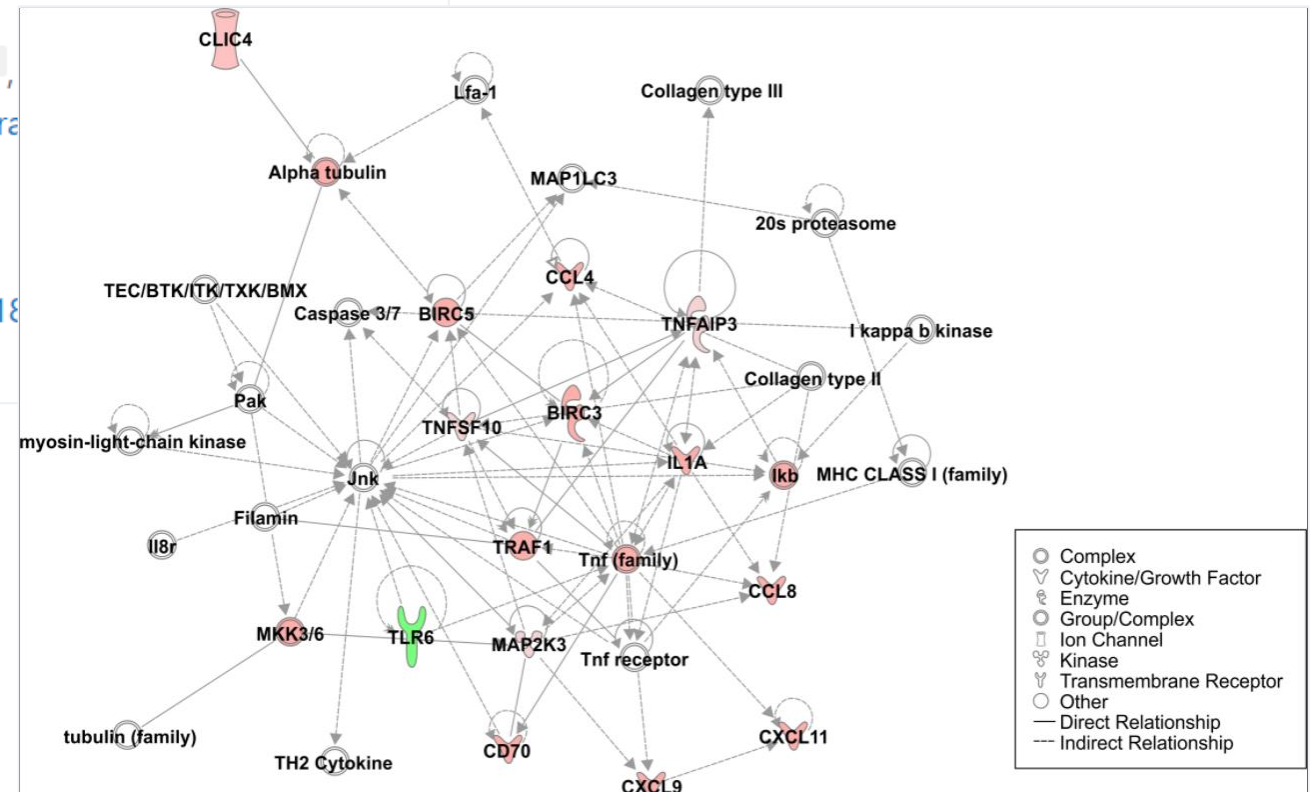
## Tumor- and cytokine-primed human natural killer cells exhibit distinct phenotypic and transcriptional signatures

May Sabry<sup>1</sup>, Agnieszka Zubiak<sup>1</sup>, Simon P Hood<sup>2</sup>, Poppy Simmonds<sup>1</sup>, Helena Arellano-Ballesteros<sup>1</sup>, Eily Cournoyer<sup>1</sup>, Meghavi Mashar<sup>1</sup>, A Gra Mark W Lowdell<sup>1,3</sup>

Affiliations + expand

PMID: 31242243 PMCID: PMC6594622 DOI: 10.1371/journal.pone.0218674

[Free PMC article](#)



# Studies using QIAGEN Ingenuity Pathway Analysis (IPA)

> [Sci Rep. 2021 Jul 6;11\(1\):13891. doi: 10.1038/s41598-021-93356-9.](#)

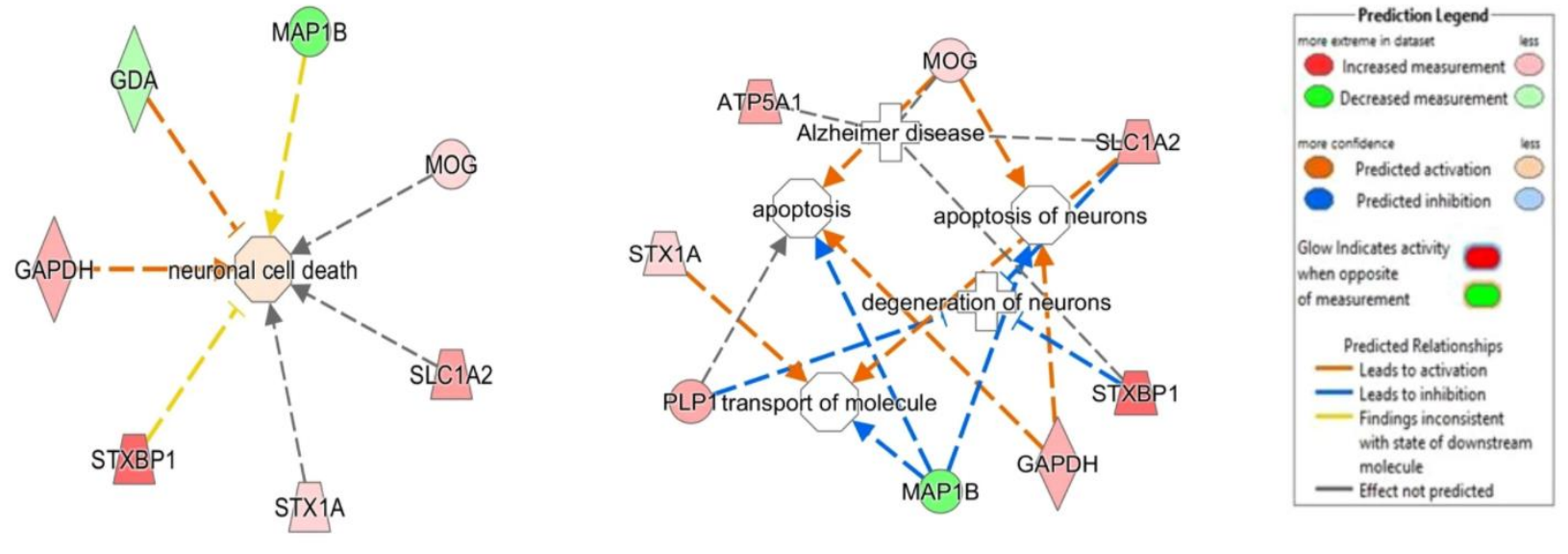
## Characterization of functional protein complexes from Alzheimer's disease and healthy brain by mass spectrometry-based proteome analysis

Beena Hasan <sup>1</sup>, Ayesha Khan <sup>1</sup>, Christof Lenz <sup>2 3</sup>, Abdul R Asif <sup>2</sup>, Nikhat Ahmed <sup>4</sup>

Affiliations + expand

PMID: 34230543 PMCID: [PMC8260596](#) DOI: [10](#)

[Free PMC article](#)



> Cells. 2020 Oct 29;9(11):2374. doi: 10.3390/cells9112374.

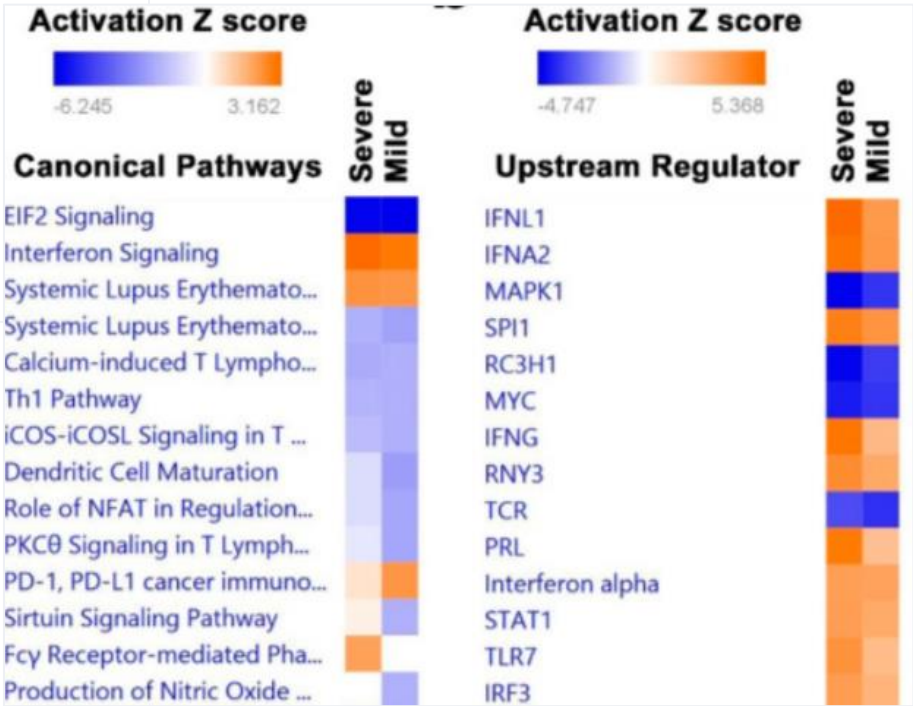
## Single-Cell Transcriptome Analysis Highlights a Role for Neutrophils and Inflammatory Macrophages in the Pathogenesis of Severe COVID-19

Hibah Shaath<sup>1 2</sup>, Radhakrishnan Vishnubalaji<sup>1</sup>, Eyad Elkord<sup>1 2</sup>, Nehad M Alajez<sup>1 2</sup>

Affiliations + expand

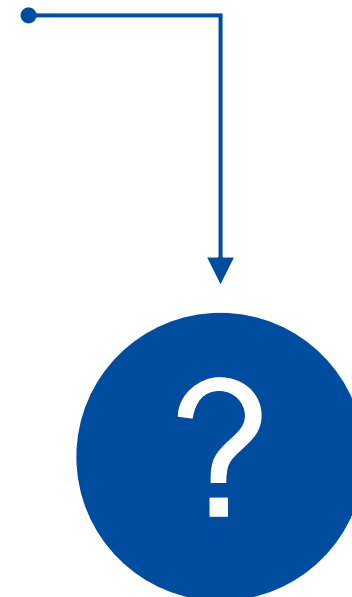
PMID: 33138195    PMCID: PMC7693119    DOI: 10.3390/cells9112374

[Free PMC article](#)





	A	B	C
1	geneid	Log2FoldChange	p-value
2	DDX11L1	-0.1067	0.2878
3	WASH7P	-0.1883	0.0097
4	FAM138F	-0.0761	0.4699
5	OR4F5	0.1474	0.5311
6	LOC729737	0.4789	0.0017
7	LOC100133331	0.4789	0.0017
8	LOC100132062	0.4789	0.0017
9	OR4F29	0.2495	0.2389
7920	CMTM2	0.4726	0.0001
7921	CMTM3	0.6099	0.000097742
7922	CMTM4	-0.815	1.5825E-07
7923	DYNC1LI2	-0.3924	7.2017E-10
7924	CCDC79	0.0023	0.9635
7925	NAE1	-0.2599	0.0098
7926	CA7	-1.8165	3.6214E-06
7927	PDP2	-0.6373	2.4407E-10
7928	CDH16	-0.0415	0.5431
7929	RRAD	0.2049	0.0106
7930	FAM96B	-0.1019	0.0571
7931	CES2	-1.1852	2.6332E-09
7932	CES3	-1.2535	1.0865E-07
7933	CES4A	0.0457	0.4449
7934	CBFB	0.8449	1.0268E-14
7935	C16orf70	-0.2996	1.1793E-07
7936	B3GNT9	0.3413	0.000032084
7937	BC007896	0.3413	0.000032084
7938	TRADD	0.0882	0.1007
7939	FBXL8	-0.073	0.2312
7940	HSF4	-0.2543	0.0015
7941	NOL3	-0.0595	0.2532
7942	KIAA0895L	-0.2385	0.001
7943	EXOC3L1	-0.2385	0.001
7944	E2F4	-0.0401	0.454
7945	ELMO3	-0.3649	0.0004
7946	LRRC29	-0.0481	0.5241
7947	TMEM208	0.2094	0.0005
7948	FHOD1	0.233	0.0024
7949	SLC9A5	-0.1668	0.0205
7950	PLEKHG4	-0.3191	2.1437E-06
7951	KCTD19	-0.095	0.062

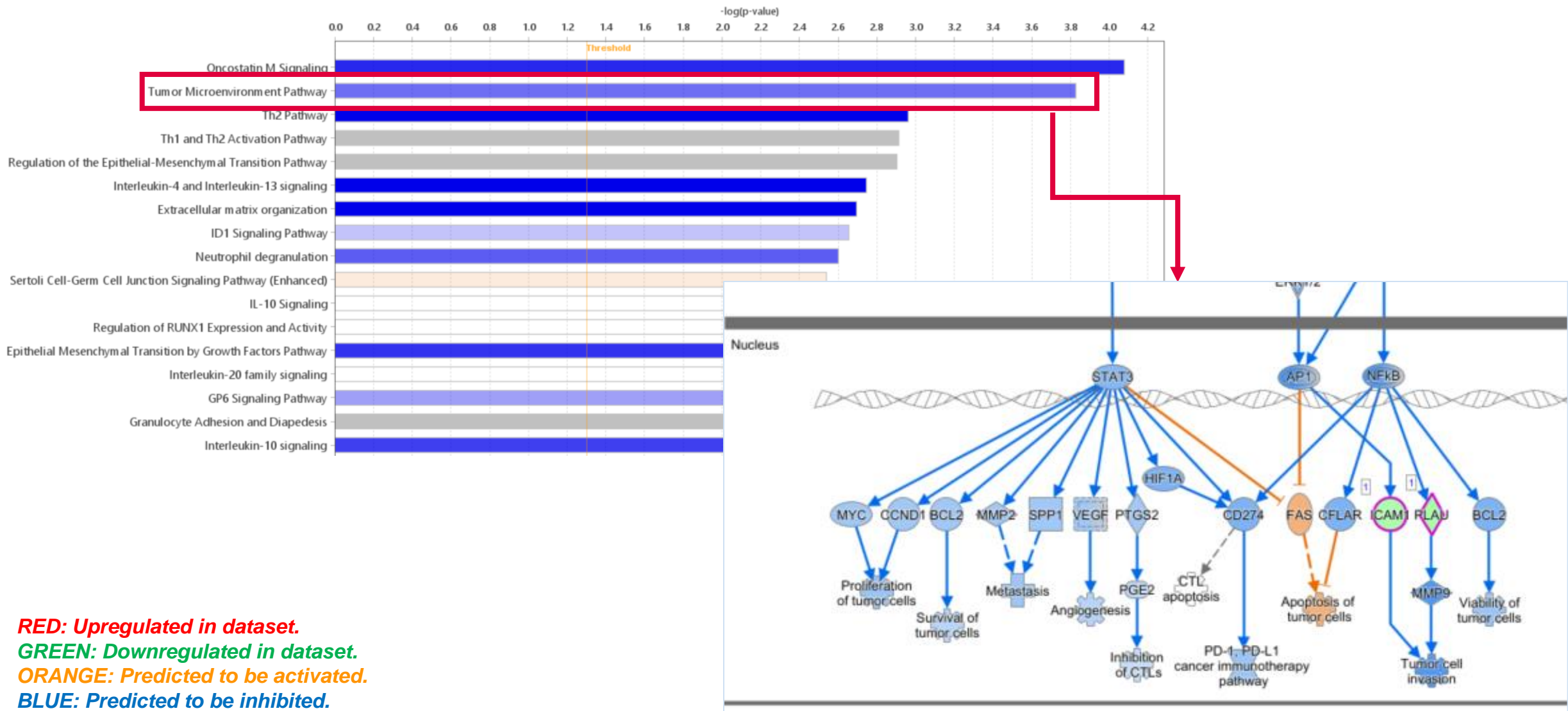




# Identify pathways and biological mechanisms






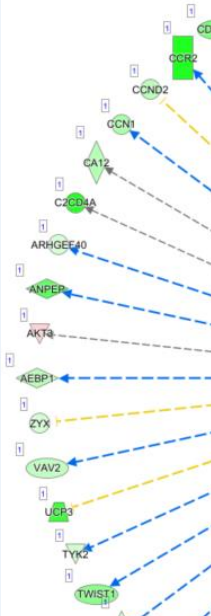
positive z-score    z-score = 0    negative z-score    no activity pattern available



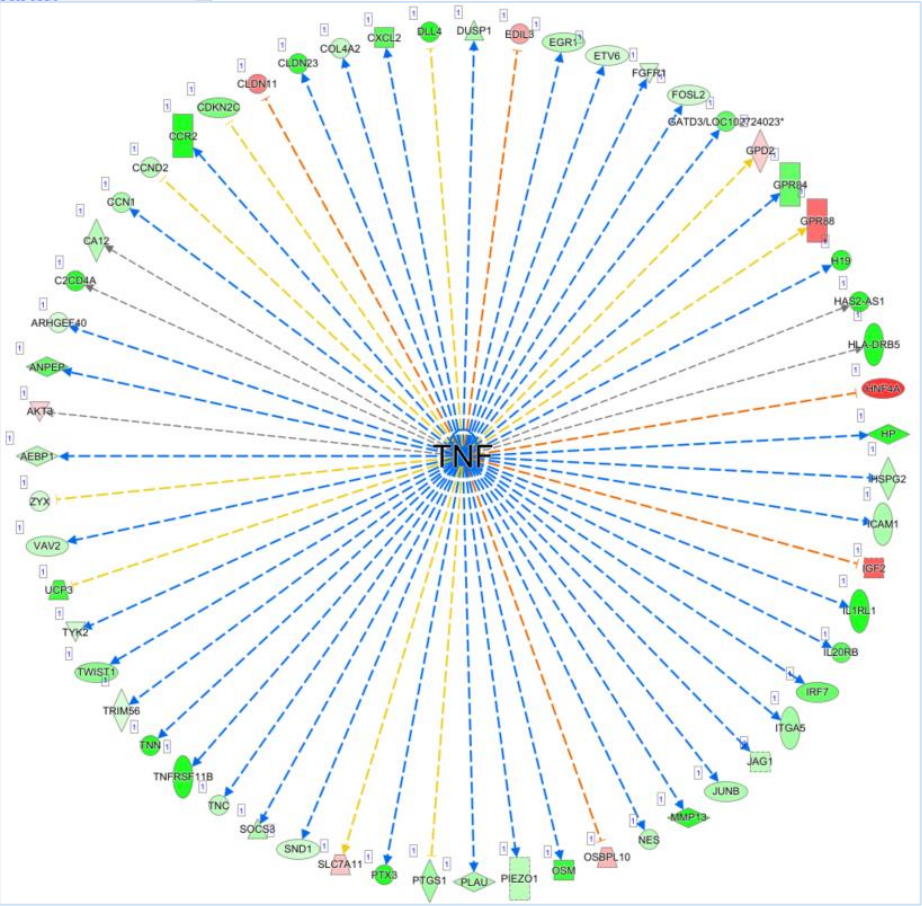
# Discover key regulators and targets



Summary	Graphical Summary	Pathways	Upstream Analysis	Diseases & Functions	Regulator Effects	Networks	Lists	Analysis Match	Molecules
Upstream Regulators									
Causal Networks									
Add To My Pathway									
Add To My List									
Display as Network									
Activity Plot									
Customize Table									
Mechanistic Networks									
  									
Upstream Regul...	Expr Log Ratio	Molecule Type	Predicted Activ...	Activation z-sc...	p-value of ...	Target Molecu...	Mechanistic Ne...		
EGF	0.525	growth factor	Inhibited	-3.640	5.03E-07	ANPEP, CCN1, ...	117 (17)		
IL3	3.619	cytokine	Inhibited	-2.708	1.97E-06	ADGRES, ATF5, ...	99 (15)		
AGT	-0.646	growth factor	Inhibited	-2.419	2.13E-06	ADD3, AEBP1, ...	109 (14)		
LY294002		chemical drug	Activated	2.191	2.22E-06	ANPEP, ART3, ...	25		
ERBB3	2.227	kinase		0.565	2.23E-06	AMOTL2, CCN1, ...	11		
FGF2	0.896	growth factor	Inhibited	-3.939	2.50E-06	ANPEP, CCN1, ...	23		
ETS1	-0.866	transcription regulator		-1.854	2.58E-06	ANPEP, EGR1, ...	15		
CCR2	-5.853	G-protein coupled recept...	Inhibited	-2.236	2.62E-06	AEBP1, C1QC, ...	10		
N-[N-(3,5-difluorophenac...		chemical - protease inhib...	Activated	2.668	2.68E-06	CXCL2, DLL4, ...	12		
TNF	-1.089	cytokine	Inhibited	-4.834	3.50E-06	AEBP1, AKT3, ...	59		
STAT3	-0.887	transcription regulator	Inhibited	-3.022	4.20E-06	CCND2, CXCL2, ...	30		
ALPHA CATENIN (family)		group	Activated	2.728	4.30E-06	CXCL2, IGF2, ...	11		
beta-estradiol		chemical - endogenous ...		-1.491	4.69E-06	ADAMTSL4, A...	75		
PD98059		chemical - kinase inhibitor	Activated	3.658	7.11E-06	ANPEP, ARPP19	25		
HRAS	-0.184	enzyme		-0.084	7.12E-06	ADGRES, AM...	28		
AKT (family)		group		-1.668	7.27E-06	CCND2, DLL4, ...	20		
TGFB1	-0.794	growth factor	Inhibited	-3.696	7.87E-06	ADRA1D, AKT3, ...	57		
TLR3	-0.697	transmembrane receptor	Inhibited	-3.396	8.10E-06	AKT3, CXCL2, ...	14		
estrogen		chemical drug		-1.084	9.88E-06	ART3, CCN1, ...	16		
PDGF-BB (complex)		complex	Inhibited	-2.441	1.33E-05	ADD3, ADRA1D, ...	18		
cycloheximide		chemical reagent		0.312	1.38E-05	CCN1, CXCL2, ...	19		
PDGF (complex)		complex		-1.085	1.63E-05	CCND2, EGR1, ...	9		
IL6	-2.805	cytokine	Inhibited	-4.212	1.81E-05	ADGRES, ANP...	29		
ESTROGEN RECEPTOR (fan...		group		0.898	1.90E-05	AKT3, CA12, ...	15		
SERPINE1	-1.921	other		-1.129	1.99E-05	CES1, CXCL2, ...	9		
IL3		cytokine		-1.673	2.08E-05	ANPEP, ATF5, ...	8		
IL1B	-1.082	cytokine	Inhibited	-4.529	2.30E-05	AKT3, ATF5, ...	37		
Isconphenbatidic acid		chemical - other	Inhibited	-2.942	2.64E-05	CCN1, CXCL2, ...	9		
Selected 1 / 1139									



RED: Upregulated in dataset.  
GREEN: Downregulated in dataset.  
ORANGE: Predicted to be activated.  
BLUE: Predicted to be inhibited.





# Study enriched biological functions and diseases



**ORANGE:** Predicted to be activated.  
**BLUE:** Predicted to be inhibited.

# IPA is powered by the QIAGEN knowledge base



Manuscripts, clinical trials, and 'omics data obtained from public and commercial sources



Weekly and quarterly updates with the latest disease, genetics, cancer, and drug findings

Over 20 years of expert literature curation



Ingenuity  
Pathway  
Analysis



Over 13.3 million research findings accessible by you in **seconds**



# QIAGEN IPA Analysis Match and Land Explorer

ArrayExpress, GEO, TCGA, SRA,  
LINCS, etc.



Processing, curation and QA

QIAGEN OmicSoft Studio



Journal articles and databases such as  
Clinical Trials, COSMIC, MGD, OMIM, etc.



Curated Findings

Ingenuity Pathway Analysis 



Land Explorer

- Explore gene expression levels
- Determine where a target is differentially expressed
- Understand how 'omics data influences survival
- Identify mutation status of a target

- Explore biological findings in public datasets
- Build confidence in your analysis results
- Make unexpected insights into shared mechanisms between studies
- “Anti-matches” may provide insights

204,000+ comparison



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### Generating hypothesis without a dataset

- Build custom networks and in-silico predictions

# Uploading data to IPA



IPA

File Edit View Window Help

Genes and Chemicals Diseases and Functions Pathways and Lists Datasets and Analyses

Create New... Search Advanced Search

QIAGEN Land Explorer

Provide Feedback | Support Close IPA

- Core Analysis...
- Comparison Analysis...
- Biomarker Filter...
- Biomarker Comparison Analysis...
- MicroRNA Target Filter...
- BioProfiler
- IsoProfiler
- My Pathway
- Path Designer
- Filter Dataset
- Upload Dataset...
- Advanced Search
- Project...
- Compare
- Import Pathway

Create Core Analysis

Upload

- > My Projects
- > Shared Projects
- > Ingenuity CWS
- > QIAGEN Demo CWS

Next

# Public data core analysis search in QIAGEN IPA



Search Results

Datasets and Analyses

Search Results

Showing first 1999 results out of 1999 in 2063ms for query [glioblastoma]

Folder Types

- dataset (1004)
- analysis (995)

Projects

- OncoHuman (1127)
- SingleCellHumanUmi (302)
- ClinicalProteomicTumor (232)
- TCGA (202)
- OncoMouse (72)

Open

Add to Comparison

Customize Table

Crea... 2024/... - 2024/... (1/50)

<<>>

Name	Type	Creation Date	case.diseasestate
726- anaplastic astrocytoma;glioblastoma (GBM) [brain] 725	analysis	2024/01/12 09:12:07	anaplastic astrocytoma;glioblastoma (GBM)
1- diffuse intrinsic pontine glioma (DIPG) [brain] NA 92	analysis	2024/01/09 02:09:40	diffuse intrinsic pontine glioma (DIPG) [brain] NA 92
1- glioblastoma (GBM) [brain] DMSO 435	analysis	2024/01/09 02:08:58	glioblastoma (GBM)
1- glioblastoma (GBM) [temporal lobe] 140	analysis	2024/01/09 02:08:36	glioblastoma (GBM)
1- glioblastoma (GBM) [brain] NA 324	analysis	2024/01/09 02:00:06	glioblastoma (GBM)
1- glioblastoma (GBM) [brain] NA 143	analysis	2024/01/09 01:36:33	glioblastoma (GBM)
10- glioblastoma (GBM) [temporal lobe] 149	analysis	2024/01/09 01:24:27	glioblastoma (GBM)
11- glioblastoma (GBM) [temporal lobe] 150	analysis	2024/01/08 22:45:55	glioblastoma (GBM)
12- glioblastoma (GBM) [temporal lobe] 151	analysis	2024/01/08 21:56:51	glioblastoma (GBM)
13- glioblastoma (GBM) [temporal lobe] 152	analysis	2024/01/08 21:11:17	glioblastoma (GBM)
14- glioblastoma (GBM) [temporal lobe] 153	analysis	2024/01/08 20:22:21	glioblastoma (GBM)
2- glioblastoma (GBM) [temporal lobe] 141	analysis	2024/01/08 16:17:19	glioblastoma (GBM)
2- glioblastoma (GBM) [brain] NA 144	analysis	2024/01/08 16:09:19	glioblastoma (GBM)

Libraries > OmicSoft > OncoLand > Pediatrics > Analyses

4- glioblastoma (GBM) [brain] NA 405

Case/Control Differences

Key	Case	Control
diseasestate	glioblastoma (GBM)	normal control

Comparison Context

> BMC Cancer. 2017 Apr 18;17(1):278. doi: 10.1186/s12885-017-3251-3.

## Search terms:

- Glioblastoma
- bevacizumab
- GSE79671

## Transcriptional changes induced by bevacizumab combination therapy in responding and non-responding recurrent glioblastoma patients

Thomas Urup<sup>1</sup>, Line Mærsk Staunstrup<sup>2</sup>, Signe Regner Michaelsen<sup>3</sup>, Kristoffer Vitting-Seerup<sup>2</sup>, Marc Bennedbæk<sup>4</sup>, Anders Toft<sup>3</sup>, Lars Rønn Olsen<sup>5,6</sup>, Lars Jønson<sup>4</sup>, Shohreh Issazadeh-Navikas<sup>7</sup>, Helle Broholm<sup>8</sup>, Petra Hamerlik<sup>3,9</sup>, Hans Skovgaard Poulsen<sup>3,10</sup>, Ulrik Lassen<sup>3,10,11</sup>

Affiliations + expand

PMID: 28420326 PMCID: PMC5395849 DOI: 10.1186/s12885-017-3251-3

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# Agenda



## Introduction to Ingenuity Pathway Analysis

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## MAP2K3

Proteome profiling of immortalization-to-senescence transition of human breast epithelial cells identified **MAP2K3** as a senescence-promoting protein which is downregulated in human breast cancer.

Jia M, Souchelnytskyi N, Hellman U, O'Hare M, Jat PS, Souchelnytskyi S.  
Proteomics Clin Appl. 2010 Nov;4(10-11):816-28. doi: 10.1002/prca.201000006.  
PMID: 21137025

Genome-wide RNA interference screening reveals a COPI-**MAP2K3** pathway required for YAP regulation.

Kim YJ, Jung E, Shin E, Hong SH, Jeong HS, Hur G, Jeong HY, Lee SH, Lee JE, Kim GH, Kim J.  
Proc Natl Acad Sci U S A. 2020 Aug 18;117(33):19994-20003. doi: 10.1073/pnas.1915387117. Epub 2020 Aug 3.  
PMID: 32747557    [Free PMC article.](#)

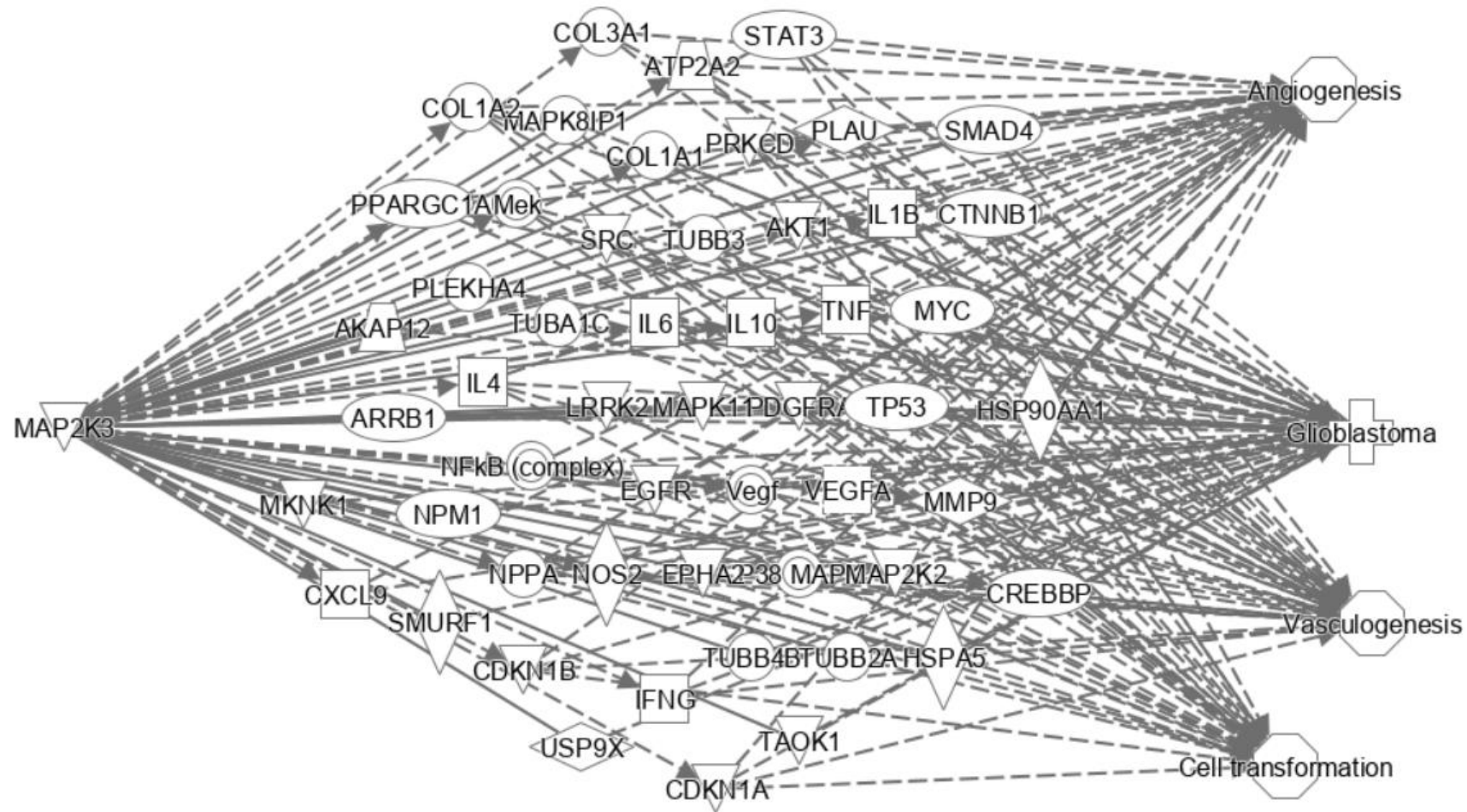
Sulforaphene inhibits esophageal cancer progression via suppressing SCD and CDH3 expression, and activating the GADD45B-**MAP2K3**-p38-p53 feedback loop.

Han S, Wang Y, Ma J, Wang Z, Wang HD, Yuan Q.  
Cell Death Dis. 2020 Sep 1;11(8):713. doi: 10.1038/s41419-020-02859-2.  
PMID: 32873775    [Free PMC article.](#)

The miR-19b-3p-**MAP2K3**-STAT3 feedback loop regulates cell proliferation and invasion in esophageal squamous cell carcinoma.

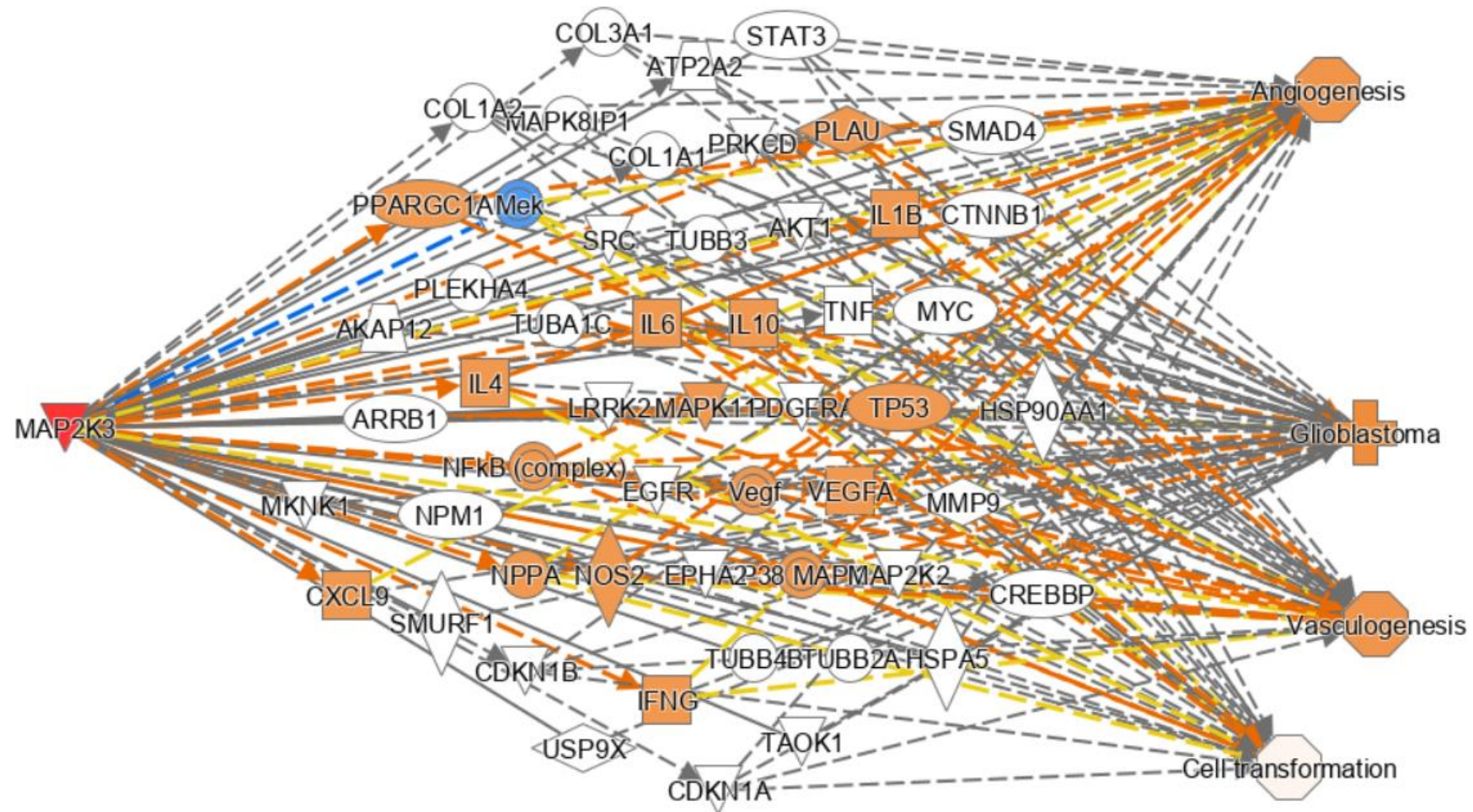
Zhang Y, Lu W, Chen Y, Lin Y, Yang X, Wang H, Liu Z.  
Mol Oncol. 2021 May;15(5):1566-1583. doi: 10.1002/1878-0261.12934. Epub 2021 Mar 14.  
PMID: 33660414    [Free PMC article.](#)

# Construct networks based on key biomarkers





# Predict molecule activity





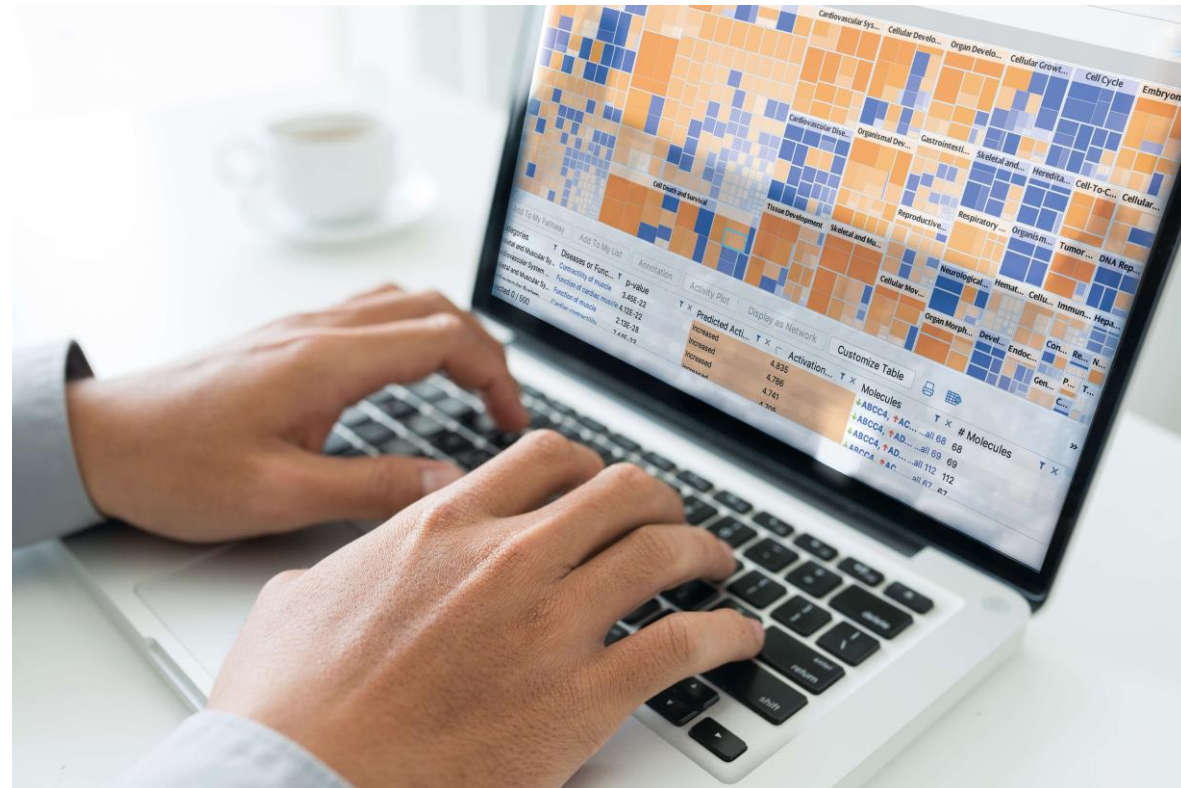
# Summary

## Biological interpretation of data using QIAGEN IPA

- Interrogate key pathways impacted by expression changes at varying levels of detail
- Identify predicted regulators driving the observed expression signature
- Compare biological findings with internal/public data to determine conserved/disparate biology
- Easily generate tables and figures based on the analysis

## Utilizing QIAGEN IPA without a dataset

- Leverage QIAGEN Knowledgebase for literature findings
- Build networks in silico and predict activity



## Contact Information

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QIAGEN Digital Insights

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**Ingenuity Pathway Analysis trial:**

<https://qiagen.showpad.com/share/RC7IW0oVJnSsEd5w9LjiA>

Software questions and support:

[ts-bioinformatics@qiagen.com](mailto:ts-bioinformatics@qiagen.com)

Additional feedback and training:

[devendra.mistry@qiagen.com](mailto:devendra.mistry@qiagen.com)

