

Additional File 2: Table S2a. Ingenuity pathway analysis – top three pathways of all atopy genes (n=160)

Pathways	-log (p-value)¹	Ratio²	Molecules
T Helper Cell Differentiation	2,95E01	3,01E-01	<i>IL21, STAT6, IFNG, IL4R, IL12RB1, IL10, IL21R, IL6R, IL12RB2, STAT3, TBX21, IL13, IL18, IL2, TGFB1, IL12B, NGFR, ICOS, CD86, IL17F, TNF, IL4</i>
Th1 and Th2 Activation Pathway	2,84E01	1,51E-01	<i>IL1RL1, IL12RB1, IL31, TBX21, IL2, TGFB1, IL9, IL4, STAT6, IFNG, PTGDR2, IL4R, IL10, HAVCR1, IL6R, TYK2, IL12RB2, STAT3, TLR9, IL13, TSLP, IL18, IL17RB, IL12B, LTA, ICOS, SIPRI, CD86</i>
Th2 Pathway	2,49E01	1,6E-01	<i>STAT6, IFNG, IL4R, PTGDR2, IL12RB1, IL10, HAVCR1, IL1RL1, TYK2, IL12RB2, IL31, TLR9, IL13, TBX21, TSLP, IL17RB, IL2, TGFB1, IL12B, ICOS, IL9, SIPRI, CD86, IL4</i>
<p>¹The -log (p-value) was calculated using a Fisher's exact test to determine the probability that the association between the atopy-related genes and the pathways is explained by a random chance alone. A -log (p-value) equal to or greater than 1.3, corresponding to a p-value of 0.05, was considered statistically significant.</p> <p>²The ratio is calculated by the atopy-related genes found in each pathway divided by the total number of molecules in that pathway.</p>			

Additional File 2: Table S2b. Ingenuity pathway analysis - all atopy genes (n=160)

Pathways	Molecules
T Helper Cell Differentiation	<i>IL21, STAT6, IFNG, IL4R, IL12RB1, IL10, IL21R, IL6R, IL12RB2, STAT3, TBX21, IL13, IL18, IL2, TGFB1, IL12B, NGFR, ICOS, CD86, IL17F, TNF, IL4</i>
Th1 and Th2 Activation Pathway	<i>IL1RL1, IL12RB1, IL31, TBX21, IL2, TGFB1, IL9, IL4, STAT6, IFNG, PTGDR2, IL4R, IL10, HAVCR1, IL6R, TYK2, IL12RB2, STAT3, TLR9, IL13, TSLP, IL18, IL17RB, IL12B, LTA, ICOS, SIPR1, CD86</i>
Th2 Pathway	<i>STAT6, IFNG, IL4R, PTGDR2, IL12RB1, IL10, HAVCR1, IL1RL1, TYK2, IL12RB2, IL31, TLR9, IL13, TBX21, TSLP, IL17RB, IL2, TGFB1, IL12B, ICOS, IL9, SIPR1, CD86, IL4</i>
TREM1 Signaling	<i>NLRP3, IL10, IL1RL1, STAT3, FCGR2B, TLR9, TLR2, TLR10, IL18, NOD2, CCL2, TLR1, TLR6, NOD1, CD86, CSF2, TNF, CCL7</i>
Neuroinflammation Signaling Pathway	<i>BDNF, CCL5, HMGB1, TLR10, CCL2, TGFB1, TLR1, NOS2, CASP8, IL4, IFNG, NLRP3, IL10, IL6R, TYK2, IRAK3, TLR9, CSF1R, TLR2, PLA2G4A, IL18, IL12B, TLR6, CD86, PTGS2, TNF, SLC6A12, MMP9</i>
Altered T Cell and B Cell Signaling in Rheumatoid Arthritis	<i>IL21, IFNG, IL10, TLR9, TLR2, TLR10, IL18, IL12B, TGFB1, IL2, LTA, TLR1, TLR6, CD86, TNFRSF13B, CSF2, TNF, IL4</i>
Role of Pattern Recognition Receptors in Recognition of Bacteria and Viruses	<i>IFNG, NLRP3, IL10, CCL5, IL13, TLR9, TLR2, IL18, NOD2, IL12B, TGFB1, IL2, LTA, TLR1, TLR6, NOD1, CSF2, IL17F, TNF, IL4</i>
Differential Regulation of Cytokine Production in Intestinal Epithelial Cells by IL-17A and IL-17F	<i>IFNG, CCL2, IL10, IL12B, IL9, DEFB1, CCL5, CSF2, IL13, IL17F, TNF</i>
Communication between Innate and Adaptive Immune Cells	<i>IFNG, IL10, CCL5, TLR9, TLR2, TLR10, IL18, IL2, IL12B, TLR6, TLR1, CD86, TNFRSF13B, CSF2, TNF, IL4</i>
Th17 Activation Pathway	<i>IL21, IFNG, IL12RB1, IL10, IL21R, IL6R, TYK2, DEFB1, IL12RB2, IRAK3, STAT3, IL12B, PTGER2, CSF2, IL17F</i>
HMGB1 Signaling	<i>IFNG, IL13, TLR9, HMGB1, IL18, CCL2, IL12B, TGFB1, IL2, NGFR, KAT6A, LTA, CSF2, SERPINE1, IL17F, TNF, IL4</i>
Role of Macrophages, Fibroblasts and Endothelial Cells in Rheumatoid Arthritis	<i>IL10, IL1RL1, IL6R, STAT3, IRAK3, CCL5, TLR9, TLR2, TLR10, IL18, NFKBIA, TRAF3IP2, F2RL1, CCL2, TGFB1, LTA, NGFR, TLR1, TLR6, CSF2, NOS2, TNF</i>
Differential Regulation of Cytokine Production in Macrophages and T Helper Cells by IL-17A and IL-17F	<i>CCL2, IL10, IL12B, IL9, CCL5, CSF2, IL13, IL17F, TNF</i>
Th1 Pathway	<i>IFNG, IL12RB1, IL10, IL6R, TYK2, IL12RB2, STAT3, TBX21, TLR9, IL18, IL12B, IL2, LTA, ICOS, CD86, IL4</i>
Role of Cytokines in Mediating Communication between Immune Cells	<i>IL21, IFNG, IL18, IL2, TGFB1, IL10, IL12B, CSF2, IL13, IL17F, TNF, IL4</i>
Glucocorticoid Receptor Signaling	<i>IFNG, IL10, MAP3K1, STAT3, CCL5, CCL11, IL13, TLR9, NR3C1, HMGB1, SCGB1A1, NFKBIA, CCL2, IL2, TGFB1, PTGS2, CSF2, NOS2, SERPINE1, TNF, ADRB2, IL4</i>
Toll-like Receptor Signaling	<i>TLR2, IL18, TLR10, NFKBIA, IL1RL1, IL12B, TLR1, MAP3K1, TLR6, CD14, IRAK3, TLR9, TNF</i>

Hepatic Cholestasis	<i>IFNG, IL1RL1, IRAK3, IL13, IL18, NFKBIA, IL12B, IL2, TGFB1, NGFR, LTA, CD14, CSF2, IL17F, TNF, IL4</i>
IL-10 Signaling	<i>IL18, IL4R, NFKBIA, IL1RL1, IL10, FCGR2A, TYK2, CD14, STAT3, FCGR2B, TNF</i>
IL-12 Signaling and Production in Macrophages	<i>TLR2, STAT6, IFNG, IL18, IL12B, TGFB1, IL10, IL12RB1, SERPINA1, IL12RB2, NOS2, TLR9, TNF, IL4</i>
Granulocyte Adhesion and Diapedesis	<i>IL18, SELP, CCL3L1, CCL2, IL1RL1, NGFR, PECAM1, CCL26, CCL5, MMP12, HRH4, CCL11, TNF, MMP9, CCL7</i>
LXR/RXR Activation	<i>IL18, CCL2, IL1RL1, NGFR, LPL, CD14, SERPINA1, PTGS2, GC, NOS2, TNF, MMP9, CCL7</i>
Hepatic Fibrosis / Hepatic Stellate Cell Activation	<i>IFNG, IL4R, CCL2, TGFB1, IL1RL1, IL10, NGFR, IL6R, CD14, COL6A5, CCL5, SERPINE1, TNF, MMP9, IL4</i>
Atherosclerosis Signaling	<i>PLA2G4A, IFNG, IL18, CCL2, SELP, TGFB1, LPL, SERPINA1, ALOX5, CCL11, TNF, PLA2G7, MMP9</i>
Role of JAK1 and JAK3 in γ c Cytokine Signaling	<i>IL7R, IL21, STAT6, IL4R, IL2, IL21R, IL9, STAT3, TLR9, TSLP, IL4</i>
Eicosanoid Signaling	<i>PLA2G4A, PTGDR, LTC4S, TBXA2R, CYSLTR1, PTGS2, PTGER2, ALOX5, CYSLTR2, PLA2G7</i>
Colorectal Cancer Metastasis Signaling	<i>IFNG, IL6R, TYK2, STAT3, TLR9, TLR2, TLR10, TGFB1, TLR6, TLR1, PTGS2, PTGER2, NOS2, MMP12, TNF, MMP9</i>
Crosstalk between Dendritic Cells and Natural Killer Cells	<i>IFNG, IL18, IL2, IL12B, LTA, CD86, CSF2, TLR9, TNF, IL4</i>
NF- κ B Signaling	<i>TLR2, TLR10, IL18, NFKBIA, NGFR, LTA, TLR6, TLR1, MAP3K1, IRAK3, CASP8, TLR9, TNF</i>
Dendritic Cell Maturation	<i>TLR2, IL18, NFKBIA, FCGR2A, IL10, IL12B, LTA, NGFR, CD86, CSF2, TLR9, FCGR2B, TNF</i>
Type I Diabetes Mellitus Signaling	<i>IFNG, NFKBIA, IL2, IL12B, NGFR, LTA, CD86, NOS2, CASP8, TNF</i>
Agranulocyte Adhesion and Diapedesis	<i>IL18, SELP, CCL2, CCL3L1, PECAM1, CCL26, CCL5, MMP12, CCL11, TNF, MMP9, CCL7</i>
Production of Nitric Oxide and Reactive Oxygen Species in Macrophages	<i>TLR2, IFNG, NFKBIA, NGFR, CAT, MAP3K1, TYK2, SERPINA1, NOS2, TLR9, TNF, IL4</i>
Role of Hypercytokinemia/hyperchemokines in the Pathogenesis of Influenza	<i>IFNG, IL18, CCL2, IL12B, IL9, CCL5, TNF</i>
MSP-RON Signaling Pathway	<i>TLR2, IFNG, KLK7, CCL2, IL12B, NOS2, TLR9, TNF</i>
LPS/IL-1 Mediated Inhibition of RXR Function	<i>GSTM1, IL18, IL1RL1, NGFR, CAT, MAP3K1, PPARGC1B, CD14, GSTO2, TNF, GSTP1, CYP2C19</i>
Role of Osteoblasts, Osteoclasts and Chondrocytes in Rheumatoid Arthritis	<i>IFNG, IL18, NFKBIA, IL1RL1, TGFB1, IL10, NGFR, CSF2, TLR9, TNF, CSF1R, IL4</i>
Fc Epsilon RI Signaling	<i>BTK, PLA2G4A, FCER1A, MS4A2, CSF2, TLR9, IL13, TNF, IL4</i>
IL-6 Signaling	<i>IL18, NFKBIA, IL1RL1, NGFR, IL6R, CD14, STAT3, TLR9, TNF</i>
Acute Phase Response Signaling	<i>IL18, NFKBIA, NGFR, MAP3K1, IL6R, SERPINA1, STAT3, SERPINE1, TNF, NR3C1</i>
Role of IL-17A in Arthritis	<i>NFKBIA, CCL2, PTGS2, CCL5, TLR9, NOS2, CCL7</i>
iNOS Signaling	<i>IFNG, NFKBIA, TYK2, CD14, IRAK3, NOS2</i>
Role of NFAT in Regulation of the Immune Response	<i>BTK, NFKBIA, FCGR2A, FCER1A, MS4A2, CD86, FCGR2B, TLR9, ITK, ORAI1</i>
Hematopoiesis from Pluripotent Stem Cells	<i>IL2, IL10, IL12B, IL9, CSF2, IL4</i>

Airway Inflammation in Asthma	<i>IL13, TNF, IL4</i>
Role of MAPK Signaling in the Pathogenesis of Influenza	<i>IFNG, PLA2G4A, CCL2, PTGS2, CCL5, PLA2G7, TNF</i>
IL-15 Signaling	<i>STAT6, TYK2, STAT3, TLR9, CSF2, TNF, IL4</i>
Osteoarthritis Pathway	<i>HMGB1, TLR2, IL1RL1, TGFB1, PTGS2, NOS2, MMP12, CASP8, TNF, MMP9</i>
Tec Kinase Signaling	<i>BTK, STAT6, TYK2, FCER1A, MS4A2, STAT3, TLR9, TNF, ITK</i>
Renin-Angiotensin Signaling	<i>CCL2, MAP3K1, CCL5, STAT3, PTGER2, TLR9, TNF, ACE</i>
IL-17 Signaling	<i>TRAF3IP2, CCL2, PTGS2, CCL11, TLR9, NOS2, IL17F</i>
MIF-mediated Glucocorticoid Regulation	<i>PLA2G4A, NFKBIA, CD14, PTGS2, NR3C1</i>
CD28 Signaling in T Helper Cells	<i>NFKBIA, ARPC1B, IL2, MAP3K1, CD86, TLR9, CTLA4, ITK</i>
Phagosome Formation	<i>TLR2, TLR10, FCGR2A, TLR6, TLR1, FCER1A, TLR9, FCGR2B</i>
Systemic Lupus Erythematosus Signaling	<i>IL18, IL2, IL10, FCGR2A, IL6R, CD86, FCGR2B, TLR9, SART1, TNF</i>
STAT3 Pathway	<i>IL4R, IL17RB, TGFB1, NGFR, TYK2, IL9, STAT3</i>
Inflammasome pathway	<i>IL18, NOD2, NLRP3, CASP8</i>
MIF Regulation of Innate Immunity	<i>PLA2G4A, NFKBIA, CD14, PTGS2, NOS2</i>
Role of IL-17F in Allergic Inflammatory Airway Diseases	<i>TRAF3IP2, CCL2, CSF2, IL17F, CCL7</i>
T Cell Receptor Signaling	<i>BTK, NFKBIA, PAG1, MAP3K1, TLR9, CTLA4, ITK</i>
VDR/RXR Activation	<i>IFNG, IL2, IL1RL1, CD14, CCL5, CSF2</i>
IL-17A Signaling in Airway Cells	<i>TRAF3IP2, NFKBIA, TYK2, STAT3, TLR9, CCL11</i>
Graft-versus-Host Disease Signaling	<i>IFNG, IL18, IL2, CD86, TNF</i>
Allograft Rejection Signaling	<i>IFNG, IL2, IL10, CD86, TNF, IL4</i>
TNFR2 Signaling	<i>NFKBIA, LTA, MAP3K1, TNF</i>
IL-4 Signaling	<i>STAT6, IL4R, TYK2, TLR9, NR3C1, IL4</i>
Hematopoiesis from Multipotent Stem Cells	<i>IL2, CSF2, IL4</i>
Glutathione-mediated Detoxification	<i>GSTM1, LTC4S, GSTO2, GSTP1</i>
Ceramide Signaling	<i>NGFR, MAP3K1, SIPR1, SMPD1, TLR9, TNF</i>
Endothelin-1 Signaling	<i>NOS1, PLA2G4A, PTGS2, PTGER2, TLR9, NOS2, CASP8, PLA2G7</i>
PPAR Signaling	<i>IL18, NFKBIA, IL1RL1, NGFR, PTGS2, TNF</i>
IL-17A Signaling in Fibroblasts	<i>TRAF3IP2, NFKBIA, CCL2, CCL7</i>
Antioxidant Action of Vitamin C	<i>PLA2G4A, NFKBIA, GSTO2, CSF2, TNF, PLA2G7</i>
Endocannabinoid Cancer Inhibition Pathway	<i>NOS1, TWIST1, SMPD1, TRPV1, CASP8, TLR9, NOS2</i>
Role of PKR in Interferon Induction and Antiviral Response	<i>IFNG, NFKBIA, CASP8, TNF</i>
p38 MAPK Signaling	<i>PLA2G4A, IL18, IL1RL1, TGFB1, IRAK3, TNF</i>
Pancreatic Adenocarcinoma Signaling	<i>TGFB1, TYK2, STAT3, PTGS2, TLR9, MMP9</i>
CD40 Signaling	<i>NFKBIA, LTA, STAT3, PTGS2, TLR9</i>
IL-9 Signaling	<i>IL9, STAT3, TLR9, TNF</i>
Xenobiotic Metabolism Signaling	<i>GSTM1, CAT, MAP3K1, GSTO2, NOS2, TLR9, TNF, GSTP1, CYP2C19</i>
Autoimmune Thyroid Disease Signaling	<i>IL10, IL2, CD86, IL4</i>

Primary Immunodeficiency Signaling	<i>IL7R, BTK, ICOS, TNFRSF13B</i>
TNFR1 Signaling	<i>NFKBIA, MAP3K1, CASP8, TNF</i>
Citrulline-Nitric Oxide Cycle	<i>NOS1, NOS2</i>
B Cell Receptor Signaling	<i>BTK, NFKBIA, FCGR2A, PAG1, MAP3K1, FCGR2B, TLR9</i>
Gα12/13 Signaling	<i>BTK, NFKBIA, F2RL1, TBXA2R, MAP3K1, TLR9</i>
NRF2-mediated Oxidative Stress Response	<i>GSTM1, CAT, MAP3K1, GSTO2, TLR9, GSTP1, EPHX1</i>
Role of JAK1, JAK2 and TYK2 in Interferon Signaling	<i>IFNG, TYK2, STAT3</i>
Role of JAK family kinases in IL-6-type Cytokine Signaling	<i>IL6R, TYK2, STAT3</i>
Leukocyte Extravasation Signaling	<i>BTK, CTNNA3, PECAM1, MMP12, TLR9, MMP9, ITK</i>
Type II Diabetes Mellitus Signaling	<i>NFKBIA, NGFR, MAP3K1, SMPD1, TLR9, TNF</i>
SPINK1 Pancreatic Cancer Pathway	<i>KLK7, F2RL1, TGFB1, MMP12</i>
Induction of Apoptosis by HIV1	<i>NFKBIA, NGFR, CASP8, TNF</i>
G-Protein Coupled Receptor Signaling	<i>NFKBIA, PTGDR, TBXA2R, SIPR1, STAT3, PTGER2, TLR9, ADRB2</i>
Activation of IRF by Cytosolic Pattern Recognition Receptors	<i>NFKBIA, IL10, LTA, TNF</i>
PXR/RXR Activation	<i>GSTM1, TNF, NR3C1, CYP2C19</i>
Airway Pathology in Chronic Obstructive Pulmonary Disease	<i>TNF, MMP9</i>
iCOS-iCOSL Signaling in T Helper Cells	<i>NFKBIA, IL2, ICOS, TLR9, ITK</i>
HIF1α Signaling	<i>NOS1, NOS2, MMP12, TLR9, MMP9</i>
FXR/RXR Activation	<i>IL18, LPL, SERPINA1, GC, TNF</i>
Chemokine Signaling	<i>CCL2, CCL5, CCL11, CCL7</i>
Role of PI3K/AKT Signaling in the Pathogenesis of Influenza	<i>IFNG, NFKBIA, CCL5, TLR9</i>
SPINK1 General Cancer Pathway	<i>IL6R, TYK2, STAT3, TLR9</i>
April Mediated Signaling	<i>NFKBIA, MAP3K1, TNFRSF13B</i>
Adipogenesis pathway	<i>ATG5, TGFB1, KAT6A, LPL, TNF</i>
Regulation of the Epithelial-Mesenchymal Transition Pathway	<i>TGFB1, TYK2, TWIST1, STAT3, TLR9, MMP9</i>
Oncostatin M Signaling	<i>TYK2, STAT3, CHI3L1</i>
CCR3 Signaling in Eosinophils	<i>PLA2G4A, MYLK, CCL26, TLR9, CCL11</i>
PI3K Signaling in B Lymphocytes	<i>BTK, IL4R, NFKBIA, FCGR2B, IL4</i>
B Cell Activating Factor Signaling	<i>NFKBIA, MAP3K1, TNFRSF13B</i>
p70S6K Signaling	<i>BTK, IL4R, F2RL1, TLR9, IL4</i>
Small Cell Lung Cancer Signaling	<i>NOS1, NFKBIA, PTGS2, TLR9</i>
Regulation of IL-2 Expression in Activated and Anergic T Lymphocytes	<i>NFKBIA, TGFB1, IL2, MAP3K1</i>
Aryl Hydrocarbon Receptor Signaling	<i>GSTM1, TGFB1, GSTO2, TNF, GSTP1</i>
Leukotriene Biosynthesis	<i>LTC4S, ALOX5</i>

JAK/Stat Signaling	<i>STAT6, TYK2, STAT3, TLR9</i>
PEDF Signaling	<i>NFKBIA, BDNF, TLR9, CASP8</i>
Death Receptor Signaling	<i>NFKBIA, CASP8, TNF, PARP1</i>
Superpathway of Citrulline Metabolism	<i>NOS1, NOS2</i>
Apoptosis Signaling	<i>NFKBIA, CASP8, TNF, PARP1</i>
PDGF Signaling	<i>MAP3K1, TYK2, STAT3, TLR9</i>
Granzyme B Signaling	<i>CASP8, PARP1</i>
cAMP-mediated signaling	<i>PTGDR, TBXA2R, SIPR1, STAT3, PTGER2, ADRB2</i>
CD27 Signaling in Lymphocytes	<i>NFKBIA, MAP3K1, CASP8</i>
PKC θ Signaling in T Lymphocytes	<i>NFKBIA, IL2, MAP3K1, CD86, TLR9</i>
Apelin Cardiomyocyte Signaling Pathway	<i>TGFB1, CAT, MYLK, TLR9</i>
Retinoic acid Mediated Apoptosis Signaling	<i>IFNG, CASP8, PARP1</i>
Apelin Cardiac Fibroblast Signaling Pathway	<i>TGFB1, SERPINE1</i>
HGF Signaling	<i>MAP3K1, STAT3, PTGS2, TLR9</i>
Neuroprotective Role of THOP1 in Alzheimer's Disease	<i>IFNG, KLK7, MMP9, ACE</i>
PPAR α /RXR α Activation	<i>NFKBIA, IL1RL1, TGFB1, LPL, CYP2C19</i>
Lymphotoxin β Receptor Signaling	<i>NFKBIA, LTA, TLR9</i>
NGF Signaling	<i>NGFR, MAP3K1, SMPD1, TLR9</i>
IL-22 Signaling	<i>TYK2, STAT3</i>
Glutathione Redox Reactions I	<i>GSTM1, GSTP1</i>
Sphingosine-1-phosphate Signaling	<i>SIPR1, SMPD1, CASP8, TLR9</i>
EGF Signaling	<i>MAP3K1, STAT3, TLR9</i>
CNTF Signaling	<i>TYK2, STAT3, TLR9</i>
IL-17A Signaling in Gastric Cells	<i>CCL5, TNF</i>
Bupropion Degradation	<i>CYP2J2, CYP2C19</i>
ILK Signaling	<i>PTGS2, NOS2, TLR9, TNF, MMP9</i>
Antiproliferative Role of TOB in T Cell Signaling	<i>IL2, TGFB1</i>
Adrenomedullin signaling pathway	<i>IL18, LTA, MYLK, TLR9, TNF</i>
IL-8 Signaling	<i>IL9, PTGS2, IRAK3, TLR9, MMP9</i>
ErbB2-ErbB3 Signaling	<i>TYK2, STAT3, TLR9</i>
Corticotropin Releasing Hormone Signaling	<i>NOS1, BDNF, PTGS2, NOS2</i>
GM-CSF Signaling	<i>STAT3, CSF2, TLR9</i>
Acetone Degradation I (to Methylglyoxal)	<i>CYP2J2, CYP2C19</i>
Human Embryonic Stem Cell Pluripotency	<i>BDNF, TGFB1, SIPR1, TLR9</i>
Apelin Adipocyte Signaling Pathway	<i>GSTM1, CAT, GSTP1</i>
Neurotrophin/TRK Signaling	<i>BDNF, NGFR, TLR9</i>
Fc γ RIIB Signaling in B Lymphocytes	<i>BTK, FCGR2B, TLR9</i>

Inhibition of Angiogenesis by TSP1	<i>TGFBI, MMP9</i>
Role of JAK2 in Hormone-like Cytokine Signaling	<i>TYK2, STAT3</i>
Macropinocytosis Signaling	<i>CD14, TLR9, CSF1R</i>
Coagulation System	<i>SERPINA1, SERPINE1</i>
TWEAK Signaling	<i>NFKBIA, CASP8</i>
IL-3 Signaling	<i>STAT6, STAT3, TLR9</i>
Prolactin Signaling	<i>STAT3, TLR9, NR3C1</i>
B Cell Development	<i>IL7R, CD86</i>
Interferon Signaling	<i>IFNG, TYK2</i>
Relaxin Signaling	<i>NFKBIA, NOS2, TLR9, MMP9</i>
FGF Signaling	<i>MAP3K1, STAT3, TLR9</i>
IL-7 Signaling Pathway	<i>IL7R, IFNG, TLR9</i>
Fcγ Receptor-mediated Phagocytosis in Macrophages and Monocytes	<i>ARPC1B, FCGR2A, CSF2</i>
IL-1 Signaling	<i>NFKBIA, MAP3K1, IRAK3</i>
LPS-stimulated MAPK Signaling	<i>NFKBIA, CD14, TLR9</i>
NF-κB Activation by Viruses	<i>NFKBIA, MAP3K1, TLR9</i>
FLT3 Signaling in Hematopoietic Progenitor Cells	<i>STAT6, STAT3, TLR9</i>
Cardiac Hypertrophy Signaling	<i>TGFBI, MAP3K1, IL6R, TLR9, ADRB2</i>
Inhibition of Matrix Metalloproteases	<i>MMP12, MMP9</i>
Phospholipase C Signaling	<i>BTK, PLA2G4A, FCGR2A, FCGR2B, ITK</i>
Tight Junction Signaling	<i>TGFBI, NGFR, MYLK, TNF</i>
Acute Myeloid Leukemia Signaling	<i>STAT3, TLR9, CSF1R</i>
CTLA4 Signaling in Cytotoxic T Lymphocytes	<i>CD86, TLR9, CTLA4</i>
Estrogen Biosynthesis	<i>CYP2J2, CYP2C19</i>
RANK Signaling in Osteoclasts	<i>NFKBIA, MAP3K1, TLR9</i>
Prostate Cancer Signaling	<i>NFKBIA, TLR9, GSTP1</i>
Role of RIG1-like Receptors in Antiviral Innate Immunity	<i>NFKBIA, CASP8</i>
Germ Cell-Sertoli Cell Junction Signaling	<i>TGFBI, MAP3K1, TLR9, TNF</i>
Synaptic Long Term Depression	<i>NOS1, PLA2G4A, NOS2, PLA2G7</i>
Cholecystokinin/Gastrin-mediated Signaling	<i>IL18, PTGS2, TNF</i>
PAK Signaling	<i>MYLK, TLR9, TNF</i>
Sertoli Cell-Sertoli Cell Junction Signaling	<i>NOS1, MAP3K1, NOS2, TNF</i>
Gas Signaling	<i>PTGDR, PTGER2, ADRB2</i>
Amyotrophic Lateral Sclerosis Signaling	<i>NOS1, CAT, TLR9</i>
UVA-Induced MAPK Signaling	<i>SMPD1, TLR9, PARP1</i>
Mouse Embryonic Stem Cell Pluripotency	<i>TYK2, STAT3, TLR9</i>
Transcriptional Regulatory Network in Embryonic Stem	<i>KAT6A, STAT3</i>

Cells	
Rac Signaling	<i>ARPC1B, MAP3K1, TLR9</i>
G <i>α</i> i Signaling	<i>TBXA2R, SIPR1, STAT3</i>
Sirtuin Signaling Pathway	<i>ATG5, STAT3, NOS2, TNF, PARP1</i>
Nicotine Degradation III	<i>CYP2J2, CYP2C19</i>
Role of NANOG in Mammalian Embryonic Stem Cell Pluripotency	<i>TYK2, STAT3, TLR9</i>
fMLP Signaling in Neutrophils	<i>NFKBIA, ARPC1B, TLR9</i>
Role of Tissue Factor in Cancer	<i>F2RL1, CSF2, TLR9</i>
PI3K/AKT Signaling	<i>NFKBIA, TYK2, PTGS2</i>
Ephrin A Signaling	<i>NGFR, TLR9</i>
Protein Kinase A Signaling	<i>NFKBIA, TGFB1, NGFR, MAP3K1, MYLK, PTGS2</i>
GP6 Signaling Pathway	<i>BTK, COL6A5, TLR9</i>
Phospholipases	<i>PLA2G4A, PLA2G7</i>
autophagy	<i>ATG5, ACE</i>
Iron homeostasis signaling pathway	<i>IL6R, TYK2, STAT3</i>
Melatonin Degradation I	<i>CYP2J2, CYP2C19</i>
Nicotine Degradation II	<i>CYP2J2, CYP2C19</i>
Actin Cytoskeleton Signaling	<i>ARPC1B, CD14, MYLK, TLR9</i>
Superpathway of Melatonin Degradation	<i>CYP2J2, CYP2C19</i>
IL-2 Signaling	<i>IL2, TLR9</i>
Thrombopoietin Signaling	<i>STAT3, TLR9</i>
Ovarian Cancer Signaling	<i>PTGS2, TLR9, MMP9</i>
Myc Mediated Apoptosis Signaling	<i>TLR9, CASP8</i>
Glioma Invasiveness Signaling	<i>TLR9, MMP9</i>
G <i>α</i> q Signaling	<i>BTK, NFKBIA, TLR9</i>
Axonal Guidance Signaling	<i>ARPC1B, BDNF, NGFR, TLR9, MMP9, ACE</i>
Antiproliferative Role of Somatostatin Receptor 2	<i>NOS1, TLR9</i>
Cdc42 Signaling	<i>ARPC1B, MYLK, ITK</i>
Angiopoietin Signaling	<i>NFKBIA, TLR9</i>
Growth Hormone Signaling	<i>STAT3, TLR9</i>
Leptin Signaling in Obesity	<i>STAT3, TLR9</i>
Erythropoietin Signaling	<i>NFKBIA, TLR9</i>
Renal Cell Carcinoma Signaling	<i>TGFB1, TLR9</i>
Regulation of Actin-based Motility by Rho	<i>ARPC1B, MYLK</i>
OX40 Signaling Pathway	<i>NFKBIA, IL2</i>
TGF- β Signaling	<i>TGFB1, SERPINE1</i>
Bladder Cancer Signaling	<i>MMP12, MMP9</i>
VEGF Family Ligand-Receptor Interactions	<i>PLA2G4A, TLR9</i>
Sumoylation Pathway	<i>NFKBIA, NR3C1</i>
Molecular Mechanisms of Cancer	<i>NFKBIA, TGFB1, TYK2, TLR9, CASP8</i>
RAR Activation	<i>TGFB1, MAP3K1, PARP1</i>
CDK5 Signaling	<i>BDNF, NGFR</i>
3-phosphoinositide Biosynthesis	<i>ICOS, CD86, TLR9</i>

ERK/MAPK Signaling	<i>PLA2G4A, STAT3, TLR9</i>
Clathrin-mediated Endocytosis Signaling	<i>ARPC1B, SERPINA1, TLR9</i>
SAPK/JNK Signaling	<i>MAP3K1, TLR9</i>
IGF-1 Signaling	<i>STAT3, TLR9</i>
Chronic Myeloid Leukemia Signaling	<i>TGFB1, TLR9</i>
Neuropathic Pain Signaling In Dorsal Horn Neurons	<i>BDNF, TLR9</i>
AMPK Signaling	<i>CFTR, TLR9, ADRB2</i>
Telomerase Signaling	<i>IL2, TLR9</i>
Integrin Signaling	<i>ARPC1B, MYLK, TLR9</i>
Circadian Rhythm Signaling	<i>ADCYAP1R1</i>
Role of NFAT in Cardiac Hypertrophy	<i>TGFB1, MAP3K1, TLR9</i>
RhoA Signaling	<i>ARPC1B, MYLK</i>
Apelin Endothelial Signaling Pathway	<i>CCL2, TLR9</i>
Sperm Motility	<i>PLA2G4A, PLA2G7</i>
Endocannabinoid Developing Neuron Pathway	<i>STAT3, TLR9</i>
Natural Killer Cell Signaling	<i>FCGR2A, TLR9</i>
Superpathway of Inositol Phosphate Compounds	<i>ICOS, CD86, TLR9</i>
14-3-3-mediated Signaling	<i>TLR9, TNF</i>
Huntington's Disease Signaling	<i>BDNF, TLR9, CASP8</i>
Signaling by Rho Family GTPases	<i>ARPC1B, MYLK, TLR9</i>
Phagosome Maturation	<i>NOS1, ACE</i>
Mitochondrial Dysfunction	<i>CAT, CASP8</i>
eNOS Signaling	<i>TLR9, CASP8</i>
Ephrin Receptor Signaling	<i>ARPC1B, STAT3</i>
Thrombin Signaling	<i>MYLK, TLR9</i>
Opioid Signaling Pathway	<i>NOS1, NFKBIA</i>
GPCR-Mediated Integration of Enteroendocrine Signaling Exemplified by an L Cell	<i>ADRB2</i>
Actin Nucleation by ARP-WASP Complex	<i>ARPC1B</i>
Remodeling of Epithelial Adherens Junctions	<i>ARPC1B</i>
RhoGDI Signaling	<i>ARPC1B</i>
Epithelial Adherens Junction Signaling	<i>ARPC1B</i>
Thyroid Cancer Signaling	<i>BDNF</i>
G Beta Gamma Signaling	<i>BTK</i>
Tumoricidal Function of Hepatic Natural Killer Cells	<i>CASP8</i>
Cytotoxic T Lymphocyte-mediated Apoptosis of Target Cells	<i>CASP8</i>
Superoxide Radicals Degradation	<i>CAT</i>

Ethanol Degradation IV	<i>CAT</i>
Pathogenesis of Multiple Sclerosis	<i>CCL5</i>
CCR5 Signaling in Macrophages	<i>CCL5</i>
Nur77 Signaling in T Lymphocytes	<i>CD86</i>
Catecholamine Biosynthesis	<i>DBH</i>
Neuregulin Signaling	<i>ERBIN</i>
HIPPO signaling	<i>FRMD6</i>
Ascorbate Recycling (Cytosolic)	<i>GSTO2</i>
Vitamin-C Transport	<i>GSTO2</i>
Histamine Degradation	<i>HNMT</i>
Role of Lipids/Lipid Rafts in the Pathogenesis of Influenza	<i>IFNG</i>
Antigen Presentation Pathway	<i>IFNG</i>
Role of Wnt/GSK-3 β Signaling in the Pathogenesis of Influenza	<i>IFNG</i>
Role of BRCA1 in DNA Damage Response	<i>IFNG</i>
Protein Ubiquitination Pathway	<i>IFNG</i>
3-phosphoinositide Degradation	<i>INPP4A</i>
Intrinsic Prothrombin Activation Pathway	<i>KLK7</i>
Retinol Biosynthesis	<i>LPL</i>
Triacylglycerol Degradation	<i>LPL</i>
GNRH Signaling	<i>MAP3K1</i>
Cellular Effects of Sildenafil (Viagra)	<i>MYLK</i>
4-1BB Signaling in T Lymphocytes	<i>NFKBIA</i>
Hypoxia Signaling in the Cardiovascular System	<i>NFKBIA</i>
ATM Signaling	<i>NFKBIA</i>
PTEN Signaling	<i>NGFR</i>
nNOS Signaling in Skeletal Muscle Cells	<i>NOS1</i>
nNOS Signaling in Neurons	<i>NOS1</i>
Dopamine-DARPP32 Feedback in cAMP Signaling	<i>NOS1</i>
Estrogen Receptor Signaling	<i>NR3C1</i>
Calcium-induced T Lymphocyte Apoptosis	<i>ORAI1</i>
BER pathway	<i>PARP1</i>
DNA Double-Strand Break Repair by Non-Homologous End Joining	<i>PARP1</i>
Role of Oct4 in Mammalian Embryonic Stem Cell Pluripotency	<i>PARP1</i>
UDP-N-acetyl-D-glucosamine Biosynthesis II	<i>PGM3</i>
GDP-glucose Biosynthesis	<i>PGM3</i>

Glucose and Glucose-1-phosphate Degradation	<i>PGM3</i>
UDP-N-acetyl-D-galactosamine Biosynthesis II	<i>PGM3</i>
Glycogen Degradation II	<i>PGM3</i>
Glycogen Degradation III	<i>PGM3</i>
Prostanoid Biosynthesis	<i>PTGS2</i>
Fatty Acid α -oxidation	<i>PTGS2</i>
Cancer Drug Resistance By Drug Efflux	<i>PTGS2</i>
GABA Receptor Signaling	<i>SLC6A12</i>
Sphingomyelin Metabolism	<i>SMPD1</i>
UVC-Induced MAPK Signaling	<i>SMPD1</i>
Mitotic Roles of Polo-Like Kinase	<i>TGFB1</i>
Cell Cycle: G1/S Checkpoint Regulation	<i>TGFB1</i>
Cyclins and Cell Cycle Regulation	<i>TGFB1</i>
Factors Promoting Cardiogenesis in Vertebrates	<i>TGFB1</i>
Wnt/ β -catenin Signaling	<i>TGFB1</i>
Role of p14/p19ARF in Tumor Suppression	<i>TLR9</i>
Docosahexaenoic Acid (DHA) Signaling	<i>TLR9</i>
Apelin Pancreas Signaling Pathway	<i>TLR9</i>
Melanoma Signaling	<i>TLR9</i>
UVB-Induced MAPK Signaling	<i>TLR9</i>
Endometrial Cancer Signaling	<i>TLR9</i>
ErbB4 Signaling	<i>TLR9</i>
GDNF Family Ligand-Receptor Interactions	<i>TLR9</i>
Non-Small Cell Lung Cancer Signaling	<i>TLR9</i>
Estrogen-Dependent Breast Cancer Signaling	<i>TLR9</i>
Reelin Signaling in Neurons	<i>TLR9</i>
HER-2 Signaling in Breast Cancer	<i>TLR9</i>
TR/RXR Activation	<i>TLR9</i>
Melanocyte Development and Pigmentation Signaling	<i>TLR9</i>
ErbB Signaling	<i>TLR9</i>
FAK Signaling	<i>TLR9</i>
VEGF Signaling	<i>TLR9</i>
p53 Signaling	<i>TLR9</i>
Nitric Oxide Signaling in the Cardiovascular System	<i>TLR9</i>
Virus Entry via Endocytic Pathways	<i>TLR9</i>
Paxillin Signaling	<i>TLR9</i>

Glioma Signaling	<i>TLR9</i>
CXCR4 Signaling	<i>TLR9</i>
Aldosterone Signaling in Epithelial Cells	<i>TLR9</i>
CREB Signaling in Neurons	<i>TLR9</i>
mTOR Signaling	<i>TLR9</i>
EIF2 Signaling	<i>TLR9</i>
Hereditary Breast Cancer Signaling	<i>TLR9</i>
Regulation of eIF4 and p70S6K Signaling	<i>TLR9</i>
Breast Cancer Regulation by Stathmin1	<i>TLR9</i>
Glioblastoma Multiforme Signaling	<i>TLR9</i>
P2Y Purigenic Receptor Signaling Pathway	<i>TLR9</i>
Gap Junction Signaling	<i>TLR9</i>
Insulin Receptor Signaling	<i>TLR9</i>
Apelin Liver Signaling Pathway	<i>TNF</i>
IL-15 Production	<i>TYK2</i>
NOTE: By default, pathways were displayed with a $-\log$ (p-value) cutoff of 1.3, meaning that pathways with a p-value equal to or greater than 0.05 are hidden.	

Additional File 2: Table S2c. Ingenuity pathway analysis – top 3 pathways of atopy genes without ‘bin’ genes (n=108)

Pathways	-log (p-value)¹	Ratio²	Molecules
Th1 and Th2 Activation Pathway	2,37E01	1,19E-01	<i>STAT6, IFNG, PTGDR2, IL12RB1, IL1RL1, TYK2, IL6R, IL12RB2, IL31, TBX21, IL13, TLR9, IL18, IL17RB, IL2, TGFB1, LTA, ICOS, IL9, SIPR1, CD86, IL4</i>
T Helper Cell Differentiation	2,18E01	2,19E-01	<i>IL21, IFNG, STAT6, IL12RB1, IL21R, IL6R, IL12RB2, TBX21, IL13, IL18, IL2, TGFB1, NGFR, ICOS, CD86, IL4</i>
Th2 Pathway	2,1E01	1,27E-01	<i>STAT6, IFNG, PTGDR2, IL12RB1, IL1RL1, TYK2, IL12RB2, IL31, TBX21, IL13, TLR9, IL17RB, IL2, TGFB1, ICOS, IL9, SIPR1, CD86, IL4</i>

¹The -log (p-value) was calculated using a Fisher’s exact test to determine the probability that the association between the atopy-related genes and the pathways is explained by a random chance alone. A -log (p-value) equal to or greater than 1.3, corresponding to a p-value of 0.05, was considered statistically significant.

²The ratio is calculated by the atopy-related genes found in each pathway divided by the total number of molecules in that pathway.

Additional File 2: Table S2d. Ingenuity pathway analysis – atopy genes without ‘bin’ genes (n=108)

Pathways	Molecules
Th1 and Th2 Activation Pathway	<i>STAT6, IFNG, PTGDR2, IL12RB1, IL1RL1, TYK2, IL6R, IL12RB2, IL31, TBX21, IL13, TLR9, IL18, IL17RB, IL2, TGFB1, LTA, ICOS, IL9, SIPR1, CD86, IL4</i>
T Helper Cell Differentiation	<i>IL21, IFNG, STAT6, IL12RB1, IL21R, IL6R, IL12RB2, TBX21, IL13, IL18, IL2, TGFB1, NGFR, ICOS, CD86, IL4</i>
Th2 Pathway	<i>STAT6, IFNG, PTGDR2, IL12RB1, IL1RL1, TYK2, IL12RB2, IL31, TBX21, IL13, TLR9, IL17RB, IL2, TGFB1, ICOS, IL9, SIPR1, CD86, IL4</i>
Neuroinflammation Signaling Pathway	<i>IFNG, NLRP3, BDNF, TYK2, IL6R, IRAK3, CCL5, TLR9, CSF1R, TLR2, PLA2G4A, IL18, CCL2, TGFB1, TLR6, CD86, NOS2, MMP9, SLC6A12, IL4</i>
TREM1 Signaling	<i>TLR2, IL18, NOD2, NLRP3, CCL2, IL1RL1, TLR6, NOD1, CD86, FCGR2B, TLR9, CCL7</i>
Role of Pattern Recognition Receptors in Recognition of Bacteria and Viruses	<i>IFNG, NLRP3, CCL5, TLR9, IL13, TLR2, IL18, NOD2, TGFB1, IL2, LTA, TLR6, NOD1, IL4</i>
Th1 Pathway	<i>IFNG, IL18, IL2, IL12RB1, LTA, ICOS, TYK2, IL6R, CD86, IL12RB2, TBX21, TLR9, IL4</i>
Altered T Cell and B Cell Signaling in Rheumatoid Arthritis	<i>TLR2, IL21, IFNG, IL18, IL2, TGFB1, LTA, TLR6, CD86, TLR9, IL4</i>
Atherosclerosis Signaling	<i>IFNG, PLA2G4A, IL18, SELP, CCL2, TGFB1, SERPINA1, CCL11, ALOX5, PLA2G7, MMP9</i>
HMGB1 Signaling	<i>IFNG, IL18, CCL2, IL2, TGFB1, NGFR, LTA, TLR9, IL13, SERPINE1, IL4</i>
Granulocyte Adhesion and Diapedesis	<i>IL18, SELP, CCL2, IL1RL1, NGFR, CCL26, CCL5, MMP12, HRH4, CCL11, MMP9, CCL7</i>
Hepatic Fibrosis / Hepatic Stellate Cell Activation	<i>IFNG, CCL2, IL1RL1, TGFB1, NGFR, IL6R, CD14, COL6A5, CCL5, SERPINE1, MMP9, IL4</i>
IL-12 Signaling and Production in Macrophages	<i>TLR2, IFNG, STAT6, IL18, TGFB1, IL12RB1, IL12RB2, SERPINA1, NOS2, TLR9, IL4</i>
Hepatic Cholestasis	<i>IFNG, IL18, IL1RL1, IL2, TGFB1, NGFR, LTA, CD14, IRAK3, IL13, IL4</i>
LXR/RXR Activation	<i>IL18, CCL2, IL1RL1, NGFR, CD14, SERPINA1, GC, NOS2, MMP9, CCL7</i>
Role of Macrophages, Fibroblasts and Endothelial Cells in Rheumatoid Arthritis	<i>IL1RL1, IL6R, CCL5, IRAK3, TLR9, TLR2, IL18, TRAF3IP2, CCL2, TGFB1, LTA, NGFR, TLR6, NOS2</i>
Th17 Activation Pathway	<i>IL21, IFNG, IL12RB1, IL21R, IL6R, TYK2, IL12RB2, PTGER2, IRAK3</i>
Communication between Innate and Adaptive Immune Cells	<i>TLR2, IFNG, IL18, IL2, TLR6, CD86, CCL5, TLR9, IL4</i>
Eicosanoid Signaling	<i>PLA2G4A, PTGDR, TBXA2R, CYSLTR1, PTGER2, ALOX5, PLA2G7, CYSLTR2</i>
Role of JAK1 and JAK3 in γ c Cytokine Signaling	<i>IL7R, IL21, STAT6, IL2, IL21R, IL9, TLR9, IL4</i>
Role of Cytokines in Mediating Communication between Immune Cells	<i>IL21, IFNG, IL18, IL2, TGFB1, IL13, IL4</i>

Glucocorticoid Receptor Signaling	<i>IFNG, CCL5, CCL11, IL13, TLR9, SCGB1A1, CCL2, TGFB1, IL2, SERPINE1, NOS2, ADRB2, IL4</i>
Colorectal Cancer Metastasis Signaling	<i>TLR2, IFNG, TGFB1, IL6R, TLR6, TYK2, PTGER2, NOS2, MMP12, TLR9, MMP9</i>
Differential Regulation of Cytokine Production in Intestinal Epithelial Cells by IL-17A and IL-17F	<i>IFNG, CCL2, IL9, CCL5, IL13</i>
Toll-like Receptor Signaling	<i>TLR2, IL18, IL1RL1, TLR6, CD14, IRAK3, TLR9</i>
Crosstalk between Dendritic Cells and Natural Killer Cells	<i>IFNG, IL18, IL2, LTA, CD86, TLR9, IL4</i>
Agranulocyte Adhesion and Diapedesis	<i>IL18, SELP, CCL2, CCL26, CCL5, MMP12, CCL11, MMP9, CCL7</i>
Production of Nitric Oxide and Reactive Oxygen Species in Macrophages	<i>TLR2, IFNG, NGFR, CAT, TYK2, SERPINA1, NOS2, TLR9, IL4</i>
MSP-RON Signaling Pathway	<i>TLR2, IFNG, KLK7, CCL2, NOS2, TLR9</i>
Differential Regulation of Cytokine Production in Macrophages and T Helper Cells by IL-17A and IL-17F	<i>CCL2, IL9, CCL5, IL13</i>
Role of Hypercytokinemia/hyperchemokemia in the Pathogenesis of Influenza	<i>IFNG, IL18, CCL2, IL9, CCL5</i>
iNOS Signaling	<i>IFNG, TYK2, CD14, IRAK3, NOS2</i>
Fc Epsilon RI Signaling	<i>BTK, PLA2G4A, FCER1A, MS4A2, IL13, TLR9, IL4</i>
Role of NFAT in Regulation of the Immune Response	<i>BTK, FCER1A, MS4A2, CD86, TLR9, FCGR2B, ORAI1, ITK</i>
LPS/IL-1 Mediated Inhibition of RXR Function	<i>IL18, IL1RL1, NGFR, CAT, CD14, PPARGC1B, GSTO2, GSTP1</i>
Type I Diabetes Mellitus Signaling	<i>IFNG, IL2, NGFR, LTA, CD86, NOS2</i>
Role of Osteoblasts, Osteoclasts and Chondrocytes in Rheumatoid Arthritis	<i>IFNG, IL18, TGFB1, IL1RL1, NGFR, TLR9, CSF1R, IL4</i>
Tec Kinase Signaling	<i>BTK, STAT6, TYK2, FCER1A, MS4A2, TLR9, ITK</i>
IL-10 Signaling	<i>IL18, IL1RL1, TYK2, CD14, FCGR2B</i>
Role of IL-17A in Arthritis	<i>CCL2, CCL5, NOS2, TLR9, CCL7</i>
NF-κB Signaling	<i>TLR2, IL18, NGFR, LTA, TLR6, IRAK3, TLR9</i>
VDR/RXR Activation	<i>IFNG, IL1RL1, IL2, CD14, CCL5</i>
Role of MAPK Signaling in the Pathogenesis of Influenza	<i>IFNG, PLA2G4A, CCL2, CCL5, PLA2G7</i>
CD28 Signaling in T Helper Cells	<i>ARPC1B, IL2, CD86, TLR9, CTLA4, ITK</i>
Dendritic Cell Maturation	<i>TLR2, IL18, NGFR, LTA, CD86, FCGR2B, TLR9</i>
IL-6 Signaling	<i>IL18, IL1RL1, NGFR, IL6R, CD14, TLR9</i>
IL-17 Signaling	<i>TRAF3IP2, CCL2, NOS2, TLR9, CCL11</i>
Graft-versus-Host Disease Signaling	<i>IFNG, IL18, IL2, CD86</i>
Inflammasome pathway	<i>IL18, NOD2, NLRP3</i>
Endocannabinoid Cancer Inhibition Pathway	<i>NOS1, TWIST1, SMPD1, TRPV1, NOS2, TLR9</i>
Airway Inflammation in Asthma	<i>IL13, IL4</i>

STAT3 Pathway	<i>IL17RB, TGFB1, NGFR, TYK2, IL9</i>
Citrulline-Nitric Oxide Cycle	<i>NOS1, NOS2</i>
T Cell Receptor Signaling	<i>BTK, PAG1, TLR9, CTLA4, ITK</i>
p38 MAPK Signaling	<i>PLA2G4A, IL18, IL1RL1, TGFB1, IRAK3</i>
HIF1 α Signaling	<i>NOS1, NOS2, MMP12, TLR9, MMP9</i>
Endothelin-1 Signaling	<i>NOS1, PLA2G4A, PTGER2, NOS2, TLR9, PLA2G7</i>
Phagosome Formation	<i>TLR2, TLR6, FCER1A, FCGR2B, TLR9</i>
CCR3 Signaling in Eosinophils	<i>PLA2G4A, MYLK, CCL26, TLR9, CCL11</i>
Chemokine Signaling	<i>CCL2, CCL5, CCL11, CCL7</i>
IL-17A Signaling in Airway Cells	<i>TRAF3IP2, TYK2, CCL11, TLR9</i>
Leukocyte Extravasation Signaling	<i>BTK, CTNNA3, MMP12, TLR9, MMP9, ITK</i>
Osteoarthritis Pathway	<i>TLR2, IL1RL1, TGFB1, NOS2, MMP12, MMP9</i>
IL-17A Signaling in Fibroblasts	<i>TRAF3IP2, CCL2, CCL7</i>
IL-15 Signaling	<i>STAT6, TYK2, TLR9, IL4</i>
Allograft Rejection Signaling	<i>IFNG, IL2, CD86, IL4</i>
Systemic Lupus Erythematosus Signaling	<i>IL18, IL2, IL6R, CD86, FCGR2B, TLR9</i>
IL-4 Signaling	<i>STAT6, TYK2, TLR9, IL4</i>
MIF Regulation of Innate Immunity	<i>PLA2G4A, CD14, NOS2</i>
Ceramide Signaling	<i>NGFR, S1PR1, SMPD1, TLR9</i>
Role of IL-17F in Allergic Inflammatory Airway Diseases	<i>TRAF3IP2, CCL2, CCL7</i>
Hematopoiesis from Multipotent Stem Cells	<i>IL2, IL4</i>
Acute Phase Response Signaling	<i>IL18, NGFR, IL6R, SERPINA1, SERPINE1</i>
Autoimmune Thyroid Disease Signaling	<i>IL2, CD86, IL4</i>
Hematopoiesis from Pluripotent Stem Cells	<i>IL2, IL9, IL4</i>
Primary Immunodeficiency Signaling	<i>IL7R, BTK, ICOS</i>
Apelin Cardiomyocyte Signaling Pathway	<i>TGFB1, CAT, MYLK, TLR9</i>
Superpathway of Citrulline Metabolism	<i>NOS1, NOS2</i>
G-Protein Coupled Receptor Signaling	<i>PTGDR, TBXA2R, S1PR1, PTGER2, TLR9, ADRB2</i>
Regulation of the Epithelial-Mesenchymal Transition Pathway	<i>TGFB1, TYK2, TWIST1, TLR9, MMP9</i>
Pancreatic Adenocarcinoma Signaling	<i>TGFB1, TYK2, TLR9, MMP9</i>
iCOS-iCOSL Signaling in T Helper Cells	<i>IL2, ICOS, TLR9, ITK</i>
SPINK1 Pancreatic Cancer Pathway	<i>KLK7, TGFB1, MMP12</i>
Renin-Angiotensin Signaling	<i>CCL2, CCL5, PTGER2, TLR9</i>
Apelin Cardiac Fibroblast Signaling Pathway	<i>TGFB1, SERPINE1</i>
cAMP-mediated signaling	<i>PTGDR, TBXA2R, S1PR1, PTGER2, ADRB2</i>
Human Embryonic Stem Cell Pluripotency	<i>BDNF, TGFB1, S1PR1, TLR9</i>

Role of JAK1, JAK2 and TYK2 in Interferon Signaling	<i>IFNG, TYK2</i>
Role of JAK family kinases in IL-6-type Cytokine Signaling	<i>IL6R, TYK2</i>
Role of PI3K/AKT Signaling in the Pathogenesis of Influenza	<i>IFNG, CCL5, TLR9</i>
SPINK1 General Cancer Pathway	<i>IL6R, TYK2, TLR9</i>
Antiproliferative Role of TOB in T Cell Signaling	<i>IL2, TGFB1</i>
Neurotrophin/TRK Signaling	<i>BDNF, NGFR, TLR9</i>
FcγRIIB Signaling in B Lymphocytes	<i>BTK, FCGR2B, TLR9</i>
Macropinocytosis Signaling	<i>CD14, TLR9, CSF1R</i>
JAK/Stat Signaling	<i>STAT6, TYK2, TLR9</i>
IL-7 Signaling Pathway	<i>IL7R, IFNG, TLR9</i>
Glutathione-mediated Detoxification	<i>GSTO2, GSTP1</i>
Synaptic Long Term Depression	<i>NOS1, PLA2G4A, NOS2, PLA2G7</i>
Inhibition of Angiogenesis by TSP1	<i>TGFB1, MMP9</i>
Coagulation System	<i>SERPINA1, SERPINE1</i>
MIF-mediated Glucocorticoid Regulation	<i>PLA2G4A, CD14</i>
CTLA4 Signaling in Cytotoxic T Lymphocytes	<i>CD86, TLR9, CTLA4</i>
B Cell Development	<i>IL7R, CD86</i>
Interferon Signaling	<i>IFNG, TYK2</i>
PPAR Signaling	<i>IL18, IL1RL1, NGFR</i>
B Cell Receptor Signaling	<i>BTK, PAG1, FCGR2B, TLR9</i>
Inhibition of Matrix Metalloproteases	<i>MMP12, MMP9</i>
Xenobiotic Metabolism Signaling	<i>CAT, GSTO2, NOS2, TLR9, GSTP1</i>
Antioxidant Action of Vitamin C	<i>PLA2G4A, GSTO2, PLA2G7</i>
Gαs Signaling	<i>PTGDR, PTGER2, ADRB2</i>
NRF2-mediated Oxidative Stress Response	<i>CAT, GSTO2, TLR9, GSTP1</i>
Adrenomedullin signaling pathway	<i>IL18, LTA, MYLK, TLR9</i>
Amyotrophic Lateral Sclerosis Signaling	<i>NOS1, CAT, TLR9</i>
UVA-Induced MAPK Signaling	<i>SMPD1, TLR9, PARP1</i>
IL-8 Signaling	<i>IL9, IRAK3, TLR9, MMP9</i>
IL-9 Signaling	<i>IL9, TLR9</i>
Neuroprotective Role of THOP1 in Alzheimer's Disease	<i>IFNG, KLK7, MMP9</i>
NGF Signaling	<i>NGFR, SMPD1, TLR9</i>
Sphingosine-1-phosphate Signaling	<i>S1PR1, SMPD1, TLR9</i>
FXR/RXR Activation	<i>IL18, SERPINA1, GC</i>
Actin Cytoskeleton Signaling	<i>ARPC1B, CD14, MYLK, TLR9</i>
GP6 Signaling Pathway	<i>BTK, COL6A5, TLR9</i>
PI3K Signaling in B	<i>BTK, FCGR2B, IL4</i>

Lymphocytes	
p70S6K Signaling	<i>BTK, TLR9, IL4</i>
Corticotropin Releasing Hormone Signaling	<i>NOS1, BDNF, NOS2</i>
Cardiac Hypertrophy Signaling	<i>TGFB1, IL6R, TLR9, ADRB2</i>
Gα12/13 Signaling	<i>BTK, TBXA2R, TLR9</i>
Aryl Hydrocarbon Receptor Signaling	<i>TGFB1, GSTO2, GSTP1</i>
Phospholipase C Signaling	<i>BTK, PLA2G4A, FCGR2B, ITK</i>
Ephrin A Signaling	<i>NGFR, TLR9</i>
Retinoic acid Mediated Apoptosis Signaling	<i>IFNG, PARP1</i>
Phospholipases	<i>PLA2G4A, PLA2G7</i>
Type II Diabetes Mellitus Signaling	<i>NGFR, SMPD1, TLR9</i>
Lymphotoxin β Receptor Signaling	<i>LTA, TLR9</i>
Relaxin Signaling	<i>NOS2, TLR9, MMP9</i>
CNTF Signaling	<i>TYK2, TLR9</i>
IL-2 Signaling	<i>IL2, TLR9</i>
PKCθ Signaling in T Lymphocytes	<i>IL2, CD86, TLR9</i>
Tight Junction Signaling	<i>TGFB1, NGFR, MYLK</i>
Cdc42 Signaling	<i>ARPC1B, MYLK, ITK</i>
ErbB2-ErbB3 Signaling	<i>TYK2, TLR9</i>
Glioma Invasiveness Signaling	<i>TLR9, MMP9</i>
CD40 Signaling	<i>LTA, TLR9</i>
Apelin Adipocyte Signaling Pathway	<i>CAT, GSTP1</i>
Antiproliferative Role of Somatostatin Receptor 2	<i>NOS1, TLR9</i>
Small Cell Lung Cancer Signaling	<i>NOS1, TLR9</i>
Regulation of IL-2 Expression in Activated and Anergic T Lymphocytes	<i>IL2, TGFB1</i>
Renal Cell Carcinoma Signaling	<i>TGFB1, TLR9</i>
IL-3 Signaling	<i>STAT6, TLR9</i>
Regulation of Actin-based Motility by Rho	<i>ARPC1B, MYLK</i>
ILK Signaling	<i>NOS2, TLR9, MMP9</i>
Axonal Guidance Signaling	<i>ARPC1B, BDNF, NGFR, TLR9, MMP9</i>
LPS-stimulated MAPK Signaling	<i>CD14, TLR9</i>
FLT3 Signaling in Hematopoietic Progenitor Cells	<i>STAT6, TLR9</i>
PEDF Signaling	<i>BDNF, TLR9</i>
TGF-β Signaling	<i>TGFB1, SERPINE1</i>
3-phosphoinositide Biosynthesis	<i>ICOS, CD86, TLR9</i>
Bladder Cancer Signaling	<i>MMP12, MMP9</i>
VEGF Family Ligand-Receptor Interactions	<i>PLA2G4A, TLR9</i>
PDGF Signaling	<i>TYK2, TLR9</i>

Clathrin-mediated Endocytosis Signaling	<i>ARPC1B, SERPINA1, TLR9</i>
Acute Myeloid Leukemia Signaling	<i>TLR9, CSF1R</i>
AMPK Signaling	<i>CFTR, TLR9, ADRB2</i>
Prostate Cancer Signaling	<i>TLR9, GSTP1</i>
Integrin Signaling	<i>ARPC1B, MYLK, TLR9</i>
CDK5 Signaling	<i>BDNF, NGFR</i>
PAK Signaling	<i>MYLK, TLR9</i>
Chronic Myeloid Leukemia Signaling	<i>TGFB1, TLR9</i>
Mouse Embryonic Stem Cell Pluripotency	<i>TYK2, TLR9</i>
Neuropathic Pain Signaling In Dorsal Horn Neurons	<i>BDNF, TLR9</i>
Superpathway of Inositol Phosphate Compounds	<i>ICOS, CD86, TLR9</i>
Telomerase Signaling	<i>IL2, TLR9</i>
Rac Signaling	<i>ARPC1B, TLR9</i>
Gai Signaling	<i>TBXA2R, SIPR1</i>
RhoA Signaling	<i>ARPC1B, MYLK</i>
Apelin Endothelial Signaling Pathway	<i>CCL2, TLR9</i>
Signaling by Rho Family GTPases	<i>ARPC1B, MYLK, TLR9</i>
Sperm Motility	<i>PLA2G4A, PLA2G7</i>
Role of NANOG in Mammalian Embryonic Stem Cell Pluripotency	<i>TYK2, TLR9</i>
fMLP Signaling in Neutrophils	<i>ARPC1B, TLR9</i>
Iron homeostasis signaling pathway	<i>IL6R, TYK2</i>
Ovarian Cancer Signaling	<i>TLR9, MMP9</i>
Gaq Signaling	<i>BTK, TLR9</i>
Germ Cell-Sertoli Cell Junction Signaling	<i>TGFB1, TLR9</i>
Sertoli Cell-Sertoli Cell Junction Signaling	<i>NOS1, NOS2</i>
PPAR α /RXR α Activation	<i>IL1RL1, TGFB1</i>
RAR Activation	<i>TGFB1, PARP1</i>
ERK/MAPK Signaling	<i>PLA2G4A, TLR9</i>
Thrombin Signaling	<i>MYLK, TLR9</i>
Role of NFAT in Cardiac Hypertrophy	<i>TGFB1, TLR9</i>
Molecular Mechanisms of Cancer	<i>TGFB1, TYK2, TLR9</i>
Protein Kinase A Signaling	<i>TGFB1, NGFR, MYLK</i>
Huntington's Disease Signaling	<i>BDNF, TLR9</i>
Sirtuin Signaling Pathway	<i>NOS2, PARP1</i>
Circadian Rhythm Signaling	<i>ADCYAP1R1</i>
GPCR-Mediated Integration of Enteroendocrine Signaling Exemplified by an L Cell	<i>ADRB2</i>

Leukotriene Biosynthesis	<i>ALOX5</i>
Actin Nucleation by ARP-WASP Complex	<i>ARPC1B</i>
Remodeling of Epithelial Adherens Junctions	<i>ARPC1B</i>
Fcγ Receptor-mediated Phagocytosis in Macrophages and Monocytes	<i>ARPC1B</i>
Epithelial Adherens Junction Signaling	<i>ARPC1B</i>
RhoGDI Signaling	<i>ARPC1B</i>
Ephrin Receptor Signaling	<i>ARPC1B</i>
Thyroid Cancer Signaling	<i>BDNF</i>
G Beta Gamma Signaling	<i>BTK</i>
Superoxide Radicals Degradation	<i>CAT</i>
Ethanol Degradation IV	<i>CAT</i>
Mitochondrial Dysfunction	<i>CAT</i>
Pathogenesis of Multiple Sclerosis	<i>CCL5</i>
IL-17A Signaling in Gastric Cells	<i>CCL5</i>
CCR5 Signaling in Macrophages	<i>CCL5</i>
Nur77 Signaling in T Lymphocytes	<i>CD86</i>
Catecholamine Biosynthesis	<i>DBH</i>
HIPPO signaling	<i>FRMD6</i>
Ascorbate Recycling (Cytosolic)	<i>GSTO2</i>
Vitamin-C Transport	<i>GSTO2</i>
Glutathione Redox Reactions I	<i>GSTP1</i>
Histamine Degradation	<i>HNMT</i>
Role of Lipids/Lipid Rafts in the Pathogenesis of Influenza	<i>IFNG</i>
Antigen Presentation Pathway	<i>IFNG</i>
Role of PKR in Interferon Induction and Antiviral Response	<i>IFNG</i>
Role of Wnt/GSK-3β Signaling in the Pathogenesis of Influenza	<i>IFNG</i>
Role of BRCA1 in DNA Damage Response	<i>IFNG</i>
Protein Ubiquitination Pathway	<i>IFNG</i>
Cholecystokinin/Gastrin-mediated Signaling	<i>IL18</i>
OX40 Signaling Pathway	<i>IL2</i>
3-phosphoinositide Degradation	<i>INPP4A</i>
IL-1 Signaling	<i>IRAK3</i>
Intrinsic Prothrombin Activation Pathway	<i>KLK7</i>
TNFR2 Signaling	<i>LTA</i>
Activation of IRF by Cytosolic Pattern Recognition Receptors	<i>LTA</i>
Airway Pathology in Chronic Obstructive Pulmonary Disease	<i>MMP9</i>
Cellular Effects of Sildenafil	<i>MYLK</i>

(Viagra)	
Induction of Apoptosis by HIV1	<i>NGFR</i>
PTEN Signaling	<i>NGFR</i>
nNOS Signaling in Skeletal Muscle Cells	<i>NOS1</i>
nNOS Signaling in Neurons	<i>NOS1</i>
Phagosome Maturation	<i>NOS1</i>
Dopamine-DARPP32 Feedback in cAMP Signaling	<i>NOS1</i>
Opioid Signaling Pathway	<i>NOS1</i>
Calcium-induced T Lymphocyte Apoptosis	<i>ORAI1</i>
BER pathway	<i>PARP1</i>
DNA Double-Strand Break Repair by Non-Homologous End Joining	<i>PARP1</i>
Granzyme B Signaling	<i>PARP1</i>
Role of Oct4 in Mammalian Embryonic Stem Cell Pluripotency	<i>PARP1</i>
Death Receptor Signaling	<i>PARP1</i>
Apoptosis Signaling	<i>PARP1</i>
UDP-N-acetyl-D-glucosamine Biosynthesis II	<i>PGM3</i>
GDP-glucose Biosynthesis	<i>PGM3</i>
Glucose and Glucose-1-phosphate Degradation	<i>PGM3</i>
UDP-N-acetyl-D-galactosamine Biosynthesis II	<i>PGM3</i>
Glycogen Degradation II	<i>PGM3</i>
Glycogen Degradation III	<i>PGM3</i>
GABA Receptor Signaling	<i>SLC6A12</i>
Sphingomyelin Metabolism	<i>SMPD1</i>
UVC-Induced MAPK Signaling	<i>SMPD1</i>
Mitotic Roles of Polo-Like Kinase	<i>TGFB1</i>
Cell Cycle: G1/S Checkpoint Regulation	<i>TGFB1</i>
Cyclins and Cell Cycle Regulation	<i>TGFB1</i>
Factors Promoting Cardiogenesis in Vertebrates	<i>TGFB1</i>
Adipogenesis pathway	<i>TGFB1</i>
Wnt/ β -catenin Signaling	<i>TGFB1</i>
Role of p14/p19ARF in Tumor Suppression	<i>TLR9</i>
Docosahexaenoic Acid (DHA) Signaling	<i>TLR9</i>
Apelin Pancreas Signaling Pathway	<i>TLR9</i>
Melanoma Signaling	<i>TLR9</i>
UVB-Induced MAPK Signaling	<i>TLR9</i>

EGF Signaling	<i>TLR9</i>
Endometrial Cancer Signaling	<i>TLR9</i>
Thrombopoietin Signaling	<i>TLR9</i>
Myc Mediated Apoptosis Signaling	<i>TLR9</i>
ErbB4 Signaling	<i>TLR9</i>
GM-CSF Signaling	<i>TLR9</i>
GDNF Family Ligand-Receptor Interactions	<i>TLR9</i>
Non-Small Cell Lung Cancer Signaling	<i>TLR9</i>
Angiopoietin Signaling	<i>TLR9</i>
Growth Hormone Signaling	<i>TLR9</i>
Estrogen-Dependent Breast Cancer Signaling	<i>TLR9</i>
Leptin Signaling in Obesity	<i>TLR9</i>
Erythropoietin Signaling	<i>TLR9</i>
Prolactin Signaling	<i>TLR9</i>
FGF Signaling	<i>TLR9</i>
Reelin Signaling in Neurons	<i>TLR9</i>
NF- κ B Activation by Viruses	<i>TLR9</i>
HER-2 Signaling in Breast Cancer	<i>TLR9</i>
TR/RXR Activation	<i>TLR9</i>
RANK Signaling in Osteoclasts	<i>TLR9</i>
Melanocyte Development and Pigmentation Signaling	<i>TLR9</i>
ErbB Signaling	<i>TLR9</i>
FAK Signaling	<i>TLR9</i>
VEGF Signaling	<i>TLR9</i>
SAPK/JNK Signaling	<i>TLR9</i>
p53 Signaling	<i>TLR9</i>
IGF-1 Signaling	<i>TLR9</i>
Nitric Oxide Signaling in the Cardiovascular System	<i>TLR9</i>
Virus Entry via Endocytic Pathways	<i>TLR9</i>
HGF Signaling	<i>TLR9</i>
Paxillin Signaling	<i>TLR9</i>
Glioma Signaling	<i>TLR9</i>
Endocannabinoid Developing Neuron Pathway	<i>TLR9</i>
Natural Killer Cell Signaling	<i>TLR9</i>
Role of Tissue Factor in Cancer	<i>TLR9</i>
14-3-3-mediated Signaling	<i>TLR9</i>
P2Y Purigenic Receptor Signaling Pathway	<i>TLR9</i>
Insulin Receptor Signaling	<i>TLR9</i>
Hereditary Breast Cancer Signaling	<i>TLR9</i>
Regulation of eIF4 and p70S6K Signaling	<i>TLR9</i>

Aldosterone Signaling in Epithelial Cells	<i>TLR9</i>
Glioblastoma Multiforme Signaling	<i>TLR9</i>
CXCR4 Signaling	<i>TLR9</i>
eNOS Signaling	<i>TLR9</i>
Gap Junction Signaling	<i>TLR9</i>
CREB Signaling in Neurons	<i>TLR9</i>
mTOR Signaling	<i>TLR9</i>
EIF2 Signaling	<i>TLR9</i>
Breast Cancer Regulation by Stathmin1	<i>TLR9</i>
IL-22 Signaling	<i>TYK2</i>
IL-15 Production	<i>TYK2</i>
Role of JAK2 in Hormone-like Cytokine Signaling	<i>TYK2</i>
Oncostatin M Signaling	<i>TYK2</i>
PI3K/AKT Signaling	<i>TYK2</i>
NOTE: By default, pathways were displayed with a $-\log$ (p-value) cutoff of 1.3, meaning that pathways with a p-value equal to or greater than 0.05 are hidden.	