

IBS Gene Matching Report

Number of genes found in open PMC research papers: 211

Number of medium and high risk genes found in a small group of IMBS patients: 1251

Number of overlapping genes between IBS reports and IMBS results: 10

Overlapping Genes:

GUCY2C

TRPV3

SCN5A

AQP8

IDO1

PGP

GAD2

FAAH

NPSR1

FUT2

Overlapping IBS genes with IMBS patient results

Gene: GUCY2C

GUC2C_HUMAN Heat-stable enterotoxin receptor

UnitprotID: P25092

Unitprot link: <https://www.uniprot.org/uniprot/P25092>

Number of IMBS patients with matches: 4

Reports:

Blunted Evoked Prouroguanylin Endocrine Secretion in Chronic Constipation

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6708669/?report=reader>

...This study suggests that CIC and IBS C can be treated by oral GUCY2C hormone replacement. Indeed ...

...these observations provide a mechanistic framework for the clinical utility of oral GUCY2C ligands like...

...a 16 amino acid peptide that activates GUCY2C with maximum...

...vates GUCY2C in neutral to slightly basic pH environments and is...

...emerging paradigm in which a novel GUCY2C endocrine gut ...

...intriguing possibility that the GUCY2C paracrine signaling axis may...

...hormone 20 23 to assess intestinal GUCY2C hormone production...

...A role for GUCY2C in disorders of intestinal secretion has...

...congenital sodium diarrhea in which GUCY2C is constitutively...

...tions of GUCY2C associated with decreased cGMP production...

...arate autosomal recessive GUCY2C loss of function mutations...

...It is noteworthy that silencing the GUCY2C axis by suppres...

...sion of the hormone but preservation of the GUCY2C receptor ...

...testine which in turn suppresses GUCY2C hormone expression...

...tion silencing hypothalamic GUCY2C regulating appetite and sa...

...hormone loss but preservation of GUCY2C receptor expression as...

...a role for hormone insufficiency silencing GUCY2C as a novel...

...of GUCY2C pro and mature hormones in humans. Limited...

...activation of intestinal GUCY2C and epithelial cell cGMP...

...using oral GUCY2C ligands like plecanatide and linaclotide...

...3 The GUCY2C receptor regulates intestinal secretion....

...peptide and binds to GUCY2C to stimulate secretion....

...syndromes reflect GUCY2C hormone insufficiency....

...3 CIC and IBS C can be treated by oral GUCY2C ligand...

...32. Lin JE Li P Snook AE et al. The hormone receptor GUCY2C suppresses...

...33. Lin JE Snook AE Li P et al. GUCY2C opposes systemic genotoxic...

...family secondary to mutations in the GUCY2C gene. Eur J Hum Genet...

Clinical utility of plecanatide in the treatment of chronic idiopathic constipation

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6089121/?report=reader>

...drome caused by an activating GUCY2C mutation. N Engl J Med. ...

...60. Lin JE Snook AE Li P et al. GUCY2C opposes systemic genotoxic ...

Gene: TRPV3

TRPV3_HUMAN Transient receptor potential cation channel subfamily V member 3

UnitprotID: Q8NET8

Unitprot link: <https://www.uniprot.org/uniprot/Q8NET8>

Number of IMBS patients with matches: 4

Reports:

TRPM8 polymorphisms associated with increased risk of IBS C and IBS M

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5561393/?report=reader>

...channels TRPV3 and TRPM8 see online...

Gene: SCN5A

SCN5A_HUMAN Sodium channel protein type 5 subunit alpha

UnitprotID: Q14524

Unitprot link: <https://www.uniprot.org/uniprot/Q14524>

Number of IMBS patients with matches: 3

Reports:

Are probiotics useful in the treatment of chronic idiopathic constipation in adults? A review of existing systematic reviews meta analyses and recommendations

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7294971/?report=reader>

...nel NaV1.5 namely SCN5A 34 . Limited data show that ...

Ethnic differences in genetic polymorphism associated with irritable bowel syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7267697/?report=reader>

...diseases and its polymorphism of SCN5A is strongly associated with cardiac...

...function mutation of SCN5A exhibited a higher risk for IBS. Further genome wide...

...by Beyder et al 62 proved that the SCN5A locus was significantly associated with IBS....

...It also provided evidence that loss of function mutation of SCN5A disrupted NaV1.5...

...racial groups also revealed a significant link between SCN5A variants and IBS even...

...in mixed racial groups 63 . Moreover the frequency of SCN5A mutations in those...

...1Irritable bowel syndrome related SCN5A missense mutations including R225W R433C R986Q G1037V S1700G and F1293S. IBS: Irritable bowel...

...Farrugia G. SCN5A is expressed in human jejunal circular smooth muscle cells. Neurogastroenterol Motil...

microRNA overexpression in slow transit constipation leads to reduced NaV1.5 current and altered smooth muscle contractility

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7147984/?report=reader>

...1.5. The expression of SCN5A mrna was ...

...1.5 encoded by the SCN5A gene is tradition ...

...and SCN5A is the only non structural gene implicated in dilated ...

...patients with IBS are more likely to have SCN5A channelopathies ...

...with a greater percentage of patients with SCN5A channelopathies ...

...Map of SCN5A mRNA 3' UTR with binding sites for miRNAs obtained ...

...qPCR array screening. D SCN5A mRNA expression is reduced in STC ...

...mirNA modulation of SCN5A expression...

...fected by Lipofectamine 3000 Invitrogen with SCN5A full ...

...fected without the SCN5A 3' UTR reporter vector and X was ...

...Multiple miRNAs predicted to target SCN5A are ...

...These results prompted us to examine if SCN5A expression ...

...controls. We found a robust decrease of SCN5A mRNA expres ...

...to target the 3' UTR of SCN5A and was not differentially ...

...Let 7f overexpression in HusMCs significantly reduced SCN5A ...

...We first used a luciferase reporter driven by SCN5A 3' UTR to ...

...determine if let 7f suppresses SCN5A expression. We found ...

...of HEK 293 cells transfected with SCN5A 3' UTR vector alone control ...

...Since let 7f targets SCN5A and was enriched in STC we next ...

...smooth muscle expresses SCN5A and has functional Na...

...the predicted target site for let 7f is conserved in the rat SCN5A ...

...to a decrease in SCN5A expression Na...

...tion to let 7f we found three miRNAs that target SCN5A mRNA ...

...participates in myocyte cellular structure.57 Interestingly SCN5A ...

...characterised by impaired cardiac contractility but also SCN5A is ...

...one of only few ion channel genes involved.19 58 SCN5A channelop ...

Irritable bowel syndrome patients have SCN5A channelopathies that lead to decreased NaV1.5 current and mechanosensitivity

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5966747/?report=reader>

...Irritable bowel syndrome patients have SCN5A channelopathies that lead to decreased NaV1.5 current and mechanosensitivity...

Gene: AQP8

AQP8_HUMAN Aquaporin-8

UnitprotID: O94778

Unitprot link: <https://www.uniprot.org/uniprot/O94778>

Number of IMBS patients with matches: 2

Reports:

Aquaporin Expression in Colonic Mucosal Biopsies From Irritable Bowel Syndrome With Diarrhea

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6602785/?report=reader>

...interstitium by a transcellular route 12 . AQP8 channels are...

...O glycosylated 2 and AQP8 is N glycosylated 18 . AQP8...

...increased expression of AQP8 P 5 0.048 nonsignificant in ...

...Our study shows increased AQP8 mRNA and protein...

...duce absorption of water conversely increased AQP8 may...

... 23 who observed reduced AQP8 mRNA expression in the as ...

...IBS D have also been associated with decreased AQP8 24 ...

...ences in AQP8 molecules reflected in their molecular weight in...

...Figure 2Western blots showing increased AQP8 and borderline increased AQP7 and decreased AQP3 expressions in rectosigmoid mucosal biopsies in...

Gene: IDO1

I23O1_HUMAN Indoleamine 2,3-dioxygenase 1

UnitprotID: P14902

Unitprot link: <https://www.uniprot.org/uniprot/P14902>

Number of IMBS patients with matches: 2

Reports:

Characterization of kynurenine pathway in patients with diarrhea predominant irritable bowel syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7388639/?report=reader>
...along with the KYN pathway. IDO1 can also further produce the...
...more IDO.3 IDO has two isoforms including IDO1 and IDO2...
...expression.4 Therefore the expression of IDO1 was significantly...
...tory bowel disease.5 Up regulation of IDO1 induces metabolic...
...activation. The preclinical models confirm that IDO1 activation...
...leading to depressive symptoms.8 Moreover the IDO1 activation...
...can predict the severity of depression although IDO1 activation is...
...certain degree of overlap of IDO1 activity between brain and...

Gene: PGP

PGP_HUMAN Glycerol-3-phosphate phosphatase

UnitprotID: A6NDG6

Unitprot link: <https://www.uniprot.org/uniprot/A6NDG6>

Number of IMBS patients with matches: 2

Reports:

Increased expression of brain derived neurotrophic factor is correlated with visceral hypersensitivity in patients with diarrhea predominant irritable bowel syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6337018/?report=reader>
...photomicrographs of the immunoreactivity of BDNF and PGP 9.5 in the mucosa of...
...0.031 Figure 2G . PGP 9.5 immunoreactive area per square millimeter of mucosa in...
...density of BDNF in the colonic mucosa in IBS D patients was significantly higher than that in controls P 0.031 H: The area occupied by PGP 9.5 immunoreactive...
...mucosa. Mucosal nerve fiber density as shown by PGP 9.5 was significantly higher in...

Gene: GAD2

DCE2_HUMAN Glutamate decarboxylase 2

UnitprotID: Q05329

Unitprot link: <https://www.uniprot.org/uniprot/Q05329>

Number of IMBS patients with matches: 2

Reports:

Dysregulation of GABAergic Signalling Contributes in the Pathogenesis of Diarrhea predominant Irritable Bowel Syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6034664/?report=reader>
...sion of GAD2 and GABA T was significantly reduced in IBS D ...
...Significant reduction in the expression of GAD2 was observed in ...

Gene: FAAH

FAAH1_HUMAN Fatty-acid amide hydrolase 1

UnitprotID: O00519

Unitprot link: <https://www.uniprot.org/uniprot/O00519>

Number of IMBS patients with matches: 1

Reports:

Ethnic differences in genetic polymorphism associated with irritable bowel syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7267697/?report=reader>
...Anandamide another essential part of the ECS is inactivated by FAAH in vivo...
...the CA/AA genotype of the 385C/A polymorphism in the FAAH gene were at a...

Gene: NPSR1

NPSR1_HUMAN Neuropeptide S receptor

UnitprotID: Q6W5P4

Unitprot link: <https://www.uniprot.org/uniprot/Q6W5P4>

Number of IMBS patients with matches: 1

Reports:

Ethnic differences in genetic polymorphism associated with irritable bowel syndrome

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7267697/?report=reader>

Gene: FUT2

FUT2_HUMAN Galactoside alpha-(1,2)-fucosyltransferase 2

UnitprotID: Q10981

Unitprot link: <https://www.uniprot.org/uniprot/Q10981>

Number of IMBS patients with matches: 1

Reports:

Microbial signatures in post infectious irritable bowel syndrome toward patient stratification for improved diagnostics and treatment

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4826089/?report=reader>

...that FUT2 deficient mice Fut2 / have...

Genes found in public PMC research papers

TRPV1	BDNF	SLC6A4	BID
AR	AQP3	OTC	CRH
CCK	BMF	GNB3	SCN5A
TLR4	FAP	GC	GUCY2C
TNFSF15	TPH1	NMS	PYY
ADRA2A	TNF	TLR2	S100A10
NGF	GDNF	NPY	C3
AQP7	MOS	FH	CHM
EGF	CCS	PRSS3	FAS
TLR5	S100A8	ACAD8	TRPM8
PC	GIP	S100A9	MB
AQP8	TLR7	TG	MF1
IDO1	CRP	CNR1	CLDN1
BAD	TSPO	TLR3	NOD2
MUC2	LBP	HP	C2
TLR8	OCLN	HTR3A	HRG
HIRA	GAPDH	GABRP	FOS
F2	DCC	CTRL	CS
TLR9	TH	TDRD6	SACS
PRSS2	PGP	NES	MCC
IMPACT	GCA	EPX	EGFR
CD4	ADAM17	ADAM10	TPH2
TCIM	PRSS1	NLRP3	LTBP1
HTR3E	EF3	CHRM3	CDA
CD80	CD68	APC	VCL
TRPV4	TLR6	SSX2IP	PTH
PPL	NXPH1	NAMPT	MET
KDELR2	IPP	HMGB1	HLA-DQB1
HLA-DQA1	GRID2IP	GCG	GAD2
FAAH	F3	EMD	DST
CPA3	CDC42	CD86	CD14
BMP7	ASIC3	ASIC1	ANO1
ZNF326	VDR	TRPV3	TPSB2
TIMP3	TFF3	TF	TAT
STAT3	SST	SMAD7	SMAD3
SKP1	SHBG	SERPING1	SERPINA1
RLF	RIDA	REST	PIEZO2
PIEZO1	PF4	PDZD3	PDIA3
PARD3	PALM	NTRK1	NSF
NPSR1	NLRP6	NF1	MSR1
MR1	MCM6	MAL	KY
KDM3A	IGLV5-48	IDO2	HTR3D
HRH1	HES1	HBZ	GUCA2B
GREM1	GHR	FUT2	F7
F12	EZR	ERG	EPO
DYM	DLD	DES	CYLD
CXCL11	CTSA	CPE	CPD
CPB1	CLEC7A	CLCN2	CGA
CDH1	CD69	CD63	CCR5
CCL2	CCL16	CAT	CACNA1A
C9	C7	ASIC4	ASIC2
AQP4	APP	AMY2B	AMY2A
AMH	ACR	ACD	

Genes of a small IMBS patient cohort

High and medium risk genes

ABCA4(1)	ABCA8(1)	ABCC11(1)	ACACB(1)
ACER1(1)	ACKR1(1)	ACKR2(1)	ACOT2(1)
ACOX3(1)	ACSM6(1)	ACVRC1(1)	ACYP1(1)
ADCY10(1)	ADGRA1(1)	ADGRA3(1)	ADGRB3(1)
ADGRE1(1)	ADGRE2(1)	ADGRE3(1)	ADGRF2(1)
ADGRF3(1)	ADGRF4(1)	ADGRF5(1)	ADGRG4(1)
ADGRG6(1)	ADH1C(1)	ADRB2(1)	AGMAT(1)
AK9(1)	AKR1E2(1)	ALDH1A2(1)	ANKK1(1)
APRT(1)	AQP1(1)	ARSA(1)	ARSB(1)
ART3(1)	ART4(1)	ASPG(1)	ATP11B(1)
ATP7B(1)	AWAT2(1)	BAAT(1)	BAI3(1)
BCO1(1)	BHMT2(1)	BMPR1A(1)	BPI(1)
BRIP1(1)	BTK(1)	BUB1B(1)	CBR1(1)
CDC42BPG(1)	CDKL1(1)	CDKL5(1)	CDYL(1)
CES5A(1)	CHD3(1)	CIT(1)	CLIC2(1)
COMT(1)	COQ5(1)	CPT2(1)	CSGALNACT2(1)
CXCR6(1)	CYB5R3(1)	CYBRD1(1)	CYP11B1(1)
CYP19A1(1)	CYP21A2(1)	CYP27B1(1)	DARC(1)
DARS2(1)	DDX11(1)	DDX4(1)	DDX43(1)
DDX51(1)	DGKK(1)	DHDH(1)	DHX29(1)
DHX58(1)	DOT1L(1)	DRD4(1)	DSE(1)
DUOX1(1)	DUSP11(1)	DUSP15(1)	DUSP21(1)
ENOSF1(1)	ENPP7(1)	ENTPD2(1)	EPHA3(1)
EPHA8(1)	ERBB3(1)	ERCC6L(1)	EXTL1(1)
EYA4(1)	F13A1(1)	F2RL3(1)	FAAH(1)
FADS2(1)	FDPS(1)	FES(1)	FGFR2(1)
FGFR4(1)	FLT4(1)	FTCD(1)	FUT2(1)
FZD6(1)	GAD1(1)	GALNT14(1)	GATM(1)
GBA(1)	GCAT(1)	GFER(1)	GGT6(1)
GJA4(1)	GLO1(1)	GLP2R(1)	GMPR(1)
GNAT3(1)	GPD2(1)	GPR101(1)	GPR110(1)
GPR123(1)	GPR128(1)	GPR39(1)	GPR56(1)
GPR64(1)	GPR88(1)	GPT(1)	GRM1(1)
GRM7(1)	GSTM1(1)	GSTM3(1)	GSTO2(1)
GSTZ1(1)	GUCY2D(1)	H6PD(1)	HACD1(1)
HACD4(1)	HIBCH(1)	HK2(1)	HRH3(1)
HTR2C(1)	HUNK(1)	INPP5J(1)	INPPL1(1)
ISPD(1)	KARS(1)	KCNJ13(1)	KMT2C(1)
KMT5B(1)	L3HYPDH(1)	LETM1(1)	LHCGR(1)
LIPG(1)	LMTK2(1)	LMTK3(1)	LPCAT3(1)
MAN2A2(1)	MAN2B1(1)	MAP2K5(1)	MAP3K5(1)
MAPK10(1)	MCEE(1)	METTL1(1)	MGAT4B(1)
MICAL1(1)	MINK1(1)	MOGAT2(1)	MOGS(1)
MOK(1)	MOV10L(1)	MRGPRE(1)	MRGPRF(1)
MTAP(1)	MTHFD1L(1)	MTHFS(1)	MTNR1B(1)
MTRR(1)	MVD(1)	MYLK3(1)	MYO3A(1)
NAT8B(1)	NDUFS8(1)	NEK9(1)	NEU4(1)
NOX5(1)	NPSR1(1)	NQO1(1)	OAS3(1)
OCA2(1)	OGDH(1)	OPA1(1)	OPLAH(1)
OPN1LW(1)	OPN1MW(1)	OPRK1(1)	OSGEP(1)
OXCT2(1)	P2RY11(1)	PADI1(1)	PADI3(1)
PADI4(1)	PANK4(1)	PAPSS1(1)	PARP14(1)
PCMT1(1)	PEAK1(1)	PEMT(1)	PFKFB2(1)
PHYH(1)	PIK3C2A(1)	PIK3C2G(1)	PIM3(1)
PIP4K2B(1)	PLA2G2C(1)	PLA2G2E(1)	PLA2G4B(1)
PLA2G4D(1)	PLCB4(1)	PLCG1(1)	PLCH2(1)
PLD2(1)	PLD4(1)	PLOD1(1)	PNKP(1)
PNLIPRP2(1)	PNP(1)	PNPLA6(1)	PNPT1(1)
PPA2(1)	PPIAL4E(1)	PPIG(1)	PRDM6(1)
PRDM9(1)	PRKACG(1)	PRKCB(1)	PRMT7(1)
PTPN21(1)	PTPN3(1)	PTPRT(1)	PTRH1(1)
PUDP(1)	PYGB(1)	QRSL1(1)	RFNG(1)
RHBG(1)	RHCE(1)	RIOK2(1)	RNLS(1)
ROS1(1)	RPS6KL1(1)	RRM2(1)	RUVBL2(1)
RYR1(1)	S1PR5(1)	SCLY(1)	SCNN1B(1)
SDC4(1)	SDHA(1)	SDS(1)	SETD2(1)
SGSH(1)	SIAE(1)	SLC11A1(1)	SLC25A13(1)
SLC25A15(1)	SLC25A22(1)	SLC27A5(1)	SLC29A1(1)
SLC35C1(1)	SLC4A2(1)	SMPD1(1)	SMPD3(1)
SOAT2(1)	SOD2(1)	SPEG(1)	SPTLC2(1)
SRMS(1)	ST3GAL4(1)	STK31(1)	STK35(1)
STK36(1)	STYK1(1)	TAAR2(1)	TARSL2(1)

TAS2R19(1)	TAS2R4(1)	TAS2R5(1)	TBK1(1)
TDRD12(1)	TKFC(1)	TM7SF2(1)	TPST2(1)
TRPA1(1)	TRPM4(1)	TRPM6(1)	TRPV2(1)
TSSK2(1)	TTBK2(1)	TYW1B(1)	UCK1(1)
UGT1A5(1)	UGT1A8(1)	UGT2A3(1)	UGT2B11(1)
UGT2B4(1)	UROS(1)	USP10(1)	USP13(1)
USP16(1)	USP30(1)	USP32(1)	USP48(1)
USP9Y(1)	VARS(1)	WARS(1)	WDYHV1(1)
WNK2(1)	WRN(1)	XYLB(1)	XYLT2(1)
ZDHHC19(1)	ZDHHC23(1)	ZDHHC4(1)	AATK(2)
ABCB1(2)	ABCB11(2)	ABCC3(2)	ABCC5(2)
ABCC8(2)	ABCG2(2)	ABHD6(2)	ABO(2)
ACACA(2)	ACAT1(2)	ACAT2(2)	ACER2(2)
ACSBG1(2)	ACSBG2(2)	ACSL1(2)	ACSL3(2)
ACSM2A(2)	ACSM5(2)	ACVRL1(2)	ACY3(2)
ADAT1(2)	ADCY9(2)	ADRA1A(2)	ADRA1B(2)
ADRA1D(2)	ADRA2C(2)	ADRB1(2)	ADSSL1(2)
AGMO(2)	AGPAT4(2)	AHCY(2)	ALDH5A1(2)
ALG6(2)	ALG9(2)	ALOX15B(2)	ALOXE3(2)
ALPI(2)	AMACR(2)	AMDHD1(2)	AMHR2(2)
AOAH(2)	AQP2(2)	AQP8(2)	ATP10D(2)
ATP1A1(2)	ATP1A4(2)	ATP5B(2)	ATP6V0A1(2)
ATP6V1A(2)	ATP8B3(2)	ATP9B(2)	ATRX(2)
AVPR1A(2)	AVPR2(2)	B3GALT6(2)	B4GALNT4(2)
B4GALT6(2)	BCKDHB(2)	BDH1(2)	BDKRB2(2)
BLVRA(2)	BMPR1B(2)	C8A(2)	CA3(2)
CACNA11(2)	CALCR(2)	CAMK1G(2)	CANT1(2)
CASK(2)	CBS(2)	CCRL2(2)	CD38(2)
CDIPT(2)	CDK16(2)	CDK17(2)	CDK8(2)
CDK9(2)	CERS5(2)	CFTR(2)	CHD2(2)
CHIT1(2)	CHRM1(2)	CHST13(2)	CHST7(2)
CHSY1(2)	CKM(2)	CLCN4(2)	CLCN7(2)
CLDN19(2)	CNDP2(2)	COASY(2)	COX7C(2)
CPT1B(2)	CRYZ(2)	CSNK1A1(2)	CSNK1A1L(2)
CSNK1G1(2)	CSNK2A1(2)	CSTB(2)	CTDP1(2)
CXCR3(2)	CYP24A1(2)	CYP27A1(2)	CYP2A13(2)
CYP3A4(2)	CYP4A22(2)	CYP4F12(2)	CYP4Z1(2)
DAO(2)	DAPK1(2)	DCLK2(2)	DCXR(2)
DDX18(2)	DDX27(2)	DDX28(2)	DDX39B(2)
DDX52(2)	DGKI(2)	DGKZ(2)	DHCR24(2)
DHCR7(2)	DHODH(2)	DHRS3(2)	DHX40(2)
DHX9(2)	DLAT(2)	DNA2(2)	DOHH(2)
DPH1(2)	DPYD(2)	DTYMK(2)	DUSP12(2)
DUSP27(2)	DUSP3(2)	DUSP9(2)	EBP(2)
ECI2(2)	EDNRA(2)	ELOVL6(2)	ENTPD3(2)
EPHA10(2)	EPHA4(2)	EPHB3(2)	EPHB6(2)
EPHX1(2)	ERBB2(2)	ERCC2(2)	ERN1(2)
ETNPPL(2)	EYA2(2)	FAAH2(2)	FASN(2)
FGFR3(2)	FLT3(2)	FMO1(2)	FMO2(2)
FMO4(2)	FPR1(2)	FSHR(2)	FUCA2(2)
FXYD5(2)	FZD2(2)	FZD3(2)	FZD7(2)
G6PC2(2)	GAA(2)	GABBR2(2)	GAD2(2)
GADL1(2)	GALNT4(2)	GALNT5(2)	GALNT8(2)
GBA3(2)	GFPT1(2)	GJB1(2)	GK(2)
GLP1R(2)	GLRA1(2)	GLRA3(2)	GMPPA(2)
GNPDA1(2)	GPER1(2)	GPR111(2)	GPR113(2)
GPR116(2)	GPR125(2)	GPR135(2)	GPR173(2)
GPR35(2)	GPR45(2)	GPR97(2)	GPRC5B(2)
GPRC5C(2)	GPX7(2)	GSTA4(2)	GSTM4(2)
GYG2(2)	HAAO(2)	HADHB(2)	HAL(2)
HCRTR1(2)	HELB(2)	HEPH(2)	HIBADH(2)
HK3(2)	HMGCLL1(2)	HNMT(2)	HPGD(2)
HPRT1(2)	HPX(2)	HS3ST3A1(2)	HSD11B1(2)
HSD17B1(2)	HSD3B1(2)	HTR1B(2)	HYAL2(2)
IDO1(2)	IDS(2)	IGHMBP2(2)	INMT(2)
INPP4A(2)	IRAK2(2)	IRAK3(2)	ISYNA1(2)
IVD(2)	IYD(2)	JAK1(2)	JOSD2(2)
KAT6B(2)	KCND2(2)	KCNK3(2)	KCNQ2(2)
KCNS1(2)	KDM8(2)	KL(2)	KMT2B(2)
KSR2(2)	LAP3(2)	LARS2(2)	LATS2(2)
LDHA(2)	LDHAL6B(2)	LDHD(2)	LFNG(2)
LGR6(2)	LHPP(2)	LIMK2(2)	LIPF(2)
LPCAT1(2)	LPHN2(2)	LPIN2(2)	LSS(2)
LTA4H(2)	MAN2B2(2)	MAOA(2)	MAP2K3(2)
MAP3K1(2)	MAP3K15(2)	MAP3K19(2)	MAP3K8(2)
MAP4K3(2)	MAPK4(2)	MAST2(2)	MAST3(2)
MCAT(2)	MCHR1(2)	MDH2(2)	ME1(2)
ME2(2)	MFN2(2)	MGST1(2)	MGST3(2)

MICAL3(2)	MMAB(2)	MOGAT3(2)	MTCH1(2)
MTHFR(2)	MTMR1(2)	MTMR8(2)	MTOR(2)
MYBBP1A(2)	NANS(2)	NARS(2)	NAT8(2)
NDUFS7(2)	NEU2(2)	NME3(2)	NMT2(2)
NNT(2)	NPC1(2)	NPL(2)	NSD1(2)
NT5E(2)	NUAK1(2)	NUDT12(2)	NUDT14(2)
OAS1(2)	OAS2(2)	OPN4(2)	OTUD3(2)
OXER1(2)	OXSR1(2)	P2RY1(2)	P2RY2(2)
P2RY6(2)	PAH(2)	PANX1(2)	PAPD7(2)
PAPOLB(2)	PAPOLG(2)	PARP10(2)	PARP9(2)
PARS2(2)	PCBD1(2)	PDE10A(2)	PDE4B(2)
PDE5A(2)	PDE7B(2)	PDGFRB(2)	PDHA1(2)
PDK3(2)	PDP2(2)	PEX6(2)	PFAS(2)
PFKFB3(2)	PGP(2)	PHYKPL(2)	PI4K2B(2)
PIGA(2)	PIP5K1C(2)	PKN1(2)	PLA2G2D(2)
PLB1(2)	PLCG2(2)	PLK4(2)	PNPLA2(2)
POFUT1(2)	POLI(2)	POMT1(2)	POMT2(2)
PON1(2)	PPIE(2)	PPIF(2)	PPM1G(2)
PPP1CB(2)	PPT2(2)	PRDM7(2)	PRKAA1(2)
PRKCD(2)	PRKCQ(2)	PRKD1(2)	PRKG2(2)
PRPS1(2)	PSEN2(2)	PTEN(2)	PTGER1(2)
PTGES(2)	PTGES3(2)	PTP4A2(2)	PTP4A3(2)
PTPN18(2)	PTPN22(2)	PTPRB(2)	PTPRC(2)
PTPRH(2)	PTPRJ(2)	PTPRK(2)	PTPRZ1(2)
PXDN(2)	QDPR(2)	RET(2)	REV3L(2)
RGN(2)	RHD(2)	RHO(2)	ROCK2(2)
RPEL1(2)	RPS6KA3(2)	RPS6KB2(2)	RTCB(2)
RYR2(2)	S1PR4(2)	SARS(2)	SBK3(2)
SCD5(2)	SETD7(2)	SIK1(2)	SLC12A2(2)
SLC25A10(2)	SLC25A14(2)	SLC27A2(2)	SLC28A2(2)
SLC2A2(2)	SLC2A5(2)	SLC30A3(2)	SLC35D1(2)
SLC38A3(2)	SLC39A2(2)	SLC43A1(2)	SLC6A1(2)
SLC9A7(2)	SLCO1B1(2)	SMARCAD1(2)	SMS(2)
SPTLC1(2)	SRC(2)	SRP72(2)	SSTR4(2)
ST3GAL6(2)	ST6GAL2(2)	ST6GALNAC1(2)	STARD3(2)
STK17A(2)	STK32B(2)	TAAR3(2)	TACR3(2)
TAS1R2(2)	TAS2R16(2)	TAS2R20(2)	TAS2R30(2)
TAS2R38(2)	TAS2R43(2)	TAS2R46(2)	TAS2R50(2)
TDRD9(2)	TGM4(2)	TGM5(2)	TGM7(2)
TRIO(2)	TRMT12(2)	TRPC5(2)	TRPM5(2)
TTK(2)	TTYH3(2)	UCP1(2)	UGP2(2)
UGT2B15(2)	UGT2B17(2)	UPB1(2)	UROC1(2)
USP11(2)	USP15(2)	USP17L2(2)	USP18(2)
USP36(2)	USP44(2)	USP47(2)	USP9X(2)
UXS1(2)	VCIPI1(2)	WEE1(2)	XCR1(2)
XDH(2)	YTHDC2(2)	ZDHC11B(2)	ZDHC7(2)
ZDHHC9(2)	AACS(3)	AADAC(3)	ACADM(3)
ACOX1(3)	ACP6(3)	ACSM2B(3)	ACSS1(3)
ADCY3(3)	AKR1B10(3)	AKR1C3(3)	ALDH3A1(3)
ALOX12(3)	ALPP(3)	ALPPL2(3)	ANPEP(3)
ANXA6(3)	ART5(3)	ASNS(3)	ATP11A(3)
ATP1A3(3)	ATP6V0A4(3)	ATP8B4(3)	ATR(3)
AURKB(3)	B3GNT3(3)	B4GALNT1(3)	BRSK2(3)
CACNA1C(3)	CACNA1H(3)	CASR(3)	CBR3(3)
CDC42BPA(3)	CDYL2(3)	CELSR1(3)	CERS4(3)
CHDH(3)	CHEK1(3)	CHSY3(3)	CHUK(3)
CLC(3)	CLDN7(3)	CMTR2(3)	COQ2(3)
CPS1(3)	CSGALNACT1(3)	CSNK2A3(3)	CX3CR1(3)
CYB5R2(3)	CYP11B2(3)	CYP1B1(3)	CYP2A7(3)
CYP2C8(3)	CYP2F1(3)	CYP3A43(3)	CYSLTR1(3)
DBT(3)	DDX31(3)	DECR2(3)	DEFA1(3)
DGKA(3)	DGKG(3)	DMGDH(3)	DRD3(3)
DSTYK(3)	DUSP13(3)	DUSP5(3)	EARS2(3)
ECHS1(3)	EIF2AK1(3)	EIF2AK3(3)	EMR1(3)
EMR2(3)	EMR3(3)	ENO3(3)	ENPP1(3)
EPHA6(3)	ETFDH(3)	FARSB(3)	FBP2(3)
FUT3(3)	FUT5(3)	FUT6(3)	FUT9(3)
GALC(3)	GALNTL5(3)	GALNTL6(3)	GBE1(3)
GHRHR(3)	GJA3(3)	GK5(3)	GLCE(3)
GNA15(3)	GOT2(3)	GPAM(3)	GPLD1(3)
GPR112(3)	GPR126(3)	GPR144(3)	GPR153(3)
GPR156(3)	GPR158(3)	GPR19(3)	GPR20(3)
GPR37L1(3)	GPR50(3)	GPR78(3)	GPR98(3)
GPRC6A(3)	GPX8(3)	GYS2(3)	HADH(3)
HAS1(3)	HCAR3(3)	HEXA(3)	HEXB(3)
HGD(3)	HSD17B12(3)	HSD17B4(3)	HTR2A(3)
IDNK(3)	IP6K3(3)	IRAK1(3)	KCNK17(3)
KCNMB3(3)	KISS1R(3)	L2HGDH(3)	LCT(3)

LPCAT2(3)	LPIN1(3)	LRRK1(3)	LRRK2(3)
MANBA(3)	MCCC1(3)	MECR(3)	MERTK(3)
MTMR2(3)	MUT(3)	MYO3B(3)	NAGLU(3)
NAV2(3)	NDUFV2(3)	NME4(3)	NQO2(3)
NRK(3)	NT5C3B(3)	OPRM1(3)	OTUD7A(3)
PAFAH1B2(3)	PAOX(3)	PARP8(3)	PCYT1A(3)
PDE3A(3)	PDE6C(3)	PFKM(3)	PGM1(3)
PGM2L1(3)	PIN4(3)	PKD1(3)	PLA2G3(3)
PLA2G4C(3)	PLA2G4F(3)	PLA2G7(3)	PPCDC(3)
PRDM2(3)	PRDX5(3)	PRKCG(3)	PRKX(3)
PRPF4B(3)	PRPS1L1(3)	PSTK(3)	PTGR1(3)
PTH2R(3)	PTPN12(3)	PTPRQ(3)	PTPRR(3)
RARS(3)	RECQL5(3)	RIPK4(3)	RPS6KA2(3)
RTEL1(3)	SAG(3)	SARDH(3)	SCN1A(3)
SCN5A(3)	SCNN1A(3)	SEC63(3)	SI(3)
SLC11A2(3)	SLC16A1(3)	SLC18A1(3)	SLC19A1(3)
SLC25A5(3)	SLC34A3(3)	SLC37A1(3)	SLC4A11(3)
SLC6A3(3)	SPHK1(3)	SRP14(3)	SUCLA2(3)
SULT1A1(3)	TAOK3(3)	TAS1R3(3)	TAS2R10(3)
TAS2R13(3)	TAS2R31(3)	TAS2R42(3)	TAS2R8(3)
TAS2R9(3)	TGM6(3)	TMEM86B(3)	TPO(3)
TRPM2(3)	TRPV6(3)	UCP2(3)	UGT1A4(3)
UGT2B28(3)	ULK2(3)	USP24(3)	USP29(3)
USP40(3)	USP42(3)	USP6(3)	VNN1(3)
ZC3HAV1(3)	AAK1(4)	AARS2(4)	ABCA2(4)
ABCC2(4)	ABCC6(4)	ABCG8(4)	ACLY(4)
ADH1B(4)	ADH4(4)	ADH6(4)	AHNAK(4)
AK5(4)	AKR1C1(4)	AKR1C4(4)	ALDH3B2(4)
ALG10B(4)	ALK(4)	ASAH1(4)	ATM(4)
ATP2C2(4)	ATP4A(4)	ATP4B(4)	ATP7A(4)
AURKA(4)	AXL(4)	B3GNT4(4)	BCO2(4)
BCR(4)	C5AR1(4)	CALCRL(4)	CATSPER1(4)
CDK11A(4)	CERS3(4)	CHAT(4)	CHD1L(4)
CHD9(4)	CHIA(4)	CHPF(4)	CLCN1(4)
CLIC6(4)	CNDP1(4)	COQ3(4)	COX4I1(4)
CP(4)	CRAT(4)	CTDSP1(4)	CTNS(4)
CYP3A7(4)	CYP4A11(4)	CYP4F11(4)	CYP8B1(4)
D2HGDH(4)	DCP2(4)	DDC(4)	DDR2(4)
DDX60L(4)	DEGS2(4)	DHTKD1(4)	DHX37(4)
DNTT(4)	DUOX2(4)	DUSP6(4)	EIF2AK4(4)
ENPP2(4)	ENTPD8(4)	EPHA1(4)	EPRS(4)
F2RL1(4)	FBP1(4)	FFAR1(4)	FPGS(4)
GALR1(4)	GANC(4)	GARS(4)	GART(4)
GCNT2(4)	GDPGP1(4)	GLB1(4)	GLYAT(4)
GMPPB(4)	GNS(4)	GPR142(4)	GPR148(4)
GPR174(4)	GPR31(4)	GPR62(4)	GSTA2(4)
GSTA5(4)	GUCY2C(4)	GUCY2F(4)	HAO2(4)
HCAR1(4)	HCRTR2(4)	HELQ(4)	HFM1(4)
HK1(4)	HKDC1(4)	HPD(4)	HPSE(4)
HSD17B2(4)	HYI(4)	IDUA(4)	IFIH1(4)
INPP1(4)	INPP5B(4)	KAT7(4)	KCNJ5(4)
LARS(4)	LIPC(4)	LIPT2(4)	MAPK11(4)
MARK3(4)	MAST4(4)	MB21D1(4)	MCM4(4)
MCM9(4)	MFN1(4)	MGAM(4)	MGAT1(4)
MKNK1(4)	MOCOS(4)	MRGPRX3(4)	MRGPRX4(4)
MST1R(4)	MTHFD1(4)	MTMR7(4)	N6AMT1(4)
NAALADL2(4)	NADSYN1(4)	NARS2(4)	NAT2(4)
NEK11(4)	NMUR2(4)	NTSR2(4)	OBSCN(4)
OPRD1(4)	P2RX7(4)	P2RY13(4)	PANK2(4)
PARP1(4)	PARP3(4)	PARP4(4)	PCK2(4)
PDE11A(4)	PDE1C(4)	PDE2A(4)	PDE6B(4)
PEX16(4)	PIKFYVE(4)	PKD2(4)	PLA2G4A(4)
PNLIPRP3(4)	PNPLA3(4)	PNPLA7(4)	POLQ(4)
POLR1A(4)	PPEF2(4)	PPM1J(4)	PRKCA(4)
PRKD2(4)	PRLHR(4)	PRMT3(4)	PTGDR2(4)
PTGER3(4)	PTGS1(4)	PTPRF(4)	PTPRN2(4)
PTPRS(4)	QPRT(4)	RECQL4(4)	ROR2(4)
RXFP4(4)	SBK2(4)	SCN4A(4)	SCN9A(4)
SETDB2(4)	SHPK(4)	SIRT6(4)	SLC10A2(4)
SLC12A3(4)	SLC17A4(4)	SLC18A3(4)	SLC23A1(4)
SLC26A2(4)	SLC28A1(4)	SLC2A9(4)	SLC39A14(4)
SORD(4)	SPTLC3(4)	TACR2(4)	TAS1R1(4)
TBXA2R(4)	TBXAS1(4)	TEK(4)	TGM3(4)
TNK1(4)	TREH(4)	TRMT5(4)	TRNT1(4)
TRPV3(4)	TSHR(4)	TTN(4)	UGT2A1(4)
UGT2B7(4)	UGT8(4)	UQCRFS1(4)	USP2(4)
USP34(4)	USP35(4)	USP37(4)	USP45(4)
WNK1(4)	ZDHHC12(4)	ZDHHC13(4)	AGA(5)

AGXT2(5)
ASCC3(5)
ATP8B1(5)
ITPKB(5)
NOX4(5)
TXNRD2(5)
ZDHHC11(5)

AK7(5)
ASH1L(5)
CA6(5)
MAN1B1(5)
PCK1(5)
ULK1(5)
CNR2(6)

ALDH1B1(5)
ATP10B(5)
ENTPD6(5)
MAP3K4(5)
PLCE1(5)
ULK4(5)
MTMR6(6)

AOC1(5)
ATP11C(5)
INSR(5)
MYLK(5)
SULT1A2(5)
VNN2(5)