

Supplementary materials: Complex Disease Networks of Trait-Associated SNPs Unveiled by Information Theory

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Supplementary Figure 1: Disease similarity network calculated using GO molecular function similarity of the host genes of trait-associated intragenic SNPs with similarities ≥ 0.3 and empirical p-value < 0.05 .

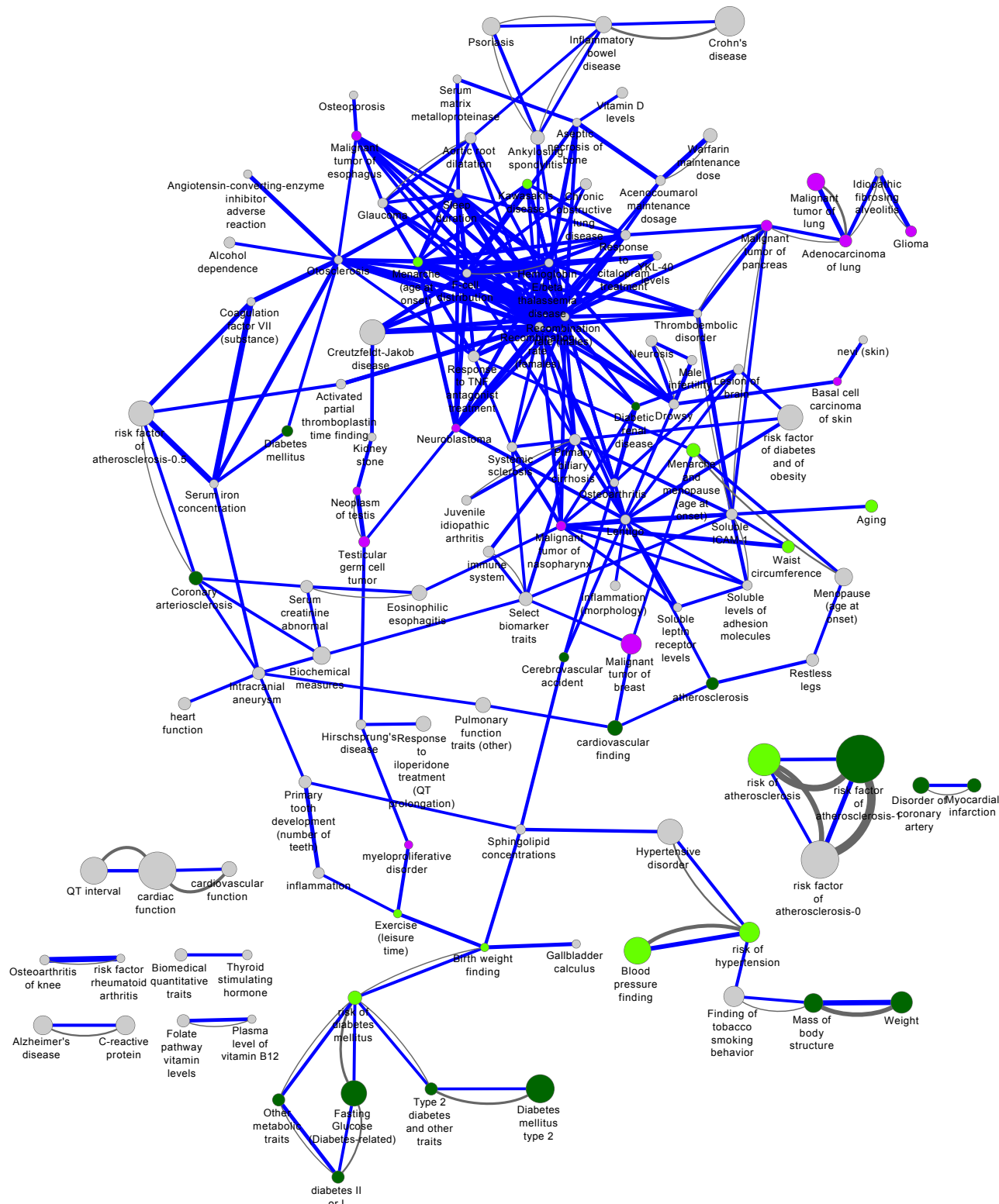
Supplementary Figure 2: Disease network constructed by overlaps of the host genes of trait-associated intragenic SNPs.

Supplementary Figure 3: Drug and therapeutic compounds annotations of the prioritized cancer biomodule from the similarity and protein interaction network.

Supplementary Table 1: Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Supplementary Table 2: Enrichment of direct and indirect protein-protein interactions in gene-gene pairs with high information similarity on a genome scale and in the subset of host genes for complex traits in NHGRI GWAS Catalog.

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits.



Legend

- Circle color**
- Metabolic syndrome traits
 - Risk factors of metabolic syndrome traits
 - Cancer traits
 - Other unclassified traits
- Size proportional to number of SNP host genes per trait**

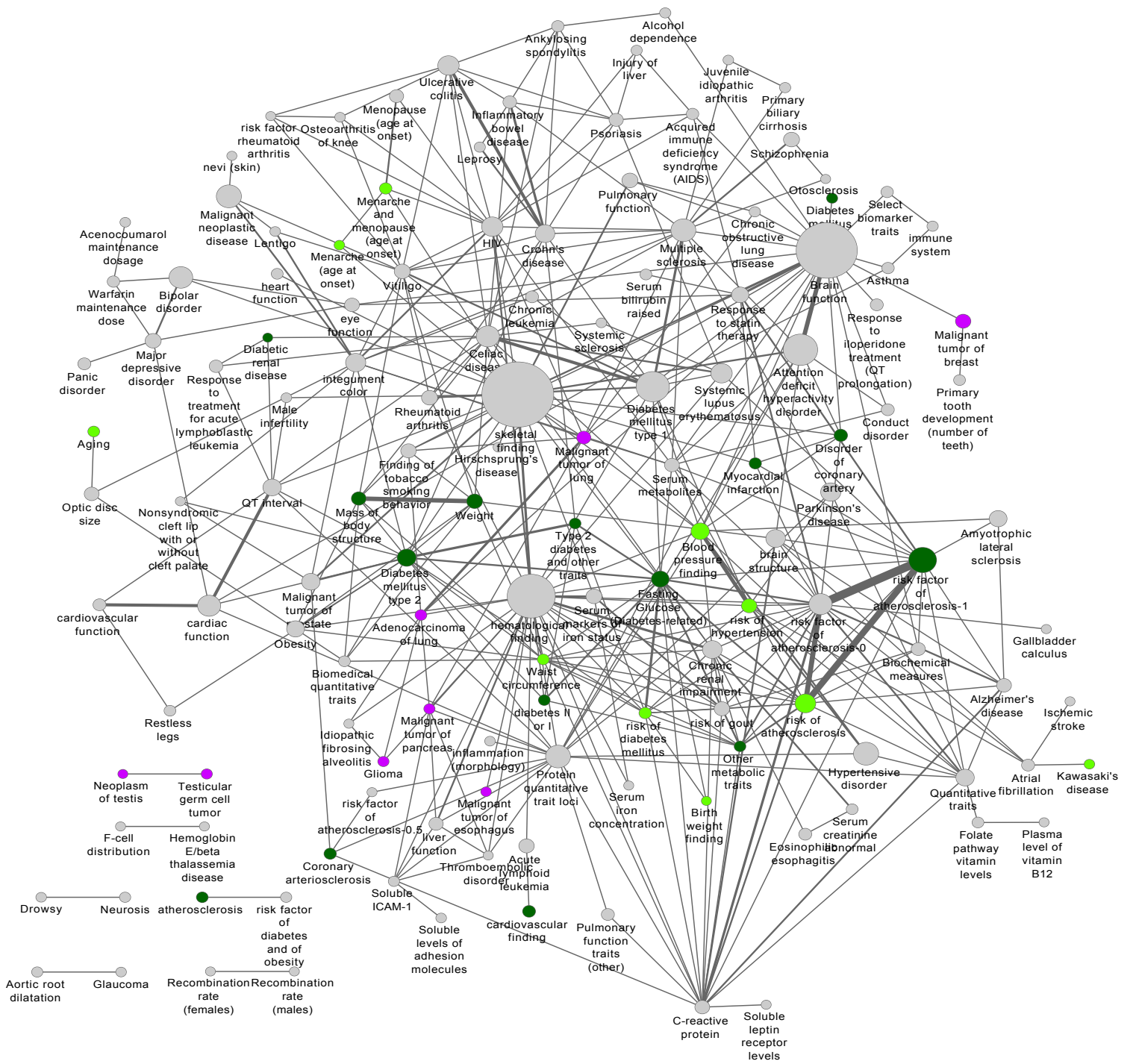
Trait-trait connections by information theoretical similarity (ITS)

Trait-trait connections by gene overlaps

Line thickness proportional to number of overlapping SNP host genes or intertrait similarity

Supplementary Figure 1

Supplementary Figure 1: Disease similarity network calculated using GO molecular function similarity of the host genes of trait-associated intragenic SNPs with similarities ≥ 0.3 and empirical p-value <0.05 . As shown, among 237 intertrait similarity connections (blue lines), 194 (81.9%) cannot be explained simply by shared host genes between the traits (grey lines) and are reported here for the first time. Therefore, this figure illustrates that our ITS method has found non-trivial relationships that would not have been found by conventional methods. As hypothesized, metabolic syndrome traits (green) were significantly enriched in connections with other traits in the same metatrait (OR=1.85, $p=0.025$, Fisher's Exact Test) but cancer traits (purple) were not found to be significantly more likely to interact with other cancer traits (OR=2.25, $p=0.11$; FET test). Circles in the figure represent diseases or traits whose sizes are proportional to their number of associated intragenic SNP host genes. Green circles represent metabolic syndrome related traits curated *a priori* (dark green for metabolic syndrome traits and light green for their risk factors), purple circles represent cancer traits and grey circles represent uncategorized traits. Blue lines represent biological process similarities ≥ 0.3 and $p\text{-value}<0.05$. Grey lines represent shared SNP host genes between diseases if their Trait_ITS is ≥ 0.3 and $p\text{-value}<0.05$ (in other words overlapping connections between our information theoretic method and conventional gene overlapping method). Line thicknesses are proportional to Trait_ITS similarity values or number of shared genes.

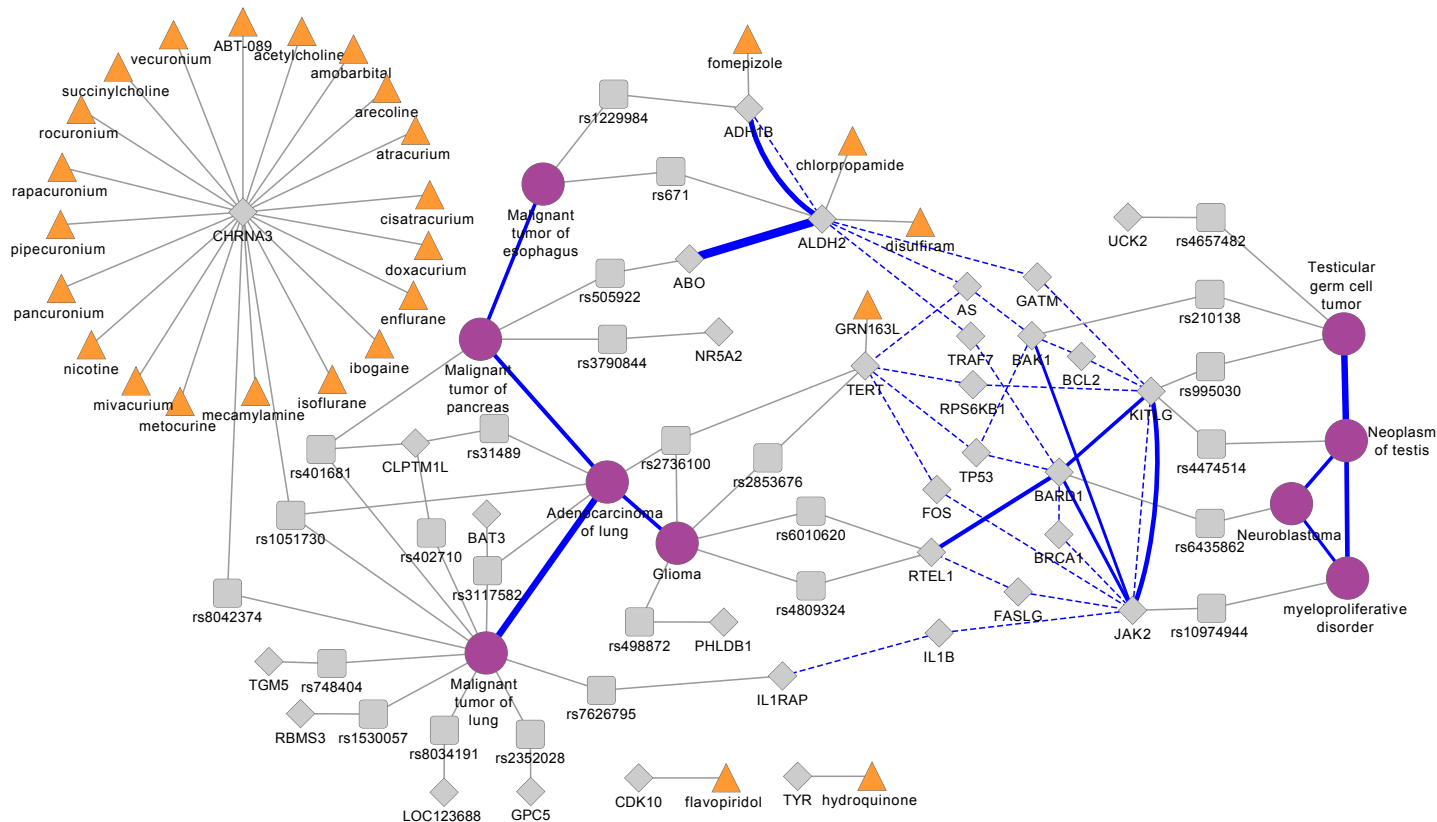


Legend

- | | | | | |
|---|---|---|---|---|
| { | ● | Metabolic syndrome traits | — | Trait-trait connections by gene overlaps |
| | ● | Risk factors of metabolic syndrome traits | = | Line thickness proportional to number of overlapping SNP host genes |
| | ● | Cancer traits | ● | Size proportional to number of SNP host genes per trait |
| | ● | Other unclassified traits | | |

Supplementary Figure 2

Supplementary Figure 2: Disease network constructed by overlaps of the host genes of trait-associated intragenic SNPs. This figure is intended to discriminate between biological similarity that can be explained by simple genetic overlap of host genes between two traits and non-trivial similarity that cannot be explained by gene overlap. As shown, among 383 intertrait similarity connections (grey lines). As hypothesized, metabolic syndrome traits (green) were significantly enriched in connections with other traits in the same metatrait (OR=4.1, $p=5.2 \times 10^{-15}$, Fisher's Exact Test) but cancer traits (purple) were not found to be significantly more likely to interact with other cancer traits (OR=1.7, $p=0.22$; FET test). In other word, the biological similarity (mechanism scale) unveiled by Trait_ITS is non-trivial because it cannot be explained at the gene overlap level (genetic scale). Circles in the figure represent diseases or traits whose sizes are proportional to their number of associated intragenic SNP host genes. Green circles represent metabolic syndrome related traits curated *a priori* (dark green for metabolic syndrome traits and light green for their risk factors), purple circles represent cancer traits and grey circles represent uncategorized traits. Grey lines represent shared SNP host genes between diseases. Line thicknesses are proportional to number of shared genes.



Supplementary Figure 3: Drug and therapeutic compounds annotations of the prioritized cancer biomodule from the similarity and protein interaction network. Legend: grey diamonds are host genes of intragenic SNPs or genes linking these host genes; orange triangles are drugs targeted to connected host genes. Grey lines represent mappings from SNPs to their host genes, associations between SNPs and their complex traits, and targeting between drugs and host genes. Connections of GO:BP intertrait similarity and host gene-gene similarity are colored in blue ($ITS \geq 0.2$). Shortest paths of protein interactions are represented by dashed lines.

Supplementary Table 1. Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	Acenocoumarol maintenance dosage	Acenocoumarol maintenance dosage	CYP2C19, CYP4F2
	Acquired immune deficiency syndrome (AIDS)	AIDS AIDS progression	TGFBRAP1, RXRG, SOX5 HCP5, ZNRD1
	Activated partial thromboplastin time finding	Activated partial thromboplastin time	KNG1, HRG
	Acute lymphoid leukemia	Acute lymphoblastic leukemia (childhood)	ARID5B, ST6GALNAC3, IKZF1, KCNE4, KRTHB5, ZNF230, CEBPE, PARD3, RYR2, KCNMB2
cancer	Adenocarcinoma of lung	Lung adenocarcinoma	CHRNA3, TERT, BAT3, CLPTM1L
	Age-related macular degeneration	Age-related macular degeneration Age-related macular degeneration (wet)	ARMS2, CFH, RREB1, COL8A1, C3, PLA2G12A, PTGES3, HTRA1, SKIV2L, CFB, C2, SYN3 HTRA1
risk factor of metabolic	Aging	Aging Aging traits	LRP1B GNG4, KCNAB1, GALNT13
	Alcohol dependence	Alcohol dependence	ERAP1, PPP2R2B, ESR1
	Alzheimer's disease	Alzheimer's disease Alzheimer's disease (late onset)	CLU, DISC1, TOMM40, PCDH11X, CD33, APOC1, CR1, PVRL2 GAB2, APOC1
	Amyotrophic lateral sclerosis	Amyotrophic lateral sclerosis	DPP6, FHDC1, UNC13A, KIFAP3, DISC1, ITPR2, CNTN4, SUSD1, LIPC, ZFP64, ATXN1, C9orf72, SLC39A11, NT5C1A
	Angiotensin-converting-enzyme inhibitor adverse reaction	Angiotensin-converting enzyme activity	ACE
	Ankylosing spondylitis	Ankylosing spondylitis	LOC729026, IL23R, LOC100128641, ERAP1, ANTXR2
	Aortic root dilatation	Aortic root size	LOC644976, SMG6, LOXL1
	Aseptic necrosis of bone	Osteonecrosis of the jaw	CYP2C8
	Asthma	Asthma Asthma (toluene diisocyanate-induced)	RAD50, CRB1, VISA, GSDML CTNNA3
metabolic syndrome	atherosclerosis	Carotid atherosclerosis in HIV infection	MAST4, LOC100133411, GRM8, RYR3
	Atopy	Atopy	LOC91461
	Atrial fibrillation	Atrial fibrillation/atrial flutter Atrial fibrillation	LOC729065 CNTN5, KCNN3, LOC729065, MTHFR, ZFH3, LOC220416

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	Attention deficit hyperactivity disorder	Attention deficit hyperactivity disorder	ATP2C2, LOC100130457, TLL2, ASTN2, C9orf98, CDH13, MMP24, UNC5B, FOXP1, MAP1B, ITGAE, CREB5, MYT1L, CRYGC, CSMD2, NAPRT1, DNMT1, MGC33657, ZNF544, MAN2A2, SUPT3H, PPM1F, REEP5, NT5DC3, C10orf79, FHIT, ITGA11, NAP5, GPC6, MOBP, MTA3
		Attention deficit hyperactivity disorder (time to onset)	ADAMTS2, SULF2
		Attention deficit hyperactivity disorder and conduct disorder	RGL1, A2BP1, KIRREL3, PKD1L3, PKD1L2, PAWR, C12orf28
		Attention deficit hyperactivity disorder symptoms (interaction)	PIWIL4, KIF6
cancer	Basal cell carcinoma of skin	Basal cell carcinoma (cutaneous)	PADI6
	Biochemical measures	Biochemical measures	RAP1GDS1, GRIK2, SLC2A9, NR3C2, PKNOX1, ZCCHC16, PCSK2, CETP
	Biomedical quantitative traits	Biomedical quantitative traits	LOC100128537, C12orf51, FAM3C, FTO
	Bipolar disorder	Bipolar disorder	CACNA1C, DGKH, ITIH1, TDRD9, LOC100132577, SYNE1, MCTP1, DPY19L3, PRSS3, CTSF, ARNT2, RNPEPL1, CDC25B, ZNF385D, GARNL3, PALB2, CMTM8, SIAE, C2orf55, LAMP3, SVEP1, ATP8B3, NPAS3, C15orf32
risk factor of metabolic syndrome	Birth weight finding	Birth weight	ADCY5
risk factor of metabolic syndrome	Blood pressure finding	Blood pressure	CAMK4, C14orf118, CDH13, CNTN4, STK39
		Diastolic blood pressure	CACNB2, PLEKHA7, CSK, C10orf107, ZNF652, MDS1, ATP2B1, SH2B3, ATXN2, ULK4
brain function		Cognitive performance	IMMP2L, MTHFD1, TSHZ3, CCDC64, CORO2B, VPS41, GRIK4, FLT1, SPG3A, UNC13C, GRIN2B, NRIP1, KCNB2, CPVL, PKNOX1, KIAA1217, CSMD1, GTF2E2, TRIM31, SEC14L1, FBXO40, CAPN5, CDH13, PLCXD2, LOC100131060, GORASP2, AFAP1L2, NCALD, IDS, PLCB1, C11orf73, FAM177B, EHHADH, LOC100129390, GABRB3, MOBP, SLC6A6, C6orf129, KIAA0984, FAM131C
		Cognitive test performance	NCAPD3, TARBP1, PPM1E, PPP2R2B
		Functional MRI	KIAA0355, DOK5
		Hyperactive-impulsive symptoms	MBOAT1, DMRT2, ZNF805, GRIK1, MEIS2
		Inattentive symptoms	LOC100127988, ZNF423, NOS1, IL16, SLCO3A1
		Major mood disorders	PBRM1
		Nicotine dependence	CHRNA3, CTNNA3
		Personality dimensions	FUNDC1, CLOCK
		Response to antidepressants	IL11, SLC27A1, UST, RGL1
		Response to antipsychotic therapy (extrapyramidal side effects)	C20orf174, MOSC2, FAM13A1, FLJ10986, ZNF202, TRIM44, A2BP1
		Response to antipsychotic treatment	LCE3E, CLMN, PRKAR2B, ATF7IP2, SOX5, LOC729993, MEIS2, CDH13, FHOD3, CNTNAP5, TRPM1, GPR98, ASTN2, KIRREL3, RNF144A, ANKS1B, PPARD

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Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	brain structure	Brain imaging	TOMM40, APOE
		Brain structure	BOK, CADPS2, CSMD2, FARP1, KIAA0090, FRMD6, SHB, C6orf140
		Normalized brain volume	KCNIP1, SVIL, BICD1, MXI1, FOXO3
		Volumetric brain MRI	CDH4, CNTN5
	cardiac function	Cardiac structure and function	FLJ43080, WWOX, GRID1, SLC35F1
		Echocardiographic traits	PDE4B, KCNB2, SLIT2, FAM5C
		Electrocardiographic conduction measures	SFRP2, STK32B, XYLB, LOC100133877, SCN5A
		Electrocardiographic traits	NOS1AP, SCN5A, KCNQ1, MYH6, CNOT1, KCNH2, CAV1, TBX5, SCN10A, KCNE1, ARHGAP24
metabolic syndrome	cardiovascular finding	Arterial stiffness	COL4A1
		Endothelial function traits	OBFC1
		Exercise treadmill test traits	WRN, RYR2, ZC3H12C
		Heart rate variability traits	DCLK1
	cardiovascular function	PR interval	SCN5A, MEIS1, CAV1, WNT11, SCN10A, ARHGAP24
metabolic syndrome	Celiac disease	Celiac disease	BACH2, MYNN, ETS1, CDGAP, ZMIZ1, PUS10, LOC729026, KIAA1109, LPP, PLEK, TAGAP, PTPN2, WNT3, HLA-DQA1, YDJC, MMEL1, ICOS, ICOSLG, ATXN2, NFIA, FRMD4B, ELMO1, CD247
	Cerebrovascular accident	Stroke	IMPA2, AIM1
cancer	Chronic leukemia	Chronic lymphocytic leukemia	PRKD2, SP140, ACOXL, FARP2, CPEB1, IRF4
	Chronic obstructive lung disease	Chronic obstructive pulmonary disease	IREB2, FAM13A1, LOC123688
	Chronic renal impairment	Chronic kidney disease	SLC6A13, WDR37, DAB2, SLC7A9, GCKR, NAT8, UBE2Q2, SHROOM3, SLC22A2, PIP5K1B, WDR72, DACH1, SLC34A1, ATXN2, PRKAG2, BCAS3
		Renal function and chronic kidney disease	SHROOM3, SPATA5L1
	Coagulation factor VII (substance)	Factor VII	F7
	Conduct disorder	Conduct disorder (interaction)	ZBTB16, RIT1, MFHAS1, A2BP1, PPM1K, SLC6A1
metabolic syndrome	Coronary arteriosclerosis	Coronary artery disease	SLC22A3, LPAL2, LPA, HNF1A, MRAS
	Crohn's disease	Crohn's disease	ATG16L1, NKX2-3, C1orf141, IL23R, NOD2, NELL1, LOC441108, ITLN1, FGFR1OP, PTPN22, FLJ45139, MST1, C13orf31, TNFSF15, CDKAL1, STAT3, BSN
metabolic syndrome	diabetes II or I	Glycated hemoglobin levels	SLC30A8, G6PC2, HK1, GCK
metabolic syndrome	Diabetes mellitus	Diabetes (incident)	TMEFF2
		Diabetes related insulin traits	CPVL, LOC728755
metabolic syndrome	Diabetes mellitus type 1	Type 1 diabetes	IGF2, GLIS3, UBASH3A, PRKCQ, BACH2, CLEC16A, CAPSL, C14orf181, DNAH2, FSTL4, ADAD1, C12orf30, PTPN2, EDG7, IFIH1, PGM1, SIRPG, GSDML, ERBB3, TYK2, PTPN22, GAB3, CTLA4, SH2B3, INS-IGF2, CLEC2D, CTSH, TNP2, PRKD2, KIAA1109, CD69, LOC729980, IL7R, CD226, SKAP2, RASGRP1, HLA-DRA, HLA-DQA1, LOC100130955, DKFZp667F0711
metabolic syndrome	Diabetes mellitus type 2	Type 2 diabetes	NOTCH2, CDKAL1, HIGD1C, SLC30A8, PTPRD, PPARG, KCNQ1, SRR, IGF2BP2, TCF7L2, LOC730057, KCNJ11, THADA, RBMS1, FTO, JAZF1

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Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)	
metabolic syndrome	Fasting Glucose (Diabetes-related)	Fasting glucose-related traits	MTNR1B, SLC30A8, CRY2, ADCY5, SLC2A2, FADS1, IGF1, TCF7L2, G6PC2, GLIS3, GCKR, MADD	
		Fasting insulin-related traits	IGF1, GCKR	
		Fasting plasma glucose	MTNR1B, PRDM5, ZMAT4, G6PC2	
metabolic syndrome	Diabetic renal disease	Diabetic nephropathy	ELMO1	
metabolic syndrome	Disorder of coronary artery	Coronary disease	SMAD3, MIA3, FMN2, PSRC1, SEZ6L, MTHFD1L, CDH13	
	Drowsy	Sleepiness	PDE4D, EYA1	
	Eosinophilic esophagitis	Eosinophilic esophagitis (pediatric)	SNTB1, SHROOM3, C8orf47, STAT6, TSLP, DSG1	
risk factor of metabolic syndrome	Exercise (leisure time)	Exercise (leisure time)	PAPSS2	
	eye function	Tonometry	EXOC4, SYNE1, CNTNAP5, SLC9A9, TNR, TGFB2, VPS37A, PREX1, MEF2C	
	F-cell distribution	F-cell distribution	BCL11A	
	Finding of bilirubin level	Bilirubin levels	TKTL1, UGT1A4	
	Finding of tobacco smoking behavior	Smoking behavior	ZNF93, CHRNA3, CABLES1, ACTN1, EGLN2, BDNF, BBX, TRPC5, CYP2B6, CAMKK1	
	Folate pathway vitamin levels	Folate pathway vitamin levels	CUBN, NBPF3, TCN1, FUT2	
	Gallbladder calculus	Gallstones	ABCG8	
	Glaucoma	Glaucoma Glaucoma (exfoliation)	SRBD1 LOXL1	
cancer	Glioma	Glioma	TERT, PHLDB1, RTEL1	
		Glioma (high-grade)	RTEL1	
	Hearing loss	Hearing impairment	PTPRK, IQGAP2	
risk factor of metabolic syndrome	Heart failure	Mortality among heart failure patients	CMTM7, IFRD1, OTUD7A, ADAMTS12, PARVA, GPM6A	
	hematological finding	heart function	RR interval (heart rate)	FRMD4A, RASGRF1, AKT3, GPR133
		Hematocrit		PRKCE, PRKAG2, HK1, HFE, TMPRSS6, TFR2
		Hematological and biochemical traits		PRKCE, WDR72, LOC387867, GCKR, 8-Mar, RPS11, MRC1, LRP2, TERT, PSORS1C1, CCND3, BRAP, TNFRSF13B, CDK6, SLC12A7, ECGF1, UBE2L3, SLC14A2, GP1BA, DENND4A, TMEM79, ALDH2, TIMM23, XPO7, ABO, THRB
		Hematological parameters		PTPN11, HFE, FIG4, TMPRSS6, TFR2
		Hemoglobin		PRKAG2, PRKCE, HK1, HFE, TMPRSS6
		Hemoglobin levels		HIST1H1T, TMPRSS6
		Hemostatic factors and hematological phenotypes		NEGR1, OR9G1, C1orf149
		Mean corpuscular hemoglobin		RCL1, GCDH, ITFG3, TFRC, TMPRSS6
		Mean corpuscular volume		RCL1, 8-Mar, IKZF1, LOC440836, HFE, TMPRSS6, FNTB, ITFG3, C6orf184, TFRC
		Mean forced vital capacity from 2 exams		COL1A2
		Mean platelet volume		NFE2, DNM3, TPM1, BET1L, RNF145, TMCC2, JMJD1C, MACROD2, EHD3, WDR66
		Neutrophil count		PLCB4
		Plasma coagulation factors		PROCR, STXB5
		Plasma eosinophil count		IL1RL1, TNXB, WDR36, SH2B3
		Other erythrocyte phenotypes		ZAN, SPTA1

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Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)	
	Hemoglobin E/beta	Beta thalassemia/hemoglobin	BCL11A	
	thalassemia disease	E disease		
	Hirschsprung's disease	Hirschsprung's disease	NRG1, RET	
	HIV	HIV-1 control	DAB1, LOC728989, TNXB, GPC5, GRIN2A, GRM5, SLC05A1, NBEA, KIAA0194, HCP5, HLA-B, WDR27, BTNL2, PSORS1C1, MCM8, EVI5L, AOA, LOC100133373, C6orf48, TRIM10	
metabolic syndrome	Hypertensive disorder	Hypertension	CACNB2, MSRA, LOC100132798, ATP2B1	
	Idiopathic fibrosing alveolitis	Idiopathic pulmonary fibrosis	TERT	
	immune system	Plasma C4b binding protein levels	C4BPB	
		Serum IgE levels	RAD50, FCER1A	
	inflammation	Fibrinogen	RAB37, NLRP3, FGB	
	C-reactive protein	C-reactive protein	LOC644171, HNF1A, TOMM40, CRP, APOC1, IL6R, LEPR, APOE, GCKR	
	inflammation (morphology)	Interleukin-18 levels	IL18, BCDO2	
	Inflammatory bowel disease	Inflammatory bowel disease	IL23R, NOD2, ZGPAT, TNFSF15	
		Inflammatory bowel disease (early onset)	ZMIZ1, HORMAD2, ATXN2L	
	Injury of liver	Drug-induced liver injury (flucloxacillin)	ST6GAL1, HCP5, MCTP2	
	integument color	Black vs. blond hair color	IRF4, HERC2, SLC45A2, EXOC2, GPC5	
		Black vs. red hair color	IRF4, HERC2, CDK10, SLC45A2, EXOC2, GPC5	
		Blond vs. brown hair color	HERC2, MC1R, TPCN2	
		Blue vs. brown eyes	HERC2	
		Blue vs. green eyes	TYR, HERC2	
		Hair morphology	TCHH, FRAS1, THADA, WNT10A, TSHR	
		Iris color	HERC2	
		Red vs non-red hair color	MC1R	
		Skin pigmentation	TYR, SLC45A2	
		Skin sensitivity to sun	TYR, MC1R	
		Tanning	GRM5, DBNDD1, TYR, PPARGC1B, SLC45A2, PRDM15	
		Intracranial aneurysm	Intracranial aneurysm	CNNM2, BOLL, SEC11B, STARD13
metabolic syndrome		Ischemic stroke	Ischemic stroke	LOC729065
	Creutzfeldt-Jakob disease	Creutzfeldt-Jakob disease	PRNP	
	Juvenile idiopathic arthritis	Arthritis (juvenile idiopathic)	VTCN1, C6orf10	
risk factor of metabolic syndrome	Kawasaki's disease	Kawasaki disease	NAALADL2, ZFH3	
	Kidney stone	Kidney stones	CLDN14	
	Left ventricular mass	Left ventricular mass	CD36	
	Lentigo	Freckles	TYR, MC1R	
	Leprosy	Leprosy	C13orf31, RIPK2, TNFSF15	
	Lesion of brain	Brain lesion load	CPAMD8, IGF2R	
	liver function	Plasma levels of liver enzymes	LOC100128604, C12orf43, JMJD1C, PNPLA3, C22orf36, C9orf7, ABO, GPLD1	

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Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	Major depressive disorder	Bipolar disorder and major depressive disorder (combined)	CACNA1C, DMTF1, FAT4, SYNE1, LOC100133877
		Major depressive disorder	ATXN7L2, SP4, GNAI3
		Major depressive disorder (broad)	ATP6V1B2, SP4, LY86, GRM7
	Malaria	Malaria	DDC
	Male infertility	Male infertility	PDE3A, EFCAB4B
cancer	Malignant neoplastic disease	Colorectal cancer	RHPN2, FLJ45803, SMAD7, CDH1
		Melanoma	TYR, PLA2G6, CDK10, MTAP, PIGU
cancer	Malignant tumor of breast	Breast cancer	FGFR2, FBN1, ABCC4, COL1A1, RNF146, LOC643714, LSP1, GRIK1, HCN1, RAD51L1
cancer	Malignant tumor of esophagus	Esophageal cancer	ADH1B, ALDH2
cancer	Malignant tumor of lung	Lung cancer	CHRNA3, RBMS3, GPC5, BAT3, CLPTM1L, TGM5, IL1RAP, LOC123688
cancer	Malignant tumor of nasopharynx	Nasopharyngeal carcinoma	ITGA9, HLA-A
cancer	Malignant tumor of pancreas	Pancreatic cancer	NR5A2, CLPTM1L, ABO
cancer	Malignant tumor of prostate	Prostate cancer	JAZF1, PKHD1, EEFSEC, MSMB, PDLIM5, ITGA6, THADA, HNF1B,
			HAPLN1, CTBP2, LMTK2, EHP1, CTDSPL, SLC22A3, TNRC6B
cancer	Malignant tumor of urinary bladder	Bladder cancer	PSCA
		Urinary bladder cancer	TACC3
metabolic syndrome	Mass of body structure	Body mass (lean)	TRHR
		Body mass index	STK33, MTCH2, SEC16B, FTO, LPP, LOC100132353, BDNF, SH2B1
risk factor of metabolic syndrome	Menarche (age at onset)	Menarche (age at onset)	LIN28B, LOC100129852
risk factor of metabolic syndrome	Menarche and menopause (age at onset)	Menarche and menopause (age at onset)	BRSK1, MCM8, SYCP2L, LIN28B, UIMC1
	Menopause (age at onset)	Menopause (age at onset)	BRSK1, LOC642340, C20orf75, MCM8, BANP, DYNC1H1, SLC44A4, GPR124
	Multiple sclerosis	Multiple sclerosis	KIF1B, DBC1, CLEC16A, ZMIZ1, IL2RA, CD58, PDZRN4, CSMD1, CD6, MPHOSPH9, TNFRSF1A, C6orf10, HLA-DRA, FAM69A, IL7R, DDEF1, CYP27B1, STAT3, HLA-DRB5, GPC5
		Multiple sclerosis (age of onset)	C1orf125, NAP5, RELN
		Multiple sclerosis (severity)	MET, FLJ16641, NLRP11
cancer	myeloproliferative disorder	Myeloproliferative neoplasms	JAK2
metabolic syndrome	Myocardial infarction	Myocardial infarction (early onset)	SMARCA4, PHACTR1, MIA3, CELSR2, WDR12
	Narcolepsy	Narcolepsy	CHKB-CPT1B
cancer	Neoplasm of testis	Testicular cancer	KITLG
cancer	Neuroblastoma	Neuroblastoma (high-risk)	BARD1
	Neurosis	Neuroticism	MDGA2, NXPH1, PDE4D
	nevi (skin)	Cutaneous nevi	PLA2G6
	Nonsyndromic cleft lip with or without cleft palate	Nonsyndromic cleft lip with or without cleft palate	THADA

Supplementary Table 1. Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
metabolic syndrome	Obesity	Adiposity	LOC728510, TBCE, TFAP2B
		Obesity	FTO, NPC1
		Obesity (early onset extreme)	FTO
		Obesity (extreme)	TMEM16C, RFTN1, RARB, FTO, MLN, FBN2, MACROD2, FLJ42562, ITPR3
		Obesity and osteoporosis	SOX6
		Obesity-related traits	FTO
	Optic disc size	Optic disc size (cup)	DENND2A, ESRRG, SCFD2, RFTN1
		Optic disc size (disc)	LRP1B, MYPN
		Optic disc size (rim)	PEX14, TSHR, MYH9
	Osteoarthritis	Osteoarthritis	COG5
	Osteoarthritis of knee	Knee osteoarthritis	BTNL2, PARD3B
	Osteoporosis	Osteoporosis	ALDH7A1
metabolic syndrome	Other metabolic traits	Other metabolic traits	PANK1, GCKR, G6PC2, APOB
	Otosclerosis	Otosclerosis	RELN
	Panic disorder	Panic disorder	TMEM16B, TNFRSF21, GRM7, SDK2, PKP1, CALCOCO1
	Parkinson's disease	Parkinson's disease	DLG2, LOC201175, DGKQ, CYP17A1, SLC2A13, NSF, STAP1, SNCA, LOC100133430, DBC1, LOC100129583, ITGA8, SEMA5A, NUCKS1
		Parkinson's disease (age of onset)	ATF6, DSG3, AAK1
		Parkinson's disease (familial)	GAK
	Periodontitis	Periodontitis	GLT6D1
	Plasma level of vitamin B12	Plasma level of vitamin B12	FUT2
	Primary biliary cirrhosis	Primary biliary cirrhosis	C6orf10, IL12RB2, IKZF3
	Primary tooth development (number of teeth)	Primary tooth development (number of teeth)	MSRB3, RAD51L1, IGF2BP1
		Primary tooth development (time to first tooth eruption)	MSRB3, EDA, IGF2BP1
	Protein quantitative trait loci	Protein quantitative trait loci	DUT, LOC51057, CTNNA2, DOCK2, STARD9, EPS8, KIRREL3, KCNQ1, BCDO2, DLG2, IL6R, SACS, BCMO1, ABO, GGT1, KHDRBS2, FLJ39080, POLR2A, IL1F10, SASH1, CACNB2, PAFAH1B2, LPA, ANGPTL6, C17orf62, OSBPL1A
	Psoriasis	Psoriasis	TSC1, IL13, STAT2, IL23R, HCP5, IL12B, SPATA2, TNFAIP3
	Pulmonary function	Pulmonary function	GSTCD, HTR4, INTS12, THSD4, PTCH1, AGER, ADAM19, DAAM2, TNS1, FAM13A1, GPR126
	Pulmonary function traits (other)	Pulmonary function traits (other)	ADARB1, SNTG1, RHBDD1, SNRPN, IL6R, NID2
	QT interval	QT interval	ELMO1, ATP1B1, SCN5A, NOS1AP, KCNQ1, TTN, PDE3A, LIG3, CNOT1, PTPRG, ARHGAP10, TMEM44, TCL6, LITAF, RNF207
		QT interval prolongation	NOS1AP
	Quantitative traits	Quantitative traits	SPPL3, CUBN, LOC283440, ARHGAP15, TRIM24, SCHIP1, HMGR, APOC1, SDK1, MGAT1, ADARB2, CACNB2, HEMGN, LOC388931, ITGA8
	Recombination rate (females)	Recombination rate (females)	RNF212
	Recombination rate (males)	Recombination rate (males)	RNF212
	Response to citalopram treatment	Response to citalopram treatment	NOL4, RORA
	Response to diuretic therapy	Response to diuretic therapy	YEATS4

Supplementary Table 1. Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	Response to hepatitis C treatment	Response to hepatitis C treatment	C6orf199
	Response to iloperidone treatment (QT prolongation)	Response to iloperidone treatment (QT prolongation)	PALLD, SLCO3A1, BRUNOL4, NRG3, NUBPL, CERKL
	Response to statin therapy	Response to statin therapy	SLC28A3, COBLL1, ASB18, FADS2, TTC7A, CNTNAP5, BAI3, SLCO1B1, CELSR2, GLIS1, PRDM16, SOX5, CLMN
	Response to TNF antagonist treatment	Response to TNF antagonist treatment	LASS6, MOBKL2B, PON1
	Response to treatment for acute lymphoblastic leukemia	Response to treatment for acute lymphoblastic leukemia	LMBRD2, ST8SIA6, ELMO1, NCOA3, DGKB, MAML2, LOC645490
	Restless legs	Restless legs syndrome	MAP2K5, PTPRD, MEIS1, BTBD9
	Rheumatoid arthritis	Rheumatoid arthritis	LOC344423, KIF5A, PTPN22, CCL21, TRAF1, ANAPC4, MMEL1, CDK6, DKFZp667F0711, CD40, PHF19
	risk factor of atherosclerosis-0	Plasma homocysteine	MTHFR, CBS
		LDL cholesterol	SF4, DOCK7, PCSK9, HMGCR, DNAH11, CELSR2, TOMM40, FADS1, FADS2, LDLR, COL11A2, ZNF101, APOC1, CR1L, AR, PSRC1, ABCG8, ZNF259, ABCG5, APOB, GCKR
risk factor of metabolic syndrome	risk factor of atherosclerosis-0.5	Plasma Lp (a) levels	LPA
metabolic syndrome	risk factor of atherosclerosis-1	Adiponectin levels	ADIPOQ, ARL15
		Cholesterol	CETP
		Cholesterol, total	DOCK7, TMEM57, DNAH11, FADS2, TOMM40, LDLR, ZNF101, HMGCR, CELSR2, ABCG5, APOB
		HDL cholesterol	CETP, TOMM40, FADS1, FADS2, LIPC, HNF4A, ABCA1, GALNT2, NUTF2, KCTD10, DPEP3, DPEP2, LPL, C9orf52, NR1H3, PCIF1, ZNF259
		Subclinical atherosclerosis traits (other)	ABI2, DNAH5, WDFY4
risk factor of metabolic syndrome	risk factor of diabetes and of obesity	Plasma chemerin levels	GRM8, PI16, EDIL3
	risk factor rheumatoid arthritis	Anti-cyclic Citrullinated Peptide Antibody	BTNL2
risk factor of metabolic syndrome	risk of atherosclerosis	Triglycerides	DOCK7, DSCAML1, ZNF259, GCKR, TBL2, FADS1, CETP, KIAA0999, GALNT2, BAZ1B, ZNF101, BUD13, LPL, MLXIPL, LOC100129500, APOC1, APOB, PCIF1, XKR6
risk factor of metabolic syndrome	risk of cancer	Telomere length	LOC100133738
	risk of diabetes mellitus	Two-hour glucose challenge	GIPR, TCF7L2, GCKR, VPS13C, ADCY5
risk factor of metabolic syndrome	risk of gout	Serum urate	SLC17A3, SLC2A9, ABCG2
		Serum uric acid	SLC17A1, SLC16A9, SLC2A9, SLC22A11, ABCG2, ARHGAP26, SLC22A12, LRRC16, GCKR
risk factor of metabolic syndrome	risk of hypertension	Systolic blood pressure	CYP17A1, CACNB2, NT5C2, CASZ1, PLCD3, MTHFR, ATP2B1, SH2B3, PLEKHA7, MDS1
	Schizophrenia	Brain imaging in schizophrenia (interaction)	TNIK
		Schizophrenia	ANK3, CCDC60, ZNF804A, ACSM1, AGBL1, TCF4, NOTCH4, PLAA, RELN, HLA-DRB5

Supplementary Table 1. Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	Select biomarker traits	Select biomarker traits	UNC13C, DRD2, CADM3, FCER1A, HIF1A
	Serum bilirubin raised	Serum bilirubin levels	SLC22A18, SLC01B1, ARHGEF7, UGT1A9
	Serum creatinine abnormal	Serum creatinine	SLC22A2, CCDC123, TBX2, SHROOM3
	Serum iron concentration	Serum iron concentration	TMPRSS6
	Serum markers of iron status	Serum markers of iron status	LUZP2, GHR, BTN1A1, LOC100131818, SLC17A1, TF, HFE, ARSB, LRRC16, KLHL13, TMPRSS6
	Serum matrix metalloproteinase	Serum matrix metalloproteinase	SLC24A3
	Serum metabolites	Serum metabolites	ANKRD30A, GPC5, FADS1, ACADS, ACADL, FGF12, LOC201725, PARK2, A2BP1
	skeletal finding	Height	HOMER1, HMGA2, PTCH1, ZBTB38, ZNF510, ADAMTSL3, CEP63, SUPT3H, PLAG1, FREM1, NTAN1, PDE3A, CATSPER4, GNA12, EXT1, NUP153, QSOX2, LOC730194, ANKFN1, DOT1L, ZNF678, TNRC6B, HHIP, GPR133, JAZF1, NHEJ1, LCORL, TNXB, CDK6, ETV6, CEP250, TSEN15, C12orf48, CYP19A1, SH3GL3, WDR60, C6orf106, LOC389328, LIN28B, ATP13A2, GPR126, CENTA2, LTBP1, EFEMP1, CABLES1, ADAMTS17, ZNF462, C20orf86, IGF1, BCR, MKL1, UQCC, DGKH, CDH13, PLEKHA1, SCMH1, DIS3L2, EFR3B, DNM3, L3MBTL3, MAP3K3, ADAMTS10, FUBP3, GLT25D2, RAB40C, PAPPA, TRIP11, ACAN, TMED10, COL27A1, PPIL6
		Anthropometric traits	GRIA1, SGCD, SEZ6L2, IFI27L1
		Bone mineral density	RBMS3, ADAMTS18, TGFBR3, CNTNAP2, JAG1, LRP5, CTNNDL1, IL21R
		Bone mineral density (hip)	CKAP5, C6orf97, C17orf53, HDAC5, GPR177, ZNF408
		Bone mineral density (spine)	C6orf97, SPTBN1, GPR177, SP7, HDAC5, LOC344382, LRP5
		Digit length ratio	LIN28B
		Hip bone size	PLCL1
		Hip geometry	VAMP1, NRG1, GPR98, KCNH8, PHACTR1
		Hippocampal atrophy	EFNA5, LOC100129762, MAGI2, MAL2, ZBP1, ARSB, C20orf132
		Sleep duration	Sleep duration
	Soluble ICAM-1	Soluble ICAM-1	ICAM1, ABO, ICAM4
	Soluble leptin receptor levels	Soluble leptin receptor levels	LEPR
	Soluble levels of adhesion molecules	Soluble levels of adhesion molecules	SELP, ICAM1
	Sphingolipid concentrations	Sphingolipid concentrations	FADS3, ATP10D
	Systemic lupus erythematosus	Systemic lupus erythematosus	TNIP1, BANK1, C10orf64, ITGAM, NTNG2, ETS1, ITGAX, HIP1, NEGR1, RASGRP3, SLC15A4, LRRC18, HLA-DQA1, TNFAIP3, BLK, MSH5, STAT4, KIAA1542, PXX, WDFY4
	Systemic sclerosis	Systemic sclerosis	CD247, STAT4
cancer	Testicular germ cell tumor	Testicular germ cell tumor	BAK1, UCK2, KITLG
	Thromboembolic disorder	Venous thromboembolism	ABO
	Thyroid stimulating hormone	Thyroid stimulating hormone	TMEM196, HACE1
metabolic syndrome	Type 2 diabetes and other traits	Type 2 diabetes and other traits	SLC30A8, WFS1, CDKAL1, TCF7L2
	Type B viral hepatitis	Hepatitis B	HLA-DPB1

Supplementary Table 1. Manual Curation of textual terms representing complex traits and diseases in NHGRI GWAS Catalog.

Metatrait	Complex Trait and Diseases (Curated Concept Used for Similarity Metric)	Complex Trait and Diseases (Original NHGRI Term)	Host Gene (dbSNP)
	Ulcerative colitis	Ulcerative colitis	CARD9, IL23R, NKX2-3, PUS10, RNF186, ZFP90, FCGR2A, SATB2, LAMB1, GSDMB, IL26, IL10, MST1, OTUD3, CIITA, IL17REL, C1orf106, CCHCR1, BTNL2, BSN
	Vascular calcification	Coronary artery calcification	NUMB, UTP20
	Vitamin D levels	Vitamin D levels	CYP2R1, GC, NADSYN1
	Vitiligo	Vitiligo	UBASH3A, SMOC2, TYR, LPP, C1QTNF6, PTPN22, BTNL2, RERE, HCG9, IL2RA, GZMB
risk factor of metabolic syndrome	Waist circumference	Waist circumference	NRXN3, FTO, LOC100132788
		Waist circumference and related phenotypes	GCKR
	Warfarin maintenance dose	Warfarin maintenance dose	CYP2C9, STX4, CYP4F2, CACNA1C, VKORC1
metabolic syndrome	Weight	Weight	BICD1, SEC16B, LPP, ADAMTS14, CCDC100, LOC100132353, BDNF, FTO, CCDC46, SH2B1, DUPD1
	YKL-40 levels	YKL-40 levels	CHI3L1

Supplementary Table 2: Enrichment of direct and indirect protein-protein interactions in gene-gene pairs with high information similarity on a genome scale and in the subset of host genes for complex traits in NHGRI GWAS Catalog

Genome-wide	num of			NHGRI-wide GO			
GO biological processes	5753 genes			biological processes	num of genes		457
	ITS>=0.7	ITS<=0.7	subtotal	ITS>=0.7	ITS<=0.7	subtotal	
PPIN_8	7,314	41,710	49,024	PPIN_8	25	384	409
Not in PPIN	53,714	16,442,890	16,496,604	Not in PPIN	285	103,502	103,787
subtotal	61,028	16,484,600	16,545,628	subtotal	310	103,886	104,196
Odds ratio	53.68	FET	<2.2E-16	Odds ratio	23.64	FET	<2.2E-16
	ITS>=0.8	ITS<=0.8	subtotal	ITS>=0.8	ITS<=0.8	subtotal	
PPIN_8	4,881	44,143	49,024	PPIN_8	19	390	409
Not in PPIN	30,091	16,466,513	16,496,604	Not in PPIN	138	103,649	103,787
subtotal	34,972	16,510,656	16,545,628	subtotal	157	104,039	104,196
Odds ratio	60.51	FET	<2.2E-16	Odds ratio	36.59	FET	<2.2E-16
	ITS>=0.9	ITS<=0.9	subtotal	ITS>=0.9	ITS<=0.9	subtotal	
PPIN_8	2,368	46,656	49,024	PPIN_8	10	399	409
Not in PPIN	11,859	16,484,745	16,496,604	Not in PPIN	49	103,738	103,787
subtotal	14,227	16,531,401	16,545,628	subtotal	59	104,137	104,196
Odds ratio	70.55	FET	<2.2E-16	Odds ratio	53.06	FET	4.12E-14
	ITS>=0.7	ITS<=0.7	subtotal	ITS>=0.7	ITS<=0.7	subtotal	
PPIN distance<=2	15,194	622,791	637,985	PPIN distance<=2	73	5,379	5,452
PPIN distance>2	45,834	15,861,809	15,907,643	PPIN distance>2	237	98,507	98,744
subtotal	61,028	16,484,600	16,545,628	subtotal	310	103,886	104,196
Odds ratio	8.44	FET	<2.2E-16	Odds ratio	5.64	FET	<2.2E-16
	ITS>=0.8	ITS<=0.8	subtotal	ITS>=0.8	ITS<=0.8	subtotal	
PPIN distance<=2	9,342	628,643	637,985	PPIN distance<=2	40	5,412	5,452
PPIN distance>2	25,630	15,882,013	15,907,643	PPIN distance>2	117	98,627	98,744
subtotal	34,972	16,510,656	16,545,628	subtotal	157	104,039	104,196
Odds ratio	9.21	FET	<2.2E-16	Odds ratio	6.23	FET	<2.2E-16
	ITS>=0.9	ITS<=0.9	subtotal	ITS>=0.9	ITS<=0.9	subtotal	
PPIN distance<=2	4,422	633,563	637,985	PPIN distance<=2	14	5,438	5,452
PPIN distance>2	9,805	15,897,838	15,907,643	PPIN distance>2	45	98,699	98,744
subtotal	14,227	16,531,401	16,545,628	subtotal	59	104,137	104,196
Odds ratio	11.32	FET	<2.2E-16	Odds ratio	5.65	FET	1.6E-06
						minimal significance	

Supplementary Table 2: Enrichment of direct and indirect protein-protein interactions in gene-gene pairs with high information similarity on a genome scale and in the subset of host genes for complex traits in NHGRI GWAS Catalog

genome-wide				NHGRI-wide			
GO molecular functions	num of genes		5955	GO molecular functions	num of genes		463
	ITS>=0.7	ITS<=0.7	subtotal		ITS>=0.7	ITS<=0.7	subtotal
PPIN_8	5,413	47,112	52,525	PPIN_8	45	383	428
Not in PPIN	138,125	17,537,385	17,675,510	Not in PPIN	485	106,040	106,525
subtotal	143,538	17,584,497	17,728,035	subtotal	530	106,423	106,953
Odds ratio	14.59 FET		<2.2e-16	Odds ratio	25.69 FET		<2.2e-16
minimal odds ratio							
	ITS>=0.8	ITS<=0.8	subtotal		ITS>=0.8	ITS<=0.8	subtotal
PPIN_8	4,066	48,459	52,525	PPIN_8	32	396	428
Not in PPIN	70,189	17,605,321	17,675,510	Not in PPIN	206	106,319	106,525
subtotal	74,255	17,653,780	17,728,035	subtotal	238	106,715	106,953
Odds ratio	21.05 FET		<2.2e-16	Odds ratio	41.71 FET		<2.2e-16
	ITS>=0.9	ITS<=0.9	subtotal		ITS>=0.9	ITS<=0.9	subtotal
PPIN_8	1,748	50,777	52,525	PPIN_8	10	418	428
Not in PPIN	22,495	17,653,015	17,675,510	Not in PPIN	45	106,480	106,525
subtotal	24,243	17,703,792	17,728,035	subtotal	55	106,898	106,953
Odds ratio	27.02 FET		<2.2e-16	Odds ratio	56.61 FET		2.36E-14
	ITS>=0.7	ITS<=0.7	subtotal		ITS>=0.7	ITS<=0.7	subtotal
PPIN	19,507	641,877	661,384	PPIN	197	5,438	5,635
distance<=2				distance<=2			
PPIN	124,031	16,942,620	17,066,651	PPIN	333	100,985	101,318
distance>2				distance>2			
subtotal	143,538	17,584,497	17,728,035	subtotal	530	106,423	106,953
Odds ratio	4.15 FET		<2.2e-16	Odds ratio	10.99 FET		<2.2e-16
minimal odds ratio							
	ITS>=0.8	ITS<=0.8	subtotal		ITS>=0.8	ITS<=0.8	subtotal
PPIN	12,255	649,129	661,384	PPIN	111	5,524	5,635
distance<=2				distance<=2			
PPIN	62,000	17,004,651	17,066,651	PPIN	127	101,191	101,318
distance>2				distance>2			
subtotal	74,255	17,653,780	17,728,035	subtotal	238	106,715	106,953
Odds ratio	5.18 FET		<2.2e-16	Odds ratio	16.01 FET		<2.2e-16
	ITS>=0.9	ITS<=0.9	subtotal		ITS>=0.9	ITS<=0.9	subtotal
PPIN	4,770	656,614	661,384	PPIN	32	5,603	5,635
distance<=2				distance<=2			
PPIN	19,473	17,047,178	17,066,651	PPIN	23	101,295	101,318
distance>2				distance>2			
subtotal	24,243	17,703,792	17,728,035	subtotal	55	106,898	106,953
Odds ratio	6.36 FET		<2.2e-16	Odds ratio	25.15 FET		<2.2e-16

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Recombination rate (females)	Recombination rate (males)	1	1	1	1	0.0005
	Hemoglobin E/beta					
F-cell distribution	thalassemia disease	1	1	1	1	0.0011
Thromboembolic disorder	YKL-40 levels	1	1	0	0.85	0.001
Plasma level of vitamin B12	Thromboembolic disorder	1	1	0	0.8	0.0011
	risk factor rheumatoid					
Osteoarthritis of knee	arthritis	2	1	1	0.67	0.0012
Mass of body structure	Weight	9	11	6	0.6	0
Hemoglobin E/beta thalassemia disease	Kawasaki's disease	1	2	0	0.59	0.0019
F-cell distribution	Kawasaki's disease	1	2	0	0.59	0.0013
Acenocoumarol maintenance dosage	Warfarin					
	maintenance dose	2	5	1	0.57	0
Adenocarcinoma of lung	Malignant tumor of lung	4	8	3	0.5	0
Soluble ICAM-1	Thromboembolic disorder	3	1	1	0.5	0.0022
Glioma	Idiopathic fibrosing alveolitis	3	1	1	0.5	0.0016
Malignant tumor of pancreas	Thromboembolic disorder	3	1	1	0.5	0.0019
Neoplasm of testis	Testicular germ cell tumor	1	3	1	0.5	0.0019
risk factor of atherosclerosis-0	risk factor of atherosclerosis-1	23	31	12	0.49	0
Sphingolipid concentrations	Warfarin					
	maintenance dose	2	5	0	0.46	0.0003
Primary biliary cirrhosis	Systemic sclerosis	3	2	0	0.45	0.0005
Malignant tumor of esophagus	Thromboembolic disorder	2	1	0	0.45	0.0054
Gallbladder calculus	Left ventricular mass	1	1	0	0.45	0.0097
Soluble ICAM-1	YKL-40 levels	3	1	0	0.43	0.0042
Malignant tumor of pancreas	YKL-40 levels	3	1	0	0.43	0.0045
Injury of liver	Thromboembolic disorder	3	1	0	0.43	0.0042
risk factor of atherosclerosis-1	risk of atherosclerosis	31	19	9	0.42	0

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Blood pressure finding	risk of hypertension	15	10	5	0.42	0
Alcohol dependence	Panic disorder	3	6	0	0.42	0.0001
Malignant tumor of nasopharynx	Type B viral hepatitis	2	1	0	0.41	0.0072
Alcohol dependence	Systemic sclerosis	3	2	0	0.40	0.0015
Folate pathway vitamin levels	Plasma level of vitamin B12	4	1	1	0.4	0.0026
Adenocarcinoma of lung	Idiopathic fibrosing alveolitis	4	1	1	0.4	0.0019
Juvenile idiopathic arthritis	Primary biliary cirrhosis	2	3	1	0.4	0.0049
Drowsy	Neurosis	2	3	1	0.4	0.0055
Soluble ICAM-1	Soluble levels of					
	adhesion molecules	3	2	1	0.4	0.0055
Aortic root dilatation	Glaucoma	3	2	1	0.4	0.0049
Malignant tumor of pancreas	Plasma level of vitamin B12	3	1	0	0.4	0.0043
Plasma level of vitamin B12	YKL-40 levels	1	1	0	0.4	0.011
Plasma level of vitamin B12	Soluble ICAM-1	1	3	0	0.4	0.0047
Malignant tumor of esophagus	Plasma level of vitamin B12	2	1	0	0.38	0.0091
Hypertensive disorder	risk of hypertension	4	10	2	0.37	0.0001
Acenocoumarol maintenance dosage	Sphingolipid concentrations	2	2	0	0.37	0.0076
Fasting Glucose (Diabetes-related)	risk of diabetes mellitus	14	5	3	0.36	0
Kawasaki's disease	Systemic sclerosis	2	2	0	0.36	0.01
	risk factor of diabetes					
Panic disorder	and of obesity	6	3	0	0.35	0.0008
Neoplasm of testis	myeloproliferative disorder	1	1	0	0.35	0.0138
risk factor of atherosclerosis-0	risk of atherosclerosis	23	19	7	0.35	0
Hypertensive disorder	Serum matrix metalloproteinase	4	1	0	0.35	0.0047
Serum matrix metalloproteinase	atherosclerosis	1	4	0	0.35	0.0043
Thromboembolic disorder	diabetes II or I	1	4	0	0.34	0.0053
YKL-40 levels	diabetes II or I	1	4	0	0.34	0.0065

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Biomedical quantitative traits	Thyroid stimulating hormone	4	2	0	0.33	0.0071
Birth weight finding	risk of diabetes mellitus	1	5	1	0.33	0.0023
Coronary arteriosclerosis	risk factor of atherosclerosis-0.5	5	1	1	0.33	0.0026
Malignant tumor of pancreas	Soluble ICAM-1	3	3	1	0.33	0.0081
Basal cell carcinoma of skin	Thyroid stimulating hormone	1	2	0	0.33	0.0128
Diabetes mellitus type 2	Type 2 diabetes and other traits	16	4	3	0.33	0
Alcohol dependence	Primary biliary cirrhosis	3	3	0	0.32	0.0108
Folate pathway vitamin levels	Thromboembolic disorder	4	1	0	0.32	0.0064
Cerebrovascular accident	Hirschsprung's disease	2	2	0	0.32	0.0154
Cerebrovascular accident	heart function	2	4	0	0.32	0.0073
Hearing loss	Serum iron concentration	2	1	0	0.32	0.0149
Acquired immune deficiency syndrome (AIDS)	Hemoglobin E/beta thalassemia disease	5	1	0	0.31	0.0026
Acquired immune deficiency syndrome (AIDS)	F-cell distribution	5	1	0	0.31	0.0045
Adenocarcinoma of lung	Malignant tumor of pancreas	4	3	1	0.31	0.0048
Menarche and menopause (age at onset)	Menopause (age at onset)	5	8	2	0.31	0.0011
Inflammatory bowel disease	Leprosy	7	3	1	0.31	0.001
Aging	Warfarin maintenance dose	4	5	0	0.30	0.004
Amyotrophic lateral sclerosis	brain structure	14	17	0	0.30	0.0001
Serum matrix metalloproteinase	diabetes II or I	1	4	0	0.30	0.0049
Serum matrix metalloproteinase	Type 2 diabetes and other traits	1	4	0	0.30	0.0082
Kawasaki's disease	Menarche (age at onset)	2	2	0	0.30	0.0169
Kawasaki's disease	Restless legs	2	4	0	0.30	0.0111
Conduct disorder	Hearing loss	6	2	0	0.30	0.0032

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Kawasaki's disease	Primary biliary cirrhosis	2	3	0	0.30	0.014
Alzheimer's disease	C-reactive protein	9	9	2	0.29	0.001
Mass of body structure	Waist circumference	9	4	1	0.29	0.0009
Hypertensive disorder	Sphingolipid concentrations	4	2	0	0.29	0.0131
Menarche (age at onset)	Menarche and menopause (age at onset)	2	5	1	0.29	0.0085
Adenocarcinoma of lung	Glioma	4	3	1	0.29	0.0118
Atrial fibrillation	Ischemic stroke risk factor of diabetes atherosclerosis	6	1	1	0.29	0.003
Other metabolic traits	and of obesity diabetes II or I	4	3	1	0.29	0.0103
Injury of liver	Malignant tumor of pancreas	4	4	1	0.29	0.0082
Injury of liver	Malignant tumor of pancreas	3	3	0	0.28	0.017
Hypertensive disorder	Soluble ICAM-1	3	3	0	0.28	0.0174
Angiotensin-converting-enzyme inhibitor adverse reaction	Warfarin maintenance dose risk factor of atherosclerosis-0.5	4	5	0	0.28	0.0068
Serum matrix metalloproteinase	Warfarin maintenance dose	1	1	0	0.28	0.0233
Serum iron concentration	Systemic sclerosis	1	5	0	0.28	0.007
cardiac function	cardiovascular function	1	2	0	0.28	0.0204
Chronic leukemia	cardiovascular function	23	6	4	0.28	0
Major depressive disorder	heart function	6	4	0	0.28	0.0055
Alzheimer's disease	eye function	11	9	1	0.27	0.0015
Coagulation factor VII (substance)	Major depressive disorder	9	11	0	0.27	0.0014
Malignant tumor of esophagus	Serum iron concentration	1	1	0	0.27	0.025
Malignant tumor of esophagus	Malignant tumor of pancreas	2	3	0	0.27	0.0193
Crohn's disease	Soluble ICAM-1	2	3	0	0.27	0.0189
Atrial fibrillation	Ulcerative colitis	17	20	4	0.27	0.0006
Neoplasm of testis	cardiovascular function	6	6	0	0.27	0.0048
	Otosclerosis	1	1	0	0.27	0.0249

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Neoplasm of testis	Neuroblastoma	1	1	0	0.27	0.0273
Acquired immune deficiency syndrome (AIDS)	Kawasaki's disease	5	2	0	0.27	0.0115
Malignant tumor of esophagus	YKL-40 levels	2	1	0	0.27	0.0228
Malignant tumor of esophagus	Osteoporosis	2	1	0	0.27	0.0228
Acenocoumarol maintenance dosage	Osteoporosis	2	1	0	0.27	0.0204
Glaucoma	Osteoporosis	2	1	0	0.27	0.0217
QT interval	cardiac function	15	23	4	0.27	0.0004
Folate pathway vitamin levels	Malignant tumor of pancreas	4	3	0	0.26	0.0171
Hearing loss	Primary biliary cirrhosis	2	3	0	0.26	0.0192
Kawasaki's disease	Response to diuretic therapy	2	1	0	0.26	0.0214
Serum bilirubin raised	Serum matrix metalloproteinase	4	1	0	0.26	0.0138
Hemoglobin E/beta thalassemia disease	Systemic sclerosis	1	2	0	0.26	0.0238
F-cell distribution	Systemic sclerosis	1	2	0	0.26	0.0245
Crohn's disease	Inflammatory bowel disease	17	7	3	0.26	0.0001
Atrial fibrillation	Hypertensive disorder	6	4	0	0.26	0.0082
Fasting Glucose (Diabetes-related)	diabetes II or I	14	4	2	0.26	0.0008
Hearing loss	Select biomarker traits	2	5	0	0.26	0.0166
Drowsy	Response to diuretic therapy	2	1	0	0.26	0.0251
Select biomarker traits	immune system	5	3	1	0.26	0.0109
Atrial fibrillation	Coronary arteriosclerosis	6	5	0	0.26	0.0085
Birth weight finding	Response to citalopram treatment	1	2	0	0.26	0.0275
Major depressive disorder	Response to statin therapy	11	13	0	0.25	0.0029
Crohn's disease	Leprosy	17	3	2	0.25	0
Hypertensive disorder	Major depressive disorder	4	11	0	0.25	0.0025
Waist circumference	Weight	4	11	1	0.25	0.0025

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Kidney stone	Malignant tumor of nasopharynx	1	2	0	0.25	0.0252
Eosinophilic esophagitis	Serum creatinine abnormal	6	4	1	0.25	0.0104
Atrial fibrillation	Hemoglobin E/beta					
Atrial fibrillation	thalassemia disease	6	1	0	0.25	0.0064
Atrial fibrillation	F-cell distribution	6	1	0	0.25	0.0063
Malignant tumor of pancreas	Response to diuretic therapy	3	1	0	0.25	0.0168
Asthma	immune system	5	3	1	0.25	0.019
Atrial fibrillation	Kawasaki's disease	6	2	1	0.25	0.0097
Diabetic renal disease	Response to treatment for acute lymphoblastic					
Acenocoumarol maintenance dosage	leukemia	1	7	1	0.25	0.0049
Acenocoumarol maintenance dosage	Malignant tumor of esophagus	2	2	0	0.25	0.0277
Glaucoma	Glaucoma	2	2	0	0.25	0.0273
Cerebrovascular accident	Malignant tumor of esophagus	2	2	0	0.25	0.028
Biomedical quantitative traits	Hearing loss	2	2	0	0.25	0.0283
Osteoarthritis	Waist circumference	4	4	1	0.25	0.0161
Acquired immune deficiency syndrome (AIDS)	inflammation	1	3	0	0.25	0.0192
Type 2 diabetes and other traits	Injury of liver	5	3	1	0.25	0.0157
Alcohol dependence	diabetes II or I	4	4	1	0.25	0.0204
Other metabolic traits	Ankylosing spondylitis	3	5	1	0.25	0.0173
Folate pathway vitamin levels	Waist circumference	4	4	1	0.25	0.0226
Folate pathway vitamin levels	Quantitative traits	4	15	1	0.25	0.0004
Aging	Warfarin maintenance dose	4	5	0	0.25	0.0124
Panic disorder	Serum bilirubin raised	4	4	0	0.25	0.0213
brain structure	Systemic sclerosis	6	2	0	0.25	0.0119
	eye function	17	9	0	0.25	0.0022

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Malignant tumor of nasopharynx	Soluble levels of adhesion molecules	2	2	0	0.25	0.0298
Aging	Lentigo	4	2	0	0.25	0.0214
Lentigo	Primary tooth development (number of teeth)	2	4	0	0.24	0.0212
Soluble ICAM-1	diabetes II or I	3	4	0	0.24	0.0229
Malignant tumor of pancreas	diabetes II or I	3	4	0	0.24	0.0242
Coronary arteriosclerosis	Serum matrix metalloproteinase	5	1	0	0.24	0.0089
Schizophrenia	Systemic lupus erythematosus	11	20	0	0.24	0.0009
Alcohol dependence	Response to treatment for acute lymphoblastic leukemia	3	7	0	0.24	0.0074
Hearing loss	Hirschsprung's disease	2	2	0	0.24	0.0287
Kawasaki's disease	Response to TNF antagonist treatment	2	3	0	0.24	0.0232
Alcohol dependence	Kawasaki's disease	3	2	0	0.24	0.0309
Chronic leukemia	Conduct disorder	6	6	0	0.24	0.0138
Acquired immune deficiency syndrome (AIDS)	Psoriasis	5	8	1	0.24	0.0103
Hearing loss	Serum bilirubin raised	2	4	0	0.24	0.0212
Acute lymphoid leukemia	Atrial fibrillation	10	6	0	0.24	0.0062
Serum bilirubin raised	Sphingolipid concentrations	4	2	0	0.23	0.0253
C-reactive protein	brain structure	9	17	2	0.23	0.0031
Aging	Mass of body structure	4	9	0	0.23	0.0068
C-reactive protein	Other metabolic traits	9	4	1	0.23	0.0076
Malignant tumor of pancreas	Response to treatment for acute lymphoblastic leukemia	3	7	0	0.23	0.0103
Celiac disease	Systemic lupus erythematosus	23	20	2	0.23	0.0034

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Neuroblastoma	myeloproliferative disorder	1	1	0	0.23	0.0319
Chronic leukemia	Primary tooth development (number of teeth)	6	4	0	0.23	0.0146
Hirschsprung's disease	Restless legs	2	4	0	0.23	0.0233
Blood pressure finding	Hypertensive disorder	15	4	2	0.23	0.0008
Psoriasis	Systemic lupus erythematosus	8	20	1	0.23	0.0013
Serum matrix metalloproteinase	cardiovascular function	1	6	0	0.23	0.009
Conduct disorder	Serum metabolites	6	9	1	0.23	0.0099
C-reactive protein	Fasting Glucose (Diabetes-related)	9	14	1	0.23	0.0065
Coagulation factor VII (substance)	Diabetic renal disease	1	1	0	0.23	0.0318
Quantitative traits	cardiovascular function	15	6	0	0.23	0.0029
Folate pathway vitamin levels	Soluble ICAM-1	4	3	0	0.23	0.0314
Aging	Serum matrix metalloproteinase	4	1	0	0.23	0.0149
Aging	Lesion of brain risk factor of diabetes	4	2	0	0.23	0.0242
Birth weight finding	and of obesity risk factor of	1	3	0	0.23	0.0234
C-reactive protein	atherosclerosis-0	9	23	3	0.23	0.0017
Exercise (leisure time)	Serum iron concentration	1	1	0	0.23	0.0323
Response to statin therapy	Sphingolipid concentrations	13	2	0	0.23	0.0004
Malignant tumor of pancreas	liver function	3	8	1	0.23	0.0097
Major depressive disorder	Panic disorder	11	6	1	0.23	0.0078
HIV	Psoriasis	20	8	1	0.23	0.0025
Major depressive disorder	risk of hypertension	11	10	0	0.23	0.0108
Coronary arteriosclerosis	Serum bilirubin raised	5	4	0	0.22	0.0205
Kawasaki's disease	cardiovascular function	2	6	0	0.22	0.0164
Fasting Glucose (Diabetes-related)	risk of gout	14	10	1	0.22	0.0113

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Chronic renal impairment	Serum creatinine abnormal	17	4	2	0.22	0.0011
Response to statin therapy	eye function	13	9	1	0.22	0.0112
Cerebrovascular accident	Chronic leukemia	2	6	0	0.22	0.0165
Disorder of coronary artery Response to treatment for acute lymphoblastic leukemia	Myocardial infarction	7	5	1	0.22	0.0168
Aging	Systemic sclerosis	7	2	0	0.22	0.0069
Hirschsprung's disease	eye function	4	9	0	0.22	0.0101
Waist circumference	heart function	2	4	0	0.22	0.0283
Type 2 diabetes and other traits	risk of diabetes mellitus	4	5	1	0.22	0.0288
Fasting Glucose (Diabetes-related)	risk of diabetes mellitus	4	5	1	0.22	0.0279
Fasting Glucose (Diabetes-related)	Type 2 diabetes and other traits	14	4	2	0.22	0.0029
Serum iron concentration	Other metabolic traits	14	4	2	0.22	0.0026
Other metabolic traits	risk factor of atherosclerosis-0.5	1	1	0	0.22	0.0347
Thromboembolic disorder	risk of diabetes mellitus	4	5	1	0.22	0.0276
Acute lymphoid leukemia	liver function	1	8	1	0.22	0.0065
Osteoporosis	cardiovascular function	10	6	0	0.22	0.0126
Acenocoumarol maintenance dosage	Sphingolipid concentrations	1	2	0	0.22	0.036
Blood pressure finding	Chronic leukemia	2	6	0	0.22	0.0184
Injury of liver	Major depressive disorder	15	11	0	0.22	0.0106
Alzheimer's disease	Psoriasis	3	8	1	0.22	0.0099
Hemoglobin E/beta thalassemia disease	Amyotrophic lateral sclerosis	9	14	1	0.22	0.0087
F-cell distribution	Menarche (age at onset)	1	2	0	0.22	0.036
Menarche (age at onset)	Menarche (age at onset)	1	2	0	0.22	0.0377
Restless legs	Primary biliary cirrhosis	2	3	0	0.22	0.0325
	Schizophrenia	4	11	0	0.22	0.0062

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Malignant tumor of esophagus	liver function	2	8	0	0.22	0.0074
Acute lymphoid leukemia	Response to statin therapy	10	13	0	0.22	0.0135
Cerebrovascular accident	Systemic sclerosis	2	2	0	0.21	0.039
Hearing loss	Systemic sclerosis	2	2	0	0.21	0.0356
Celiac disease	Diabetes mellitus type 1	23	40	4	0.21	0.004
Aging	inflammation	4	3	0	0.21	0.0343
Malignant tumor of nasopharynx	risk factor of diabetes and of obesity	2	3	0	0.21	0.0356
Diabetic renal disease	nevi (skin)	1	1	0	0.21	0.0337
Lentigo	Vitiligo	2	11	1	0.21	0.0021
Acquired immune deficiency syndrome (AIDS)	Systemic sclerosis	5	2	0	0.21	0.0243
Panic disorder	Primary biliary cirrhosis	6	3	0	0.21	0.0246
Biochemical measures	Response to statin therapy	8	13	0	0.21	0.013
Cerebrovascular accident	Restless legs	2	4	0	0.21	0.0292
Aging	atherosclerosis	4	4	0	0.21	0.0337
Hemoglobin E/beta thalassemia disease	Response to diuretic therapy	1	1	0	0.21	0.0361
F-cell distribution	Response to diuretic therapy	1	1	0	0.21	0.0328
Response to statin therapy	cardiovascular function	13	6	0	0.21	0.0096
Atrial fibrillation	risk of hypertension	6	10	1	0.21	0.0168
Major depressive disorder	cardiovascular function	11	6	0	0.21	0.0153
Serum markers of iron status	risk of gout	11	10	2	0.21	0.0166
C-reactive protein	Coronary arteriosclerosis	9	5	1	0.21	0.0168
Fasting Glucose (Diabetes-related)	Major depressive disorder	14	11	0	0.21	0.0132
Alzheimer's disease	Select biomarker traits	9	5	0	0.21	0.0174
Mass of body structure	eye function	9	9	0	0.21	0.0206
Atrial fibrillation	Serum creatinine abnormal	6	4	0	0.21	0.0282

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
cardiovascular function	eye function	6	9	0	0.21	0.02
Acquired immune deficiency syndrome (AIDS)	Restless legs	5	4	0	0.21	0.0346
Chronic leukemia	Hearing loss	6	2	0	0.21	0.0265
Weight	eye function	11	9	0	0.21	0.0195
Biochemical measures	risk of gout	8	10	1	0.21	0.0246
Otosclerosis	myeloproliferative disorder	1	1	0	0.21	0.0372
Serum metabolites	integument color	9	18	1	0.21	0.0102
Primary tooth development (number of teeth)	immune system	4	3	0	0.21	0.0372
Panic disorder	Psoriasis	6	8	0	0.21	0.0232
Kawasaki's disease	Malignant tumor of pancreas	2	3	0	0.21	0.0347
Amyotrophic lateral sclerosis	eye function	14	9	0	0.21	0.0171
Alcohol dependence	cardiovascular function	3	6	0	0.21	0.0299
C-reactive protein	risk of gout	9	10	1	0.20	0.026
Primary biliary cirrhosis	Response to treatment for acute lymphoblastic leukemia	3	7	0	0.20	0.018
Thyroid stimulating hormone	risk factor of atherosclerosis-0.5	2	1	0	0.20	0.0399
Alzheimer's disease	brain structure	9	17	1	0.20	0.0112
C-reactive protein	Quantitative traits	9	15	1	0.20	0.0167
Ageing	risk of gout	4	10	0	0.20	0.0142
Finding of bilirubin level	YKL-40 levels	2	1	0	0.20	0.0375
Major depressive disorder	atherosclerosis	11	4	0	0.20	0.0114
nevi (skin)	risk factor of atherosclerosis-0.5	1	1	0	0.20	0.0366
Lentigo	Soluble leptin receptor levels	2	1	0	0.20	0.0388
Kawasaki's disease	Menarche and menopause (age at onset)	2	5	0	0.20	0.0302
Acquired immune deficiency syndrome (AIDS)	Response to statin therapy	5	13	1	0.20	0.012

Supplementary Table 3: Detailed information about 280 trait-trait similarity connections selected as significant ones among traits

trait1	trait2	number of hostgenes in trait1	number of hostgene in trait2	number of overlapping hostgenes	ITS of GO:BP	P-value of ITS
Chronic leukemia	Hirschsprung's disease	6	2	0	0.20	0.0262
Acenocoumarol maintenance dosage	Aortic root dilatation	2	3	0	0.2	0.0427
Restless legs	cardiovascular function	4	6	1	0.2	0.0366
Hemoglobin E/beta thalassemia disease	Primary biliary cirrhosis	1	3	0	0.2	0.0347
Lentigo	integument color	2	18	2	0.2	0.0001
Cerebrovascular accident	Lesion of brain	2	2	0	0.2	0.0478
C-reactive protein	Soluble leptin receptor levels	9	1	1	0.2	0.0049
Aortic root dilatation	Malignant tumor of esophagus	3	2	0	0.2	0.0435
Aortic root dilatation	Osteoporosis	3	1	0	0.2	0.0325
Malignant neoplastic disease	nevi (skin)	9	1	1	0.2	0.0049
Alcohol dependence	Cerebrovascular accident	3	2	0	0.2	0.0411
Alcohol dependence	Hearing loss	3	2	0	0.2	0.0398
Response to citalopram treatment	Systemic sclerosis	2	2	0	0.2	0.0493
Hearing loss	Lesion of brain	2	2	0	0.2	0.0468
Injury of liver	Plasma level of vitamin B12	3	1	0	0.2	0.0328
Basal cell carcinoma of skin	Biomedical quantitative traits	1	4	0	0.2	0.0268
F-cell distribution	Primary biliary cirrhosis	1	3	0	0.2	0.0348
Ageing	Osteoarthritis	4	1	0	0.2	0.0254