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Currently Recognized Genes for Schizophrenia: High-Resolution Chromosome Ideogram Representation

Merlin G. Butler^{1,2,*}, Austen B. McGuire¹, Humaira Masoud¹, Ann M. Manzardo¹

¹Department of Psychiatry and Behavioral Sciences, University of Kansas Medical Center, Kansas City, Kansas

²Department of Pediatrics, University of Kansas Medical Center, Kansas City, Kansas

Abstract

A large body of genetic data from schizophrenia-related research has identified an assortment of genes and disturbed pathways supporting involvement of complex genetic components for schizophrenia spectrum and other psychotic disorders. Advances in genetic technology and expanding studies with searchable genomic databases have led to multiple published reports, allowing us to compile a master list of known, clinically relevant, or susceptibility genes contributing to schizophrenia. We searched key words related to schizophrenia and genetics from peer-reviewed medical literature sources, authoritative public access psychiatric websites and genomic databases dedicated to gene discovery and characterization of schizophrenia. Our list of 560 genes were arranged in alphabetical order in tabular form with gene symbols placed on high-resolution human chromosome ideograms. Genome wide pathway analysis using GeneAnalytics was carried out on the resulting list of genes to assess the underlying genetic architecture for schizophrenia. Recognized genes of clinical relevance, susceptibility or causation impact a broad range of biological pathways and mechanisms including ion channels (e.g., *CACNA1B*, *CACNA1C*, *CACNA1H*), metabolism (e.g., *CYP1A2*, *CYP2C19*, *CYP2D6*), multiple targets of neurotransmitter pathways impacting dopamine, GABA, glutamate, and serotonin function, brain development (e.g., *NRG1*, *RELN*), signaling peptides (e.g., *PIK3CA*, *PIK4CA*) and immune function (e.g., *HLA-DRB1*, *HLA-DQA1*) and interleukins (e.g., *IL1A*, *IL10*, *IL6*). This summary will enable clinical and laboratory geneticists, genetic counselors, and other clinicians to access convenient pictorial images of the distribution and location of contributing genes to inform diagnosis and gene-based treatment as well as provide risk estimates for genetic counseling of families with affected relatives.

Keywords

schizophrenia spectrum; genetic biomarkers; gene distribution and location; autism spectrum disorder

*Correspondence to: Merlin G. Butler, M.D., Ph.D., University of Kansas Medical Center, Department of Psychiatry and Behavioral Sciences, 3901 Rainbow Boulevard, MS 4015, Kansas City, KS 66160, mbutler4@kumc.edu.

INTRODUCTION

Schizophrenia is a chronic debilitating psychiatric disorder that affects approximately 1% of the general population; occurring equally across gender and ethnicity [National Institute of Mental Health Web site, <http://www.nimh.nih.gov/health/topics/schizophrenia/index.shtml>]. The disorder is characterized by delusions, hallucinations, disorganized speech and behavior, and other symptoms that hinder daily functioning [American Psychiatric Association, 2013]. These symptoms and other factors associated with schizophrenia have serious negative effects on individuals and society as a whole including high risk of suicide, unemployment, and substance abuse [Andreasen and Black, 2006; Andrew et al., 2012]. Despite the relatively low frequency of illness, the economic burden for both the direct and indirect costs of schizophrenia is estimated to be in the tens of billions of dollars [Chong et al., 2014]. Schizophrenia is recognized as one of the most burdening disabilities globally by the World Health Organization [WHO, 2008]. Given the seriousness and devastating effects of this disorder, both for the diagnosed individual and society, it is important for researchers to understand factors that contribute to schizophrenia including genetics, the focus of this review.

Several decades of research support the role of genetics in the development, diagnosis, and treatment of schizophrenia [Riley and Kendler, 2006; Kavanagh et al., 2015]. An approximate 10-fold increased frequency of schizophrenia is reported among relatives with affected family members compared with relatives of normal controls (i.e., 4.8% to 0.5%, respectively) [Kendler and Diehl, 1993]. Twin studies in schizophrenia have reported concordance rates as high as 85% for monozygotic twins, and 25% for dizygotic twins [Franzek and Beckmann, 1998]. Additionally, schizophrenia prevalence in a study of over two million Swedish families showed a significantly increased frequency and risk of schizophrenia in adopted children from biological parents with schizophrenia when compared to those children adopted away from parents without schizophrenia [Lichtenstein et al., 2009]. Combined twin and family studies and meta-analysis approaches have estimated that the heritability of schizophrenia is as high as 80% [Cardno and Gottesman, 2000].

The importance of genes in the etiology of schizophrenia is reinforced by advances in genetic technology and consortium studies with combined patient databases and genetic analytical approaches (e.g., linkage, genome wide association studies [GWAS], chromosomal variants, functional assessments, next generation sequencing and high-resolution microarrays utilizing single nucleotide polymorphism, and copy number probes). No clear relationship has been found to explain observed genetic risks and specific DNA variants or pathways with biological processes or protein alterations, but over-lapping data from regions of the human genome does support linkage (e.g., *DTNBPI*, *NRG1*, *TAAR6*) or identification of candidate genes (e.g., *COMT*, *AKT1*, *RGS4*) in schizophrenia [Riley and Kendler, 2006]. The emergence of a number of replicated genetic linkage studies have identified targeted chromosomal regions of interest and candidate gene locations. For example, there is growing evidence for linkage replication across several chromosomal regions including 1q, 5q, 6p, 6q, 8p, 10p, 13q, 15q, and 22q [Riley and Kendler, 2006]. Recently, the Schizophrenia Working Group of the Psychiatric Genomics Consortium [2014]

identified 108 potential schizophrenia-associated genetic loci. Focused attention on molecular genetics and these chromosome regions have identified several potential candidate genes for schizophrenia.

Schizophrenia spectrum and other related disorders, which include schizoaffective, schizophreniform, delusional, and schizotypal personality disorders, are also increased in family members of those with schizophrenia and can be components of single-gene defects, such as *COMT* and *PRODH* mutations or copy number variants as a component of syndromic cytogenetic disorders including the 22q11.2 deletion, but most individuals with schizophrenia are non-syndromic [Riley and Kendler, 2006]. The high-heritability estimates for schizophrenia further emphasize the need to explore genetic causation for diagnosis and to inform and guide gene-based treatment options depending on specific genetic disturbances or lesions. A large number of validated genes are now recognized as playing a pivotal role in schizophrenia [Riley and Kendler, 2006; Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium, 2011; Schizophrenia Working Group of the Psychiatric Genomics Consortium, 2014; Kavanagh et al., 2015]. Hence, a current list is needed of recognized clinically relevant, susceptible, or known genes as genetic biomarkers for schizophrenia. These genetic biomarkers can then be assessed to identify the role in schizophrenia and for new diagnostic approaches in the clinical evaluation of those presenting with schizophrenia as well as supplying more accurate and informative genetic counseling for family members.

The goal of our study was to utilize high-resolution chromosome ideograms (850 band level) and plot the location of genes identified by searching the literature, genetic databases, and consortium and authoritative federally sponsored websites for genes playing a documented role in schizophrenia. In tabular form, the individual gene symbols will be listed in alphabetical order along with their expanded names or description and chromosome location. The reader will then be able to quickly identify the gene of interest and access conveniently the visual image of the location and distribution of specific genes on individual high-resolution chromosome ideograms. To further assess the underlying genetic architecture of schizophrenia, we used the GeneAnalytics (<http://geneanalytics.genecards.org/>) and VarElect (<http://varelect.genecards.org/>) data analysis computer tools to map the identified genes to tissues and cells, diseases, phenotypes, molecular pathways, and biological processes with the greatest overlap and probable relevance to schizophrenia.

METHODS

For our study, we used computer-based authoritative internet websites, schizophrenia genomics consortiums databases and peer-reviewed medical literature reports to search for genes associated with schizophrenia. We initially examined the literature and databases utilizing pertinent key words (i.e., human genes, gene variants, genetics, mutations, schizophrenia) searching for sources with involvement of genetics in the etiology of schizophrenia. Source materials included genetic linkage and functional associations from peer-reviewed research articles and authoritative computer website genomic databases on this topic in humans. Disequilibrium data, single nucleotide polymorphisms, or copy number

variation supporting a relationship between the individual gene and schizophrenia were reviewed. We found data from whole-genome sequencing of families with relatives having schizophrenia and large collaborative research consortiums on schizophrenia and psychosis gene expression or transcriptome profiles, genetic linkage, copy number variation, and genome wide association studies (GWAS). Hundreds of published research articles were reviewed from PubMed (<https://www.ncbi.nlm.nih.gov/pubmed>) and a list of genes were compiled having more than one source contributing to schizophrenia. Our report compiled a current list of recognized genes with proposed associations with schizophrenia causation, pathology, or course with possible impact on treatment response (e.g., drug metabolism). The number of clinically relevant genes impacting schizophrenia is expected to expand as additional causal genes and gene/phenotype associations will be reported in the future using expanding genetic tools such as next generation sequencing, copy number variant analysis and data from large collaborative research consortiums [International Schizophrenia Consortium, 2009; Stefansson et al., 2009; Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium, 2011; Ripke et al., 2013; Schizophrenia Working Group of the Psychiatric Genomics Consortium, 2014].

Our approach also focused on integrated online gene disease catalogs particularly Mendelian Inheritance in Man (OMIM) (www.OMIM.org) and other respected and searchable sources, such as the National Center for Biotechnology Information (NCBI) (<http://www.ncbi.nlm.nih.gov/>), PubMed (<https://www.ncbi.nlm.nih.gov/pubmed>), GeneCards (<https://www.genecards.org>), and Phenopedia (<http://www.hugenavigator.net/HuGENavigator/startPagePhenoPedia.do>). The literature sources that were searched consisted of both primary research articles and meta-analyses with reviews summarizing genetic evidence from several sources. If possible, specific sources for genes associated with schizophrenia embedded in meta-analyses and reviews were extracted and used in development of the master gene summary table. Genes located within potential loci regions were not included, unless a specific gene was located or documented in another source.

For each gene fitting our criteria, the gene symbol, expanded name, chromosome band location, and a reference source for each gene was compiled in a master summary table (Table I). The master table was organized alphabetically by gene symbol. The most current gene information, such as location and symbol, was obtained from OMIM and GeneCards with each gene plotted on high-resolution chromosome ideograms (850 band level) (Fig. 1).

Genome wide pathway analysis was carried out for the derived gene master list and all mapped genomic variants associated with schizophrenia using a commercially available software program and data analysis application, GeneAnalytics (<http://geneanalytics.genecards.org/>) which is part of the GeneCards Suite developed by LifeMap Sciences (<http://www.lifemapsc.com/products/genecards-suite-premium-tools/>). GeneCards Suite provides enhanced gene variant prioritization, gene feature, and pathway analysis through three premium analytical tools: VarElect, the NGS phenotyper, GeneAnalytics™, a novel gene set analysis tool, and GeneALaCart, the GeneCards batch querying application. These applications are integrated with GeneCards® human gene database, MalaCards human disease database, PathCards, human biological pathways database, and LifeMap Discovery®

tissues and cells database to provide an extensive universe of data from human genes, proteins, cells, biological pathways, diseases and their relationships.

The GeneAnalytics program was used to organize mammalian gene sets into functional categories based upon tissues and cells, diseases, pathways, GO-biological processes, GO-molecular function, phenotypes, and compounds (endogenous or exogenous) with functional links to the queried schizophrenia gene set. Gene ontology (GO) terms (e.g., superpathways and GO-biological function) were scored based upon transformation of the binomial P -value which is equivalent to a corrected P -value with significance defined at $P < 0.0001$. Disease-matching scores were derived based upon the number of overlapping genes and the nature of the gene-disease association. Tissues and cells were scored using a matching algorithm that weighs tissue specificity, abundance, and function of the gene. Related pathways were then grouped into superpathways to improve inferences, pathway enrichment, reduce redundancy, and rank genes within a biological mechanism via the multiplicity of constituent pathways.

RESULTS AND DISCUSSION

Based on existing literature in peer-reviewed journal articles and computer genomic-based websites for schizophrenia, we identified a total of 560 recognized or proposed, clinically relevant or susceptibility genes for schizophrenia. VarElect NGS phenotyping of the derived list of genes identified a direct relationship between 465 of those genes and schizophrenia phenotype; 86 genes were indirectly associated with schizophrenia phenotype; two genes were found to be unrelated to schizophrenia phenotype (*COMTD1*, *LIRE1*) and seven genes were not recognized by the VarElect application. Our analysis considered the spatial relationship of the identified genes to ascertain any patterning or potential for hot spot regions relevant to causation or course. This analysis was necessarily adjusted for the total length of the chromosome which is related to the total number of genes per chromosome. Our master list of genes or genetic markers provides additional support for previous reports of targeted chromosomal regions associated with schizophrenia. For example, chromosomes 1, 6, and 22 contained genetic regions previously identified as areas of interest for schizophrenia [Riley and Kendler, 2006]. These three chromosomes also possessed over 30% of the total number of genes identified on our master gene list but reflect only 15% of the chromosomal material by size in humans [Shaffer et al., 2012] (Table II). When examining the distribution of genes by chromosome arm for these top three chromosomes (i.e., 1, 6, 22), we found that chromosome 1, considered the largest human chromosome with nearly equal length short (p) and long (q) arms, contained a similar number of genes on each chromosome arm. In contrast, chromosome 22 is the second smallest chromosome but had the third highest number of genes recorded for schizophrenia. Chromosome 22 is an acrocentric chromosome as are chromosomes 13, 14, 15, and 21 and contain only ribosomal genes on their p arms. Chromosome 6 is approximately two-thirds the length of chromosome 1, but showed an unexpectedly high number of schizophrenia genes in relationship to its size. In addition, the short arm of chromosome 6 is about one-half the size of the long arm but contained three times the number of genes for schizophrenia than the long arm. Interestingly, the major histocompatibility immune function gene complex is located on the short arm of chromosome 6.

Genome wide pathway analysis found the identified genes with a proposed role in schizophrenia and of potential clinical relevance for susceptibility, causation, treatment response, or course of illness impacted a broad range of biological pathways, mechanisms, tissues, and cell types including significant association with the cerebellum, cerebral cortex, medulla, thalamus, hypothalamus, pons, and amygdala. These genes were significantly associated with 10 recognized disease states with strongest overlap to schizophrenia (score = 126.6, 141 of 239 genes) supporting the validity of our compiled list to predict phenotype. Additionally, disease states, such as obesity (score = 32.3, 44 of 576 genes), breast cancer (score = 32.2, 47 of 781 genes), malaria (score = 28.8, 35 of 335 genes), rheumatoid arthritis (score = 24.2, 37 of 502 genes), bipolar disorder (score = 23.0, 20 of 31 genes), lung cancer (score = 22.4, 34 of 622 genes), colorectal cancer (score = 22.2, 37 of 807), and obsessive-compulsive disorder (score = 211, 15 of 17) significantly overlapped with our compiled gene list and may suggest genetic pleiotropic relationships with clinical relevance to co-morbidity and outcome. Not surprisingly, 20 different GeneAnalytics molecular pathways associated with our gene list impacted ionotropic glutamate and GABA activity, protein/amino acid binding, transporter activity and receptor binding/function for dopamine and serotonin were broadly represented by significant associations with 69 biological processes in 95 superpathways. Pathways and mechanisms included ion channels (e.g., *CACNA1B*, *CACNA1C*, *CACNA1H*), metabolic enzymes (e.g., *CYP1A2*, *CYP2C19*, *CYP2D6*), brain development (e.g., *NRG1*, *RELN*), signaling peptides (e.g., *PIK3CA*, *PIK4CA*), and immune function (e.g., *HLA-A*, *HLA-DRB1*) and interleukins [e.g., *IL1A*, *IL10*, *IL6*]. Multiple genes involved with neurotransmitter function were identified impacting dopamine (e.g., *DRD1*, *DRD2*), GABA (e.g., *GABBR1*, *GABRA1*), and serotonin (e.g., *HTR1A*, *HTR2C*) pathways with a large number directly tied to glutamate processing (e.g., *GADI*, *GLUL*) and signaling (e.g., *GRIK3*, *GRM5*).

To further assess the role of genetics in the neurodevelopment and function, we compared our list of proposed schizophrenia genes with a separate list of genes recently recognized in Autism Spectrum Disorders (ASD) [Butler et al., 2015]. Researchers have sought to uncover the similarities and differences between these two common neurobehavioral disorders [Cheung et al., 2010; Meyer et al., 2011; Hommer and Swedo, 2015]. We found overlap with a shared group of 116 genes between the two disorders (Table I), and the list of genes, their names, expression, and function may begin to suggest possible mechanisms including epigenetics playing a role in schizophrenia as well as a multifactorial basis. VarElect NGS phenotyping similarly identified a direct relationship between 191 genes from our schizophrenia gene list and autism phenotype; 352 genes were indirectly associated with autism phenotype; 10 genes were found to be unrelated to autism phenotype (seven genes were not recognized). The master list of recognized genes represented several molecular mechanisms further supporting that schizophrenia is not due to a single condition but results from a combination of neurochemical disturbances and manifest themselves differently across affected people. The changes that occur over time in those with schizophrenia may represent endophenotypes of the disorder that are genetically based and include interactions with environmental factors (epigenetics). More studies are required in schizophrenia to address these observations and patterns in affected individuals. Research involving the

common genes should further advance our knowledge in the causation of brain disorders, psychiatry, neurological function, and development.

Better understanding of factors contributing to schizophrenia can be advanced through the genetic testing and analysis of several types of tissue sources (e.g., peripheral blood and saliva) and not solely brain specimens. Progress in the field of genetics has made tissue sources, such as the ones previously mentioned, readily available for testing; helping to accelerate the potential for discovery of novel genes associated with schizophrenia. For example, a growing number of biological specimens exist at tissue bank repositories for obtaining RNA to study transcription or coding with non-coding expression pattern profiles in individuals with schizophrenia, along with other brain disorders.

The authors encourage the use of this collection of recognized or proposed clinically relevant candidate and susceptibility genes and biomarkers for schizophrenia in their evaluation of patients and families presenting for genetic services requiring accurate information for diagnosis, genetic counseling risk estimates, and natural history and prognostic concerns. Early detection of schizophrenia, possibly through the use of genetic involvement, may help reduce the potentially devastating long-term effects of the disorder for an individual [Abbas and Lieberman, 2015]. A comprehensive approach should include a clinical genetics evaluation to rule out dysmorphic features or recognizable syndromes in which schizophrenia is a feature, cytogenetic or metabolic testing, identification of single gene disorders, or the use of high-resolution microarrays to identify subtle structural abnormalities supported by next generation DNA sequencing analysis for discovery of new gene mutations or variants. Interviews with parents for collection of family history and individual medical records are needed for support from health caregivers and their record overviews of medical history information. Additionally, a three-generation family pedigree should be obtained to include recording of developmental milestones and description with recording of onset of atypical behaviors and triggering events, if any.

A current list of medications and ongoing treatments with list of previous medications and outcomes, along with diagnostic or surgical procedures, should be obtained and may be helpful, given the role genetics play in medication metabolism and effects as several key cytochrome p450 hepatic enzymes involved with medication/drug metabolism were identified and included in our master list [Smith et al., 2015]. Pharmacogenetics has also been shown to contribute in weight gain as side effects associated with antipsychotic medications [Kao and Müller, 2013; Smith et al., 2015]. Also, much of the time a single type of antipsychotic medication is not sufficient to manage symptoms and these medications are often taken in conjunction with other psychoactive medications, such as mood stabilizers and antidepressants [Abbas and Lieberman, 2015]. Genetic information regarding medication metabolism and selectivity could potentially aid health care providers to optimize safety and efficacy of treatment plans for their patients. Furthermore, brain imaging and electroencephalogram patterns should be reviewed, if available, along with analysis of routine laboratory test results to assess drug screens, liver, vision, kidney and cardiac function, metabolic and immune status, complete blood counts, and neurological system findings.

In summary, we illustrated the master list of recognized or proposed clinically relevant, susceptible genes for schizophrenia as genetic biomarkers by plotting on individual high-resolution chromosome ideograms. We generated a table to increase awareness required for diagnosis, genetic testing, and counseling purposes for family members presenting for neuropsychiatric and genetic services. Creating a master list of genes related to schizophrenia is a complicated process; new genes are continually identified, but not all genes are equally important as biomarkers or certain to be causative. The authors encourage the undertaking of additional research to further investigate the causal relationships between specific genes and schizophrenia and understanding the molecular pathways that lead to this debilitating neuropsychiatric disorder.

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FIG. 1.

High resolution human chromosome ideograms (850 band level) with gene symbols representing currently recognized genes for schizophrenia plotted on chromosome bands for each of the 560 genes. The centromere area is highlighted in black which separates the upper short 'p' arm from the lower long 'q' arm for each chromosome. The gene symbols are arranged in alphabetical order with the expanded name and precise chromosome band location listed in Table 1. [Color figure can be seen in the online version of this article, available at <http://wileyonlinelibrary.com/journal/ajmgb>].

TABLE I.

Currently Recognized Genes for Schizophrenia and Their Chromosome Locations

Gene symbol	Gene name	Location	References
ABAI ^a	4-Aminobutyrate aminotransferase	<i>16p13.2</i>	Tabarés-Seisdedos et al. [2011]
ABCA13	ATP (adenosine triphosphate)-binding cassette, subfamily A, member 13	<i>7p12.3</i>	Knight et al. [2009]
ABCB1	ATP-binding cassette, sub-family B (MDR/TAP), member 1	<i>7q21.12</i>	Tabarés-Seisdedos et al. [2011]
ACADVL	Acyl-CoA dehydrogenase, very long chain	<i>17p13.1</i>	Sanders et al. [2013]
ACE	Angiotensin I converting enzyme	<i>17q23.3</i>	Tabarés-Seisdedos et al. [2011]
ACHE	Acetylcholinesterase	<i>7q221</i>	Tabarés-Seisdedos et al. [2011]
ACSL6	Acyl-CoA synthetase long-chain family member 6	<i>5q31.1</i>	Tabarés-Seisdedos et al. [2011]
ACSM1	Acyl-CoA synthetase medium-chain family member 1	<i>16p12.3</i>	Athanasou et al. [2010]
ADCY1	Adenylate cyclase 1	<i>7p12.3</i>	Wright et al. [2013]
ADCY9	Adenylate cyclase 9	<i>16p13.3</i>	Wright et al. [2013]
ADCYAP1	Adenylate cyclase activating polypeptide 1	<i>18p11.32</i>	Tabarés-Seisdedos et al. [2011]
ADIPOQ	Adiponectin, C1Q, and collagen domain containing	<i>3q27.3</i>	Tabarés-Seisdedos et al. [2011]
ADORA2A ^a	Adenosine A2a receptor	<i>22q11.23</i>	Tabarés-Seisdedos et al. [2011]
ADRA1A	Adrenoceptor alpha 1A	<i>8p21.2</i>	Tabarés-Seisdedos et al. [2011]
ADRA2A	Adrenoceptor alpha 2A	<i>10q25.2</i>	Tabarés-Seisdedos et al. [2011]
ADRA2C	Adrenoceptor alpha 2C	<i>4p16.3</i>	Tabarés-Seisdedos et al. [2011]
ADRB3	Adrenoceptor beta 3	<i>8p11.23</i>	Tabarés-Seisdedos et al. [2011]
ADRBK2	Adrenergic, beta, receptor kinase 2	<i>22q12.1</i>	Tabarés-Seisdedos et al. [2011]
ADSS	Adenylosuccinate synthase	<i>1q44</i>	Tabarés-Seisdedos et al. [2011]
AHCYL2	Adenosylhomocysteinase-like 2	<i>7q32.1</i>	Wright et al. [2013]
AHI1 ^a	Abelson helper integration site 1	<i>6q23.3</i>	Ingason et al. [2010]
AKT1 ^a	V-Akt murine thymoma viral oncogene homolog 1	<i>14q32.33</i>	Shi et al. [2008]
AKT3	V-Akt murine thymoma viral oncogene homolog 3	<i>1q44</i>	Ripke et al. [2013]
ALDH3B1	Aldehyde dehydrogenase 3 family, member B1	<i>11q13.2</i>	Tabarés-Seisdedos et al. [2011]
ALDH5A1 ^a	Aldehyde dehydrogenase 5 family, member A1	<i>6p22.31</i>	Tabarés-Seisdedos et al. [2011]
ANK3 ^a	Ankyrin 3	<i>10q21.2</i>	Athanasou et al. [2010]
ANKK1	Ankyrin repeat and kinase domain containing 1	<i>11q23.2</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
APBA2^a	Amyloid beta (A4) precursor protein-binding, family A, member 2	<i>15q13.1</i>	Tabarés-Seisdedos et al. [2011]
APOD	Apolipoprotein D	<i>3q29</i>	Tabarés-Seisdedos et al. [2011]
APOE	Apolipoprotein E	<i>19q13.32</i>	Allen et al. [2008]
APOL1	Apolipoprotein L-I	<i>22q12.3</i>	Mimmack et al. [2002]
APOL2	Apolipoprotein L-II	<i>22q12.3</i>	Mimmack et al. [2002]
APOL4	Apolipoprotein L-IV	<i>22q12.3</i>	Mimmack et al. [2002]
AR^a	Androgen receptor	<i>Xq12</i>	Tabarés-Seisdedos et al. [2011]
ARHGAP18	Rho GTPase activating protein 18	<i>6p22.33</i>	Potkin et al. [2009]
ARHGAP44	Rho GTPase activating protein 44	<i>17p12</i>	Wright et al. [2013]
ARNTL	Aryl hydrocarbon receptor nuclear translocator-like	<i>11p15.2</i>	Tabarés-Seisdedos et al. [2011]
ARRB2	Arrestin, beta 2	<i>17p13.2</i>	Tabarés-Seisdedos et al. [2011]
ARVCF	Armadillo repeat gene deleted in velocardiofacial syndrome	<i>22q11.21</i>	Tabarés-Seisdedos et al. [2011]
AS3MT	Arsenic (+3 oxidation state) methyltransferase	<i>10q24.32</i>	Aberg et al. [2006]
ASCL1	Achaete-scute family bHLH transcription factor 1	<i>12q23.2</i>	Tabarés-Seisdedos et al. [2011]
ASTN2^a	Astrotactin 2	<i>9q33.1</i>	Wang et al. [1996]
ATF2	Activating transcription factor 2	<i>2q31.1</i>	Tabarés-Seisdedos et al. [2011]
ATF4	Activating transcription factor 4	<i>22q131</i>	Tabarés-Seisdedos et al. [2011]
ATF5	Activating transcription factor 5	<i>19q13.33</i>	Tabarés-Seisdedos et al. [2011]
ATP5A1	ATP synthase, H+ transporting, mitochondrial F1 complex, alpha subunit 1	<i>18q21.1</i>	Lauriat et al. [2006]
ATXN1	Ataxin 1	<i>6p22.33</i>	Wang et al. [1996]
ATXN80S	Ataxin 8 opposite strand	<i>13q21.33</i>	Tabarés-Seisdedos et al. [2011]
AUTS2^a	Autism susceptibility candidate 2	<i>7q11.22</i>	Tabarés-Seisdedos et al. [2011]
AXIN1	Axis inhibitor 1	<i>16p13.3</i>	Wright et al. [2013]
B3GNT2	Beta-1,3-n-acetylglucosaminyltransferase 2	<i>2p15</i>	Sanders et al. [2013]
BARD1	BRCA1 (breast cancer 1 gene) associated RING domain 1	<i>2q35</i>	van Schijndel et al. [2009]
BAI3	Brain-specific angiogenesis inhibitor 3	<i>6q12</i>	Wright et al. [2013]
BCL2L13	BCL2 (B-cell CLL/lymphoma 2)-like 13 (apoptosis facilitator)	<i>22q11.21</i>	Wright et al. [2013]
BCL2L2	BCL2-like 2	<i>14q11.2</i>	Sanders et al. [2013]
BCL9	B-cell CLL (chronic lymphocytic leukemia)/lymphoma 9	<i>1q21.2</i>	Xu and He [2010]
BDNF^a	Brain-derived neurotrophic factor	<i>11p14.1</i>	Wockner et al. [2014]

Gene symbol	Gene name	Location	References
BIK	BCL2-interacting killer	<i>22q13.31</i>	Sanders et al. [2013]
BRD1	Bromodomain containing 1	<i>22q13.33</i>	Kushima et al. [2010]
BTN2A2	Butyrophilin, subfamily 2, member A2	<i>6p22.2</i>	Shi et al. [2009]
BTN3A1	Butyrophilin, subfamily 3, member A1	<i>6p22.2</i>	Shi et al. [2009]
BTN3A2	Butyrophilin, subfamily 3, member A2	<i>6p22.2</i>	Shi et al. [2009]
C12orf65	Chromosome 12 open reading frame 65	<i>12q24.31</i>	Ripke et al. [2013]
C2orf82	Chromosome 2 open reading frame 82	<i>2q37.1</i>	Ripke et al. [2013]
CACNA1B^a	Calcium channel, voltage-dependent, N-type, alpha 1B subunit	<i>9q34.3</i>	Tabarés-Seisdedos et al. [2011]
CACNA1C^a	Calcium channel, voltage-dependent, L-type, alpha 1C subunit	<i>12p13.33</i>	Neale and Sklar [2015]
CACNA1H^a	Calcium channel, voltage-dependent, T-type, alpha 1H subunit	<i>16p13.3</i>	Wright et al. [2013]
CACNB2^a	Calcium channel, voltage-dependent, beta 2 subunit	<i>10p12.33</i>	Neale and Sklar [2015]
CACNG2	Calcium channel, voltage-dependent, gamma subunit 2	<i>22q12.3</i>	Tabarés-Seisdedos et al. [2011]
CAMK2B	Calcium/calmodulin-dependent protein kinase II beta	<i>7p13</i>	Novak et al. [2000]
CARTPT	CART (cocaine and amphetamine regulated transcript) prepropeptide	<i>5q13.2</i>	Tabarés-Seisdedos et al. [2011]
CBS^a	Cystathionine-beta-synthase	<i>21q22.3</i>	Tabarés-Seisdedos et al. [2011]
CCDC68	Coiled-coil domain containing 68	<i>18q21.2</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
CCK	Cholecystokinin	<i>3p22.1</i>	Tabarés-Seisdedos et al. [2011]
CCKAR	Cholecystokinin A receptor	<i>4p15.2</i>	Ocklenburg et al. [2013]
CCL2	Chemokine (C-C motif) ligand 2	<i>17q12</i>	Tabarés-Seisdedos et al. [2011]
CD28	Antigen CD28	<i>2q33.2</i>	Frydecka et al. [2015]
CDC42	Cell division cycle 42	<i>1p36.12</i>	Wright et al. [2013]
CDC42SE2	CDC42 (cell division cycle 42) small effector 2	<i>5q31.1</i>	Tabarés-Seisdedos et al. [2011]
CDK6	Cyclin-dependent kinase 6	<i>7q21.2</i>	Wright et al. [2013]
CEACAM21	Carcinoembryonic antigen-related cell adhesion molecule 21	<i>19q13.2</i>	Alkelai et al. [2012]
CERK	Ceramide kinase	<i>22q13.31</i>	Wright et al. [2013]
CHAT	Choline acetyltransferase	<i>10q11.23</i>	Tabarés-Seisdedos et al. [2011]
CHD1^a	Chromodomain helicase DNA (deoxyribonucleic acid) binding protein 1	<i>5q21.1</i>	Wright et al. [2013]
CHGA	Chromogranin A	<i>14q32.12</i>	Sun et al. [2008]
CHGB	Chromogranin B	<i>20p12.3</i>	Tabarés-Seisdedos et al. [2011]
CH3L1	Chitinase 3-like 1 (cartilage glycoprotein-39)	<i>1q32.1</i>	Ohi et al. [2010]

Gene symbol	Gene name	Location	References
CHL1	Cell adhesion molecule L1-like	<i>3p26.3</i>	Tabarés-Seisdedos et al. [2011]
CHRM1	Cholinergic receptor, muscarinic 1	<i>11q12.3</i>	Tabarés-Seisdedos et al. [2011]
CHRM2	Cholinergic receptor, muscarinic 2	<i>7q33</i>	Tabarés-Seisdedos et al. [2011]
CHRM5	Cholinergic receptor, muscarinic 5	<i>15q14</i>	Tabarés-Seisdedos et al. [2011]
CHRNA3	Cholinergic receptor, nicotinic, alpha 3 (neuronal)	<i>15q25.1</i>	Tabarés-Seisdedos et al. [2011]
CHRNA4	Cholinergic receptor, nicotinic, alpha 4 (neuronal)	<i>20q13.33</i>	Tabarés-Seisdedos et al. [2011]
CHRNA5	Cholinergic receptor, nicotinic, alpha 5 (neuronal)	<i>15q25.1</i>	Jackson et al. [2013]
CHRNA7^a	Cholinergic receptor, nicotinic, alpha 7 (neuronal)	<i>15q13.3</i>	Harrison and Weinberger [2005]
CHRN2	cholinergic receptor, nicotinic, beta 2 (neuronal)	<i>1q21.3</i>	Tabarés-Seisdedos et al. [2011]
CLDN5	Claudin 5	<i>22q11.21</i>	Tabarés-Seisdedos et al. [2011]
CLINT1	Clathrin interactor 1	<i>5q33.3</i>	Tabarés-Seisdedos et al. [2011]
CLOCK	Clock circadian regulator	<i>4q12</i>	Zhang et al. [2011]
CMYA5	Cardiomyopathy-associated protein 5	<i>5q14.1</i>	Chen et al. [2011b]
CNNM2	Cyclin M2	<i>10q24.32</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
CNP	Cyclic nucleotide phosphodiesterase	<i>17q21.2</i>	Tabarés-Seisdedos et al. [2011]
CNR1^a	Cannabinoid receptor 1	<i>6q15</i>	Tabarés-Seisdedos et al. [2011]
CNTF	Ciliary neurotrophic factor	<i>11q12.1</i>	Tabarés-Seisdedos et al. [2011]
CNTNAP2^a	Contactin-associated protein-like 2	<i>7q35</i>	Wang et al. [1996]
CNTNAP5^a	Contactin-associated protein-like 5	<i>2q14.3</i>	Tabarés-Seisdedos et al. [2011]
COMT	Catechol-O-methyltransferase	<i>22q11.21</i>	Allen et al. [2008]
COMTD1	Catechol-O-methyltransferase domain containing 1	<i>10q22.1</i>	Wockner et al. [2014]
CPLX2	Complexin 2	<i>5q35.2</i>	Tabarés-Seisdedos et al. [2011]
CRKL	V-erb avian sarcoma virus CT10 oncogene homolog-like	<i>22q11.21</i>	Wright et al. [2013]
CSF2RA	Colony stimulating factor 2 receptor, alpha, low-affinity (granulocyte-macrophage)	<i>Xp22.33</i>	Loe-Mie et al. [2010]
CSF2RB	Granulocyte-macrophage colony-stimulating factor receptor, beta	<i>22q12.3</i>	Tabarés-Seisdedos et al. [2011]
CSMD1^a	CUB (complement C1r/C1s, Uegf, Bmp1) and Sushi multiple domains 1	<i>8p23.2</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
CTLA4	Cytotoxic T-lymphocyte-associated protein 4	<i>2q33.2</i>	Frydecka et al. [2015]
CTNNA3^a	Catenin, alpha 3	<i>10q21.3</i>	Xu and He [2010]
CYBB	Cytochrome b-245, beta polypeptide	<i>Xp11.4</i>	Sanders et al. [2013]

Gene symbol	Gene name	Location	References
CYP17A1	Cytochrome P450, family 17, subfamily A, polypeptide 1	10q24.32	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
CYP1A2	Cytochrome P450, family 1, subfamily A, polypeptide 2	15q24.1	Tabarés-Seisdedos et al. [2011]
CYP2C19	Cytochrome P450, family 2, subfamily C, polypeptide 19	10q23.33	Tabarés-Seisdedos et al. [2011]
CYP2D6	Cytochrome P450, family 2, subfamily D, polypeptide 6	22q13.2	Allen et al. [2008]
CYP3A4	Cytochrome P450, family 3, subfamily A, polypeptide 4	7q22.1	Tabarés-Seisdedos et al. [2011]
CYP3A5	cytochrome P450, family 3, subfamily A, polypeptide 5	7q22.1	Tabarés-Seisdedos et al. [2011]
DAO	D-amino-acid oxidase	12q24.11	Harrison and Weinberger [2005]
DAOA	D-amino acid oxidase activator	13q33.2	Shi et al. [2008]
DAOAAS	DAOA (D-amino acid oxidase activator) antisense RNA (ribonucleic acid) 1	13q33.2	Chumakov et al. [2002]
DBH	Dopamine beta-hydroxylase	9q34.2	Tabarés-Seisdedos et al. [2011]
DBNDD2	Dysbindin domain containing 2	20q13.12	Sanders et al. [2013]
DBP	D site of albumin promoter binding protein	19q13.33	Sanders et al. [2013]
DCDC2	Doublecortin domain containing 2	6p22.31	Tabarés-Seisdedos et al. [2011]
DDC ^a	Dopa decarboxylase	7p12.1	Tabarés-Seisdedos et al. [2011]
DGCR2	DiGeorge syndrome critical region gene 2	22q11.21	Tabarés-Seisdedos et al. [2011]
DGCR8	DiGeorge syndrome critical region gene 8	22q11.21	Chun et al. [2014]
DICER1	Dicer, Drosophila, homolog of, 1	14q32.13	Sanders et al. [2013]
DISC1 ^a	Disrupted in schizophrenia 1	1q42.2	Harrison and Weinberger [2005]
DISC2	Disrupted in schizophrenia 2	1q42.2	Millar et al. [2004]
DKK2	Dickkopf, Xenopus, homolog of, 2	4q25	van Schijndel et al. [2009]
DLG1	Discs, large homolog 1 (Drosophila)	3q29	Uezato et al. [2012]
DLG2	Discs, large homolog 2 (Drosophila)	11q14.1	Tabarés-Seisdedos et al. [2011]
DLG4 ^a	Discs, large homolog 4 (Drosophila)	17p11.2	Tabarés-Seisdedos et al. [2011]
DNMT1	DNA (cytosine-5)-methyltransferase 1	19p13.2	Guidotti et al. [2000]
DOC2A	Double C2-like domains, alpha	16p11.2	Tabarés-Seisdedos et al. [2011]
DOCK4 ^a	Dedicator of cytokinesis 4	7q31.1	Alkelai et al. [2012]
DPP10 ^a	Dipeptidyl-peptidase X	2q14.1	Tabarés-Seisdedos et al. [2011]
DPYD	Dihydropyrimidine dehydrogenase	1p21.3	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
DPYSL2	Dihydropyrimidinase-like 2	8p21.2	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
DR1	Down-regulator of transcription 1, TBP (TATA box-binding protein)-binding	<i>1p22.1</i>	Wright et al. [2013]
DRD1^a	Dopamine receptor D1	<i>5q35.2</i>	Allen et al. [2008]
DRD2^a	Dopamine receptor D2	<i>11q23.2</i>	Shi et al. [2008]
DRD3^a	Dopamine receptor D3	<i>3q13.31</i>	Williams et al. [1998]
DRD4	Dopamine receptor D4	<i>11p15.5</i>	Wockner et al. [2014]
DRD5	Dopamine receptor D5	<i>4p16.1</i>	Tabarés-Seisdedos et al. [2011]
DRP2	Dystrophin-related protein 2	<i>Xq22.1</i>	Tabarés-Seisdedos et al. [2011]
DTNBP1	Dystrobrevin-binding protein1	<i>6p22.33</i>	Shi et al. [2008]
EGF	Epidermal growth factor	<i>4q25</i>	Tabarés-Seisdedos et al. [2011]
EGR2^a	Early growth response 2	<i>10q21.3</i>	Tabarés-Seisdedos et al. [2011]
EGR3	Early growth response 3	<i>8p21.3</i>	Tabarés-Seisdedos et al. [2011]
ELK1	ELK1, member of ETS oncogene family	<i>Xp11.23</i>	Sanders et al. [2013]
EML5	Echinoderm microtubule-associated protein like 5	<i>14q31.3</i>	Chen et al. [2011a]
EN2^a	Engrailed 2	<i>7q36.3</i>	Wright et al. [2013]
ERBB3	V-erb-b2 avian erythroblastic leukemia viral oncogene homolog 3	<i>12q13.2</i>	Tabarés-Seisdedos et al. [2011]
ERBB4^a	V-erb-b2 avian erythroblastic leukemia viral oncogene homolog 4	<i>2q34</i>	Sun et al. [2008]
ESR1^a	Estrogen receptor 1	<i>6q25.1</i>	Tabarés-Seisdedos et al. [2011]
FAAH	Fatty acid amide hydrolase	<i>1p33</i>	Tabarés-Seisdedos et al. [2011]
FABP3^a	Fatty acid binding protein 3	<i>1p35.2</i>	Tabarés-Seisdedos et al. [2011]
FABP5^a	Fatty acid binding protein 5	<i>8q21.13</i>	Tabarés-Seisdedos et al. [2011]
FABP7^a	Fatty acid binding protein 7	<i>6q22.31</i>	Tabarés-Seisdedos et al. [2011]
FAM7A	Family with sequence similarity 7A	<i>15q13.2</i>	Riley et al. [2002]
FAM69A	Family with sequence similarity 69, member A	<i>1p22.1</i>	Sanders et al. [2013]
FAM84A	Family with sequence similarity 84, member A	<i>2p24.3</i>	Wright et al. [2013]
FAM135B^a	Family with sequence similarity 135, member B	<i>8q24.23</i>	Wright et al. [2013]
FEZ1	Fasciculation and elongation protein zeta 1	<i>11q24.2</i>	Tabarés-Seisdedos et al. [2011]
FGF1	Fibroblast growth factor 1	<i>5q31.3</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
FGR	Feline Gardner-Rasheed sarcoma viral oncogene homolog	<i>6q21</i>	Tabarés-Seisdedos et al. [2011]
FMNL2	Formin-like 2	<i>2q23.3</i>	Wright et al. [2013]
FNBP1L	Formin binding protein 1-like	<i>1p22.1</i>	Wright et al. [2013]
FOXP2^a	Forkhead box P2	<i>7q31.1</i>	Tabarés-Seisdedos et al. [2011]
FTCDNLI	Forminotransferase cyclodeaminase n-terminal like	<i>2q33.1</i>	Ripke et al. [2013]
FXYD2	FXYD domain containing ion transport regulator 2	<i>11q23.3</i>	Sun et al. [2008]
FXYD6	FXYD domain containing ion transport regulator 6	<i>11q23.3</i>	Choudhury et al. [2007]
FYN	FYN oncogene related to SRC (v-src avian sarcoma (Schmidt-Ruppin A-2) viral oncogene homolog)	<i>6q21</i>	Tabarés-Seisdedos et al. [2011]
FZD3	Frizzled class receptor 3	<i>8p21.1</i>	Tabarés-Seisdedos et al. [2011]
GABBR1	GABA (gamma-aminobutyric acid) B receptor, 1	<i>6p22.1</i>	Tabarés-Seisdedos et al. [2011]
GABRA1^a	GABA A receptor, alpha 1	<i>5q34</i>	Perryshen et al. [2005]
GABRA2	GABA A receptor, alpha 2	<i>4p12</i>	Tabarés-Seisdedos et al. [2011]
GABRA4^a	GABA A receptor, alpha 4	<i>4p12</i>	Tabarés-Seisdedos et al. [2011]
GABRA6	GABA A receptor, alpha 6	<i>5q34</i>	Perryshen et al. [2005]
GABRB2	GABA A receptor, beta 2	<i>5q34</i>	Allen et al. [2008]
GABRB3^a	GABA A receptor, beta 3	<i>15q12</i>	Tabarés-Seisdedos et al. [2011]
GABRG1	GABA A receptor, gamma-1	<i>4p12</i>	Tabarés-Seisdedos et al. [2011]
GABRG2	GABA A receptor, gamma-2	<i>5q34</i>	Tabarés-Seisdedos et al. [2011]
GABRG3	GABA A receptor, gamma-3	<i>15q12</i>	Tabarés-Seisdedos et al. [2011]
GABRR1	GABA A receptor, rho 1	<i>6q15</i>	Wang et al. [1996]
GABRR2	GABA A receptor, rho 2	<i>6q15</i>	Wang et al. [1996]
GABRP	GABA A receptor, pi	<i>5q35.1</i>	Perryshen et al. [2005]
GAD1^a	Glutamate decarboxylase 1	<i>2q31.1</i>	Tabarés-Seisdedos et al. [2011]
GAD2	Glutamate decarboxylase 2	<i>10p12.1</i>	Tabarés-Seisdedos et al. [2011]
GBP2	Guanylate binding protein 2, interferon-inducible	<i>1p22.2</i>	Sanders et al. [2013]
GBP4	Guanylate binding protein 4	<i>1p22.2</i>	Sanders et al. [2013]
GCLC	Glutamate-cysteine ligase, catalytic subunit	<i>6p12.1</i>	Gysin et al. [2007]
GCLM	Glutamate-cysteine ligase, subunit	<i>1p22.1</i>	Tosic et al. [2006]
GDNF	Glial cell derived neurotrophic factor	<i>5p13.2</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
GFRA2	GDNF family receptor alpha 2	8p21.3	Tabarés-Seisdedos et al. [2011]
GLIS2	GLIS (GLI-similar) family zinc finger 2	16p13.3	Wright et al. [2013]
GLO1^a	Glyoxalase I	6p21.2	Sanders et al. [2013]
GLS	Glutaminase	2q32.2	Tabarés-Seisdedos et al. [2011]
GLUD1	Glutamate dehydrogenase 1	10q23.2	Tabarés-Seisdedos et al. [2011]
GLUL	Glutamate-ammonia ligase	1q25.3	Tabarés-Seisdedos et al. [2011]
GNBIL^a	Guanine nucleotide binding protein, beta 1-like	22q11.21	Tabarés-Seisdedos et al. [2011]
GNB3	Guanine nucleotide binding protein, beta-3	12p13.31	Tabarés-Seisdedos et al. [2011]
GPHN^a	Gephyrin	14q23.3	Lionel et al. [2013]
GPR50	G protein-coupled receptor 50	Xq28	Thomson et al. [2005]
GPR85	G protein-coupled receptor 85	7q31.1	Matsumoto et al. [2008]
GPX1^a	Glutathione peroxidase 1	3p21.31	Tabarés-Seisdedos et al. [2011]
GRAMD4	GRAM domain containing 4	22q13.31	Wright et al. [2013]
GRIA1	Glutamate receptor, ionotropic, AMPA (alpha-amino-3-hydroxy-5-methyl-4-isoxazole propionate) 1	5q33.2	Tabarés-Seisdedos et al. [2011]
GRIA2	Glutamate receptor, ionotropic, AMPA 2	4q32.1	Tabarés-Seisdedos et al. [2011]
GRIA3	Glutamate receptor, ionotropic, AMPA 3	Xq25	Tabarés-Seisdedos et al. [2011]
GRIA4	Glutamate receptor, ionotropic, AMPA 4	11q22.3	Tabarés-Seisdedos et al. [2011]
GRID1^a	Glutamate receptor, ionotropic, delta 1	10q23.2	Tabarés-Seisdedos et al. [2011]
GRIK3	Glutamate receptor, ionotropic, kainate 3	1p34.3	Dai et al. [2014]
GRIK4	Glutamate receptor, ionotropic, kainate 4	11q23.3	Tabarés-Seisdedos et al. [2011]
GRIK5	Glutamate receptor, ionotropic, kainate 5	19q13.2	Tabarés-Seisdedos et al. [2011]
GRIN1^a	Glutamate receptor, ionotropic, N-methyl D-aspartate 1	9q34.3	Begni et al. [2003]
GRIN2A^a	Glutamate receptor, ionotropic, N-methyl D-aspartate 2A	16p13.2	Tabarés-Seisdedos et al. [2011]
GRIN2B^a	Glutamate receptor, ionotropic, N-methyl D-aspartate 2B	12p13.1	Allen et al. [2008]
GRIN2C	Glutamate receptor, ionotropic, N-methyl D-aspartate 2C	17q25.1	Tabarés-Seisdedos et al. [2011]
GRIN2D	Glutamate receptor, ionotropic, N-methyl D-aspartate 2D	19q13.33	Tabarés-Seisdedos et al. [2011]
GRIN3A	Glutamate receptor, ionotropic, N-methyl-D-aspartate 3A	9q31.1	Takata et al. [2013]
GRIN3B	Glutamate receptor, ionotropic, N-methyl-D-aspartate 3B	19p13.3	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
GRIP1^a	Glutamate receptor interacting protein 1	<i>12q14.3</i>	Tabarés-Seisdedos et al. [2011]
GRM2	Glutamate receptor, metabotropic 2	<i>3p21.2</i>	Tabarés-Seisdedos et al. [2011]
GRM3	Glutamate receptor, metabotropic 3	<i>7q21.11</i>	Harrison and Weinberger [2005]
GRM4^a	Glutamate receptor, metabotropic 4	<i>6p21.31</i>	Tabarés-Seisdedos et al. [2011]
GRM5^a	Glutamate receptor, metabotropic 5	<i>11q14.3</i>	Wright et al. [2013]
GRM7	Glutamate receptor, metabotropic 7	<i>3p26.1</i>	Tabarés-Seisdedos et al. [2011]
GRM8^a	Glutamate receptor, metabotropic 8	<i>7q31.33</i>	Tabarés-Seisdedos et al. [2011]
GSK3A	Glycogen synthase kinase 3 alpha	<i>19q13.2</i>	Tabarés-Seisdedos et al. [2011]
GSK3B^a	Glycogen synthase kinase 3 beta	<i>3q13.33</i>	Luo et al. [2014]
GSTM1^a	Glutathione S-transferase mu 1	<i>1p13.3</i>	Tabarés-Seisdedos et al. [2011]
GSTP1	Glutathione S-transferase pi 1	<i>11q13.2</i>	Tabarés-Seisdedos et al. [2011]
GSTT1	Glutathione S-transferase theta 1	<i>22q11.23</i>	Tabarés-Seisdedos et al. [2011]
GSTT2	Glutathione S-transferase theta 2	<i>22q11.23</i>	Tabarés-Seisdedos et al. [2011]
HCRTR1	Hypocretin receptor 1	<i>1p35.2</i>	Tabarés-Seisdedos et al. [2011]
HERC2^a	HECT domain and RCC1-like domain 2	<i>15q13.1</i>	Sanders et al. [2013]
HINT1	Histidine triad nucleotide-binding protein 1	<i>5q23.3</i>	Tabarés-Seisdedos et al. [2011]
HIST1H2AG	Histone cluster 1, H2AG	<i>6p22.1</i>	Shi et al. [2009]
HIST1H2BC	Histone cluster 1, H2BC	<i>6p22.2</i>	Sanders et al. [2013]
HIST1H2BD	Histone cluster 1, H2BD	<i>6p22.2</i>	Sanders et al. [2013]
HIST1H2BG	Histone cluster 1, H2BG	<i>6p22.2</i>	Sanders et al. [2013]
HIST1H2BH	Histone cluster 1, H2BH	<i>6p22.2</i>	Sanders et al. [2013]
HIST1H2BI	Histone cluster 1, H2BI	<i>6p22.2</i>	Stefansson et al. [2009]
HIST1H2BJ	Histone gene cluster 1, H2B histone family, member J	<i>6p22.1</i>	Loe-Mie et al. [2010]
HIST1H2BK	Histone cluster 1, H2BK	<i>6p22.1</i>	Sanders et al. [2013]
HLA-A^a	Major histocompatibility complex, class I, A	<i>6p22.1</i>	Tabarés-Seisdedos et al. [2011]
HLA-B	Major histocompatibility complex, class I, B	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]
HLA-DQA1	Major histocompatibility complex, class II, DQ alpha 1	<i>6p21.32</i>	Jia et al. [2012]
HLA-DQB1	Major histocompatibility complex, class II, DQ beta 1	<i>6p21.32</i>	Tabarés-Seisdedos et al. [2011]
HLA-DRB1^a	Major histocompatibility complex, class II, DR beta 1	<i>6p21.32</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
HLA-DRB3	Major histocompatibility complex, class II, DR beta 3	<i>6p21.3</i>	de Jong et al. [2012]
HLA-DRB9	Major histocompatibility complex, class II, DR beta 9 (pseudogene)	<i>6p21.32</i>	Ripke et al. [2013]
HNMT	Histamine N-methyltransferase	<i>2q22.1</i>	Sanders et al. [2013]
HOMER1^a	Homer, Drosophila, homolog of, 1	<i>5q14.1</i>	Tabarés-Seisdedos et al. [2011]
HOMER2	Homer, Drosophila, homolog of, 2	<i>15q25.2</i>	Tabarés-Seisdedos et al. [2011]
HP	Haptoglobin	<i>16q22.2</i>	Allen et al. [2008]
HRH1	Histamine receptor H1	<i>3p25.3</i>	Tabarés-Seisdedos et al. [2011]
HRH2	Histamine receptor H2	<i>5q35.2</i>	Tabarés-Seisdedos et al. [2011]
HRH3	Histamine receptor H3	<i>20q13.33</i>	Tabarés-Seisdedos et al. [2011]
HSPA1A	Heat shock 70 kDa protein 1A	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]
HSPA1B	Heat shock 70 kDa protein 1B	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]
HSPA1L	Heat shock 70 kDa protein-like 1	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]
HSPA6	Heat-shock 70 kDa protein 6	<i>1q23.3</i>	Brzustowicz et al. [2002]
HSPA7	Heat-shock 70 kDa protein7	<i>1q23.3</i>	Brzustowicz et al. [2002]
HTR1A	5-Hydroxytryptamine receptor 1A	<i>5q12.3</i>	Tabarés-Seisdedos et al. [2011]
HTR1B^a	5-Hydroxytryptamine receptor 1B	<i>6q14.1</i>	Tabarés-Seisdedos et al. [2011]
HTR1D	5-Hydroxytryptamine receptor 1D	<i>1p36.12</i>	Tabarés-Seisdedos et al. [2011]
HTR2A^a	5-Hydroxytryptamine receptor 2A	<i>13q14.2</i>	Williams et al. [1997]
HTR2C	5-Hydroxytryptamine receptor 2C	<i>Xq23</i>	Wright et al. [2013]
HTR3A^a	5-Hydroxytryptamine receptor 3A	<i>11q23.2</i>	Tabarés-Seisdedos et al. [2011]
HTR3B	5-Hydroxytryptamine receptor 3B	<i>11q23.2</i>	Tabarés-Seisdedos et al. [2011]
HTR3C^a	5-Hydroxytryptamine receptor 3C	<i>3q27.1</i>	Tabarés-Seisdedos et al. [2011]
HTR3D	5-Hydroxytryptamine receptor 3D	<i>3q27.1</i>	Tabarés-Seisdedos et al. [2011]
HTR3E	5-Hydroxytryptamine receptor 3E	<i>3q27.1</i>	Tabarés-Seisdedos et al. [2011]
HTR4	5-Hydroxytryptamine receptor 4	<i>5q32</i>	Tabarés-Seisdedos et al. [2011]
HTR5A	5-Hydroxytryptamine receptor 5A	<i>7q36.2</i>	Tabarés-Seisdedos et al. [2011]
HTR6	5-Hydroxytryptamine receptor 6	<i>1p36.13</i>	Tabarés-Seisdedos et al., 2011]
HTR7^a	5-Hydroxytryptamine receptor 7	<i>10q23.31</i>	Tabarés-Seisdedos et al. [2011]
ICAM1	Intercellular adhesion molecule 1	<i>19p13.2</i>	Tabarés-Seisdedos et al. [2011]
IFITM3	Interferon-induced transmembrane protein 3	<i>11p15.5</i>	Sanders et al. [2013]

Gene symbol	Gene name	Location	References
IL10	Interleukin 10	<i>1q32.1</i>	Tabarés-Seisdedos et al. [2011]
IL12B	Interleukin 12B	<i>5q33.3</i>	Tabarés-Seisdedos et al. [2011]
IL1A	Interleukin 1, alpha	<i>2q13</i>	Tabarés-Seisdedos et al. [2011]
IL1B	Interleukin 1, beta	<i>2q13</i>	Xu and He [2010]
IL1RN	Interleukin 1 receptor antagonist	<i>2q14.2</i>	Tabarés-Seisdedos et al. [2011]
IL3	Interleukin 3	<i>5q31.1</i>	Tabarés-Seisdedos et al. [2011]
IL3RA	Interleukin 3 receptor, alpha	<i>Xp22.33</i>	Tabarés-Seisdedos et al. [2011]
IL4	Interleukin 4	<i>5q31.1</i>	Tabarés-Seisdedos et al. [2011]
IL6	Interleukin 6	<i>7p15.3</i>	Tabarés-Seisdedos et al. [2011]
IMMP2L^a	Inner mitochondrial membrane peptidase, subunit 2, <i>S. cerevisiae</i> , homolog of	<i>7q31.1</i>	Tabarés-Seisdedos et al. [2011]
IMPA2	Myo-inositol monophosphatase 2	<i>18p11.21</i>	Tabarés-Seisdedos et al. [2011]
INSIG2	Insulin-induced gene 2	<i>2q14.2</i>	Tabarés-Seisdedos et al. [2011]
IPO5	Importin 5	<i>13q32.2</i>	Tabarés-Seisdedos et al. [2011]
ITIH3	Inter-alpha-trypsin inhibitor heavy chain 3	<i>3p21.1</i>	Ripke et al. [2013]
JAG2	Jagged 2	<i>14q32.33</i>	Tabarés-Seisdedos et al. [2011]
JARID2^a	Jumonji, AT-rich interactive domain 2	<i>6p22.33</i>	Tabarés-Seisdedos et al. [2011]
KCNH2	Potassium voltage-gated channel, subfamily H, member 2	<i>7q36.1</i>	Hashimoto et al. [2013]
KCNH7	Potassium voltage-gated channel, subfamily H (eag-related), member 7	<i>2q24.2</i>	Zhang et al. [2012]
KCNN3	Potassium channel, calcium-activated, intermediate/small conductance, subfamily N, member 3	<i>1q21.3</i>	Chandy et al. [1998]
KIAA0513	KIAA0513 designated gene	<i>16q24.1</i>	Lauriat et al. [2006]
KIAA1644	KIAA1644 designated gene	<i>22q13</i>	Wright et al. [2013]
L1RE1	LINE1 (long interspersed nuclear element) retrotransposable element 1	<i>22q11.1-q11.2</i>	Bundo et al. [2014]
LAMA5	Laminin, alpha 5	<i>20q13.33</i>	van Schijndel et al. [2009]
LEP^a	Leptin	<i>7q32.1</i>	Tabarés-Seisdedos et al. [2011]
LEPR	Leptin receptor	<i>1p31.3</i>	Tabarés-Seisdedos et al. [2011]
LPL	Lipoprotein lipase	<i>8p21.3</i>	Tabarés-Seisdedos et al. [2011]
LRRC4^a	Leucine rich repeat containing 4	<i>7q32.1</i>	Wright et al. [2013]
LSM1	LSM1 protein	<i>8p11.23</i>	Shi et al. [2011]
LTA	Lymphotoxin alpha	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
MIAP	Meiosis 1 associated protein	<i>2p13.1</i>	Ripke et al. [2013]
MAD1L1	Mitotic arrest-deficient 1, yeast, homolog-like 1	<i>7p22.3</i>	Ripke et al. [2013]
MAG	Myelin-associated glycoprotein	<i>19q13.12</i>	Bahn [2002]
MAGH1	Membrane-associated guanylate kinase, WW, and PDZ domain containing 1	<i>3p14.1</i>	Sun et al. [2008]
MAG12	Membrane-associated guanylate kinase, WW, and PDZ domain containing 2	<i>7q21.11</i>	Sun et al. [2008]
MAG13	Membrane-associated guanylate kinase, WW, and PDZ domain containing 3	<i>1p13.2</i>	Sun et al. [2008]
MAOA^a	Monoamine oxidase A	<i>Xp11.3</i>	Tabarés-Seisdedos et al. [2011]
MAOB^a	Monoamine oxidase B	<i>Xp11.3</i>	Rice et al. [1984]
MAP2K4	Mitogen-activated protein kinase kinase 4	<i>17p12</i>	Wright et al. [2013]
MAPK14	Mitogen-activated protein kinase 14	<i>6p21.31</i>	Tabarés-Seisdedos et al. [2011]
MAPK3^a	Mitogen-activated protein kinase 3	<i>16p11.2</i>	Wright et al. [2013]
MAPT	Microtubule-associated protein tau	<i>17q21.31</i>	Tabarés-Seisdedos et al. [2011]
MAU2	MAU2 (maternally affected uncoordinated 2) sister chromatid cohesion factor	<i>19p13.11</i>	Ripke et al. [2013]
MCHR1	Melanin-concentrating hormone receptor 1	<i>22q13.2</i>	Tabarés-Seisdedos et al. [2011]
MDGA1	MAM (nephrin, A5 protein, and protein tyrosine phosphatase Mu) domain containing glycosylphosphatidylinositol anchor 1	<i>6p21.2</i>	Ocklenburg et al. [2013]
MECP2^a	Methyl CpG binding protein 2	<i>Xq28</i>	Tabarés-Seisdedos et al. [2011]
MED1	Mediator complex subunit 1	<i>17q12</i>	Wright et al. [2013]
MED12^a	Mediator complex subunit 12	<i>Xq13.1</i>	Tabarés-Seisdedos et al. [2011]
MED15	Mediator complex subunit 15	<i>22q11.21</i>	Tabarés-Seisdedos et al. [2011]
MEGF10	Multiple epidermal growth factor-like domains 10	<i>5q23.2</i>	Tabarés-Seisdedos et al. [2011]
MGRN1	Mahogunin ring finger 1	<i>16p13.3</i>	Wright et al. [2013]
MGST1	Microsomal glutathione S-transferase 1	<i>12p12.3</i>	Wockner et al. [2014]
MICB	Major histocompatibility complex class I chain-related gene B	<i>6p21.33</i>	Tabarés-Seisdedos et al. [2011]
MIR137	MicroRNA 137	<i>1p21.3</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
MIR30E	MicroRNA 30e	<i>1p34.2</i>	Tabarés-Seisdedos et al. [2011]
MKL1	Megakaryoblastic leukemia 1	<i>22q13.2</i>	Luo et al. [2014]
MLC1	Megalencephalic leukoencephalopathy with subcortical cysts 1	<i>22q13.33</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
MMPL16	Matrix metalloproteinase 16	8q21.3	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
MMPP9	Matrix metalloproteinase 9	20q13.12	Tabarés-Seisdedos et al. [2011]
MOXD1	Monooxygenase, DBH-like 1	6q23.2	Sanders et al. [2013]
MPO	Myeloperoxidase	17q22	Tabarés-Seisdedos et al. [2011]
MTHFRa	Methylenetetrahydrofolate reductase	1p36.22	Zintzaras [2006]
MYH9	Myosin, heavy chain 9, non-muscle	22q12.3	Tabarés-Seisdedos et al. [2011]
MYO16^a	Myosin XVI	13q33.3	Rodriguez-Murillo et al. [2014]
NALCN	Sodium leak channel, non-selective	13q33.1	Wang et al. [1996]
NCAM1	Neural cell adhesion molecule 1	11q23.2	Tabarés-Seisdedos et al. [2011]
NDE1	NudE neurodevelopment protein 1	16p13.11	Tabarés-Seisdedos et al. [2011]
NDEL1	NudE neurodevelopment protein 1-like 1	17p13.1	Tabarés-Seisdedos et al. [2011]
NETO1	Neuropilin and tolloid-like 1	18q22.3	Banno et al. [2011]
NEUROD2	Neuronal differentiation 2	17q12	Wright et al. [2013]
NEUROG1	Neurogenin 1	5q31.1	Tabarés-Seisdedos et al. [2011]
NLG1^a	Neuregulin 1	3q26.31	Tabarés-Seisdedos et al. [2011]
NLRP1	NLR (NOD-like microbial receptor) family, pyrin domain containing 1	17p13.2	Sanders et al. [2013]
NOD2	Nucleotide-binding oligomerization domain containing 2	16q12.1	van Schijndel et al. [2009]
NOS1	Nitric oxide synthase 1	12q24.22	Weber et al. [2014]
NOS1AP^a	Nitric oxide synthase 1 adaptor protein	1q23.3	Weber et al. [2014]
NOS3	Nitric oxide synthase 3	7q36.1	Tabarés-Seisdedos et al. [2011]
NOTCH2	Notch, Drosophila, homolog of, 2	1p11.2	Tabarés-Seisdedos et al. [2011]
NOTCH3^a	Notch, Drosophila, homolog of, 3	19p13.12	Tabarés-Seisdedos et al. [2011]
NOTCH4	Notch, Drosophila, homolog of, 4	6p21.32	Ikeda et al. [2011]
NPAS3	Neuronal PAS domain protein 3	14q13.1	Macintyre et al. [2010]
NPPC	Natriuretic peptide precursor C	2q37.1	Roussos and Haroutunian [2014]
NPY	Neuropeptide Y	7p15.3	Tabarés-Seisdedos et al. [2011]
NQO1	NAD(P)H dehydrogenase, quinone 1	16q22.1	Tabarés-Seisdedos et al. [2011]
NR4A1^a	Nuclear receptor subfamily 4, group A, member 1	12q13.13	Tabarés-Seisdedos et al. [2011]
NR4A2	Nuclear receptor subfamily 4, group A, member 2	2q24.1	Tabarés-Seisdedos et al. [2011]
NRG1^a	Neuregulin 1	8p12	Wockner et al. [2014]

Gene symbol	Gene name	Location	References
NRG2	Neuregulin 2	<i>5q31.2</i>	Wright et al. [2013]
NRG3	Neuregulin 3	<i>10q23.1</i>	Kao et al. [2010]
NRGN	Neurogranin	<i>11q24.2</i>	Wockner et al. [2014]
NRXN1^a	Neurexin 1	<i>2p16.3</i>	Kirov et al. [2008]
NRXN3^a	Neurexin 3	<i>14q24.3</i>	Tabarés-Seisdedos et al. [2011]
NSF	N-ethylmaleimide-sensitive factor	<i>17q21.31</i>	Mirnes et al. [2000]
NT5C2	5-prime-nucleotidase, cytosolic II	<i>10q24.33</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
NTF3	Neurotrophin 3	<i>12p13.31</i>	Tabarés-Seisdedos et al. [2011]
NTNG1^a	Netrin G1	<i>1p13.3</i>	Tabarés-Seisdedos et al. [2011]
NTRK1^a	Neurotrophic tyrosine kinase, receptor, type 1	<i>1q23.1</i>	van Schijndel et al. [2009]
NTRK2	Neurotrophic tyrosine kinase, receptor, type 2	<i>9q21.33</i>	Tabarés-Seisdedos et al. [2011]
NTRK3^a	Neurotrophic tyrosine kinase, receptor, type 3	<i>15q25.3</i>	Tabarés-Seisdedos et al. [2011]
NUDT9P1	Nudix (nucleoside diphosphate linked moiety X)-type motif 9 pseudogene 1	<i>10q23.32</i>	Tabarés-Seisdedos et al. [2011]
NUMBL	Numb, Drosophila, homolog-like	<i>19q13.2</i>	Sun et al. [2008]
OLIG2	Oligodendrocytes lineage transcription factor 2	<i>21q22.11</i>	Georgieva et al. [2006]
OXT	Oxytocin	<i>20p13</i>	Tabarés-Seisdedos et al. [2011]
OXTR^a	Oxytocin receptor	<i>3p25.3</i>	Tabarés-Seisdedos et al. [2011]
PAFAH1B1^a	Platelet-activating factor acetylhydrolase 1b, regulatory subunit 1	<i>17p13.3</i>	Tabarés-Seisdedos et al. [2011]
PAH^a	Phenylalanine hydroxylase	<i>12q23.2</i>	Tabarés-Seisdedos et al. [2011]
PAWR	PRKC (protein kinase 3), apoptosis, WT1 (Wilms tumor 1), regulator	<i>12q21.2</i>	Tabarés-Seisdedos et al. [2011]
PBRM1^a	Polybromo 1	<i>3p21.1</i>	Kondo et al. [2013]
PCGEM1	Prostate-specific gene PCGEM1	<i>2q32.3</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
PCMI	Pericentriolar material 1	<i>8p22</i>	Moens et al. [2010]
PCNT	Pericentrin	<i>21q22.3</i>	Tabarés-Seisdedos et al. [2011]
PDE4B^a	Phosphodiesterase 4B, cAMP-specific	<i>1p31.3</i>	Millar et al. [2005]
PDLIM5	PDZ (pSD95, Dlg1, and zo-1) and LIM Lin11, Isl-1, and Msc-3) domain 5	<i>4q22.3</i>	Tabarés-Seisdedos et al. [2011]
PDYN	Prodynorphin	<i>20p13</i>	Tabarés-Seisdedos et al. [2011]
PENT	Phosphatidylethanolamine N-methyltransferase	<i>17p11.2</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
PER3	Period circadian clock 3	<i>1p36.23</i>	Tabarés-Seisdedos et al. [2011]
PGBD1	PiggyBac transposable element derived 1	<i>6p22.1</i>	Alkelai et al. [2012]
PGP	Phosphoglycolate phosphatase	<i>19p13.11</i>	Wright et al. [2013]
PHF3	PHD (plant homeodomain) finger protein 3	<i>6q12</i>	Wright et al. [2013]
PHOX2B	Paired-like homeobox 2B	<i>4p13</i>	Toyota et al. [2004]
PI4KA	Phosphatidylinositol 4-kinase, catalytic, alpha	<i>22q11.21</i>	Tabarés-Seisdedos et al. [2011]
PICK1	Protein interacting with C kinase 1	<i>22q13.1</i>	Tabarés-Seisdedos et al. [2011]
PIK3C3	Phosphatidylinositol 3-kinase, class 3	<i>18q12.3</i>	Tabarés-Seisdedos et al. [2011]
PIK4CA	Phosphatidylinositol 4-kinase, catalytic, alpha	<i>22q11.21</i>	Sullivan [2005]
PIP4K2A	Phosphatidylinositol-5-phosphate 4-kinase, type II, alpha	<i>10p12.2</i>	Tabarés-Seisdedos et al. [2011]
PLA2G1B	Phospholipase A2, group IB	<i>12q24.31</i>	Tabarés-Seisdedos et al. [2011]
PLA2G4A	Phospholipase A2, group IVA	<i>1q31.1</i>	Tabarés-Seisdedos et al. [2011]
PLA2G4C	Phospholipase A2, group IVC	<i>19q13.33</i>	Tabarés-Seisdedos et al. [2011]
PLA2G4D	Phospholipase A2, group IVD	<i>15q15.1</i>	Tabarés-Seisdedos et al. [2011]
PLA2G6	Phospholipase A2, group VI	<i>22q13.1</i>	Tabarés-Seisdedos et al. [2011]
PLA2G7	Phospholipase A2, group VII	<i>6p12.3</i>	Tabarés-Seisdedos et al. [2011]
PLAA	Phospholipase A2-activating protein	<i>9p21.2</i>	Athanasu et al. [2010]
PLP1	Proteolipid protein 1	<i>Xq22.2</i>	Aberg et al. [2006]
PLXNA2	Plexin A2	<i>1q32.2</i>	Allen et al. [2008]
PNOC	Prepronociceptin	<i>8p21.1</i>	Tabarés-Seisdedos et al. [2011]
POM121L2	POM121 transmembrane nucleoporin) transmembrane nucleoporin-like 2	<i>6p22.1</i>	Aberg et al. [2006]
PONI^a	Paraoxonase 1	<i>7q21.3</i>	Tabarés-Seisdedos et al. [2011]
PPARG	Peroxisome proliferator-activated receptor gamma	<i>3p25.2</i>	Tabarés-Seisdedos et al. [2011]
PPP1R1B^a	Protein phosphatase 1, regulatory (inhibitor) subunit 1B	<i>17q12</i>	Meyer-Lindenberg et al. [2007]
PPP2R2B	Protein phosphatase 2, regulatory subunit B, beta	<i>5q32</i>	Tabarés-Seisdedos et al. [2011]
PPP3CC	Protein phosphatase 3, catalytic subunit, gamma isoform	<i>8p21.3</i>	Wockner et al. [2014]
PRKAB2	Protein kinase, AMP-activated, beta 2 non-catalytic subunit	<i>1q21.1</i>	Wright et al. [2013]
PRKCA	Protein kinase C, alpha	<i>17q24.2</i>	Tabarés-Seisdedos et al. [2011]
PRKCD	Protein kinase C, delta	<i>3p21.1</i>	Sanders et al. [2013]
PRODH^a	Proline dehydrogenase	<i>22q11.21</i>	Sullivan [2005]

Gene symbol	Gene name	Location	References
PRODH2	Proline dehydrogenase 2	<i>19q13.12</i>	Harrison and Weinberger [2005]
PRNP	Prion protein	<i>20p13</i>	Tabarés-Seisdedos et al. [2011]
PRRT4	Proline-rich transmembrane protein 4	<i>7q32.1</i>	Wright et al. [2013]
PRSSI6	Protease, serine, 16	<i>6p22.1</i>	Stefansson et al. [2009]
PTBP3	Polypyrimidine tract-binding protein 3	<i>9q32</i>	Sanders et al. [2013]
PTGS2^a	Prostaglandin-endoperoxide synthase 2	<i>1q31.1</i>	Tabarés-Seisdedos et al. [2011]
PTPN21	Protein tyrosine phosphatase, non-receptor type 21	<i>14q31.3</i>	Chen et al. [2011a]
PTPRZ1	Protein tyrosine phosphatase, receptor-type, zeta 1	<i>7q31.32</i>	Tabarés-Seisdedos et al. [2011]
QKI	QKI, KH (K homology) domain containing, RNA binding	<i>6q26</i>	Aberg et al. [2006]
QPCT	Glutaminyl-peptide cyclotransferase	<i>2p22.2</i>	Ripke et al. [2013]
RAI1^a	Retinoic acid induced 1	<i>17p11.2</i>	Toulouse et al. [2003]
RANBP2	Ran binding protein 2	<i>2q12.3</i>	Wright et al. [2013]
RAPGEF6	Rap guanine nucleotide exchange factor 6	<i>5q31.1</i>	Tabarés-Seisdedos et al. [2011]
RELN^a	Reelin	<i>7q22.1</i>	van Schijndel et al. [2009]
REST	RE1-silencing transcription factor	<i>4q12</i>	Loe-Mie et al. [2010]
RGS2	Regulator of G-protein signaling 2	<i>1q31.2</i>	Tabarés-Seisdedos et al. [2011]
RGS4	Regulator of G-protein signaling 4	<i>1q23.3</i>	Harrison and Weinberger [2005]
RGS9	Regulator of G-protein signaling 9	<i>17q24.1</i>	Tabarés-Seisdedos et al. [2011]
RNF144	Ring finger protein 144A	<i>2p25.2</i>	Xu and He [2010]
RNF5	Ring finger protein 5	<i>6p21.32</i>	de Jong et al. [2012]
RSRC1	Arginine/serine-rich coiled-coil 1	<i>3q25.32</i>	Potkin et al. [2009]
RTN4	Reticulon 4	<i>2p16.1</i>	Tabarés-Seisdedos et al. [2011]
RTN4R	Reticulon 4 receptor	<i>22q11.21</i>	Sinibaldi et al. [2004]
RXRB	Retinoid X receptor, beta	<i>6p21.32</i>	Tabarés-Seisdedos et al. [2011]
S100A10	S100 calcium-binding protein A10	<i>1q21.3</i>	Sanders et al. [2013]
S100B	S100 calcium-binding protein beta	<i>21q22.3</i>	Tabarés-Seisdedos et al. [2011]
SBK1	SH3 (SRC homology 3) domain-binding kinase 1	<i>16p11.2</i>	Wright et al. [2013]
SDCCAG8	Serologically defined colon cancer antigen 8	<i>1q43</i>	Ripke et al. [2013]
SELENBP1	Selenium-binding protein 1	<i>1q21.3</i>	Tabarés-Seisdedos et al. [2011]
SEMA3D	Semaphorin 3D	<i>7q21.11</i>	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
SEZ6L2^a	Seizure-related 6 homolog (mouse)-like 2	<i>16p11.2</i>	Wright et al. [2013]
SGK1	Serum/glucocorticoid-regulated kinase 1	<i>6q23.2</i>	Sanders et al. [2013]
SHANK3a	SH3 and multiple ankyrin repeat domains 3	<i>22q13.33</i>	Gauthier et al. [2010]
SHMT1	Serine hydroxymethyltransferase, cytosolic	<i>17p11.2</i>	Tabarés-Seisdedos et al. [2011]
SHOX	Short stature homeobox	<i>Xp22.33</i>	Loe-Mie et al. [2010]
SIGMAR1	Sigma non-opioid intracellular receptor 1	<i>9p13.3</i>	Ohi et al. [2011]
SLC17A1	Solute carrier family 17 (organic anion transporter), member 1	<i>6p22.2</i>	Shi et al. [2009]
SLC17A3	Solute carrier family 17 (organic anion transporter), member 3	<i>6p22.2</i>	Shi et al. [2009]
SLC17A6	Solute carrier family 17 (vesicular glutamate transporter), member 6	<i>11p14.3</i>	Tabarés-Seisdedos et al. [2011]
SLC17A7	Solute carrier family 17 (vesicular glutamate transporter), member 7	<i>19q13.33</i>	Tabarés-Seisdedos et al. [2011]
SLC18A1	Solute carrier family 18 (vesicular glutamate transporter), member 1	<i>8p21.3</i>	Tabarés-Seisdedos et al. [2011]
SLC18A2	Solute carrier family 18 (vesicular glutamate transporter), member 2	<i>10q25.3</i>	Tabarés-Seisdedos et al. [2011]
SLC1A1^a	Solute carrier family 1, member 1	<i>9p24.2</i>	Allen et al. [2008]
SLC1A2	Solute carrier family 1 (glial high-affinity glutamate transporter), member 2	<i>11p13</i>	Tabarés-Seisdedos et al. [2011]
SLC1A3	Solute carrier family 1 (glial high-affinity glutamate transporter), member 3	<i>5p13.2</i>	Tabarés-Seisdedos et al. [2011]
SLC1A4	Solute carrier family 1 (glutamate/neutral amino acid transporter), member 4	<i>2p14</i>	Tabarés-Seisdedos et al. [2011]
SLC1A6	Solute carrier family 1 (high affinity aspartate/glutamate transporter), member 6	<i>19p13.12</i>	Tabarés-Seisdedos et al. [2011]
SLC24A5	Solute carrier family 24 (sodium/potassium/calcium exchanger), member 5	<i>15q21.1</i>	Tabarés-Seisdedos et al. [2011]
SLC39A8	Solute carrier family 39 (zinc transporter), member 8	<i>4q24</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
SLC5A7	Solute carrier family 5 (sodium/choline cotransporter), member 7	<i>2q12.3</i>	Wright et al. [2013]
SLC6A2	Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	<i>16q12.2</i>	Tabarés-Seisdedos et al. [2011]
SLC6A3^a	Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	<i>5p15.33</i>	Tabarés-Seisdedos et al. [2011]
SLC6A4^a	Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	<i>17q11.2</i>	Allen et al. [2008]
SLC6A9	Solute carrier family 6 (neurotransmitter transporter, glycine), member 9	<i>1p34.1</i>	Tabarés-Seisdedos et al. [2011]
SLC9A3R2	Solute carrier family 9, member 3, regulator 2	<i>16p13.3</i>	Wright et al. [2013]
SLC06A1	Solute carrier organic anion transporter family, member 6A1	<i>5q21.1</i>	Ripke et al. [2013]
SLX4	SLX4, S. cerevisiae, homolog of	<i>16p13.3</i>	Wright et al. [2013]

Gene symbol	Gene name	Location	References
SMARCA2	SWI/SNF-related, matrix-associated, actin-dependent regulator of chromatin, subfamily A, member 2	9p24.3	Loe-Mie et al. [2010]
SNAP25	Synaptosomal-associated protein, 25kDa	20p12.2	Dai et al. [2014]
SNAP29	Synaptosomal-associated protein, 29-kDa	22q11.21	Sun et al. [2008]
SNX19^a	Sorting nexin 19	11q24.3	Ripke et al. [2013]
SOD2	Superoxide dismutase 2	6q25.3	Tabarés-Seisdedos et al. [2011]
SOX10	SRY (sex determining region Y)-box 10	22q13.1	Yuan et al. [2012]
SP4	Sp4 transcription factor	7p15.3	Tabarés-Seisdedos et al. [2011]
SP8	Sp8 transcription factor	7p21.1	Kondo et al. [2013]
SRC	V-src avian sarcoma (Schmidt-Ruppin A-2) viral oncogene homolog	20q11.23	Pitcher et al. [2011]
SRD5A1	Steroid-5-alpha-reductase 1	5p15.31	Tabarés-Seisdedos et al. [2011]
SREBF1	Sterol regulatory element binding transcription factor 1	17p11.2	Tabarés-Seisdedos et al. [2011]
SREBF2	Sterol regulatory element binding transcription factor 2	22q13.2	Tabarés-Seisdedos et al. [2011]
SRR	Serine racemase	17p13.3	Tabarés-Seisdedos et al. [2011]
ST3GAL1	ST3 beta-galactoside alpha-2,3-sialyltransferase 1	8q24.22	Xu and He [2010]
ST6GAL2	ST6 beta-galactosamide alpha-2,6-sialyltransferase 2	2q12.3	Wright et al. [2013]
ST8SIA2^a	ST8 alpha-N-acetyl-neuraminide alpha-2,8-sialyltransferase 2	15q26.1	Tabarés-Seisdedos et al. [2011]
STAC2	SH3 and cysteine-rich domain 2	17q12	Wright et al. [2013]
STT3A	Oligosaccharyltransferase complex, catalytic subunit STT3A	11q24.2	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
STX1B	Syntaxin 1B	16p11.2	Wright et al. [2013]
STX6^a	Syntaxin 6	1q25.3	Sanders et al. [2013]
SULT4A1	Sulfotransferase family 4A, member 1	22q13.31	Tabarés-Seisdedos et al. [2011]
SYN2^a	Synapsin II	3p25.2	Saviouk et al. [2007]
SYN3^a	Synapsin III	22q12.3	Kao et al. [1998]
SYNGRI	Synaptogyrin 1	22q13.1	Tabarés-Seisdedos et al. [2011]
SYT11	Synaptotagmin 11	1q22	Sanders et al. [2013]
TAAR6	Trace amine-associated receptor 6	6q23.2	Duan et al. [2004]
TACRI	Tachykinin receptor 1	2p12	Tabarés-Seisdedos et al. [2011]
TAF15	TAF15 RNA polymerase II, TATA box binding protein (TBP)-associated factor, 68 kDa	17q12	Wright et al. [2013]
TAP2	Transporter, ATP-binding cassette, major histocompatibility complex, 2	6p21.32	Tabarés-Seisdedos et al. [2011]

Gene symbol	Gene name	Location	References
TBX1^a	T-box 1	22q11.21	Tabarés-Seisdedos et al. [2011]
TCF4^a	Transcription factor 4	18q21.2	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
TF	Transferrin	3q22.1	Aberg et al. [2006]
TH^a	Tyrosine hydroxylase	11p15.5	Tabarés-Seisdedos et al. [2011]
TIMELESS	Timeless, Drosophila, homolog of	12q13.3	Tabarés-Seisdedos et al. [2011]
TMED5	Transmembrane emp24 protein transport domain containing 5	1p22.1	Wright et al. [2013]
TMEM245	Transmembrane protein 245	9q31.3	Xu and He [2010]
TNF	Tumor necrosis factor	6p21.33	Sacchetti et al. [2007]
TNFRSF1B	Tumor necrosis factor receptor superfamily, member 1B	1p36.22	Tabarés-Seisdedos et al. [2011]
TNR	Tenascin R	1q25.1	Tabarés-Seisdedos et al. [2011]
TP53	Tumor protein p53	17p13.1	Allen et al. [2008]
TPH1	Tryptophan hydroxylase 1	11p15.1	Allen et al. [2008]
TPH2^a	Tryptophan hydroxylase 2	12q21.1	Tabarés-Seisdedos et al. [2011]
TRAX	Translin-associated factor X	1q42.2	Cannon et al. [2005]
TRIM26	Tripartite motif containing 26	6p22.1	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]
TSNARE1	T-SNARE (soluble NSF attachment protein receptor) domain containing 1	8q24.3	Ripke et al. [2013]
TSNAX	Translin-associated factor X	1q42.2	Tabarés-Seisdedos et al. [2011]
TSPAN33	Tetraspanin 33	7q32.1	Wright et al. [2013]
TXNDC5	Thioredoxin domain containing 5	6p24.3	Tabarés-Seisdedos et al. [2011]
UBE3C^a	Ubiquitin protein ligase E3C	7q36.3	Wright et al. [2013]
UFDIL	Ubiquitin fusion degradation 1 like	22q11.21	Tabarés-Seisdedos et al. [2011]
UGT1A4	UDP (uridine 5'-diphospho-) glucuronosyltransferase 1 family, polypeptide A4	2q37.1	Tabarés-Seisdedos et al. [2011]
UHMK1	U2AF (U2 auxiliary factor) homology motif kinase 1	1q23.3	Dumaine et al. [2011]
VAMP4	Vesicle-associated membrane protein 4	1q24.3	Sanders et al. [2013]
VDR	Vitamin D receptor	12q13.11	Tabarés-Seisdedos et al. [2011]
VIPR2	Vasoactive intestinal peptide receptor 2	7q36.3	Vacic et al. [2011]
VKORC1	Vitamin K epoxide reductase complex, subunit 1	16p11.2	Wright et al. [2013]
VRK2	Vaccinia related kinase 2	2p16.1	Stefansson et al. [2009]
WHSC1L1	Wolf-Hirschhorn syndrome candidate 1-like 1	8p11.23	Shi et al. [2011]

Gene symbol	Gene name	Location	References
WWC1	WW, C2, and coiled-coil domain-containing 1	<i>5q34</i>	Tabarés-Seisdedos et al. [2011]
XBPI	X-box binding protein 1	<i>22q12.1</i>	Tabarés-Seisdedos et al. [2011]
XKR4	XK, Kell blood group complex subunit-related family, member 4	<i>8q12.1</i>	Tabarés-Seisdedos et al. [2011]
YES	V-yes-1 Yamaguchi sarcoma viral related oncogene homolog	<i>6q21</i>	Tabarés-Seisdedos et al. [2011]
YWHA^a	Tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, epsilon isoform	<i>17p13.3</i>	Ikeda et al. [2008]
YWHAH	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, Eta	<i>22q12.3</i>	Tabarés-Seisdedos et al. [2011]
ZBTB42	Zinc finger and BTB (BR-C, ttk and bab) domain containing 42	<i>14q32.33</i>	Ocklenburg et al. [2013]
ZDHHC8	Zinc finger, DHHC (Asp-His-His-Cys)-type containing 8	<i>22q11.21</i>	Sullivan [2005]
ZEB2	Zinc finger E-box binding homeobox 2	<i>2q22.3</i>	Ripke et al. [2013]
ZNF184	Zinc finger protein 184	<i>6p22.1</i>	Shi et al. [2009]
ZNF385D	Zinc finger protein 385D	<i>3p24.3</i>	Xu and He [2010]
ZNF804^a	Zinc finger protein 804A	<i>2q32.1</i>	Williams et al. [2011]
ZSWIM6	Zinc finger, SWIM (SWI2/SNF2 and MuDR)-type containing 6	<i>5q12.1</i>	Schizophrenia Psychiatric Genome-Wide Association Study (GWAS) Consortium [2011]

^aOverlap with recognized Autism Spectrum Disorders (ASD) genes.

TABLE II.

The Number of Schizophrenia Genes With Distribution Among Chromosomes

Chromosome	Schizophrenia genes	Percentage of total genes	Genes on p arm	Genes on q arm
6	66	11.8	49	17
1	57	10.2	27	30
22	48	8.6	0	48
7	39	7.0	9	30
2	37	6.6	10	27
5	35	6.2	4	31
17	30	5.3	15	15
11	27	4.8	8	19
3	25	4.5	14	11
16	22	3.9	17	5
8	21	3.7	15	6
10	20	3.7	3	17
19	19	3.4	7	12
12	18	3.2	5	13
15	15	2.7	0	15
X	15	2.7	7	8
4	14	2.5	7	7
9	12	2.1	4	8
14	11	2.0	0	11
20	11	2.0	5	6
18	7	1.2	2	5
13	7	1.2	0	7
21	4	0.7	0	4
Y	0	0.0	0	0
Total	560	100	208	352

p, short arm; q, long arm.

Chromosomes are arranged by the highest to lowest number of contained schizophrenia genes.