

Bioinformatics, Network Pleiotropy & Comparative Human Genomics | Signal Rating: 4/5 Stars | Oct 29, 2026 | 15 min read

Human Disease Gene Pleiotropy, Repeat-Expansion Motifs & Structural Sequence Architecture Across 32 Bioinformatic Gene Panels (630 Loci)

Bipartite network analysis of 953 gene-pathway assignments across 630 unique human disease-associated genes and 32 bioinformatic gene panels isolating 224 multi-pathway pleiotropic loci, 22 cross-panel hubs, and five sequence-structure annotation classes.

Mapping 630 human disease-associated and pharmacogenomic genes across 32 curated bioinformatic panels (953 gene-pathway links) indicates that 35.6% of cataloged loci (224 genes) recur across multiple panels, anchored by 22 high-degree hubs spanning neurodegeneration, psychiatry, immunity, and cardiometabolic pathways.

Cross-referencing these panels with sequence and pangenome annotations highlights five recurring sequence-structure feature classes for downstream genomic research.

| Genomic Element / Modality || Optimal Resolution Window || Empirical Failure Boundary || Corrective Bioinformatic Protocol |

| 32-Panel Curated Disease & PGx Gene Matrix (630 Unique Loci / 953 Assignments) || Cross-Panel Pleiotropic Network Mapping & Multi-Locus Exome/Genome Sequence Annotation (H_pleio up to 2.32 bits) || Single-panel short-read SNV workflows miss intronic tandem-repeat expansions (C9orf72, FMR1, CACNA1C), high-homology paralog gene conversions (SMN1/SMN2, CYP2D6, GBA1), and cross-panel pleiotropic overlap. || Integrate bipartite pleiotropy scoring with HPRC pangenome VNTR graph alignment (SMN2/CYP2D6/CACNA1C), non-B DNA repeat-motif scanning, and parallel CYP/HLA/MT-RNR1 sequence variant annotation. |

Generated by: Native Rust GFA Pangenome Graph Topology, Residue-Interaction Network (RIN) & Cryptic Cavity Engine (pseudo_pancryptic.rs) * Native Rust 32-Panel Bipartite Disease-Gene & Pleiotropy Entropy Engine (disease_genes.rs)

1. Bipartite Network Architecture of the 32 Bioinformatic Gene Panels

To establish a unified reference map of human disease-associated gene sets across CRV Science Labs, we compiled 32 curated human disease, biological pathway, and pharmacogenomic gene panels encompassing 953 panel-gene assignments across 630 unique human HGNC loci . Bipartite graph projection indicates that 224 of the 630 genes (35.56%) appear across multiple panels (≥ 2 panels), with 22 high-degree hub genes recurring across 4 to 5 gene panels (Shannon pathway pleiotropy entropy $H_{\text{pleio}} = 2.0000\text{--}2.3219$ bits).

| Clinical / Mechanistic Panel (1-32) || Clinical Domain || Genes (N) || Primary Structural Modality || Verified CRV Lab Anchors || Representative Panel Loci |

| 1. Alzheimer's Disease & Tauopathies || Neurology & Neurodegeneration || 35 || chrom-condensate / pan-cryptic || APOE, APP || APOE, APP, PSEN1, PSEN2, MAPT, TREM2, SORL1, ABCA7, +27 more |

- | 2. Parkinson's Disease & Synucleinopathies || Neurology & Neurodegeneration || 13 || pan-cryptic / co-evo || Pathway-Specific || SNCA, LRRK2, GBA1, PRKN, PINK1, PARK7, VPS35, VPS13C, +5 more |
- | 3. ALS, Frontotemporal Dementia & Motor Neuron Disease || Neurology & Neurodegeneration || 17 || chrom-condensate || SMN1, SMN2 || C9orf72, SOD1, TARDBP, FUS, TBK1, OPTN, NEK1, UNC13A, +9 more |
- | 4. Autism Spectrum & Neurodevelopmental Disorders || Neuropsychiatry & Synaptic Signaling || 38 || pan-cryptic / chrom-condensate || ARID1B, CACNA1C || SHANK3, SHANK2, NRXN1, NLGN3, NLGN4X, SYNGAP1, CHD8, SCN2A, +30 more |
- | 5. ADHD & Dopaminergic Catecholamine Signaling || Neuropsychiatry & Synaptic Signaling || 24 || pan-cryptic || Pathway-Specific || DRD4, DRD5, DRD2, SLC6A3, SLC6A2, SLC6A4, COMT, DBH, +16 more |
- | 6. Schizophrenia & Bipolar Psychosis || Neuropsychiatry & Synaptic Signaling || 41 || pan-cryptic / chrom-condensate || CACNA1C || C4A, DRD2, CACNA1C, CACNB2, CACNA1G, GRIN2A, GRIA1, GRIA3, +33 more |
- | 7. Depression, Anxiety & Circadian Sleep Regulation || Neuropsychiatry & Synaptic Signaling || 33 || pan-cryptic || Pathway-Specific || HCRTR1, HCRTR2, HCRT, SLC6A4, HTR1A, HTR2A, HTR2C, TPH2, +25 more |
- | 8. Pain, Migraine & Nociceptive Channelopathies || Neurology & Ion Channelopathies || 28 || pan-cryptic / co-evo || Pathway-Specific || CALCA, CALCB, RAMP1, CALCRL, SCN9A, SCN10A, SCN11A, TRPV1, +20 more |
- | 9. Asthma, Airway Hyperresponsiveness & Atopy || Immunology & Pulmonary Medicine || 30 || pan-cryptic || Pathway-Specific || TSLP, IL33, IL1RL1, IL4R, IL13, IL4, IL5, IL5RA, +22 more |
- | 10. Neuroinflammation & Microglial Innate Signaling || Neurology & Immunology || 26 || co-evo / pan-cryptic || Pathway-Specific || TREM2, CD33, MS4A4A, MS4A6A, PLCG2, ABI3, INPP5D, SPI1, +18 more |
- | 11. Endolysosomal Trafficking, Autophagy & Proteostasis || Cell Biology & Neurodegeneration || 29 || pan-cryptic || Pathway-Specific || SORL1, BIN1, PICALM, CD2AP, GBA1, LRRK2, VPS35, VPS13C, +21 more |
- | 12. Amyloid Precursor Processing & Brain Lipid Metabolism || Neurology & Lipidomics || 12 || pan-cryptic / pseudo-loss || APOE, APP || APOE, APP, PSEN1, PSEN2, ABCA7, CLU, SORL1, ADAM10, +4 more |
- | 13. Cytoskeletal Dynamics & Axonal Transport || Neurology & Structural Cell Biology || 13 || chrom-condensate || Pathway-Specific || MAPT, BIN1, CASS4, FERMT2, PTK2B, CD2AP, EPHA1, STMN2, +5 more |
- | 14. RNA Metabolism, Splicing & Tandem Repeat Expansions || Structural Genomics & RNA Biology || 13 || chrom-condensate / pan-cryptic || SMN1, SMN2 || C9orf72, TARDBP, FUS, ATXN2, SMN1, SMN2, FMR1, HTT, +5 more |
- | 15. Synaptic Transmission, Channelopathies & Ion Flux || Neuropsychiatry & Ion Channelopathies || 63 || pan-cryptic || CACNA1C, APP || SCN1A, SCN2A, SCN9A, SCN10A, SCN11A, KCNQ2, KCNK18, CACNA1A, +55 more |

- | 16. Mitochondrial Bioenergetics, OXPHOS & Neuropathies || Mitochondrial Genomics & Bioenergetics || 26 || coi-barcode / co-evo || MT-CO1, MT-RNR1 || POLG, TWNK, OPA1, MFN2, DNMT1L, SURF1, NDUFS1, NDUFV1, +18 more |
- | 17. Oncology: Receptor Tyrosine Kinases & RAS-MAPK-PI3K || Oncology & Precision Medicine || 33 || clonal-synth / co-evo || EGFR, KRAS, STK11 || EGFR, ERBB2, ERBB3, ERBB4, MET, ALK, ROS1, RET, +25 more |
- | 18. Oncology: DNA Damage Repair (DDR) & Cell Cycle Checkpoints || Oncology & Synthetic Lethality || 34 || clonal-synth || TP53, BRCA1, BRCA2, PARP1, WRN || TP53, BRCA1, BRCA2, ATM, ATR, PALB2, CHEK1, CHEK2, +26 more |
- | 19. Oncology: Epigenetics, Chromatin Remodeling & Transcription || Oncology & Epigenomics || 36 || clonal-synth / chrom-condensate || ARID1A, ARID1B, SMARCA4 || MYC, MYCN, ARID1A, ARID1B, SMARCA4, SMARCB1, EZH2, DNMT3A, +28 more |
- | 20. Oncology: Hormone Receptors, Hypoxia & Metabolic Synthetic Lethality || Oncology & Synthetic Lethality || 31 || clonal-synth / pan-cryptic || MTAP, PRMT5, WRN, STK11 || ESR1, AR, PGR, VHL, HIF1A, EPAS1, KEAP1, NFE2L2, +23 more |
- | 21. Immuno-Oncology, T-Cell Checkpoints & B-Cell Lineage Targets || Oncology & Immunology || 22 || clonal-synth / co-evo || Pathway-Specific || CD274, PDCD1, CTLA4, LAG3, TIGIT, HAVCR2, IDO1, CD47, +14 more |
- | 22. Autoimmune & Autoinflammatory Disorders || Immunology & Rheumatology || 43 || pan-cryptic / co-evo || HLA-B || TNF, IL6, IL6R, IL23A, IL12B, IL17A, IL4R, IL13, +35 more |
- | 23. Cardiovascular Lipid Metabolism, Lipoproteins & Coagulation || Cardiometabolic & Vascular Medicine || 31 || pseudo-loss / pan-cryptic || PCSK9, APOE, LPA, ANGPTL3 || PCSK9, LDLR, APOB, APOE, LPA, ANGPTL3, ANGPTL4, APOC3, +23 more |
- | 24. Cardiomyopathies & Cardiac Arrhythmia Channelopathies || Cardiometabolic & Vascular Medicine || 19 || pan-cryptic || CACNA1C || MYBPC3, MYH7, TNNT2, TNNI3, TTN, LMNA, DSP, PKP2, +11 more |
- | 25. Metabolic, Endocrine, Obesity & MASLD/MASH Hepatology || Cardiometabolic & Endocrine Medicine || 50 || pseudo-loss / pan-cryptic || HSD17B13, APOE, ANGPTL3 || GLP1R, GIPR, GCGR, MC4R, LEP, LEPR, POMC, PCSK1, +42 more |
- | 26. Pulmonary & Renal Fibrosis, Telomeropathies & Glomerulopathies || Pulmonary & Renal Medicine || 31 || chrom-condensate / pan-cryptic || Pathway-Specific || MUC5B, TERT, TERC, RTEL1, PARN, SFTPC, SFTPA2, ABCA3, +23 more |
- | 27. Bone, Skeletal & Connective Tissue Homeostasis || Musculoskeletal & Connective Tissue || 26 || pseudo-loss / pan-cryptic || Pathway-Specific || SOST, TNFSF11, TNFRSF11A, TNFRSF11B, LRP5, LRP6, WNT1, WNT16, +18 more |
- | 28. Hematology, Hemoglobinopathies, Coagulation & Complement || Hematology & Complement Biology || 36 || chrom-condensate / pan-cryptic || HBA1, HBA2 || HBB, HBA1, HBA2, BCL11A, GATA1, KLF1, JAK2, CALR, +28 more |
- | 29. Monogenic Rare Diseases, Lysosomal Storage & Ion Transport || Medical Genetics & Rare Diseases || 40 || pan-cryptic / chrom-condensate || SMN1, SMN2 |

| CFTR, SMN1, SMN2, DMD, HTT, FMR1, MECP2, UBE3A, +32 more |

| 30. Infectious Disease Host Entry Factors & Antiviral Innate Immunity ||
Infectious Disease & Host-Pathogen Genetics || 31 || co-evo / pseudo-loss || G6PD
|| CCR5, CXCR4, ACE2, TMPRSS2, CDHR3, IFITM3, IFNL3, IFNL4, +23 more |

| 31. Ophthalmology, Macular Degeneration & Retinal Dystrophies || Ophthalmology &
Sensory Genetics || 21 || pseudo-loss / coi-barcode || ABCA4, APOE || CFH,
ARMS2, HTRA1, C3, C2, CFB, C5, ABCA4, +13 more |

| 32. Pharmacogenomics: Cytochrome P450 ADME, HLA & Drug Toxicity ||
Pharmacogenomics & Clinical Safety || 28 || pan-cryptic / co-evo || CYP2D6,
CYP2C19, CYP2C9, DPYD, TPMT || CYP2D6, CYP2C19, CYP2C9, CYP3A4, CYP3A5, CYP2B6,
CYP1A2, DPYD, +20 more |

Generated by: Native Rust 3D Chromatin Graph Laplacian & RNA Phase-Separation
Scaffolder Engine (coevo_condensate_clonal.rs) * Native Rust Somatic Coalescent,
96-Channel Mutational JSD & Synthetic Lethality Engine (coevo_condensate_clonal.rs
) * Native Rust 32-Panel Bipartite Disease-Gene & Pleiotropy Entropy Engine (
disease_genes.rs)

2. Master Pleiotropic Hubs & Cross-Syndrome Pathway Convergence

Ranking all 630 loci by bipartite node degree isolates the 22 master pleiotropic
hubs (≥ 4 panels) that physically couple distinct clinical syndromes. Four genes --
APOE , BDNF , COMT , and DRD2 -- each span five clinical panels (H pleio = 2.3219
bits), while 18 additional hubs -- including the L-type calcium channel CACNA1C ,
endolysosomal regulators LRRK2 , GBA1 , GRN , TBK1 , and OPTN , chromatin remodelers
MECP2 and KANSL1 , and repeat-expansion loci FMR1 , HTT , and FXN -- span four
panels (H pleio = 2.0000 bits).

| Gene Symbol || Panels (N) || Pleiotropy Entropy (bits) || Domains (N) ||
Bioinformatic Classification || Connected Disease & Pathway Panels |

| APOE || 5 || 2.3219 || 5 || Verified CRV Labs Locus / Multi-Panel Hub ||
Alzheimer's Disease & Tauopathies * Amyloid Precursor Processing & Brain Lipid
Metabolism * Cardiovascular Lipid Metabolism, Lipoproteins & Coagulation *
Metabolic, Endocrine, Obesity & MASLD/MASH Hepatology * Ophthalmology, Macular
Degeneration & Retinal Dystrophies |

| COMT || 5 || 2.3219 || 4 || Cross-Panel Pleiotropic Hub (5 Panels) || ADHD &
Dopaminergic Catecholamine Signaling * Schizophrenia & Bipolar Psychosis * Pain,
Migraine & Nociceptive Channelopathies * Synaptic Transmission, Channelopathies &
Ion Flux * Pharmacogenomics: Cytochrome P450 ADME, HLA & Drug Toxicity |

| BDNF || 5 || 2.3219 || 3 || Cross-Panel Pleiotropic Hub (5 Panels) || ADHD &
Dopaminergic Catecholamine Signaling * Schizophrenia & Bipolar Psychosis *
Depression, Anxiety & Circadian Sleep Regulation * Synaptic Transmission,
Channelopathies & Ion Flux * Metabolic, Endocrine, Obesity & MASLD/MASH Hepatology |

| DRD2 || 5 || 2.3219 || 3 || Cross-Panel Pleiotropic Hub (5 Panels) || ADHD &
Dopaminergic Catecholamine Signaling * Schizophrenia & Bipolar Psychosis *
Depression, Anxiety & Circadian Sleep Regulation * Synaptic Transmission,
Channelopathies & Ion Flux * Pharmacogenomics: Cytochrome P450 ADME, HLA & Drug

Toxicity |

| ABCA7 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * Neuroinflammation & Microglial Innate Signaling
* Amyloid Precursor Processing & Brain Lipid Metabolism * Cardiovascular Lipid
Metabolism, Lipoproteins & Coagulation |

| CLU || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * Neuroinflammation & Microglial Innate Signaling
* Amyloid Precursor Processing & Brain Lipid Metabolism * Cardiovascular Lipid
Metabolism, Lipoproteins & Coagulation |

| EPHA1 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * Neuroinflammation & Microglial Innate Signaling
* Cytoskeletal Dynamics & Axonal Transport * Oncology: Receptor Tyrosine Kinases &
RAS-MAPK-PI3K |

| FMR1 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || Autism
Spectrum & Neurodevelopmental Disorders * RNA Metabolism, Splicing & Tandem Repeat
Expansions * Synaptic Transmission, Channelopathies & Ion Flux * Monogenic Rare
Diseases, Lysosomal Storage & Ion Transport |

| FXN || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || RNA
Metabolism, Splicing & Tandem Repeat Expansions * Mitochondrial Bioenergetics,
OXPHOS & Neuropathies * Cardiomyopathies & Cardiac Arrhythmia Channelopathies *
Monogenic Rare Diseases, Lysosomal Storage & Ion Transport |

| GBA1 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Parkinson's Disease & Synucleinopathies * Endolysosomal Trafficking, Autophagy &
Proteostasis * Amyloid Precursor Processing & Brain Lipid Metabolism * Monogenic
Rare Diseases, Lysosomal Storage & Ion Transport |

| HTT || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || ALS,
Frontotemporal Dementia & Motor Neuron Disease * Cytoskeletal Dynamics & Axonal
Transport * RNA Metabolism, Splicing & Tandem Repeat Expansions * Monogenic Rare
Diseases, Lysosomal Storage & Ion Transport |

| KANSL1 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * Autism Spectrum & Neurodevelopmental Disorders *
Synaptic Transmission, Channelopathies & Ion Flux * Oncology: Epigenetics, Chromatin
Remodeling & Transcription |

| LRRK2 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Parkinson's Disease & Synucleinopathies * Neuroinflammation & Microglial Innate
Signaling * Endolysosomal Trafficking, Autophagy & Proteostasis * Synaptic
Transmission, Channelopathies & Ion Flux |

| MECP2 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || Autism
Spectrum & Neurodevelopmental Disorders * Synaptic Transmission, Channelopathies &
Ion Flux * Oncology: Epigenetics, Chromatin Remodeling & Transcription * Monogenic
Rare Diseases, Lysosomal Storage & Ion Transport |

| OPTN || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || ALS,
Frontotemporal Dementia & Motor Neuron Disease * Neuroinflammation & Microglial

Innate Signaling * Endolysosomal Trafficking, Autophagy & Proteostasis *
Ophthalmology, Macular Degeneration & Retinal Dystrophies |

| P2RX7 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || Pain,
Migraine & Nociceptive Channelopathies * Neuroinflammation & Microglial Innate
Signaling * Synaptic Transmission, Channelopathies & Ion Flux * Autoimmune &
Autoinflammatory Disorders |

| TBK1 || 4 || 2.0000 || 4 || Cross-Panel Pleiotropic Hub (4 Panels) || ALS,
Frontotemporal Dementia & Motor Neuron Disease * Neuroinflammation & Microglial
Innate Signaling * Endolysosomal Trafficking, Autophagy & Proteostasis * Infectious
Disease Host Entry Factors & Antiviral Innate Immunity |

| CACNA1C || 4 || 2.0000 || 3 || Verified CRV Labs Locus / Multi-Panel Hub ||
Autism Spectrum & Neurodevelopmental Disorders * Schizophrenia & Bipolar Psychosis *
Synaptic Transmission, Channelopathies & Ion Flux * Cardiomyopathies & Cardiac
Arrhythmia Channelopathies |

| GRN || 4 || 2.0000 || 3 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * ALS, Frontotemporal Dementia & Motor Neuron
Disease * Neuroinflammation & Microglial Innate Signaling * Endolysosomal
Trafficking, Autophagy & Proteostasis |

| SLC6A4 || 4 || 2.0000 || 3 || Cross-Panel Pleiotropic Hub (4 Panels) || ADHD
& Dopaminergic Catecholamine Signaling * Depression, Anxiety & Circadian Sleep
Regulation * Synaptic Transmission, Channelopathies & Ion Flux * Pharmacogenomics:
Cytochrome P450 ADME, HLA & Drug Toxicity |

| HTR2A || 4 || 2.0000 || 2 || Cross-Panel Pleiotropic Hub (4 Panels) || ADHD &
Dopaminergic Catecholamine Signaling * Schizophrenia & Bipolar Psychosis *
Depression, Anxiety & Circadian Sleep Regulation * Synaptic Transmission,
Channelopathies & Ion Flux |

| MAPT || 4 || 2.0000 || 2 || Cross-Panel Pleiotropic Hub (4 Panels) ||
Alzheimer's Disease & Tauopathies * Parkinson's Disease & Synucleinopathies * ALS,
Frontotemporal Dementia & Motor Neuron Disease * Cytoskeletal Dynamics & Axonal
Transport |

Generated by: Native Rust 32-Panel Bipartite Disease-Gene & Pleiotropy Entropy
Engine (disease_genes.rs)

3. Pairwise Pathway Jaccard Topology & Five Bioinformatic Sequence-Structure Modalities

Evaluating pairwise Jaccard similarity across all 496 panel pairs highlights
statistical overlaps between gene sets that may point to shared sequence and pathway
features worth further bioinformatic and experimental investigation:

| Disease / Pathway Panel A || Disease / Pathway Panel B || Shared Genes (N) ||
Jaccard Index || Shared Mechanistic Loci |

| ALS, Frontotemporal Dementia & Motor Neuron Disease || RNA Metabolism, Splicing &
Tandem Repeat Expansions || 9 || 0.4286 || ATXN2, C9orf72, FUS, HTT, SMN1, SMN2,
STMN2, TARDBP, UNC13A |

| Parkinson's Disease & Synucleinopathies || Endolysosomal Trafficking, Autophagy & Proteostasis || 11 || 0.3548 || CTSD, CTSD, GAK, GBA1, LRRK2, PARK7, PINK1, PRKN, TMEM175, VPS13C, VPS35 |

| Alzheimer's Disease & Tauopathies || Amyloid Precursor Processing & Brain Lipid Metabolism || 11 || 0.3056 || ABCA7, ACE, ADAM10, APOE, APP, BACE1, BACE2, CLU, PSEN1, PSEN2, SORL1 |

| Alzheimer's Disease & Tauopathies || Neuroinflammation & Microglial Innate Signaling || 14 || 0.2979 || ABCA7, ABI3, CD33, CLU, CR1, EPHA1, GRN, INPP5D, MS4A4A, MS4A6A, PILRA, PLCG2, SPI1, TREM2 |

| Pain, Migraine & Nociceptive Channelopathies || Synaptic Transmission, Channelopathies & Ion Flux || 17 || 0.2297 || ATP1A2, CACNA1A, COMT, HTR1F, KCNK18, OPRD1, OPRK1, OPRM1, P2RX3, P2RX7, SCN10A, SCN11A, SCN1A, SCN9A, TRPA1, TRPM8, TRPV1 |

| ALS, Frontotemporal Dementia & Motor Neuron Disease || Cytoskeletal Dynamics & Axonal Transport || 5 || 0.2000 || HTT, MAPT, NEK1, PMP22, STMN2 |

| Autism Spectrum & Neurodevelopmental Disorders || Synaptic Transmission, Channelopathies & Ion Flux || 16 || 0.1882 || CACNA1C, CACNA1H, FMR1, GABRB3, GRIN2A, GRIN2B, KANSL1, MECP2, NLGN3, NLGN4X, NRXN1, SCN1A, SCN2A, SHANK2, SHANK3, SYNGAP1 |

| Asthma, Airway Hyperresponsiveness & Atopy || Autoimmune & Autoinflammatory Disorders || 11 || 0.1774 || GSDMB, HLA-DQB1, HLA-DRB1, IL13, IL33, IL4, IL4R, IL5, ORMDL3, STAT6, TSLP |

| Alzheimer's Disease & Tauopathies || Cytoskeletal Dynamics & Axonal Transport || 7 || 0.1707 || BIN1, CASS4, CD2AP, EPHA1, FERMT2, MAPT, PTK2B |

| Schizophrenia & Bipolar Psychosis || Synaptic Transmission, Channelopathies & Ion Flux || 15 || 0.1685 || ANK3, BDNF, CACNA1C, CACNA1G, CACNB2, COMT, DRD2, GRIA1, GRIA3, GRIN2A, GRM3, HTR2A, NRXN1, SHANK3, SYNGAP1 |

| ADHD & Dopaminergic Catecholamine Signaling || Synaptic Transmission, Channelopathies & Ion Flux || 12 || 0.1600 || BDNF, CHRNA7, COMT, DRD2, DRD4, DRD5, HTR1B, HTR2A, SLC6A2, SLC6A3, SLC6A4, SNAP25 |

| Depression, Anxiety & Circadian Sleep Regulation || Synaptic Transmission, Channelopathies & Ion Flux || 13 || 0.1566 || BDNF, DRD2, GABRA1, GABRA2, GABRB2, GABRG2, GRIN2B, GRM2, GRM5, HTR1A, HTR2A, HTR2C, SLC6A4 |

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Generated by: Native Rust Sliding-Window Information-Theoretic & Non-B DNA Scanner (complexity.rs : Shannon H3 + LZ76 + DFA + G4Hunter + Z-DNA) * Native Rust Codon dN/dS, Selection Relaxation (RELAX k) & Trait-Loss Engine (pseudo_pancryptic.rs) * Native Rust GFA Pangenome Graph Topology, Residue-Interaction Network (RIN) & Cryptic Cavity Engine (pseudo_pancryptic.rs) * Native Rust APC-Corrected Mutual Information & Potts Hamiltonian Co-Evolution Engine (coevo_condensate_clonal.rs) * Native Rust 3D Chromatin Graph Laplacian & RNA Phase-Separation Scaffold Engine (

coevo_condensate_clonal.rs) * Native Rust Somatic Coalescent, 96-Channel Mutational JSD & Synthetic Lethality Engine (coevo_condensate_clonal.rs)

Discussion & Key Takeaways

* Shared Endolysosomal and Repeat-Condensate Loci Suggest Candidate Links Across Neurodegenerative Syndromes: The bipartite Jaccard overlap observed between ALS/FTD and tandem-repeat RNA metabolism (0.4286) and between Parkinson's disease, Alzheimer's disease, and endolysosomal/microglial panels (0.2979-0.3548) offers a correlative line of evidence suggesting that shared pathways involving GRN , TMEM106B , TBK1 , OPTN , C9orf72 , MAPT , GBA1 , and LRRK2 warrant deeper experimental investigation into overlapping clinical phenotypes across dementia, motor neuron disease, and movement disorders.

* Structural Genomics Prioritizes High-Homology and Repeat-Rich Candidate Loci: Several recurrent clinical genes in the 32-panel catalog -- including SMN1 / SMN2 , GBA1 / GBAP1 , CYP2D6 / CYP2D7 , C4A / C4B , LPA kringle-IV repeats, and the 865-motif G-quadruplex VNTR in CACNA1C intron 30 -- reside in segmental duplications or non-B DNA tandem repeats where pangenome graph phasing may help resolve variants missed by standard short-read alignment.

* Cross-Referencing Disease Gene Panels With Pharmacogenomic Sequence Loci (Panel #32): Including the 28-gene Pharmacogenomics ADME & Sequence Variation panel (CYP2D6 , CYP2C19 , DPYD , TPMT , NUDT15 , UGT1A1 , SLCO1B1 , VKORC1 , G6PD , HLA-A , HLA-B , and mitochondrial MT-RNR1) alongside the 31 disease-pathway panels allows computational bioinformatics workflows to flag shared pleiotropic genes, star-allele paralog conversions, and mitochondrial rRNA secondary-structure variants -- providing sequence-level annotations that can contribute to downstream clinical genetics , pharmacogenomics, and diagnostic genomics research.

4. Interactive Exploration & Reference Provenance

All 32 bioinformatic gene panels and 630 HGNC gene symbols are interactively searchable in the CRV Science Labs Human Disease & Pathway Gene Panels Explorer , where clicking any gene symbol filters related Lab Discoveries and cross-references foundational articles on CRV Wiki. Full machine-readable JSON telemetry is available at /labs/releases/disease-genes-atlas.json .