Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
DISORDERS OF NITROGEN-CONTAINING COMPOUNDS												
Disorders of purine metabolism												
Inosine triphosphatase deficiency	*ITPA*		X						Encephalopathy, seizures, delayed myelination	DNA		30856165
Disorders of nucleotide and nucleic acid metabolism												
ENPP1 deficiency	*ENPP1*		X			**Calcification and stenoses**	**Calcification**	**Myocardial infarction**	Periarticular calcification, hypophosphatemic rickets	Pyrophosphate (S)		22209248
ABCC6 deficiency	*ABCC6*		X			**Calcification and stenoses**	**Calcification**	**Myocardial infarction**	Flexural yellowish papules, angioid streaks of the retina	Pyrophosphate (S)		22209248
CD73 deficiency	*NT5E*						**Calcification**		Periarticular calcifications			21288095
TREX1 deficiency	*TREX1*						Cerebroretinal vasculopathy	Pulmonary HTN, Raynaud	Spasticity, leukodystrophy, intracerebral calcification, chillblains	ASAT/ALAT (P), Blood count (B), Interferon signature (B), pterins (CSF), C26:0 lysophosphatidylcholine		30219631, 17660820
SAMHD1 deficiency	*SAMHD1*						Arterial stenoses and aneurysms		Spasticity, leukodystrophy, intracerebral calcification, strokes	ASAT/ALAT (P), Blood count (B), Interferon signature (B), pterins (CSF), C26:0 lysophosphatidylcholine		21402907
MDA5 (IFIH1) superactivity	*IFIH1*					Calcification	Calcification	Pulmonary HTN	Spasticity, leukodystrophy, intracerebral calcification, strokes	ASAT/ALAT (P), Blood count (B), Interferon signature (B), pterins (CSF)		30219631, 25620204
Disorders of glutathione metabolism												
Glutathione peroxidase 4 deficiency	*GPX4*				X				Metaphapyseal dysplasia, platyspondyly, CNS involvement	DNA		24706940
Disorders of amino acid transport												
Lysinuric protein intolerance	*SLC7A7*				X			Myocardial infarction	Pulmonary alveolar proteinosis, hemophagocytic lymphohistiocytosis, glomerulonephritis, fractures	Amino acids (P, U), Ammonia (P), Ferritin (S), Lipid panel (S), Orotic acid (U)	Protein restriction, ammonia scavengers, citrulline	28057010
Disorders of monoamine metabolism												
Dopamine beta-hydroxylase deficiency	*DBH*							**Orthostatic hypotension**	Ptosis of eyelids, nasal congestion, impaired ejaculation	Norepinephrine (P, U), Dopamine (P), HVA (CSF), 5HIAA (CSF), L-dopa (CSF)	Droxidopa	16722595
Cytochrome b561 deficiency	*CYB561*							**Orthostatic hypotension**	Renal dysfunction possible	Norepinephrine (P, U), Serotonin (S), Dopamine (P)	Droxidopa	29343526
Norepinephrine transporter deficiency	*SLC6A2*							Orthostatic hypotension	-	Norepinephrine (P, U)		10684912
Disorders of tyrosine metabolism												
Alkaptonuria	*HGD*					**Aortic**	Calcification, decreased aortic distensibility		Arthritis, ochronosis, urine darkening on standing	Homogentisate (U)	Nitisinone	22100375, 32466960
Disorders of sulfur amino acid and sulfide metabolism												
Cystathionine beta-synthase deficiency	*CBS*						**X**		Ectopia lentis, arachnodactyly, developmental delay, osteoporosis	Total homocysteine (P), Amino acids (P)	Pyridoxine, betaine, protein restriction	9211201, 11742888
Adenosine kinase deficiency	*ADK*							ASD, VSD, PDA, PFO	Developmental delay, seizures, frontal bossing, liver dysfunction	SAM/SAH (P), ASAT/ALAT (P), Glucose (S), Amino acids (P), Purines (U), Total/direct bilirubin (S)		26642971
Ethylmalonic encephalopathy	*ETHE1*						**X**		Petechiae, intellectual disability, seizures	Organic acid (U), acylcarnitines (P), thiosulphate (P), lactate (B)	Liver transplant	7726376
Disorders of branched-chain amino acid metabolism												
Dihydrolipoamide dehydrogenase deficiency	*DLD*	X							Hypotonia, recurrent liver failure	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Acylglycines (U), ASAT/ALAT (P), CK (P), Lactate (P), Ammonia (P), Glucose (S), Urinalysis		
Isovaleric acidemia	*IVD*				X				Encephalopathic crises, odor of sweaty feet	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Acylglycines (U), ASAT/ALAT (P), CK (P), Lactate (P), Ammonia (P), Glucose (S), Urinalysis	Glycine, levocarnitine	9438897
Isobutyryl-CoA dehydrogenase deficiency	*ACAD8*		X						-	Acylcarnitines (DBS, P), Acylglycines (U), Carnitine (P)	Levocarnitine	9889013
3-Methylcrotonyl-CoA carboxylase deficiency	*MCCC1, MCCC2*		X						-	Organic acids (U), Acylcarnitines (DBS, P)		11131348, 22642865
HSD10 disease	*HSD17B10*	**X**	**X**						Intellectual disability, seizures, movement disorder	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Lactate (P), Glucose (S)		22127393
3-Hydroxy-3-methylglutaryl-CoA lyase deficiency	*HMGCL*		X		X				Lethargy during crises, episodic vomiting	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), Lactate (P), Ammonia (P)	Low protein diet, carnitine	7807935, 19893767, 28583327
Propionic acidemia	*PCCA, PCCB*		**X**		**X**				Encephalopathic crises, intellectual disability, progressive renal dysfunction, feeding difficulty	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Acylglycines (U), Lactate (P), Ammonia (P), Glucose (S)	Low protein diet, carnitine	DOI: 10.29245/2572-9411/2018/3.1162
Methylmalonic aciduria due to methylmalonyl-CoA mutase deficiency	*MMUT*		X						Encephalopathic crises, intellectual disability, movement disorder, feeding difficulty	Amino acids (P), Organic acids (U), MMA (S), Acylcarnitines (DBS, P)	Low protein diet, carnitine, hydroxycobalamin	21784454
Malonic aciduria	*MLYCD*		**X**						Developmental delay, vomiting	Organic acids (U), Acylcarnitines (DBS, P), Lactate (P), Glucose (S), Lipid panel (S)	LCT restriction, MCT supplementation	7609455, 7537025, 9177981, 20549361
Disorders of proline and ornithine metabolism												
Pyrroline-5-carboxylate synthetase deficiency	*ALDH18A1*						Arterial tortuosity	ASD, VSD, PDA, persistance of SVC	Developmental delay, cataracts, cutis laxa, progeroid appearance	Amino acids (P), Ammonia (P)		21739576, 24913064
X-prolyl aminopeptidase 3 deficiency	*XPNPEP3*	X	X						Kidney cysts, chronic renal disease			20179356
Disorders of tryptophan metabolism												
Kynureninase deficiency	*KYNU*							HLHS, PDA	Renal defects, vertebral defects, hyperphalangism	3-Hydroxykynurenine (P, U), NAD+ (P), Kynurenine (U), Xanthurenic acid (U)		28792876, 31923704
3-Hydroxyanthranilate 3,4-dioxygenase deficiency	*HAAO*							HLHS, ASD	Renal defects, vertebral defects	3-Hydroxyanthranilic acid (P)		28792876
DISORDERS OF VITAMINS, COFACTORS, METALS AND MINERALS												
Disorders of lipoic acid and iron-sulfur metabolism												
Lipoic acid synthase deficiency	*LIAS*	X							Hypotonia, seizures			22152680
Lipoyltransferase 1 deficiency	*LIPT1*							Pulmonary hypertension	Intellectual disability, seizures, spasticity	Lactate (P), Organic acids (U)		24256811
NFU1 deficiency	*NFU1*							**Pulmonary hypertension**	Intellectual disability, leukodystrophy			22077971, 31516295
BOLA3 deficiency	*BOLA3*	X	X						Intellectual disability, leukodystrophy	Amino acids (CSF, P), Lactate (P)		22562699, 24334290
Frataxin deficiency	*FXN*	**X**	X		X				Ataxia, areflexia, diabetes	Glucose (S)		30705738, 22379112

Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
NFS1 deficiency	*NFS1*		X						Hypotonia, seizures, developmental delay	Lactate (P)		24498631
Disorders of cobalamin metabolism												
Adenosylcobalamin and methylcobalamin synthesis defect - cblF	*LMBRD1*							Congenital heart defects	Hypotonia, stomatitis	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), tHcy (P), SAM/SAH (P), Blood count	Hydroxycobalamin	19136951
Adenosylcobalamin and methylcobalamin synthesis defect - cblJ	*ABCD4*							Congenital heart defects	Neurologic involvement, skin hyperpigmentation	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), tHcy (P), SAM/SAH (P)	Hydroxycobalamin	22922874
Adenosylcobalamin and methylcobalamin synthesis defect - cblC	*MMACHC*		X	X		X		Congenital heart defects	Neurologic involvement, hemolytic uremic syndrome, maculopathy	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), SAM/SAH (P), Blood count	Hydroxycobalamin	19767224, 23430797
Disorders of folate metabolism												
Hereditary folate malabsorption	*SLC46A1*		X						Failure to thrive, diarrhea, infections with unsual organisms	Folate (S), 5-Methyl-THF (CSF), Blood count (B), Immunoglobulins (S)	Folate (active forms)	20005757
Disorders of thiamine metabolism												
Thiamine-responsive megaloblastic anemia syndrome	*SLC19A2*		X		X			Congenital heart defects	Diabetes mellitus, progressive sensorineural hearing loss	Lactate (P), Glucose (S)	Thiamine	14627317, 21285901
Disorders of riboflavin metabolism												
Multiple acyl-CoA dehydrogenase deficiency	*ETFDH, ETFA, ETFB*		X		X				Lipid myopathy, liver dysfunction	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Acylglycines (U), ASAT/ALAT (P), CK (P), Glucose (S)	Riboflavin; D,L-3-hydroxybutyrate	17912479, 32190638, 31904027
Disorders of niacin and NAD metabolism												
NAD(P)HX dehydratase deficiency	*NAXD*		X						Developmental regression, ataxia, skin lesions			30576410
Disorders of pantothenate metabolism												
Phosphopantothenoylcysteine synthetase deficiency	*PPCS*		**X**						-			29754768
Mitochondrial coenzyme A transporter deficiency	*SLC25A42*		X						Myopathy			29327420
Disorder of vitamin C metabolism												
Arterial tortuosity syndrome	*SLC2A10*					X	**Tortuosity; pulmonary artery stenosis**		Joint laxity, skin hyperextensibility	DNA		17935213, 29323665
Disorders of copper metabolism												
Menkes disease	*ATP7A*						**Tortuosity**		Intellectual disability, seizures, bladder diverticula, cutis laxa, kinky hair	Copper (S), Ceruloplasmin (S)		28495946
Disorders of iron metabolism												
Hereditary hemochromatosis type 1	*HFE*		X		X			Restrictive cardiomyopathy	Hypogonadism, liver disease, diabetes, arthralgia, skin hyperpigmentation	Iron (S), Ferritin (S), Transferrin (S)	Phlebotomy	24503941, 7446557, 3389642
Hemojuvelin deficiency	*HFE2*		**X**						Hypogonadism, liver disease	Iron (S), Ferritin (S), Transferrin (S)	Phlebotomy	31286966, 29743178
Hereditary hepcidin deficiency	*HAMP*		**X**						Hypogonadism, liver disease	Iron (S), Ferritin (S), Transferrin (S)	Phlebotomy	29743178
Transferrin receptor 2 deficiency	*TFR2*		X						Hypogonadism, liver disease	Iron (S), Ferritin (S), Transferrin (S)	Phlebotomy	29743178
DISORDERS OF CARBOHYDRATES												
Disorders of the pentose phosphate pathway and polyol metabolism												
Transaldolase deficiency	*TALDO1*	X	X					Congenital heart defects	Liver cirrhosis, cutis laxa, renal tubular dysfunction	ASAT/ALAT (P), ALP (S), GGT (S), Glucose (S), Total/direct bilirubin (S), Ferritin (S), Polyol (U)		30740741
Transketolase deficiency	*TKT*							Congenital heart defects	Developmental delay, short stature	Polyol (U)		27259054
Glycogen storage diseases												
Glycogenin 1 deficiency	*GYG1*	X	X		X				Muscle weakness	Glycogen (M)		20357282, 27718144
Glycogen synthase 1 deficiency	*GYS1*	X	X		X				Muscle weakness	Glycogen (M)		19699667, 21958591, 17928598
Pompe disease	*GAA*	**X**	X		X				Hypotonia, muscle weakness, macroglossia	ASAT/ALAT (P), CK (P), Glycogen (M)	Alglucosidase alpha	21543987, 25213570, 18813140, 25213570
Glycogen debranching enzyme deficiency	*AGL*	**X**	X						Hepatomegaly, liver dysfunction, muscle weakness	ASAT/ALAT (P), CK (P), Lactate (P), Glucose (S), Glycogen (L), Biotinidase (P)	D,L-3-hydrobutyrate, ketogenic and high-protein diet	27106217, 8407725, 21857385
Glycogen branching enzyme deficiency	*GBE1*	X	X						Hepatomegaly, liver dysfunction, muscle weakness	ASAT/ALAT (P), Bilirubin (P), Coagulation factors (P), Glycogen (L)		23056054, 10552189, 8881867
HOIL1 deficiency	*RBCK1*	X	**X**						Muscle weakness			23104095, 23889995
Cardiac phosphorylase kinase (PRKAG2) deficiency	*PRKAG2*	**X**			**X**				-	CK (P), Glucose (S)		11407343, 11371514, 15877279, 16487706
Danon disease	*LAMP2*	**X**	X		**X**				Intellectual disability, skeletal myopathy, retinal changes	ASAT/ALAT (P), CK (P), Glycogen (M)		15673802, 12084876
MITOCHONDRIAL DISORDERS OF ENERGY METABOLISM												
Disorders of the Krebs cycle												
D-2-hydroxyglutaric aciduria type 2	*IDH2*	X	**X**						Intellectual disability, hypotonia	Organic acids (U)		22391998
GTP-specific succinyl-CoA ligase α subunit deficiency	*SUCLG1*	X							Hypotonia, intellectual disability, liver disease, hearing loss	Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), Lactate (P)		26475597
Disorders of mitochondrial carriers												
Adenine nucleotide translocator 1 (SLC25A4) deficiency	*SLC25A4*		**X**						External ophthalmoplegia, skeletal myopathy	Lactate (P)		22187496, 27693233
Mitochondrial phosphate carrier deficiency	*SLC25A3*	X	X						Hypotonia, failure to thrive	Lactate (P)		
Disorders of complex I subunits												
NDUFS1 deficiency	*NDUFS1*	X							Psychomotor delay, leukodystrophy			
NDUFS2 deficiency	*NDUFS2*		X						Myopathy, basal ganglia abnormalities	Lactate (P)		11220739
NDUFS4 deficiency	*NDUFS4*	X							Leukodystrophy, basal ganglia abnormalities	Lactate (P)		19107570
NDUFS8 deficiency	*NDUFS8*	X							Myopathy, external ophthalmoplegia	Lactate (P)		9837812
NDUFV2 deficiency	*NDUFV2*	X							Encephalopathy, hypotonia	Lactate (P)		12754703
NDUFA2 deficiency	*NDUFA2*	X							Encephalopathy, hypotonia	Lactate (P)		18513682
NDUFA10 deficiency	*NDUFA10*	X							Hypotonia, basal ganglia lesions	Lactate (P)		21150889
NDUFA11 deficiency	*NDUFA11*	X							Encephalopathy	Lactate (P)		18306244
NDUFB8 deficiency	*NDUFB8*	X								Lactate (P)		29429571
NDUFB10 deficiency	*NDUFB10*	X								Lactate (P)		28040730
NDUFB11 deficiency	*NDUFB11*							**Histiocytoid cardiomyopathy**	Linear skin defects	Lactate (P)		25921236, 25772934, 28050600
MT-ND1 deficiency	*MT-ND1*			X					Skeletal myopathy, Leber hereditary optic neuropathy	Lactate (P)		20211276
MT-ND2 deficiency	*MT-ND2*		X						Myopathy with ragged red fibers	Lactate (P)		9811342

Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
NT-ND4L deficiency	*MT-ND4L*		X						Leber hereditary optic neuropathy	Lactate (P)		11145757, 9344764
MT-ND5 deficiency	*MT-ND5*	X			Wolff-Parkinson-White syndrome				MELAS-like features	Lactate (P)		19054921, 17106447
Disorders of complex I assembly												
NDUFAF1 deficiency	*NDUFAF1*	**X**							Failure to thrive, hypotonia	Lactate (P)		21931170
NDUFAF4 deficiency	*NDUFAF4*		X						Dystonia, encephalomyopathy	Lactate (P)		18179882
FOXRED1 deficiency	*FOXRED1*	X						Pulmonary hypertension	Encephalomyopathy	Lactate (P)		20858599, 31065540
Acyl-CoA dehydrogenase 9 deficiency	*ACAD9*		X						Hypotonia, encephalopathy, liver failure	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), CK (P), Lactate (P), Ammonia (P), Glucose (S)	Riboflavin	30025539, 31473688
TMEM126B deficiency	*TMEM126B*	X							Muscle weakness	Lactate (P)		27374774
Disorders of complex II subunits												
Succinate dehydrogenase subunit A deficiency	*SDHA*	X	X	X					Encephalopathy	Lactate (P)		27683074, 20551992
Succinate dehydrogenase subunit D deficiency	*SDHD*	X		X					Encephalopathy	Lactate (P)		26008905
Disorders of complex III subunits												
UQCRFS1 deficiency	*UQCRFS1*	**X**						Pericardial effusion	Alopecia totalis	CBC, Lactate (P)		31883641, 21457908
Disorders of complex IV subunits												
MT-CO1 deficiency	*MT-CO1*		X						Muscle weakness, seizures	Lactate (P)		9344764
MT-CO2 deficiency	*MT-CO2*		X						Muscle weakness	Lactate (P)		11145757
MT-CO3 deficiency	*MT-CO3*		X						Muscle weakness	Lactate (P)		11145757
COX6B1 deficiency	*COX6B1*	X							Muscle weakness, seizures	Lactate (P)		24781756
COX7B deficiency	*COX7B*	X							Linear skin defects	Lactate (P)		23122588
Disorders of complex IV assembly and ancillary proteins												
COA5 deficiency	*COA5*	**X**							-	Lactate (P)		21457908
COA6 deficiency	*COA6*	**X**		X					Muscle weakness	Lactate (P)		25339201
COX10 deficiency	*COX10*	X							Hypotonia, developmental delay	Lactate (P)		12928484
COX14 deficiency	*COX14*	X							Dysmorphic features	Lactate (P)		22243966
COX15 deficiency	*COX15*	X							Developmental delay, seizures	Lactate (P)		21412973
SCO1 deficiency	*SCO1*	X							Seizures, failure to thrive, muscle weakness	Lactate (P)		19295170
SCO2 deficiency	*SCO2*	**X**							Muscle weakness	Lactate (P)		10545952
SURF1 deficiency	*SURF1*	X							Developmental delay, poor feeding, movement disorder	Lactate (P)		23829769
Disorders of complex V subunits												
MT-ATP6 deficiency	*MT-ATP6*	X							Ataxia, peripheral neuropathy, retinitis pigmentosa	Lactate (P)		8042671
MT-ATP8 deficiency	*MT-ATP8*	**X**							Neuropathy	Lactate (P)		17954552
ATP5F1D deficiency	*ATP5F1D*		X						-	Ammonia (P), Lactate (P), 3-Methylglutaconic acid (U)		29478781
Disorders of complex V assembly												
Transmembrane protein 70 deficiency	*TMEM70*	X						Pulmonary hypertension	Hypotonia, developmental delay	CK (P), Lactate (P), Ammonia (P), 3-Methylglutaconic acid (U)		21147908, 24485043
Disorders of mitochondrial cytochrome synthesis and incorporation												
Mitochondrial cytochrome b (MT-CYB) deficiency	*MT-CYB*	X						Histiocytoid cardiomyopathy	Exercise intolerance	Lactate (P)		10960495, 24498601
Holocytochrome c synthase deficiency	*HCCS*							Histiocytoid cardiomyopathy	Linear skin defects, multiple congenital anomalies	Lactate (P)		24735900
Disorders of mitochondrial DNA depletion, multiple deletion, or intergenomic communication												
POLG deficiency	*POLG*				X				Intellectual disability, neuropathy, ataxia, liver disease, external ophthalmoplegia	Lactate (P)		26224072
MGME1 deficiency	*MGME1*		X		X				Muscle weakness, external ophthalmoplegia	Lactate (P)		23313956
Disorders of mitochondrial transcription and RNA transcript processing												
TRMT10C deficiency	*TRMT10C*	X							Hypotonia, feeding difficulties, hearing loss	Lactate (P)		27132592
TRMT5 deficiency	*TRMT5*	X							Exercise intolerance	Lactate (P)		26189817
ELAC2 deficiency	*ELAC2*	**X**							Failure to thrive, hypotonia	Lactate (P)		23849775
GTPBP3 deficiency	*GTPBP3*	**X**							Hypotonia, developmental delay, basal ganglia lesions	Lactate (P)		25434004
MTO1 deficiency	*MTO1*	**X**							Hypotonia	Lactate (P)		22608499
TRNT1 defciency	*TRNT1*	X			X					Lactate (P), Blood count		27370603, 23553769
Mitochondrial ribosomopathies												
MRPL3 deficiency	*MRPL3*	**X**							Developmental delay, hearing loss	Lactate (P), Ammonia (P)		27815843, 21786366
MRPL44 disease	*MRPL44*	**X**							-	Lactate (P)		23315540
MRPS14 deficiency	*MRPS14*	**X**			Wolff-Parkinson-White syndrome				Hypotonia, failure to thrive, developmental delay	Lactate (P)		30358850
MRPS22 deficiency	*MRPS22*	**X**							Renal tubular dysfunction	Lactate (P)		17873122, 21189481
Mitochondrial ribosomal RNA 12S deficiency	*MT-RNR1*		X						Hearing loss	Lactate (P)		9811342
Mitochondrial ribosomal RNA 16S deficiency	*MT-RNR2*		X						-	Lactate (P)		15120634
Disorders of mitochondrial tRNA												
MT-TA deficiency	*MT-TA*		X						Muscle weakness	Lactate (P)		9811342, 9344764
MT-TC deficiency	*MT-TC*		X						Encephalopathy, ophthalmolplegia, stroke-like episodes	Lactate (P)		doi.org/10.1253/jcj.56.1045
MT-TD deficiency	*MT-TD*		X						Exercise intolerance	Lactate (P)		9811342
MT-TE deficiency	*MT-TE*		X						Skeletal myopathy, diabetes mellitus, hearing loss	Lactate (P)		17891417
MT-TG deficiency	*MT-TG*	X			X				Exercise intolerance	Lactate (P)		8079988
MT-TH deficiency	*MT-TH*	X	X						Pigmentary retinopathy, sensorineural hearing loss	Lactate (P)		11038324
MT-TI deficiency	*MT-TI*	**X**	**X**						Encephalopathy	Lactate (P)		1978914, 1632786, 8889580
MT-TK deficiency	*MT-TK*	X							Myopathy with ragged red fibers, myoclonic epilepsy	Lactate (P)		8651277
MT-TL1 deficiency	*MT-TL1*	**X**	X		**X**			Restrictive cardiomyopathy	MELAS-like features	Lactate (P)		9222976, 7473662, 11241464, 23243073, 18579503

Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
MT-TL2 deficiency	*MT-TL2*		**X**					Endocardial fibroelastosis	External ophthalmoplegia, pigmentary retinopathy, hearing loss	Lactate (P)		11313776, 10602359
MT-TP deficiency	*MT-TP*		X						Myopathy	Lactate (P)		22954281
MT-TR deficiency	*MT-TR*		X						Encephalomyopathy	Lactate (P)		9344764, 15120634
MT-TT deficiency	*MT-TT*		X						-	Lactate (P)		9811342, 15120634
MT-TY deficiency	*MT-TY*		X						Exercise intolerance, external ophthalmoplegia, focal segmental glomerulosclerosis	Lactate (P)		14598342
MT-TV deficiency	*MT-TV*		X						Ataxia, seizures, intellectual disability, hearing loss	Lactate (P)		9811342
Disorders of mitochondrial tRNA incorporation and recycling												
AARS2 deficiency	*AARS2*	**X**							Muscle weakness	Lactate (P)		21549344
GATB deficiency	*GATB*		**X**					Pulmonary hypertension	-	Lactate (P)		30283131
GATC deficiency	*GATC*		**X**						-	Lactate (P)		30283131
QRSL1 deficiency	*QRSL1*	**X**	**X**						Sensorineural hearing loss	Lactate (P)		30283131, 29440775
LARS2 deficiency	*LARS2*				X			Pulmonary hypertension	Liver dysfunction	Lactate (P)		26537577
SARS2 deficiency	*SARS2*	X						**Pulmonary hypertension**	Alkalosis, renal failure	Lactate (P), Uric acid (S)		24034276, 21255763
YARS2 deficiency	*YARS2*	X							Skeletal myopathy	Lactate (P), Blood count		24430573, 24344687, 23918765
WARS2 deficiency	*WARS2*		X						Intellectual disability, movement disorder	Lactate (P)		28905505
Disorders of mitochondrial phospholipid metabolism												
Sengers syndrome	*AGK*	**X**							Skeletal myopathy, cataracts	Lactate (P)		22284826
Barth syndrome	*TAZ*		**X**	**X**	X			Endocardial fibroelastosis	Skeletal myopathy, failure to thrive	Organic acids (U), Lipid panel (S), Urinalysis, 3-Methylglutaconic acid (U), 3-Methylglutaric acid (U), Carnitine, free (P), Blood count	Elamipretide	23656970, 33077895
DNAJC19 deficiency	*DNAJC19*		**X**	X					Ataxia	Organic acids (U), CK (P), Lactate (P), 3-Methylglutaconic acid (U), Blood count		16055927, 17244376, 22797137
TIMM50 deficiency	*TIMM50*		X						Intellectual disability, seizures	Organic acids (U), Lactate (P), 3-Methylglutaconic acid (U)		31058414
PAM16 deficiency	*PAM16*		X						Spondylometaphyseal dysplasia			24458487
Disorders of mitochondrial protein quality control												
MIPEP deficiency	*MIPEP*	X	X	X					Hypotonia, developmental delay	Lactate (P)		27799064
Other disorders of mitochondrial homeostasis												
Mitochondrial inorganic pyrophosphatase deficiency	*PPA2*				**X**				-	Organic acids (U), Lactate (P)		27523598, 27523597
ATAD3A deficiency	*ATAD3A*	X							Hypotonia, pontocerebellar hypoplasia	Lactate (P)		27640307
C1QBP deficiency	*C1QBP*		X						Myopathy, external ophthalmoplegia, nephrotic syndrome	Lactate (P)		28942965
Primary CoQ10 deficiencies												
COQ2 deficiency	*COQ2*	X							Developmental delay, seizures, nephrotic syndrome	Lactate (P), CoQ10 (M, P, WBC)		23816342
COQ4 deficiency	*COQ4*	X			X				Hypotonia, seizures	Lactate (P), CoQ10 (M, P, WBC)		25658047, 26185144
COQ9 deficiency	*COQ9*	X	X	X					Hypotonia, seizures	Lactate (P), CoQ10 (M, P, WBC)		31821167, 29560582, 19375058
DISORDERS OF LIPIDS												
Disorders of carnitine metabolism												
Carnitine transporter deficiency	*SLC22A5*	X	X					Endocardial fibroelastosis	Hypotonia possible	Total/free carnitine (DBS, P)	Carnitine	7131143, 7254270, 8674264, 28295041
Carnitine palmitoyltransferase 2 deficiency	*CPT2*	X	X		X				Skeletal myopathy, liver dysfunction	Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), CK (P)	Frequent feeds, low-fat diet, MCT supplementation	9924637, 1999498
Carnitine acylcarnitine translocase deficiency	*SLC25A20*	X	X		X				Skeletal myopathy, liver dysfunction	Ammonia (P), Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), CK (P), Lactate (P), Glucose (S)	Frequent feeds, low-fat diet, MCT supplementation	25614308, 7807931, 7564255
Disorders of fatty acid oxidation and transport												
Very long - chain acyl CoA dehydrogenase deficiency	*ACADVL*	X	X		X			Pericardial effusion	Skeletal myopathy	Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), CK (P), Glucose (S), Dicarboxylic acids (U)	Frequent feeds, low-fat diet, MCT supplementation; triheptanoin	27995075, 27590926, 29768383
Trifunctional protein deficiency	*HADHA, HADHB*	X	X		X			Pericardial effusion	Skeletal myopathy, peripheral neuropathy, pigmentary retinopathy	Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), Lactate (P), Glucose (S), Dicarboxylic acids (U)	Frequent feeds, low-fat diet, MCT supplementation; triheptanoin	27590926, 29124685, 14630990
Long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency	*HADHA*	X	X		X				Skeletal myopathy, peripheral neuropathy, pigmentary retinopathy	Organic acids (U), Acylcarnitines (DBS, P), ASAT/ALAT (P), CK (P), Lactate (P), Ammonia (P), Glucose (S), Dicarboxylic acids (U)	Frequent feeds, low-fat diet, MCT supplementation; triheptanoin	27590926, 2284166, 25888220
TANGO2 deficiency	*TANGO2*	X			**X**				Intellectual disability, seizures, rhabdomyolysis	Organic acids (U), Acylcarnitines (DBS, P), CK (P), Lactate (P), Glucose (S), Dicarboxylic acids (U)		30245509, 26805781, 26805782
Disorders of ketone body metabolism												
Beta-ketothiolase deficiency	*ACAT1*		X						Encephalopathy with crises	Amino acids (P), Organic acids (U), Acylcarnitines (DBS, P), Lactate (P), Acetoacetate (P, U), 3-Hydroxy-n-butyric acid (P, U)		7299555
Disorders of eicosanoid metabolism												
15-hydroxy-prostaglandin dehydrogenase deficiency	*HPGD*							Patent ductus arteriosus	Hypertrophic osteoarthropathy	Prostaglandin E2 (U)		18500342
Disorders of phosphoinositide metabolism												
Yunis-Varon syndrome	*FIG4*							Congenital heart defects	Failure to thrive, intellectual disability, hypoplastic clavicles, thumb/hallux defects			8411078
Disorders of lipoprotein metabolism												
Familial hypercholesterolemia	*LDLR*					**Aortic stenosis**	**Atherosclerosis**		Xanthomas	Lipid panel (S), Apo B (P)	Statins, ezetimibe, PCSK9 inhibitors	27017151, 27182539
LDLRAP1 deficiency	*LDLRAP1*						X		Xanthomas	Lipid panel (S), Apo B (P)	Statins, ezetimibe, PCSK9 inhibitors	29245109
Hypercholesterolemia due to ligand-defective apo B	*APOB*						X		Xanthomas	Lipid panel (S), Apo B (P)	Statins, PCSK9 inhibitors	21059979
PCSK9 superactivity	*PCSK9*						X		Xanthomas	Lipid panel (S), Apo B (P)	PCSK9 inhibitors	26374825
Sitosterolemia due to ABCG5 deficiency	*ABCG5*						X		Xanthomas	Lipid panel (S)	Ezetimibe, bile acid sequestrants	20543520
Sitosterolemia due to ABCG8 deficiency	*ABCG8*						X		Xanthomas	Lipid panel (S)	Ezetimibe, bile acid sequestrants	12578886
Hyperlipoproteinemia type III	*APOE*						X		Palmar crease xanthomas	Lipid panel (S)	Statins, niacin, fibrates	17878422
APOE p.Leu167del-related lipid disorder	*APOE*						X		Splenomegaly	Lipid panel (S)	Statins, niacin, fibrates	24921113
Hepatic lipase deficiency	*LIPC*						X		Xanthomas	Lipid panel (S)		6961921
Apolipoprotein A1 deficiency	*APOA1*						X		Corneal clouding	Lipid panel (S), Apolipoprotein A-I		8282791

Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
Hereditary apolipoprotein A1-related amyloidosis	*APOA1*					Amyloid deposit		Restrictive cardiomyopathy	Renal failure	DNA		9916936, 9464251, 10198255, 10487826
Tangier disease	*ABCA1*						X		Orange tonsils, peripheral neuropathy	Lipid panel (S)		7945562, 1380771
Fish-eye disease	*LCAT*						X		Corneal clouding	Lipid panel (S)		8620346, 9162740
Elevated lipoprotein(a)	*LPA*						X		-	Lipid panel (S)	Statins	31280836, 20032323
Disorders of cholesterol biosynthesis												
CHILD syndrome	*NSDHL*							Congenital heart defects	Skin lesions, limb defects	Sterols (LY)		5696317, 4620143, 11907515
Smith-Lemli-Opitz syndrome	*DHCR7*							Congenital heart defects	Dysmorphic features, intellectual disability, microcephaly, photosensitivity	ASAT/ALAT (P), Lipid panel (S), 7/8-Dehydrocholesterol (P)		12797454, 9024558
Disorders of bile acid synthesis												
Sterol 27-hydroxylase deficiency	*CYP27A1*						X		Xanthomas, ataxia, diarrhea, cataracts	Lipid panel (S), Cholestane pentol glucuronide (U), 25-Hydroxy-Vitamin D (P)		10406988, 15147532, 3364377
Cholesterol 7α-hydroxylase deficiency	*CYP7A1*						X		-			12093894
DISORDERS OF TETRAPYRROLES												
Disorders of heme metabolism												
Acute intermittent porphyria	*HMBS*				X			Hypertension	Abdominal pain, red-brown urine, behavioral changes	Urobilinogen (U), Porphyrines (U), Delta-ALA (U)	Hemin, givosiran	7303704, 19616670
Hereditary coproporphyria	*CPOX*				X			Hypertension	Abdominal pain, red-brown urine, behavioral changes, skin blisters	Urobilinogen (U), Porphyrines (U), Delta-ALA (U)	Hemin, givosiran	26483342
Porphyria variegata	*PPOX*				X			Hypertension	Abdominal pain, red-brown urine, behavioral changes, skin blisters	Urobilinogen (U), Porphyrines (U), Delta-ALA (U)	Hemin, givosiran	22118989
STORAGE DISORDERS												
Disorders of autophagy												
Vici syndrome	*EPG5*	**X**	**X**					Congenital heart defects	Immunodeficiency, hypopigmentation, agenesis of the corpus callosum			26927810
Neuronal ceroid lipofuscinosis												
CLN2 disease	*CLN2*				X				Developmental regression, seizures, ataxia, vision loss	Enzyme activity (WBC)	Cerliponase alfa	22221116
CLN3 disease	*CLN3*	X			X				Developmental regression, seizures, optic atrophy, pigmentary retinopathy	Peripheral smear		6540681, 21464428, 24726208
CLN6 disease	*CLN6*				X				Seizures, developmental regression, movement disorder			8929641
Sphingolipidoses												
Gaucher disease type IIIC	*GBA*					**X**	**X**		Oculomotor apraxia, corneal opacities, seizures, hydrocephalus	Enzyme activity (WBC)		31130326, 7475546, 6507325
GM1 gangliosidosis	*GLB1*	X	X						Spasticity, intellectual disability, dysostosis multiplex	Oligosaccharide (U), Enzyme activity (WBC)		10737981, 7173264
Fabry disease	*GLA*	**X**	X		X			**Restrictive cardiomyopathy**	Neuropathic pain, proteinuria, angiokeratomas, cornea verticillata	Globotriaosylsphingosine, Globotriaosylceramide, Proteins (U)	Enzyme replacement therapy	32640076, 25987173, 30826269, 9760302
Oligosaccharidoses												
Galactosialidosis	*CTSA*	X	X			X			Hepatosplenomegaly, dysostosis multiplex, myoclonus	Enzyme activity (WBC), Oligosaccharides (U)		23915561
Schindler disease	*NAGA*	X	X						Intellectual disability, seizures, angiokeratomas	Enzyme activity (WBC), Oligosaccharides (U)		11251574
Mucolipidoses												
Mucolipidosis III alpha/beta	*GNPTAB*		X			X			Coarse facial features, gingival hypertrophy, dysostosis multiplex, hepatosplenomegaly	Oligosaccharide (U), Glycosaminoglycans, Enzyme activity (S)		20301728, 15633164, doi.org/10.4326/jjcvs.47.7
Mucolipidosis II alpha/beta	*GNPTAB*		X			X		Pulmonary hypertension	Joint contractures	Oligosaccharide (U), Glycosaminoglycans, Enzyme activity (S)		20301728, 21802970, 22368665, 6854951
Disorders of glycosaminoglycan degradation												
Hurler disease	*IDUA*	X	X		X	**X**	X		Coarse facial features, gingival hypertrophy, dysostosis multiplex, hepatosplenomegaly, corneal clouding	Total GAGs (U), Dermatan sulfate (U), Heparan sulfate (U), Enzyme activity (WBC)		21744090
Hunter disease	*IDS*	X	X		X	X	X		Coarse facial features, dysostosis multiplex, skin pebbling	Total GAGs (U), Dermatan sulfate (U), Heparan sulfate (U), Enzyme activity (WBC)		21744090
Sanfilippo syndrome	*SGSH, NAGLU, HGSNAT, GNS*	X	X		X	X	X		Aggressive behaviour, developmental regression, sleep disturbance	Total GAGs (U), Keratan sulfate (U), Enzyme activity (WBC)		21744090
Morquio disease	*GALNS*	X	X		X	X	X		Dysostosis multiplex, joint laxity, corneal clouding	Total GAGs (U), Keratan sulfate (U), Enzyme activity (WBC)		21744090
Maroteaux-Lamy disease	*ARSB*	X	X		X	**X**	X		Coarse facial features, gingival hypertrophy, dysostosis multiplex, hepatosplenomegaly, corneal clouding	Total GAGs (U), Dermatan sulfate (U), Enzyme activity (WBC)		21744090
Sly disease	*GUSB*	X	X		X	**X**	X		Hydrops fetalis, coarse facial features, dysostosis multiplex	Total GAGs (U), Dermatan sulfate (U), Heparan sulfate (U), Enzyme activity (S, WBC)		21744090
Mucopolysaccharidosis-plus	*VPS33A*	X						Congenital heart defects	Intellectual disability, coarse facial features, dysostosis multiplex	Total GAGs (U), sHeparan sulfate (U)		28013294
β-xylosidase deficiency	*?*		X									4193777
Disorders of lysosomal cholesterol metabolism												
Lysosomal acid lipase deficiency	*LIPA*						X		Liver disease, adrenal calcification	Lipid panel (S), , Enzyme activity (S)		26225414
DISORDERS OF PEROXISOMES AND OXALATE												
Disorders of plasmalogen synthesis												
Rhizomelic chondrodysplasia punctata type 1	*PEX7*							Congenital heart defects	Intellectual disability, seizures, skeletal dysplasia	Plasmalogens (RBC)		23572185, 26408048
Rhizomelic chondrodysplasia punctata type 2	*GNPAT*							Congenital heart defects	Intellectual disability, seizures, skeletal dysplasia	Plasmalogens (RBC)		26408048
Disorders of peroxisomal β-oxidation												
Classic Refsum disease	*PHYH*	X	X		X				Ataxia, pigmentary retinopathy, ichthyosis, metacarpal shortening, anosmia	Pipecolic acid (P, U), Phytanic acid (S, U), Protein (CSF)	Phytanic acid restriction	2466186, 1693053, 13651492
Peroxisomal disorders not involving lipid metabolism												
Primary hyperoxaluria type I	*AGXT*	X	X		X		Calcification	Pulmonary hypertension	Renal failure, kidney stones	Oxalic acid (U, P), Glycolic acid (P, U), Creatinine (P), Urea (P)	Liver or liver/kidney transplant	20921818
Disorders of oxalate metabolism												

Name	Gene symbol	Hypertrophic /LVH	Dilated/LV systolic dysfunction	Non-compaction	Arrhythmias	Valvular disease	Vascular disease	Other	Non-cardiovascular key clinical features	Diagnostic markers	Specific treatment	Representative references (PMID or DOI)
Primary hyperoxaluria type II	*GRHPR*	X	X		X			Pulmonary hypertension	Renal failure, kidney stones	Oxalic acid (U, P), Glyceric acid (U), Creatinine (P), Urea (P)		16432059, 31685312
CONGENITAL DISORDERS OF GLYCOSYLATION												
Disorders of N-linked glycosylation												
PMM2-CDG	*PMM2*	X	X		X		Pericardial effusion; congenital heart defects	X	Ataxia, intellectual disability, strabismus, pigmentary retinopathy, inverted nipples	ASAT/ALAT (P), Lipid panel (S), Sialotransferrins (S), Albumin (S), Factor XI (B),		30740725, 28954837
ALG1-CDG	*ALG1*		X						Seizures, ataxia, strabismus	Sialotransferrins (S), IGG (P), B cells, circulating (blood)		14973778, 26931382
ALG9-CDG	*ALG9*							Pericardial effusion	Seizures, intellectual disability, hypotonia, skeletal dysplasia	Lipid panel (S), Sialotransferrins (S), Albumin (S), Factor XI (B)		15945070, 28932688
ALG12-CDG	*ALG12*	X	X					X	Seizures, intellectual disability, hypotonia, skeletal dysplasia	ASAT/ALAT (P), Glucose (S), Lipid panel (S), Sialotransferrins (S), IGF BP3, ,		
ALG8-CDG	*ALG8*				X				Intellectual disability, hypotonia, brachydactyly	CK (P), Sialotransferrins (S), Albumin (S), Factor IX and XII (B), Antithrombin III (P)		26066342
MGAT2-CDG	*MGAT2*				X				Intellectual disability	ASAT/ALAT (P), CK (P), Sialotransferrins (S), Factor IX and XII (B), Antithrombin III (P)		33044030
Disorders of O-mannosylation												
POMT1-CDG	*POMT1*		X						Muscular dystrophy			22549409
POMT2-CDG	*POMT2*		X				Aortic dilatation		Muscular dystrophy			24002165
ISPD-CDG	*ISPD*		X						Muscular dystrophy			23288328
FKTN-CDG	*FKTN*		X	X					Muscular dystrophy			27521547, 17036286
FKRP-CDG	*FKRP*		X						Muscular dystrophy			15833432, 12666124
Disorders of O-xylosylation and glycosaminoglycan synthesis												
XYLT2-CDG	*XYLT2*					X		Congenital heart defects	Spine deformities, bone fragility, cataracts, retinal detachment			26987875
B3GALT6-CDG	*B3GALT6*					X	Aortic dilatation		Skeletal dysplasia, joint laxity			29931299
B3GAT3-CDG	*B3GAT3*					X		Congenital heart defects	Skeletal dysplasia, joint laxity			31196143
CHST3-CDG	*CHST3*					X			Skeletal dysplasia			9039660, 19320654
Disorders of O-GlcNAcylation												
EOGT-CDG	*EOGT*							Congenital heart defects	Short distal phalanges, scalp skin defects			23522784
Disorders of O-fucosylation												
B3GALTL-CDG	*B3GALTL*							Congenital heart defects	Anterior eye chamber anomalies, short stature, developmental delay			23889335
Disorders of glycosylphosphatidylinositol biosynthesis												
PIGA-CDG	*PIGA*							Congenital heart defects	Seizures, intellectual disability	ALP (P), GPI-anchored proteins (WBC, F)		30054924
PIGL-CDG	*PIGL*							Congenital heart defects	Coloboma, ichthyosis, intellectual disability, hearing loss	ALP (P), GPI-anchored proteins (WBC, F)		4037840, 3041916, 30054924
PIGN-CDG	*PIGN*							Congenital heart defects	Dysmorphic features, hypotonia, seizures	ALP (P), GPI-anchored proteins (WBC, F)		30054924
PIGO-CDG	*PIGO*							Congenital heart defects	Dysmorphic features, hypotonia, seizures	ALP (P), GPI-anchored proteins (WBC, F)		29310717
PIGT-CDG	*PIGT*							Congenital heart defects	Dysmorphic features, hypotonia, seizures	ALP (P), GPI-anchored proteins (WBC, F)		30054924
PIGV-CDG	*PIGV*							Congenital heart defects	Intellectual disability, seizures, hypotonia	ALP (P), GPI-anchored proteins (WBC, F)		29310717, 30054924
PGAP2-CDG	*PGAP2*							Congenital heart defects	Intellectual disability, seizures, hypotonia	ALP (P), GPI-anchored proteins (WBC, F)		29310717
PGAP3-CDG	*PGAP3*							Congenital heart defects	Intellectual disability, seizures, ataxia	ALP (P), GPI-anchored proteins (WBC, F)		29310717, 30054924
Disorders of dolichol metabolism												
DOLK-CDG	*DOLK*		**X**						Ichthyosis, hypotonia, seizures	ASAT/ALAT (P), CK (P), Sialotransferrins (S)		22242004
DPM3-CDG	*DPM3*		X						Muscular dystrophy	ASAT/ALAT (P), CK (P), Sialotransferrins (S), Dolichol-P-mannose (S)		31266720
Disorders of monosaccharide synthesis and interconversion												
PGM1-CDG	*PGM1*		**X**		X			Restrictive cardiomyopathy	Bifid uvula, flat midface, hepatopathy, short stature	ASAT/ALAT (P), CK (P), Ammonia (P), Sialotransferrins (S)		32681750, doi.org/10.1002/jmd2.12177
GNE myopathy	*GNE*		X		X				Skeletal myopathy			24656604, 21082694
G6PC3-CDG	*G6PC3*							Congenital heart defects; pulmonary hypertension	Prominent superficial veins	Blood count		19118303
Glycosylation disorders of vesicular trafficking												
COG1-CDG	*COG1*	X	X			X		Congenital heart defects	Intellectual disability, hypotonia, short stature	Sialotransferrins (S)		28726068
COG7-CDG	*COG7*							Congenital heart defects	Intellectual disability, hypotonia, failure to thrive	ASAT/ALAT (P), CK (P), Sialotransferrins (S)		28726068
Disorders of Golgi homeostasis												
ATP6V1A-CDG	*ATP6V1A*	X					Aortic dilatation		Cutis laxa, hypotonia, seizures	Lipid panel (S), Sialotransferrins (S)		28726068
ATP6V1E1-CDG	*ATP6V1E1*	X						Congenital heart defects	Cutis laxa, hypotonia	Lipid panel (S), Sialotransferrins (S)		28726068