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Supplementary information

cGAS-mediated induction of type I interferon due to inborn errors of histone pre-mRNA processing

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Supplementary Materials for

cGAS-mediated induction of type I interferon due to inborn errors of histone pre-mRNA processing

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This PDF file includes:

Supplementary Figures 1 and 2
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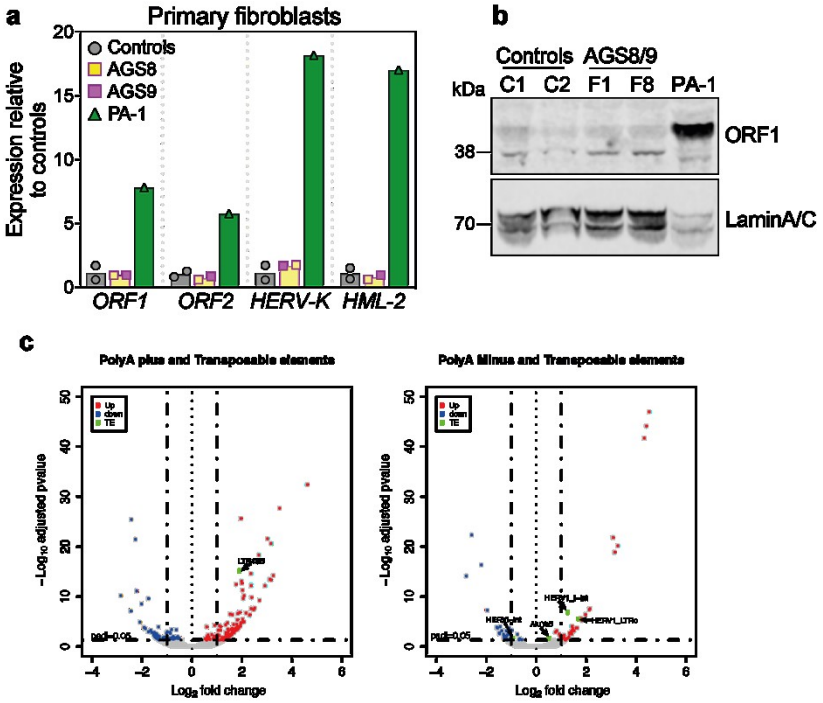
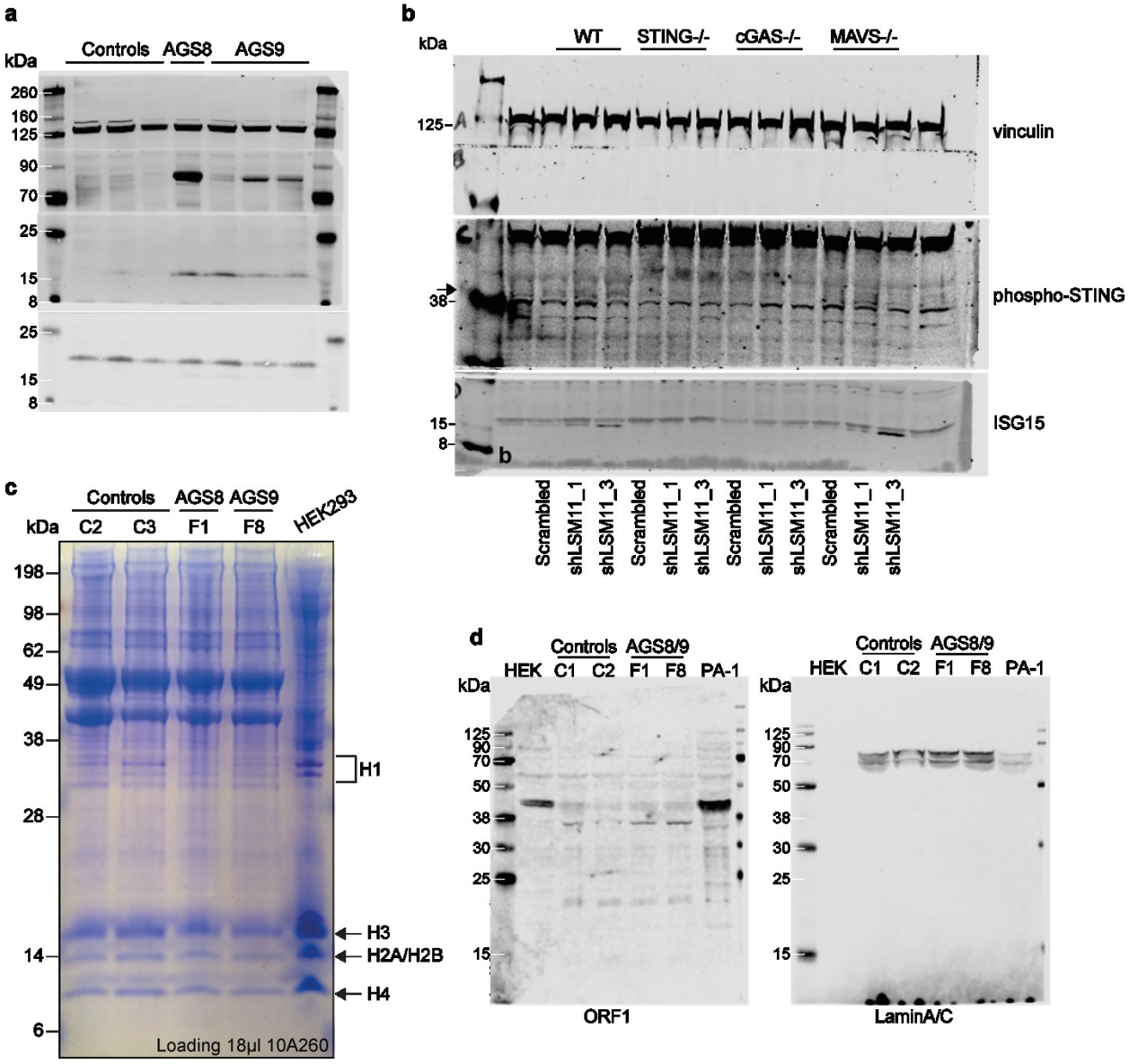
Supplementary Figure 1.



Supplementary Figure 1 | Assessment of retrotransposon expression in patient fibroblasts compared to control cells. A, Expression of L1-*ORF1*, L1-*ORF2*, and HERV (*HERV-K* and *HML2*) in control and patient fibroblasts measured by RT-qPCR. n = 2 biological independent samples for control and/or patient fibroblasts. **b**, Expression of ORF1 protein in control and patient fibroblasts measured by western blot. PA-1 cell line was used as control for L1 expression[49]. **c**, Expression of transposable elements in RNA-seq data of patient and control fibroblasts as determined using SQUIRE[50].

Supplementary Figure 2.



Supplementary Figure 2. Full gel/blots corresponding to Figure 4d (**a**); Extended Data Figure 6b (**b**); Extended Data Figure 9a (**c**) and Supplementary Figure 1b (**d**)

Supplementary Table 1.

Genomic	Chr5(GRCh37):g.157181054G>A; Chr5(GRCh38):g.157754046G>A
cDNA	c.347G>C
Protein	p.(Gly211Ser)
gnomAD	Novel (221,000 recorded alleles)
SIFT	Deleterious (0.01)
Polyphen2	Probably damaging (1.00)
Mutation taster	Disease causing (1)
CADD	Deleterious (34)
Condel	Deleterious (0.905)

Supplementary Table 1. *In silico* predictions of pathogenicity associated with the homozygous p.(Gly211Ser) substitution in LSM11 identified in the two affected individuals from family AGS114. LSM11: ENST00000286307.5; NM_173491; NP_775762.

Supplementary Table 2.

Genomic coordinates	rs number	*RNU7-1* nomenclature	gnomAD total allele count	Hom	Het	gnomAD frequency	Control panel	Families harbouring variant
g.12-7053001T>G	Novel	n.23T>G	31402	0	0	Novel	0/663	AGS554
g.12-7053006C>T	rs180837208	n.28C>T	31392	0	16	0.0005	3/663	AGS271 AGS520 AGS532 AGS561 AGS695 AGS909 AG2412
g.12-7053008A>G	rs781842057	n.30A>G	31402	0	1	3e-5	0/663	AGS1283
g.12-7053011_7053027delins25	Novel	n.33_49delins25	31398	0	0	Novel	0/663	AGS694
g.12-7053012_7053019del	Novel	n.34_41del	31402	0	0	Novel	0/663	AGS1283
g.12-7053013G>A	Not annotated	n.35G>A	31404	0	2	6e-5	0/663	AGS694 AGS909
g.12-7053013G>T	Novel	n.35G>T	31404	0	0	Novel	0/663	AGS924
g.12-7053011-AGGCTTTCT-A	rs782368655	n.40_47del	31398	0	6	0.0002	1/663	AGS271 AGS561 AGS2412
g.12-7053019T>G	rs782444004	n.41T>G	31396	0	3	9e-5	0/663	AGS695
g.12-7053029C>T	rs139594532	n.51C>T	31396	1	160	0.0050	4/663	AGS520 AGS532
g.12-7053032G>C	rs782223539	n.54G>C	31384	0	3	9e-5	1/663	AGS554
g.12-7053032G>GT	rs782223539	n.54_55insT	31384	0	16	0.0005	0/663	AGS924
g.12-7053037C>T	rs187552855	n.59C>T	31402	0	26	0.0008	0/663	AGS532
g.12-7053040C>G	rs148496170	n.62C>G	31398	0	5	0.0001	1/663	AGS924

Supplementary Table 2. Variants identified in patients with Aicardi-Goutières syndrome harboring biallelic *RNU7-1* substitutions. gnomAD (Genome aggregation database); Hom = homozygous; Het = heterozygous. Note: n.59C>T and. N.62C>G (shaded in grey) are rare alleles identified in AGS532 and AGS924 respectively. However, it is considered that they are unlikely to be disease causing given the allelic segregation in these pedigrees (see Supplementary Figure 3). U7: Ensembl gene ID: ENSG00000238923; Ensembl transcript ID: ENST00000458811.

Supplementary Table 3

Nucleotide change	WT	Het	Hom	Control frequency (663)	gnomAD frequency
n.1C>T	661	2	0	0.00151	0.0019
n.4T>G	662	1	0	0.00075	3.2e-5
n.5G>A	662	1	0	0.00075	0.0001
n.12C>T	662	1	0	0.00075	0.0001
n.26G>A	662	1	0	0.00075	6.4e-5
n.28C>G	662	1	0	0.00075	6.4e-5
n.28C>T	660	3	0	0.00226	0.0005
n.32T>C	661	2	0	0.00151	0.0008
n.36C>T	658	5	0	0.00377	0.0049
n.37T>C	662	1	0	0.00075	0.0001
n.40C>T	662	1	0	0.00075	0.0009
n.40_47del	662	1	0	0.00075	0.0002
n.44C>G	662	1	0	0.00075	0.0004
n.49T>C	662	1	0	0.00075	0.0035
n.51C>T	659	4	0	0.00302	0.0051
n.54G>T	661	2	0	0.00151	0.0005
n.54G>C	662	1	0	0.00075	9.6e-5
n.58G>A	661	2	0	0.00151	0.0005
n.62C>T	656	7	0	0.00528	0.0017
n.62C>G	662	1	0	0.00075	0.0002

Supplementary Table 3. *RNU7-1* variants identified in 663 neurologically normal controls.

All *RNU7-1* rare variants (gnomAD allelic frequency ≤ 0.005 – last column on right) identified in 663 controls are listed, with rare variants also observed in the Aicardi-Goutières syndrome patient cohort highlighted in red (note that the n.62C>G variant is considered likely to be non-pathogenic on the basis of familial segregation).

Supplementary Table 4

	Total	Total WT (i.e. only variants >1%)	Total carrying 1 rare variant (<1%)	Total with 2 or more rare variants (<1%)	Total with 2 rare variants on different alleles (<1%)	Total with a novel variant (not found on ExAC)
Controls	663	625	37	1	0	0
Probands	18	7	0	11	11	4

Supplementary Table 4. Comparison of *RNU7-1* variant load between controls and patients.

Composite data of the number of variants observed in the coding sequence of *RNU7-1* in a panel of 663 European control DNA samples in comparison to probands with Aicardi-Goutières syndrome (AGS) negative for mutations in *AGS1-7* and *LSM11* and carrying biallelic rare variants in *RNU7-1* identified in this study. Probands are from the 11 families identified with biallelic *RNU7-1* variants and seven other *AGS1-7* mutation-negative families demonstrating classical features of AGS also negative for rare variants in *LSM11* and *RNU1-7* (AGS110; AGS113; AGS125; AGS149; AGS218; AGS488; AGS556).

Supplementary Table 5

Family_ patient	Sex	Consang -uinity	Ancestry	Nucleotide / amino acid substitutions	Current age / status (years)	Phenotype	Brain imaging	Interferon score (age in decimalised years at sampling)
AGS114 _1	M	Yes	Pakistani	c.631G>A / p.Gly211Ser	Died aged 2 years	Presented at birth with abnormal genitalia and jitteriness in the neonatal period, with the identification of ICC and an increased CSF white cell count on two occasions. He demonstrated severe DD with seizures, and exhibited a progression of his poor neurological state leading to his death at age 2 years	Diffusely abnormal WM with BG calcification and severe CA particularly affecting the temporal and frontal lobes	Never tested
AGS114 _2	M			c.631G>A / p.Gly211Ser	Died aged 23 months	Delivered prematurely (30 weeks of gestation), and diagnosed with hemolytic disease of the newborn. Went home at term but presented soon thereafter with nystagmus, irritability and abnormal movements. Like his brother, he was noted to have small genitalia. Again, his neurological state deteriorated and he died at 23 months of age	Diffusely abnormal WM with BG calcification and severe CA particularly affecting the temporal and frontal lobes	8.6 (0.36); 3.6 (1.3)

Supplementary Table 5. Demographic and clinical features of the patients biallelic for putative mutations in *LSM11*.

Abbreviations: BG: Basal ganglia; CA: Cerebral atrophy; CSF: Cerebrospinal fluid; DD: Developmental delay; ICC: Intracranial calcification; M: Male; MRI: WM: White matter.

Supplementary Table 6

Family_patient	Sex	Consang-uinity	Ancestry	Nucleotide substitutions	Current age / status (years)	Phenotype	Brain imaging	Interferon score (age in decimalised years at sampling)
AGS271	F	No	White British	n.28C>T het + n.40_47del het	15	Born at 40 weeks gestation weighing 3.5 kg. Increased tone from birth, together with difficulty sleeping and irritability. Microcephaly evident at age 5 months, with ICC. At age 10 years she was microcephalic and spastic quadriplegic, but cognition was remarkably well preserved so that she was able to interact using an iPad, recognise commands and understand quite complex situations. Cold hands and red feet, with generalised skin mottling leading to rheumatology referral	At 10 years, radiological phenotype is mild, with some cortical volume loss, spots of low signal in the deep WM of frontal and parietal lobes, globus pallidus and possibly the dentate nucleus, and no WM disease	8.8 (9.86); 8.7 (10.16); 11.5 (10.61); 8.5 (11.62); 5.6 (12.76); 8.6 (13.36)
AGS520_1	M	No	Japanese	n.28C>T het + n.51C>T het	Died aged 11 years (possibly related to epilepsy)	Most severe clinical picture of the 3 siblings, with no trunk control, bilateral spasticity and epilepsy	Cortical and subcortical volume loss particularly of frontal and temporal lobes with abnormal high T2 signal especially in frontal and parietal deep and subcortical WM. Brain stem, CC and C are also small. Low signal spots on GRE in deep WM, putamen, globus pallidus and C	22.420 (8.69); 7.398 (9.04)

AGS520_2	F	n.28C>T het + n.51C>T het	10	Bilateral spasticity, no trunk control but less severe than her older brother, with no epilepsy. No apparent response to pain stimuli. Good visual contact and smiles with social interaction. Non-verbal. Dry skin, with superficial scars. Moderate scoliosis	Age 10 months CA, particularly involving the temporal and frontal lobes, with abnormal high signal in the WM of all lobes especially temporal and frontal with cystic swelling of temporal lobes. Low signal spots in deep frontal WM, BG and dentate nuclei consistent with calcification	9.8 (4.48); 7.26 (4.83); 4.4 (8.32)
AGS520_3	M	n.28C>T het + n.51C>T het	7	The least severely affected of these three siblings. Was able to walk with support. Since then he lost ambulation, but is still able to crawl fast and sit without support, with good use of his hands. Bilateral hypertonia in lower limbs, with flexion deformity of the feet. Difficult to elicit deep tendon reflexes in all four limbs (he has a peripheral neuropathy), and no reaction to pain stimulus. Good visual contact and interaction, but non-verbal. Very dry skin, with severe scars of self-incurred lesions	Age 5 months CA with abnormal high signal in the WM of all lobes but especially the frontal and temporal lobes with temporal lobe swelling. Low signal spots in deep frontal WM consistent with calcification	9.9 (1.73); 10.1 (2.08); 7.2 (5.57)

AGS532_1	M	No	French European	n.28C>T het + n.51C>T het	Died aged 7 years of liver failure	Normal pregnancy and birth at term weighing 2.2 kg. Hepatomegaly and transaminitis noted at age 10 months, with fibrosis and steatosis on liver biopsy aged 2 years. DD obvious by 18 months of age. Able to sit but did not stand independently. Demonstrated a severe spastic dystonia with peripheral sensory neuropathy. Acquired around 50 words but was never able to speak in sentences. Features of portal hypertension evident by age 6 years. Diagnosed with chorioretinal atrophy and antibody negative hypothyroidism at age 3 and 4 years respectively. Arterial hypertension noted at 4 years of age, with cystic changes in both kidneys and possible features of thrombotic microangiopathy on renal biopsy. One episode of pericardial effusion at age 4 years. Telangiectatic-like changes in the hands and feet	Cerebral and C WM disease with extensive bilateral calcification, particularly in the deep WM and BG, and some CA	Never tested
AGS532_2	M			n.28C>T het + n.51C>T het	Died aged 9 years of liver failure	Normal pregnancy and delivery at 38 weeks gestation weighing 2.050 kg. ICC noted on CT soon after birth, and hepatosplenomegaly recognised at age 2 months. Hypothyroidism treated from age 6 months (anti-TPO antibodies weakly positive). Spastic dystonia. Never acquired the ability to walk and has no spoken language. Hepatosplenomegaly with chronic transaminitis and liver impairment (oedema and hypoalbuminemia requiring albumin infusion every 5 - 6 weeks). No liver biopsy performed. One episode of pericardial effusion treated by fenestration at age 3 years. Hypertension and proteinuria. Abnormal dentition requiring multiple extractions. He has not had neuro-electrophysiology, but clinically demonstrates an apparent indifference to pain considered likely due to a sensory neuropathy	CT scan close to birth showed subtle evidence of small calcium deposits and abnormal myelin	18.6 (5.70); 6.7 (6.56); 20.5 (7.78)
AGS554	F	No	Mixed (European / South American)	n.23T>G het + n.54G>C het	8	Born at 36 weeks demonstrating IUGR (weight 1.6 kg), OFC 31 cm. Normal perinatal period followed by onset of irritability, feeding difficulties and epileptic seizures at age 4 months. Spastic-dystonic tetraparesis with severe functional impairment (GMFCS level V, MACS level V, CFCS level IV). No extra-neurological features noted	MRI (6 months and 30 months): diffuse leukoencephalopathy and delayed myelination. CT (6 months):	6.2 (1.23); 11.3 (3.89)

							bilateral putaminal spot-like calcification	
AGS561_1	M	No	Belgian European	n.28C>T het + n.40_47del het	23	Normal pregnancy and birth at term (weight 3 kg). Early irritability with significant feeding difficulties, failure to thrive and subsequent severe DD (spastic quadriplegia, microcephaly and almost no contact)	CT scan age 7 years showing extensive bilateral calcification. MRI at age 15 years surprisingly healthy looking, with probably normal myelination, non-atrophic beyond some slight dilatation of the lateral ventricles. High signal of periventricular WM and deep WM in frontal and, to a lesser extent, in parietal regions	8.4 (17.48); 4.8 (18.53); 5.9 (18.74); 6.8 (21.48)

AGS694_1	F	No	White European	n.35G>A het + n.33_49delins25 het	Died aged 7 years of renal failure	Spasticity from birth with ICC thought to be due to CMV initially. Small. Experienced one episode of pericarditis, was hypothyroid, and demonstrated a chronic transaminitis, haemolytic anaemia, recurrent bouts of unexplained inflammation and UTIs associated with end stage renal failure precipitated by an episode of acute pancreatitis	MRI at age 5 years showed an AP gradient for atrophy with diffuse high signal in frontal and parietal WM	36.5 (7.77)
AGS694_2	F			n.35G>A het + n.33_49delins25 het	Died aged 9 years of renal failure complicated by pancreatitis and pneumonia	Noted to be irritable at age 3 months, becoming encephalopathic leading to severe DD and spastic diplegia. Significant osteoporosis with fractures. Recurrent UTIs and anaemia, developing end stage renal failure by age 7 years	MRI at age 2 years showed some CA, with increased signal in frontal WM and extensive calcification in the deep WM, C, BG and internal capsule	10.2 (2.57); 11.5 (2.81); 10.6 (4.60)
AGS695	M	No	White British	n.28C>T het + n.41T>G het	Died at age 8 years - cause unexplained despite post-mortem	Normal delivery at term (birth weight 2.45 kg). Referred at age 4 months because of irritability, delayed smiling and concerns about vision with a diagnosis of optic atrophy. Increased tone in all four limbs related to a spastic dystonia. Significant feeding issues and weight loss necessitating jejunal feeding. Variably elevated LFTs with normal liver ultrasound aged 4 years. Hypothyroidism diagnosed at age 3 months with variably elevated antibody titres (TPO). Increased blood pressure led to the identification of echogenic kidneys and renal impairment at age 4 years. He can not sit independently, has limited head control, is non-verbal but with some understanding, indicating 'yes' and 'no'. Chilblains on hands and feet	MRI at 7 months: WM diffusely bright on T2 with very little myelin, and ICC seen on CT	8.8 (1.75); 6.3 (2.06); 7.9 (2.67); 10.0 (5.61)

AGS909	F	No	White British	n.28C>T het + n.35G>A het	13	Early-onset, apparently static spasticity with some dystonia (uses electric wheelchair but can crawl short distances); good use of hands - telephone and PC, and can use a fork - but not cut food with a knife. Cognition apparently well preserved; can answer questions and talk with limited fluency. Asymptomatic micro and macro-vesicular steatosis and fibrosis identified on liver biopsy at age 7 years. Mitochondrial testing of skin and muscle normal. Hypertension, treated with an ace inhibitor, with blood and protein in urine noted at age 11 years, and non-specific glomerulosclerosis and basement membrane thickening recorded on renal biopsy. Persistently cold feet and red finger tips	Initially delayed myelination on MRI but later considered as normal	13.4 (8.49); 8.9 (9.01); 10.7 (10.28)
AGS924	M	No	French Europea n	n.35G>T het + n.54_55insT het	8	Early recognition of DD with the evolution of a severe, non-progressive spastic dystonia. No words but has relatively preserved understanding and can use a tablet for communication. Feeds orally. Chronic transaminitis not investigated further at this time. Has chilblains and a poikiloderma aspect over his arms	CT scan at age 3 years showed no calcification. MRI revealed a mild retardation of myelination at age 1 year	16.2 (3.24); 4.3 (4.02); 5.0 (4.89); 7.1 (6.02)

AGS1283	M	No	Russian European	n.30A>G het + n.34_41del het	4	Born at 41 weeks gestation (weight 3.9 kg). Neonatal investigations identified ICC and elevated neopterin in the CSF. Now demonstrates spastic-dystonia with severe motor and intellectual delay and microcephaly. Transaminitis noted at age 1 year	T2 MR aged 1 week showing high signal in the WM with multiple spots of calcification seen in deep WM (also observed on CT)	1.1 (0.27); 28.2 (4.25)
AGS2412_1	M	No	French European	n.28C>T het + n.40_47del het	Died age 9 years after a haematemesis	Born at 38 weeks gestation. DD noted by 2 months, with irritability and feeding difficulties. Micropenis also recognised at this time. Spastic dystonic tetraparesis with pyramidal and extrapyramidal features, and almost no useful hand function. Interferon activity assay negative in CSF and blood at this time. At age 4 years he could hold his head and indicate certain parts of his body, but could not sit. At best he could understand simple commands, with relatively preserved social interaction, using pictogram to communicate. He was fed orally and by nasogastric tube. Epilepsy at age 2 years. Chronic transaminitis noted at age 5 months (not biopsied). Difficult to treat arterial hypertension noted at 4 years of age. Antibody negative hypothyroidism diagnosed at age 5 years. Pericardial effusion with left ventricular hypertrophy at age 8 years requiring drainage due to tamponade. Also noted to demonstrate chronic renal insufficiency and a non-regenerative anaemia. Bone marrow aspiration non-contributory. Shortly before his death he experienced a further pericardial effusion, with ascites, hypoalbuminemia and renal insufficiency	ICC and WM disease	4.6 (8.16); 41.4 (8.93)
AGS2412_2	F			n.28C>T het + n.40_47del het	2	DD with nystagmus noted soon after birth. Demonstrates spastic dystonia with pyramidal and extrapyramidal signs and with truncal hypotonia. At age 14 months she could not sit independently. She exhibits a transaminitis with hypertension and anaemia like her sibling	ICC and WM disease	2.3 (0.76); 4.0 (0.83)

Supplementary Table 6. Demographic and clinical features of the patients biallelic for putative mutations in *RNU7-1*.

Abbreviations: BG: Basal ganglia; C: Cerebellum; CA: Cerebral atrophy; CC: Corpus callosum; CMV: Cytomegalovirus; CSF: Cerebrospinal fluid; CT: Computed tomography; DD: Developmental delay; F: Female; GRE: Gradient echo; ICC: Intracranial calcification; LFTs: Liver function tests; M: Male; MRI: Magnetic resonance imaging; UTIs: Urinary tract infections; WM: White matter.

Supplementary Table 7. Read counts (RPKM – Reads Per Kilobase of transcript per Million mapped reads) of linker histones in patient and control fibroblasts.

Gene name	**Controls** (RPKM+1)		**AGS8/9** (RPKM+1)	
	poly(A)+	**poly(A)-**	**poly(A)+**	**poly(A)-**
HIST1H1A (H1.1)	0	0.233	0	0.284
HIST1H1B (H1.5)	0.013	3.914	0.014	1.892
HIST1H1C (H1.2)	4.285	20.524	92.356	9.083
HIST1H1D (H1.3)	0.013	3.477	1.677	3.122
HIST1H1E (H1.4)	0.047	18.537	0.165	3.812

Supplementary Table 8

Sanger sequencing		
Name	Sequence (5' to 3')	**Ref.**
LSM11 Ex1aF	ACCTGTCAGCTATGGGAGGA	This study
LSM11 Ex1aR	GACGAGTCCTGCCCGAGG	This study
LSM11 Ex2F	TGGGTGGTCGTGGCTTAATT	This study
LSM11 Ex2R	AATGCAGTTACTCAGGTCCTTT	This study
LSM11 Ex3F	TCTGCCTAGGAGCTGAGTCA	This study
LSM11 Ex3R	TGGGCTCAGGGATCTTAATTCC	This study
LSM11 Ex4F	TGAAAGAGGGTGATGAAGGCT	This study
LSM11 Ex4R	GCATATGCAGGACCAGAGGG	This study
RNU7 F	GAACAAATGTTCGCGAACTCT	This study
RNU7 R	CGTCCTACAACCGTTCCCAA	This study
RTqPCR (Syber Green)		
Name	**Sequence (5' to 3')**	**Ref.**
HIST1H2AC_MP_F	GACCATTGCTCAGGGCGGCGTCCT	[51]
HIST1H2AC_MP_R	CCTTCTACCTACAAGCAGTGAGGTT	[51]
HIST2H3A_MP_F	CGAAGACACGAACCTGTGCGCC	[51]
HIST2H3A_MP_R	GGCAAGCGGTACAGCTTCTTCCAA	[51]
HPRT_F	TGCTGAGGATTTGGAAAGGG	[51]
HPRT_R	ACAGAGGGCTACAATGTGATG	[51]
HML-2_1778_for1	CCCCCAGAAAGTCAGTATGGA	[52]
HML-2_1778_for2	TCTCCAGAGGTTCAGTATGGA	[52]
HML-2_1778_for3	CCCCCAGAAAATCAGTATGGA	[52]
HML-2_1778_for4	TCTCCAGAGGTGCAGTATAGA	[52]
HML-2_2396_rev1	TTTCCCAGGCTCTAAGGCAG	[52]
HML-2_2396_rev2	TTCCCAGGCCCTGAGGCAA	[52]
HML-2_2396_rev3	TTTCCTAGGCTCTAAGGCAG	[52]
ORF1_F	GAATGATTTTGACGAGCTGAGAGAA	[53]
ORF1_R	GTCCTCCCGTAGCTCAGAGTAATT	[53]
ORF2_F	CAAACACCGCATATTCTCACTCA	[53]
ORF2_R	CTTCCTGTGTCCATGTGATCTCA	[53]
HERKV_F	GGCCATCAGAGTCTAAACCACG	[53]
HERKV_R	CTGACTTTCTGGGGGTGGCCG	[53]
GAPDH_F	ACATCGCTCAGACACCATG	This study
GAPDH_R	TGTAGTTGAGGTCAATGAAGGG	This study

RTqPCR (TaqMan assays)		
Gene name	**Assay ID**	**Manufacturer**
H1F0	Hs00271174_s1	Applied biosystem
H1FX	Hs00366688_s1	Applied biosystem
H2AFZ	Hs01888362_g1	Applied biosystem
H3F3A, H3F3AP4	Hs02598544_g1	Applied biosystem
HIST1H1A	Hs00271225_s1	Applied biosystem
HIST1H1B	Hs00271207_s1	Applied biosystem
HIST1H1C	Hs00271185_s1	Applied biosystem
HIST1H1D	Hs00271187_s1	Applied biosystem
HIST1H1E	Hs00271195_s1	Applied biosystem
HIST1H2AC	Hs00374312_s1	Applied biosystem
HIST2H3A/C	Hs00824204_s1	Applied biosystem
HIST2H4A/B	Hs00269118_s1	Applied biosystem
HIST3H2BB	Hs01592663_s1	Applied biosystem
HIST3H2BC	Hs00818513_sH	Applied biosystem
HPRT	Hs03929096_g1	Applied biosystem
IFI27	Hs01086370_m1	Applied biosystem
IFI44L	Hs00199115_m1	Applied biosystem
IFIT1	Hs00356631_g1	Applied biosystem
IFNB1	Hs01077958_s1	Applied biosystem
IFNL1	Hs00601677_g1	Applied biosystem
ISG15	Hs00192713_m1	Applied biosystem
LSM11	Hs00542854_m1	Applied biosystem
RSAD2	Hs01057264_m1	Applied biosystem
SIGLEC1	Hs00988063_m1	Applied biosystem
18S	Hs999999001_s1	Applied biosystem
F = forward strand; R = reverse strand; lower case = intron/3'utr		

Supplementary Table 8. Human primers/assays used in this study.

Supplementary Table 9

shRNA		
Gene/ Name	**Assay ID**	**Manufacturer**
LSM11 / shLSM11_1	TRCN0000074440	SIGMA
LSM11 / shLSM11_2	TRCN0000426232	SIGMA
Non-targeted scrambled	SHC016	SIGMA
shScrambled	SHC002	SIGMA
siRNA		
Gene name	**Assay ID**	**Manufacturer**
MB21D1 (cGAS)	s41746	Life Technologies
TMEM173 (STING)	s50645	Life Technologies
MAVS	148763	Life Technologies
MYD88	11601	Life Technologies
IFIH1 (MDA5)	HSS127415	Life Technologies
Negative Control Kit	12935100	Life Technologies

Supplementary Table 9. RNA interference probes used in this study.

Supplementary references

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