

Extended Data Table 1 | Cryo-EM data collection, refinement and validation statistics

	PSP-RS case 1	GGT-I case 1			PSP-F case 2			+16 case 1	
Data collection and processing									
Electron Gun	XFEG	XFEG			CFEG			XFEG	
Detector	K2	K2			Falcon4			K2	
Magnification	105k	105k			165k			105k	
Voltage (kV)	300	300			300			300	
Electron exposure (e−/Å²)	40	50			50			54	
Defocus range (μm)	1.7-2.2	1.5-2.5			0.8-2.0			1.7-2.8	
Pixel size (Å)	1.15	1.15			0.727			1.15	
Initial particle images (no.)	155,030	408,018			630,640			375,898	
Symmetry imposed	C1	type 1 C1	type 2 C1	type 3 C1	type 1a C1	type 1b C1	type 2 C1	type 1 C1	type 2 C2
Final particle images (no.)	17,316	28,058	42,381	84,438	53,363	15,096	16,813	14,582	52,134
Map resolution (Å; FSC=0.143)	2.7	3.0	3.1	2.9	1.9	2.3	2.5	5.7	3.4
Helical rise (Å)	4.78	4.75	2.37	4.75	4.78	4.78	2.39	4.80	4.80
Helical twist (°)	-0.86	-0.75	179.65	-0.73	-0.36	-0.39	179.82	-0.36	-0.40
	PSP-RS case 1 type 1	GGT-I case 1 type 1	GGT-I case 1 type 2	GGT-I case 1 type 3	PSP-F case 2 type 1a	PSP-F case 2 type 1b	PSP-F case 2 type 2	AGD case 1 type 1	+16 case 1 type 2
Refinement									
Initial model used (PDB code)	-	-	-	-	-	-	-	6TJX	6TJX
Model resolution (Å) FSC threshold	2.7	3.1	3.0	3.0	1.9	2.1	2.6	3.9	3.3
Map sharpening <i>B</i> factor (Å²)	-24.89	-20.19	-34.53	-29.03	-18.89	-20.16	-23.15	-35.52	-35.83
Model composition									
Non-hydrogen atoms	4145	4060	8210	8120	4166	4060	8120	4340	4854
Protein residues	550	540	1090	1080	540	540	1080	575	630
Waters	-	-	-	-	76	-	-	-	-
<i>B</i> factors (Å²)									
Protein	23.36	68.49	36.29	70.77	25.15	35.28	50.31	71.32	107.39
Waters	-	-	-	-	30.00	-	-	-	-
R.m.s. deviations									
Bond lengths (Å)	0.004	0.011	0.010	0.010	0.005	0.004	0.003	0.003	0.009
Bond angles (°)	0.742	1.197	0.914	1.094	0.779	0.824	0.726	0.641	1.298
Validation									
MolProbity score	1.19	1.61	1.68	1.54	1.53	1.48	1.54	1.60	1.65
Clashscore	2.60	3.97	6.44	3.43	5.23	4.45	3.61	8.90	4.83
Poor rotamers (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ramachandran plot									
Favored (%)	97.22	93.40	95.33	93.87	96.23	96.23	94.34	97.35	94.06
Allowed (%)	2.78	6.60	4.67	6.13	3.77	3.77	5.66	2.65	5.94
Disallowed (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PDB									
EMDB									
EMPIAR									

Extended Data Table 2 | Cryo-EM data collection of other PSP and GGT cases

	PSP-RS case 2	PSP-RS case 3 (T)	PSP-CBS case 1	PSP-P case 1	PSP-F 1 case 1	GGT-II case 1	GGT-III case 1
Data collection and processing							
Electron Gun	XFEG	XFEG	XFEG	XFEG	XFEG	XFEG	XFEG
Detector	K2	K2	K2	K2	K2	K2	K2
Magnification	105k	105k	105k	105k	105k	105k	105k
Voltage (kV)	300	300	300	300	300	300	300
Electron exposure (e ⁻ /Å ²)	40	39	51	54	40	47	52
Defocus range (μm)	1.4-2.5	1.5-2.5	1.0-3.2	1.0-2.7	1.2-2.7	1.0-2.5	1.2-2.5
Pixel size (Å)	1.15	1.15	1.15	1.15	1.065	1.15	0.83
Symmetry imposed	C1	C1	C1	C1	C1	Type 2: C1 Type 3: C1	
Initial particle images (no.)	44,221	88,114	80,637	66,597	37,847	97,787	
Final particle images (no.)	23,640	3,006	26,073	3,782	25,178	Type 2: 23,377 Type 3: 17,671	
Map resolution (Å; FSC=0.143)	3.6	3.7	3.5	3.4	4.0	Type 2: 4.0 Type 3: 4.9	
Helical rise (Å)	4.78	4.78	4.80	4.77	4.84	Type 2: 4.76 Type 3: 4.79	
Helical twist (°)	-0.81	-0.83	-0.88	-0.88	-0.86	Type 2: -0.68 Type 3: -0.70	

Extended Data Table 3 | Cryo-EM data collection of AGD, ARTAG, +3 cases, and PSP-RS case 3 (EC)

	AGD case 1	AGD case 2	PSP-RS case 3 (EC)	ARTAG case 1	+3 case 1	+3 case 2
Data collection and processing						
Electron Gun	XFEG	XFEG	XFEG	XFEG	XFEG	XFEG
Detector	K3	K3	K3	K3	K2	K2
Magnification	64k	64k	64k	64k	81k	105k
Voltage (kV)	300	300	300	300	300	300
Electron exposure (e-/Å ²)	31	30	37	40	52	53
Defocus range (μm)	1.0-3.0	1.5-2.5	1.5-2.5	1.2-2.8	1.7-2.8	1.7-2.8
Pixel size (Å)	1.17	1.17	1.17	1.17	1.06	1.15
Symmetry imposed	Type 1: C1 Type 2: C2 Type 3: C1 PHF: C1 CTE Type 1: C1	Type 2: C2 Type 3: C1 PHF: C1 SF: C1	AGD Type 2: C2 AGD Type 3: C1 PHF: C1 SF: C1	AGD Type 2: C2 AGD Type 3: C1 PHF: C1 SF: C1	AGD Type 2: C2	AGD Type 2: C2
Initial particle images (no.)	414,341	495,315	166,987	389,113	884,933	809,408
Final particle images (no.)	Type 1: 9,305 Type 2: 53,872 Type 3: 82,054 PHF: 57,725 CTE Type 1: 28,549	Type 2: 40,827 Type 3: 42,139 PHF: 75,614 SF: 110,573	AGD Type 2: 17,238 AGD Type 3: 48,964 PHF: 2,396 SF: 2,230	AGD Type 2: 30,626 AGD Type 3: 137,217 PHF: 68,972 SF: 41,151	AGD Type 2: 13,939	AGD Type 2: 43,642
Map resolution (Å; FSC=0.143)	Type 1: 3.4 Type 2: 3.4 Type 3: 8.3 PHF: 4.1 CTE Type 1: 4.7	Type 2: 4.1 Type 3: 7.5 PHF: 3.7 SF: 3.4	AGD Type 2: 3.6 AGD Type 3: 6.0 PHF: 9.4 SF: 8.8	AGD Type 2: 4.2 AGD Type 3: 6.0 PHF: 4.3 SF: 4.4	AGD Type 2: 3.2	AGD Type 2: 3.4
Helical rise (Å)	Type 1: 4.88 Type 2: 4.87 Type 3: 4.84 PHF: 2.42 CTE Type 1: 2.42	Type 2: 4.85 Type 3: 4.84 PHF: 2.42 SF: 4.84	AGD Type 2: 4.90 AGD Type 3: 4.84 PHF: 2.42 SF: 4.84	AGD Type 2: 4.87 AGD Type 3: 4.84 PHF: 2.39 SF: 4.79	AGD Type 2: 4.78	AGD Type 2: 4.80
Helical twist (°)	Type 1: -0.40 Type 2: -0.31 Type 3: -0.32 PHF: 179.4 CTE Type 1: 179.4	Type 2: -0.36 Type 3: -0.4 PHF: 179.4 SF: -1.05	AGD Type 2: -0.33 AGD Type 3: -0.38 PHF: 179.4 SF: -1.05	AGD Type 2: -0.32 AGD Type 3: -0.38 PHF: 179.43 SF: -1.04	AGD Type 2: -0.40	AGD Type 2: -0.39

Extended Data Table 4 | Cryo-EM data collection of FBD and FDD cases

	FBD Case1	FDD Case 1
Data collection and processing		
Electron Gun	XFEG	XFEG
Detector	Falcon III	Falcon III
Magnification	75k	75k
Voltage (kV)	300	300
Electron exposure (e-/Å ²)	50	40
Defocus range (μm)	1.6-2.2	1.2-2.4
Pixel size (Å)	1.04	1.04
Symmetry imposed	PHF: C1 SF: C1 CTE Type 1: C1 CTE Type 2: C1	C1
Initial particle images (no.)	721,421	286,689
Final particle images (no.)	PHF: 187,685 SF:137,235 CTE Type 1: 264,106 CTE Type 2: 24,182	214,400
Map resolution (Å; FSC=0.143)	PHF:3.3 SF:3.2 CTE Type 1: 3.1 CTE Type 2: 3.7	3.2
Helical rise (Å)	PHF:2.37 SF:4.74 CTE Type 1: 2.36 CTE Type 2: 2.36	2.36
Helical twist (°)	PHF: 179.43 SF: -1.04 CTE Type 1: 179.42 CTE Type 2: 179.42	179.44