

**Table S1.** Country-wise population coverage of each epitopes.

population/area	Class I	Class II	Class combined
	Coverage		
Algeria	0.00%	77.15%	77.15%
Algeria Arab	0.00%	77.15%	77.15%
American Samoa	98.75%	0.00%	98.75%
American Samoa Polynesian	98.75%	0.00%	98.75%
Argentina	97.50%	62.67%	99.07%
Argentina Amerindian	97.50%	45.78%	98.64%
Argentina Caucasoid	0.00%	80.65%	80.65%
Australia	94.51%	33.15%	96.33%
Australia Australian Aborigines	87.31%	33.15%	91.52%
Australia Caucasoid	99.94%	0.00%	99.94%
Austria	99.91%	93.34%	99.99%
Austria Caucasoid	99.91%	93.34%	99.99%
Belarus	0.00%	43.81%	43.81%
Belarus Caucasoid	0.00%	43.81%	43.81%
Belgium	99.39%	79.39%	99.87%
Belgium Caucasoid	99.39%	79.39%	99.87%
Bolivia	0.00%	77.82%	77.82%
Bolivia Amerindian	0.00%	77.82%	77.82%
Borneo	0.00%	49.02%	49.02%
Borneo Austronesian	0.00%	49.02%	49.02%
Brazil	96.10%	63.80%	98.59%
Brazil Amerindian	93.24%	48.60%	96.52%
Brazil Caucasoid	99.32%	84.39%	99.89%
Brazil Mixed	97.02%	77.50%	99.33%
Brazil Mulatto	0.00%	74.09%	74.09%
Bulgaria	99.42%	57.23%	99.75%
Bulgaria Caucasoid	99.52%	57.23%	99.79%
Bulgaria Other	99.58%	0.00%	99.58%
Burkina Faso	67.18%	0.00%	67.18%
Burkina Faso Black	67.18%	0.00%	67.18%

Cameroon	89.72%	49.87%	94.85%
Cameroon Black	89.72%	49.87%	94.85%
Canada	0.00%	38.41%	38.41%
Canada Amerindian	0.00%	38.41%	38.41%
Cape Verde	99.18%	80.38%	99.84%
Cape Verde Black	99.18%	80.38%	99.84%
Central Africa	86.04%	62.71%	94.79%
Central African Republic	28.02%	82.69%	87.54%
Central African Republic Black	28.02%	82.69%	87.54%
Central America	7.76%	49.91%	53.80%
Chile	95.94%	67.08%	98.66%
Chile Amerindian	99.63%	72.65%	99.90%
Chile Mixed	90.09%	52.65%	95.31%
China	94.57%	59.99%	97.83%
China Oriental	94.57%	59.99%	97.83%
Colombia	8.36%	54.02%	57.86%
Colombia Amerindian	0.00%	47.40%	47.40%
Colombia Black	3.65%	65.25%	66.51%
Colombia Mestizo	14.07%	56.31%	62.45%
Congo	0.00%	68.66%	68.66%
Congo Black	0.00%	68.66%	68.66%
Cook Islands	0.00%	78.59%	78.59%
Cook Islands Polynesian	0.00%	78.59%	78.59%
Costa Rica	0.00%	24.31%	24.31%
Costa Rica Mestizo	0.00%	24.31%	24.31%
Croatia	99.79%	66.71%	99.93%
Croatia Caucasoid	99.79%	66.71%	99.93%
Cuba	98.92%	85.48%	99.84%
Cuba Caucasoid	99.05%	0.00%	99.05%
Cuba Mixed	0.00%	85.48%	85.48%
Cuba Mulatto	98.74%	0.00%	98.74%
Czech Republic	99.08%	86.21%	99.87%
Czech Republic Caucasoid	99.08%	88.76%	99.90%
Czech Republic Other	0.00%	64.14%	64.14%

Denmark	0.00%	88.98%	88.98%
Denmark Caucasoid	0.00%	88.98%	88.98%
East Africa	90.78%	68.30%	97.08%
East Asia	98.18%	81.82%	99.67%
Ecuador	77.35%	52.17%	89.16%
Ecuador Amerindian	77.35%	52.17%	89.16%
England	99.93%	93.48%	100.00%
England Caucasoid	99.93%	93.48%	100.00%
Equatorial Guinea	0.00%	47.58%	47.58%
Equatorial Guinea Black	0.00%	47.58%	47.58%
Ethiopia	0.00%	83.00%	83.00%
Ethiopia Black	0.00%	83.00%	83.00%
Europe	99.68%	85.83%	99.96%
Fiji	0.00%	79.87%	79.87%
Fiji Melanesian	0.00%	79.87%	79.87%
Finland	99.99%	51.14%	100.00%
Finland Caucasoid	99.99%	51.14%	100.00%
France	99.80%	88.54%	99.98%
France Caucasoid	99.80%	88.54%	99.98%
Gabon	0.00%	41.78%	41.78%
Gabon Black	0.00%	41.78%	41.78%
Georgia	98.32%	75.05%	99.58%
Georgia Caucasoid	98.94%	75.05%	99.74%
Georgia Kurd	98.19%	0.00%	98.19%
Germany	99.93%	91.14%	99.99%
Germany Caucasoid	99.93%	91.14%	99.99%
Greece	0.00%	66.92%	66.92%
Greece Caucasoid	0.00%	66.92%	66.92%
Guatemala	7.76%	49.16%	53.11%
Guatemala Amerindian	7.76%	49.16%	53.11%
Guinea-Bissau	96.39%	71.16%	98.96%
Guinea-Bissau Black	96.39%	71.16%	98.96%
Hong Kong	96.05%	0.00%	96.05%
Hong Kong Oriental	96.05%	0.00%	96.05%
India	89.41%	74.99%	97.35%

India Asian	89.41%	74.99%	97.35%
Indonesia	86.79%	47.84%	93.11%
Indonesia Austronesian	86.79%	47.84%	93.11%
Iran	97.50%	64.22%	99.11%
Iran Kurd	0.00%	55.78%	55.78%
Iran Persian	97.50%	65.72%	99.14%
Ireland Northern	99.94%	94.65%	100.00%
Ireland Northern Caucasoid	99.94%	94.65%	100.00%
Ireland South	99.93%	93.15%	100.00%
Ireland South Caucasoid	99.93%	93.15%	100.00%
Israel	89.39%	68.79%	96.69%
Israel Arab	94.42%	67.51%	98.19%
Israel Jew	93.75%	69.65%	98.10%
Italy	99.03%	85.90%	99.86%
Italy Caucasoid	99.03%	85.90%	99.86%
Ivory Coast	67.75%	0.00%	67.75%
Ivory Coast Black	67.75%	0.00%	67.75%
Jamaica	0.00%	27.41%	27.41%
Jamaica Black	0.00%	27.41%	27.41%
Japan	98.63%	74.83%	99.66%
Japan Oriental	98.63%	74.83%	99.66%
Jordan	90.83%	52.88%	95.68%
Jordan Arab	90.83%	52.88%	95.68%
Kenya	89.56%	0.00%	89.56%
Kenya Black	89.56%	0.00%	89.56%
Kiribati	0.00%	10.89%	10.89%
Kiribati Micronesian	0.00%	10.89%	10.89%
Korea; South	98.21%	85.32%	99.74%
Korea; South Oriental	98.21%	85.32%	99.74%
Lebanon	0.00%	70.46%	70.46%
Lebanon Arab	0.00%	70.46%	70.46%
Macedonia	26.72%	66.53%	75.47%
Macedonia Caucasoid	26.72%	66.53%	75.47%
Malaysia	81.38%	57.99%	92.18%
Malaysia Austronesian	63.18%	55.38%	83.57%

Malaysia Oriental	87.82%	70.35%	96.39%
Mali	96.02%	0.00%	96.02%
Mali Black	96.02%	0.00%	96.02%
Martinique	22.56%	74.51%	80.26%
Martinique Black	22.56%	74.51%	80.26%
Mexico	97.97%	55.04%	99.09%
Mexico Amerindian	99.87%	42.59%	99.93%
Mexico Mestizo	98.13%	68.51%	99.41%
Mongolia	95.31%	81.85%	99.15%
Mongolia Oriental	95.31%	81.85%	99.15%
Morocco	98.63%	83.44%	99.77%
Morocco Arab	99.32%	85.07%	99.90%
Morocco Caucasoid	97.94%	79.75%	99.58%
Nauru	0.00%	38.66%	38.66%
Nauru Micronesian	0.00%	38.66%	38.66%
Netherlands	0.00%	83.44%	83.44%
Netherlands Caucasoid	0.00%	83.44%	83.44%
New Caledonia	98.18%	81.41%	99.66%
New Caledonia Melanesian	98.18%	81.41%	99.66%
New Zealand	0.00%	84.46%	84.46%
New Zealand Polynesian	0.00%	84.46%	84.46%
Niue	0.00%	77.82%	77.82%
Niue Polynesian	0.00%	77.82%	77.82%
North Africa	96.03%	75.06%	99.01%
North America	99.06%	87.89%	99.89%
Northeast Asia	94.70%	59.99%	97.88%
Norway	0.00%	94.71%	94.71%
Norway Caucasoid	0.00%	94.71%	94.71%
Oceania	94.71%	59.87%	97.88%
Oman	99.69%	0.00%	99.69%
Oman Arab	99.69%	0.00%	99.69%
Pakistan	97.09%	1.18%	97.13%
Pakistan Asian	96.75%	1.45%	96.79%
Pakistan Mixed	97.73%	0.00%	97.73%
Papua New Guinea	97.92%	69.15%	99.36%

Papua New Guinea Melanesian	97.92%	69.15%	99.36%
Paraguay	0.00%	4.90%	4.90%
Paraguay Amerindian	0.00%	4.90%	4.90%
Peru	99.99%	49.87%	100.00%
Peru Amerindian	99.99%	49.87%	100.00%
Philippines	94.98%	28.56%	96.41%
Philippines Austronesian	94.98%	28.56%	96.41%
Poland	99.77%	84.46%	99.96%
Poland Caucasoid	99.77%	84.46%	99.96%
Portugal	98.72%	78.00%	99.72%
Portugal Caucasoid	98.72%	78.00%	99.72%
Romania	99.67%	0.00%	99.67%
Romania Caucasoid	99.67%	0.00%	99.67%
Russia	99.27%	77.62%	99.84%
Russia Caucasoid	3.96%	88.52%	88.97%
Russia Mixed	5.05%	0.00%	5.05%
Russia Other	99.98%	85.01%	100.00%
Russia Siberian	99.43%	78.83%	99.88%
Rwanda	24.87%	62.79%	72.05%
Rwanda Black	24.87%	62.79%	72.05%
Samoa	0.00%	80.86%	80.86%
Samoa Polynesian	0.00%	80.86%	80.86%
Sao Tome and Principe	97.02%	66.50%	99.00%
Sao Tome and Principe Black	97.02%	66.50%	99.00%
Saudi Arabia	98.26%	80.14%	99.65%
Saudi Arabia Arab	98.26%	80.14%	99.65%
Scotland	65.34%	90.82%	96.82%
Scotland Caucasoid	65.34%	90.82%	96.82%
Senegal	95.58%	30.28%	96.92%
Senegal Black	95.58%	30.28%	96.92%
Serbia	73.37%	0.00%	73.37%
Serbia Caucasoid	73.37%	0.00%	73.37%
Singapore	92.66%	65.78%	97.49%

Singapore Austronesian	90.55%	65.78%	96.77%
Singapore Oriental	94.81%	0.00%	94.81%
Slovakia	0.00%	18.28%	18.28%
Slovakia Caucasoid	0.00%	18.28%	18.28%
Slovenia	0.00%	84.85%	84.85%
Slovenia Caucasoid	0.00%	84.85%	84.85%
South Africa	93.03%	32.10%	95.27%
South Africa Black	91.96%	32.10%	94.54%
South Africa Other	97.61%	0.00%	97.61%
South America	88.30%	58.59%	95.15%
South Asia	94.73%	75.38%	98.70%
Southeast Asia	94.56%	56.98%	97.66%
Southwest Asia	92.50%	43.93%	95.79%
Spain	87.52%	80.51%	97.57%
Spain Caucasoid	87.52%	80.84%	97.61%
Spain Other	0.00%	6.30%	6.30%
Sri Lanka	52.39%	0.00%	52.39%
Sri Lanka Asian	52.39%	0.00%	52.39%
Sudan	93.78%	60.56%	97.55%
Sudan Arab	70.21%	0.00%	70.21%
Sudan Black	2.19%	0.00%	2.19%
Sudan Mixed	94.39%	60.56%	97.79%
Sweden	99.99%	88.07%	100.00%
Sweden Caucasoid	99.99%	88.07%	100.00%
Taiwan	97.77%	67.88%	99.29%
Taiwan Oriental	97.77%	67.88%	99.29%
Thailand	91.21%	63.90%	96.83%
Thailand Oriental	91.21%	63.90%	96.83%
Tokelau	0.00%	55.11%	55.11%
Tokelau Polynesian	0.00%	55.11%	55.11%
Tonga	0.00%	71.91%	71.91%
Tonga Polynesian	0.00%	71.91%	71.91%
Tunisia	97.52%	74.26%	99.36%
Tunisia Arab	97.52%	74.97%	99.38%
Tunisia Berber	0.00%	74.47%	74.47%

Turkey	44.80%	76.19%	86.85%
Turkey Caucasoid	44.80%	76.19%	86.85%
Uganda	94.87%	0.00%	94.87%
Uganda Black	94.87%	0.00%	94.87%
Ukraine	0.00%	50.64%	50.64%
Ukraine Caucasoid	0.00%	50.64%	50.64%
United Arab Emirates	3.37%	32.92%	35.19%
United Arab Emirates Arab	3.37%	32.92%	35.19%
United States	99.10%	88.10%	99.89%
United States Amerindian	99.67%	42.79%	99.81%
United States Asian	97.46%	78.84%	99.46%
United States Austronesian	0.00%	58.09%	58.09%
United States Black	97.11%	71.50%	99.18%
United States Caucasoid	99.83%	90.15%	99.98%
United States Hispanic	98.92%	72.95%	99.71%
United States Mestizo	99.23%	72.23%	99.79%
United States Polynesian	99.57%	73.18%	99.88%
Venezuela	90.04%	3.01%	90.34%
Venezuela Amerindian	90.07%	0.00%	90.07%
Venezuela Caucasoid	11.45%	0.00%	11.45%
Venezuela Mestizo	9.75%	0.00%	9.75%
Venezuela Mixed	0.00%	3.17%	3.17%
Vietnam	91.82%	54.44%	96.27%
Vietnam Oriental	91.82%	54.44%	96.27%
Wales	1.00%	0.00%	1.00%
Wales Caucasoid	1.00%	0.00%	1.00%
West Africa	95.49%	65.23%	98.43%
West Indies	98.98%	69.22%	99.69%
Zambia	98.10%	0.00%	98.10%
Zambia Black	98.10%	0.00%	98.10%
Zimbabwe	93.79%	68.30%	98.03%
Zimbabwe Black	93.79%	68.30%	98.03%
Average	62.93	55.21	82.86
Standard deviation	43.71	30.27	25.28

**Table S2.** Selected epitopes.

	<i>IEDB ID</i>		Protein Names	Assay Type Category
1	101	AAECPFLPKPKVA	nucleoprotein,	B Cell
2	432	AASGDPTSPDNIDS	nucleocapsid protein,	B Cell
3	638	ADAVSRKKMD	N protein,nucleocapsid protein,	B Cell
4	637	ADAVSRKKMD	nucleocapsid protein,	B Cell
5	677	ADIDKLIDYAASGD	nucleocapsid protein,	B Cell
6	723	ADLVAAQKLATKP	nucleoprotein,	B Cell
7	881	AEELKKKSSFYQS	nucleocapsid protein,	B Cell
8	883	AEELTPGRFRTVC	nucleocapsid protein,	B Cell
9	1146	AERAVEVDPDDVNK	nucleocapsid protein,	B Cell
10	1299	AFFSILQDMRNTIM	nucleocapsid protein,	B Cell
11	1872	AIDIEPSGQ	N protein,nucleocapsid protein,	B Cell
12	2621	ALIDQKVKEI	nucleocapsid protein,	B Cell
13	4074	AQSTMKAELTPGR	nucleocapsid protein,	B Cell
14	4220	ARQKLKDAER	N protein,nucleocapsid protein,	B Cell
15	4219	ARQKLKDAER	nucleocapsid protein,	B Cell
16	4227	ARQQTVSALE	N protein,nucleocapsid protein,	B Cell
17	4226	ARQQTVSALE	nucleocapsid protein,	B Cell
18	4228	ARQQTVSALEDKLA	nucleocapsid protein,	B Cell
19	5311	AVEVDPDDVN	N protein,nucleocapsid protein,	B Cell
20	5310	AVEVDPDDVN	nucleocapsid protein,	B Cell
21	5312	AVEVDPDDVNKNTL	nucleocapsid protein,	B Cell
22	6762	CPFIKPEVKPGTPA	nucleocapsid protein,	B Cell
23	6764	CPFLPKPKVASEAFMSTNKM	nucleoprotein,	B Cell
24	7496	DAEKAVEVDPDDV	nucleoprotein,	B Cell
25	7671	DAVSRKKMDTKPTD	nucleocapsid protein,	B Cell
26	7885	DDVNKNTLQARQQT	nucleocapsid protein,	B Cell

27	8760	DIQEDITRHE	nucleocapsid protein,	B Cell
28	8761	DIQEITRHE	N protein,nucleocapsid protein,	B Cell
29	8804	DITRHEQLIVARQ	nucleocapsid protein,	B Cell
30	8918	DKLADYKRRM	N protein,nucleocapsid protein,	B Cell
31	8917	DKLADYKRRM	nucleocapsid protein,	B Cell
32	8927	DKLIDYAASGDPTS	nucleocapsid protein,	B Cell
33	9399	DMRNTIMASK	nucleocapsid protein,	B Cell
34	9401	DMRNTIMASKTVGTA	nucleocapsid protein,	B Cell
35	9472	DNIDSPNAPWVFAC	nucleocapsid protein,	B Cell
36	9789	DPTSPDDIES	N protein,	B Cell
37	10387	DTKPTDPTGIEPDDHLKERSRLRYGNVLDVNAIDIEEPSGQTADW	nucleocapsid protein,	B Cell
38	10677	DVNAIDIEEPSGQT	nucleocapsid protein,	B Cell
39	10685	DVNKSTLQARQQTVSALEDKLADYKRRMADAVSRKKMDTKPTDPT	nucleocapsid protein,	B Cell
40	10821	DWPERIRDFM	N protein,	B Cell
41	10824	DWSERIREFM	nucleocapsid protein,	B Cell
42	10843	DWYTIGVYVIGFTL	nucleocapsid protein,	B Cell
43	11353	EDINGIRRPK	N protein,nucleocapsid protein,	B Cell
44	11354	EDINGIRRPKHLVY	nucleocapsid protein,	B Cell
45	11370	EDKLADYKRRMADA	nucleocapsid protein,	B Cell
46	11724	EEKLKKKSSF	nucleocapsid protein,	B Cell
47	11772	EELTPGRFRT	N protein,nucleocapsid protein,	B Cell
48	12050	EFMEKECPFIKPEV	nucleocapsid protein,	B Cell
49	12440	EIEMLKRNKIYFMQ	nucleocapsid protein,	B Cell
50	12659	EKECPFIKPEVKPG	nucleocapsid protein,	B Cell
51	12660	EKECPFIKPEVKPGTPAQEIEMLKRNKIYF	nucleocapsid protein,	B Cell
52	13063	ELGAFFSILQ	N protein,nucleocapsid protein,	B Cell
53	13064	ELGAFFSILQDMR	nucleoprotein,	B Cell

54	13065	ELGAFFSILQDMRN	nucleocapsid protein,	B Cell
55	987	AEIESATLF	nucleocapsid protein,	MHC Binding
56	1044	AELGAFFSI	nucleocapsid protein,	MHC Binding
57	1357	AFMATNKAY	nucleocapsid protein,	MHC Binding
58	3989	AQKLATKPV	nucleocapsid protein,	MHC Binding
59	5080	ATPHSVWVF	nucleocapsid protein,	MHC Binding
60	13137	ELKRQLADL	nucleocapsid protein,	MHC Binding
61	13230	ELQENITAH	nucleocapsid,nucleocapsid protein,	MHC Binding
62	639	ADAVSRKKMDTKPTDPT	N protein,	T Cell
63	2000	AILQDMRNTI	nucleocapsid protein,	T Cell
64	5767	AYFITRQL	nucleocapsid protein,	T Cell
65	8762	DIQEEITRHEQQQLVVARQKLKD	N protein,	T Cell
66	10650	DVKVKEISNQEPLKL	Nucleoprotein,hypothetical protein,nucleocapsid protein,	T Cell
67	11258	ECPFIKPEV	nucleocapsid protein,	T Cell
68	13061	ELGAFFAI	nucleocapsid protein,	T Cell
69	13247	ELRGLAQALIDQKV	nucleocapsid protein,	B Cell
70	13248	ELRGLAQALIDQKVK	nucleocapsid protein,	B Cell
71	13253	ELRQLAQSLIDTKVKEISNQEPLKL	nucleoprotein,	B Cell
72	13396	EMLKRNKIYF	nucleocapsid protein,	B Cell
73	13501	ENKGTRIRFK	nucleocapsid protein,	B Cell
74	13503	ENKGTRIRFKDDTS	nucleocapsid protein,	B Cell
75	13763	EPGQTADWY	N protein,nucleocapsid protein,	B Cell
76	14191	ESKVQDIIDLIDH	nucleoprotein,	B Cell
77	14751	EVKPGTPAQEIEML	nucleocapsid protein,	B Cell

78	15511	FEDVNGIRRP	N protein,	B Cell
79	15517	FEEINGIRKP	nucleocapsid protein,	B Cell
80	15518	FEEINGIRRP	nucleocapsid protein,	B Cell
81	15523	FEEVNGIRKP	nucleoprotein,	B Cell
82	15524	FEEVNGIRRP	nucleocapsid protein,	B Cell
83	16120	FHLGDDMDPELRGL	nucleocapsid protein,	B Cell
84	16229	FIKPEVKPGT	nucleocapsid protein,	B Cell
85	17052	FMLEWGKEMVDHFF	nucleocapsid protein,	B Cell
86	18951	GDDMDPELRGLAQA	nucleocapsid protein,	B Cell
87	19081	GDPTSPDNIDSPNA	nucleocapsid protein,	B Cell
88	20769	GLAQALIDQKVKEI	nucleocapsid protein,	B Cell
89	21247	GMAELGAFFSILQD	nucleocapsid protein,	B Cell
90	22037	GRFRTIVCGLFPTQ	nucleocapsid protein,	B Cell
91	22178	GRQTVKENKGTRIR	nucleocapsid protein,	B Cell
92	22799	GTRIRFKDDTSFED	nucleocapsid protein,	B Cell
93	22999	GVIGSFFVK	N protein,nucleocapsid protein,	B Cell
94	23727	HEQQLVTARQKLK	nucleoprotein,	B Cell
95	23728	HEQQLVVARQKLKDAERAVEVDPDDV	nucleocapsid protein,	B Cell
96	24209	HLGDDMDPEL	N protein,nucleocapsid protein,	B Cell
97	24330	HLVYSMPAQ	nucleocapsid protein,	B Cell
98	25013	HVADIDKLID	N protein,nucleocapsid protein,	B Cell
99	25653	IDQKVKEISNQEPL	nucleocapsid protein,	B Cell
100	25786	IEEPSGQTADWYTI	nucleocapsid protein,	B Cell
101	26225	IGFSFFVKDWSERI	nucleocapsid protein,	B Cell
102	26227	IGFTLPILKALYM	nucleocapsid protein,	B Cell
103	26575	IILKALYMLSTRGR	nucleocapsid protein,	B Cell
104	27449	IMASKTVGTA	nucleocapsid protein,	B Cell
105	27451	IMASKTVGTAEEL	nucleocapsid protein,	B Cell
106	28144	IQEDITRHEQQQLIV	nucleocapsid protein,	B Cell

107	28268	IRDFMEKESP	N protein,	B Cell
108	28291	IRFKDDTSFEDING	nucleocapsid protein,	B Cell
109	28389	IRRPKHLYVS	N protein,nucleocapsid protein,	B Cell
110	29067	ITRHEQQLIV	nucleocapsid protein,	B Cell
111	29068	ITRHEQQLIV	nucleocapsid protein,	B Cell
112	29205	IVARQKLKDAERAV	nucleocapsid protein,	B Cell
113	29578	IYFMQRQDVLDKNH	nucleocapsid protein,	B Cell
114	29883	KALYMLSTRG	nucleocapsid protein,	B Cell
115	30105	KDAERAVEVD	N protein,nucleocapsid protein,	B Cell
116	30104	KDAERAVEVD	nucleocapsid protein,	B Cell
117	30130	KDDTSFEDINGIRR	nucleocapsid protein,	B Cell
118	14363	ETESATLFT	nucleocapsid,nucleocapsid protein,	MHC Binding
119	16490	FLAAECPFL	nucleocapsid protein,	MHC Binding
120	17108	FMVAWGKEA	Nucleoprotein,hypothetical protein,	MHC Binding
121	18201	FVKDWMMDRI	nucleocapsid protein,	MHC Binding
122	18203	FVKDWMERI	nucleocapsid protein,	MHC Binding
123	21234	GLYPAQIKA	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
124	23092	GVPELGAFF	nucleocapsid protein,	MHC Binding
125	23523	HAIESATL	nucleocapsid protein,	MHC Binding
126	23529	HAETESATL	nucleocapsid,nucleocapsid protein,	MHC Binding
127	26574	IILKALYML	nucleocapsid protein,	MHC Binding

128	27259	ILQDMRNTI	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding, T Cell
129	28289	IRFKDDSSF	nucleocapsid protein,	MHC Binding
130	14852	EVQDNITL	nucleocapsid protein,	T Cell
131	15104	FAILQDMRNT	nucleocapsid protein,	T Cell
132	15195	FAILQDMRNTIMASK	nucleocapsid protein,	T Cell
133	17746	FSILQDMRNTIMASK	Nucleoprotein,hypothetical protein,nucleocapsid protein,	T Cell
134	20865	GLFPTQIQV	nucleocapsid protein,	T Cell
135	28282	IREFMEKECPFIKPE	nucleocapsid protein,	T Cell
136	28390	IRRPKHLYVSMPTAQST	N protein,	T Cell
137	30596	KERSSLRYGN	N protein,nucleocapsid protein,	B Cell
138	30597	KERSSLRYGNVLDV	nucleocapsid protein,	B Cell
139	31133	KHLYVSMPTAQSTM	nucleocapsid protein,	B Cell
140	31701	KKSSFYQSYL	N protein,nucleocapsid protein,	B Cell
141	32296	KMDTKPTDPTGIEP	nucleocapsid protein,	B Cell
142	32617	KNTLQARQQT	N protein,nucleocapsid protein,	B Cell
143	32616	KNTLQARQQT	nucleocapsid protein,	B Cell
144	34065	KVKEISNQEPLKI	nucleocapsid protein,	B Cell
145	34727	LADYKRRMADAVSR	nucleocapsid protein,	B Cell
146	35199	LDKNHVADIDKLID	nucleocapsid protein,	B Cell
147	35947	LFPTQIQVRNIMSP	nucleocapsid protein,	B Cell
148	36816	LKDAERAVEVDPDD	nucleocapsid protein,	B Cell
149	39198	LRRTQSMGIQLDQ	nucleoprotein,	B Cell
150	39199	LRRTQSMGIQLDQR	nucleocapsid protein,	B Cell
151	39251	LRYGNVLDVN	N protein,nucleocapsid protein,	B Cell

152	39714	LSTRGRQTVK	nucleocapsid protein,	B Cell
153	39849	LTDIQEDITRHEQQ	nucleocapsid protein,	B Cell
154	40099	LTPGRFRTIVCGLF	nucleocapsid protein,	B Cell
155	41258	MDPELRGLAQ	N protein,nucleocapsid protein,	B Cell
156	41259	MDPELRGLAQALID	nucleocapsid protein,	B Cell
157	41592	MGQLDQRIILLFM	nucleocapsid protein,	B Cell
158	41644	MGVIGFSFFVKDWS	nucleocapsid protein,	B Cell
159	41979	MLKRNKIYFMQRQD	nucleocapsid protein,	B Cell
160	42327	MPTAQSTMKA	nucleocapsid protein,	B Cell
161	42329	MPTAQSTMKAELT	nucleocapsid protein,	B Cell
162	42408	MQRQDVLDKNHVAD	nucleocapsid protein,	B Cell
163	42531	MSDLTDIQED	nucleocapsid protein,	B Cell
164	42532	MSDLTDIQEDITRH	nucleocapsid protein,	B Cell
165	42533	MSDLTDIQEDITRHEQQLVVARQKLKDAEKAVEMYPPDDVNKNTLQ	nucleocapsid protein,	B Cell,T Cell
166	42534	MSDLTDIQEE	N protein,nucleocapsid protein,	B Cell,
167	42536	MSDLTDIQEEITRHEQQLVVARQKLKDAERAVEVDPDDVNKSTLQ	nucleocapsid protein,	B Cell
168	42678	MSTLQELQENITA	nucleoprotein,	B Cell
169	42923	MVDHFLGDD	N protein,nucleocapsid protein,	B Cell
170	44002	NGIRRPKHLVVSMP	nucleocapsid protein,	B Cell
171	44172	NHVADIDKLIDYAA	nucleocapsid protein,	B Cell
172	44293	NIMSPVMGVIGFSF	nucleocapsid protein,	B Cell
173	44563	NKNTLQARQQTVA	nucleocapsid protein,	B Cell
174	44602	NKSTLQNRRAAVS	nucleoprotein,	B Cell
175	46127	NTIMASKSVGTAE	nucleoprotein,	B Cell
176	46417	NVLDVNAIDIEEPS	nucleocapsid protein,	B Cell
177	46912	PAQEIEMLKR	nucleocapsid protein,	B Cell
178	47072	PDDHLKERSS	N protein,nucleocapsid protein,	B Cell

179	47078	PDDVNKNTLQ	N protein,nucleocapsid protein,	B Cell
180	47077	PDDVNKNTLQ	nucleocapsid protein,	B Cell
181	47765	PGTPAQEIEMLKRN	nucleocapsid protein,	B Cell
182	48115	PKPKVASEAFMST	nucleoprotein,	B Cell
183	48603	PNAPWVFACA	N protein,nucleocapsid protein,	B Cell
184	49388	PSGQTADWYTIGVY	nucleocapsid protein,	B Cell
185	49631	PTGIEPDDHL	N protein,nucleocapsid protein,	B Cell
186	50307	QALIDQKVKEISNQ	nucleocapsid protein,	B Cell
187	50494	QDMRNTIMASKTVG	nucleocapsid protein,	B Cell
188	50528	QDVLDKNHVADIDK	nucleocapsid protein,	B Cell
189	51313	QLDQRIILLFMLEW	nucleocapsid protein,	B Cell
190	51576	QLVTARQKLKDAEKAVEVDPDDVNKSTLQNRRAAVSTLETKL	nucleoprotein,	B Cell
191	30311	KEAVNHFHL	nucleocapsid protein,	MHC Binding
192	32130	KLRKKSSFY	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
193	32739	KPKALSEAF	nucleocapsid,nucleocapsid protein,	MHC Binding
194	32772	KPKHLYVSM	nucleocapsid protein,	MHC Binding
195	32777	KPKVASEAF	nucleocapsid protein,	MHC Binding
196	39249	LRYGNVLDV	nucleocapsid,nucleocapsid protein,	MHC Binding
197	47346	PELGAFFAI	nucleocapsid protein,	MHC Binding
198	30485	KEKSSLRYGNVLDVN	nucleocapsid protein,	T Cell
199	35267	LDQKIIIL	nucleocapsid protein,	T Cell
200	36052	LGAFFAIL	nucleocapsid protein,	T Cell
201	39252	LRYGNVLDVNAIDIEEPSGQTA	N protein,	T Cell

202	41256	MDPELREL	nucleocapsid protein,	T Cell
203	46910	PAQEIEFLKRNRYFMTRQDVL	N protein,	T Cell
204	49914	PVMGVIGFS	nucleocapsid protein,	T Cell
205	52058	QQLIVARQKL	nucleocapsid protein,	B Cell
206	52059	QQLIVARQKLKDAE	nucleocapsid protein,	B Cell
207	52060	QQLIVARQKLKDAER	nucleocapsid protein,	B Cell
208	52456	QSYLRRTQSMGIQL	nucleocapsid protein,	B Cell
209	52466	QTADWYTIGVYVIG	nucleocapsid protein,	B Cell
210	52660	QTVSALEDKLADYK	nucleocapsid protein,	B Cell
211	52720	QVKARNIISPVMG	nucleoprotein,	B Cell
212	52777	QVRNIMSPVM	N protein,nucleocapsid protein,	B Cell
213	52778	QVRNIMSPVMGVIG	nucleocapsid protein,	B Cell
214	53905	RGLAQALIDQ	nucleocapsid protein,	B Cell
215	53906	RGLAQSLIDQ	N protein,	B Cell
216	53967	RGRQAVKDNKGTRIRFKDDSSFEENV	nucleoprotein,	B Cell
217	54047	RHEQQLIVARQKLK	nucleocapsid protein,	B Cell
218	54233	RIREFMEKECPFIK	nucleocapsid protein,	B Cell
219	54238	RIRFKDDTSF	N protein,nucleocapsid protein,	B Cell
220	54237	RIRFKDDTSF	nucleocapsid protein,	B Cell
221	54375	RKKMDTKPTD	nucleocapsid protein,	B Cell
222	54848	RMADAVSRKKMDTK	nucleocapsid protein,	B Cell
223	55007	RNKIYFMQRQDVL	nucleocapsid protein,	B Cell
224	55066	RNTIMASKTVGTAE	nucleocapsid protein,	B Cell
225	55436	RQKLKDAERADEV	nucleocapsid protein,	B Cell
226	55494	RQTVKENKGT	nucleocapsid protein,	B Cell
227	55675	RRPKHLYVSMPTAQ	nucleocapsid protein,	B Cell
228	55751	RRTQSMGIQL	N protein,nucleocapsid protein,	B Cell
229	56089	RTIVCGLFPTQIQV	nucleocapsid protein,	B Cell
230	56537	RYGNVLDVNAIDIE	nucleocapsid protein,	B Cell

231	56852	SALEDKLADYKRRM	nucleocapsid protein,	B Cell
232	57351	SEAFMSTNMKYFL	nucleoprotein,	B Cell
233	57767	SFFVKDWPER	N protein,	B Cell
234	57770	SFFVKDWSER	nucleocapsid protein,	B Cell
235	57771	SFFVKDWSERIREF	nucleocapsid protein,	B Cell
236	57957	SFYQSYLRRTQSMG	nucleocapsid protein,	B Cell
237	58614	SILQDMRNTIMASK	nucleocapsid protein,	B Cell
238	58954	SKTVGTAEELKKK	nucleocapsid protein,	B Cell
239	60319	SPVMGVIGFSFFVK	nucleocapsid protein,	B Cell
240	60714	SRKKMDTKPTDPTG	nucleocapsid protein,	B Cell
241	61192	SSLRYGNVLDVNAI	nucleocapsid protein,	B Cell
242	61862	STRGRQTVKENKGT	nucleocapsid protein,	B Cell
243	62824	TADWYTIGVY	N protein,nucleocapsid protein,	B Cell
244	62975	TAQSTMKAEEITP	nucleoprotein,	B Cell
245	63215	TDPTGIEPDDHLKE	nucleocapsid protein,	B Cell
246	63856	TGIEPDDHLKERSS	nucleocapsid protein,	B Cell
247	64317	TIGVYVIGFTLPII	nucleocapsid protein,	B Cell
248	64644	TKPTDPTGIE	N protein,nucleocapsid protein,	B Cell
249	64645	TKPTDPTGIEPDDH	nucleocapsid protein,	B Cell
250	64782	TLETKLGELEKRL	nucleoprotein,	B Cell
251	65006	TLPIILKALYMLST	nucleocapsid protein,	B Cell
252	65021	TLQARQQTVSALED	nucleocapsid protein,	B Cell
253	65210	TMKAEEELTPGRFRT	nucleocapsid protein,	B Cell
254	65881	TQIQVRNIMSPVMG	nucleocapsid protein,	B Cell
255	65938	TQSMGIQLDQRIIL	nucleocapsid protein,	B Cell
256	66194	TSFEDINGIRRPKH	nucleocapsid protein,	B Cell
257	66354	TSPDNIDSPNAPWV	nucleocapsid protein,	B Cell
258	67017	TVGTAEELK	nucleocapsid protein,	B Cell

259	51616	QMISPVMSV	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
260	59708	SMSYGNVL	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
261	60318	SPVMGVIGF	nucleocapsid protein,	MHC Binding
262	61191	SSLRYGNVL	nucleocapsid protein,	MHC Binding
263	64724	TLAQSLIDV	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
264	52779	QVRNIMSPVMGVIGFSFFVKDW	N protein,	T Cell
265	54068	RHLYVSMPTAQSTMK	nucleocapsid protein,	T Cell
266	55184	RPKHLVYSM	nucleocapsid protein,	T Cell
267	57017	SATIFADI	nucleocapsid protein,	T Cell
268	59737	SMPTAQSTM	nucleocapsid protein,	T Cell
269	60320	SPVMGVIGFSFFVKD	nucleocapsid protein,	T Cell
270	61190	SSLRYGNV	nucleocapsid protein,	T Cell
271	65587	TPGRFRTI	nucleocapsid protein,	T Cell
272	66195	TSFEDINGIRPKHL	nucleocapsid protein,	T Cell
273	164647	EEINGIRKPR	nucleocapsid protein,	B Cell
274	150982	FEDINGIRRP	nucleocapsid protein,	B Cell
275	956355	GKNIGQDRDPTGVEPGDHLKERSALSYGNTLDLNSLDID	nucleocapsid protein,	B Cell
276	165026	LKDAEKAVEVDPDDVNVKSTLQSRRAAV	nucleocapsid protein,	B Cell
277	956424	PIAGSLSGNPVNRD	nucleocapsid protein,	B Cell
278	165338	THEQQLVTARQKLKDAEKAVEVDPDDVNVKSTLQSRRAAV	nucleocapsid protein,	B Cell
279	67018	TVGTAEKLLK	N protein,nucleocapsid protein,	B Cell
280	67042	TVKENKGTRIRFKD	nucleocapsid protein,	B Cell
281	67972	VDHFHLGDDMDPEL	nucleocapsid protein,	B Cell
282	68034	VDPDDVNVKNTLQAR	nucleocapsid protein,	B Cell

283	68042	VDPTGLEPDDHLK	nucleoprotein,	B Cell
284	68420	VFACAPDRCP	N protein,nucleocapsid protein,	B Cell
285	68800	VGTAEEKLKKKSSF	nucleocapsid protein,	B Cell
286	69199	VKDWSEIRREFMEK	nucleocapsid protein,	B Cell
287	69289	VKPGTPAQEI	nucleocapsid protein,	B Cell
288	69441	VLDVNAIDIE	N protein,nucleocapsid protein,	B Cell
289	70109	VNKNTLQARQQTVSA	nucleocapsid protein,	B Cell
290	70879	VSALEDKLAD	N protein,nucleocapsid protein,	B Cell
291	70878	VSALEDKLAD	nucleocapsid protein,	B Cell
292	72183	VYVIGFTLPILKA	nucleocapsid protein,	B Cell
293	73067	WSEIRREFMEKECP	nucleocapsid protein,	B Cell
294	73191	WVFACAPDRCPPTC	nucleocapsid protein,	B Cell
295	73529	YDDVNGIRKP	nucleocapsid protein,	B Cell
296	151073	YEDVNGIRK	nucleocapsid protein,	B Cell
297	73645	YEEINGIRRP	nucleocapsid protein,	B Cell
298	74501	YKRRMADAVS	nucleocapsid protein,	B Cell
299	74503	YKRRMADAVSRKKM	nucleocapsid protein,	B Cell
300	76234	YVAGMAELGAFFSI	nucleocapsid protein,	B Cell
301	92496	DWMDRIEEF	nucleocapsid protein,	MHC Binding
302	92574	ELRQLAQSL	nucleocapsid protein,	MHC Binding
303	164233	FVVPILLKA	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
304	92998	ILYMLSWGK	nucleocapsid protein,	MHC Binding
305	93361	LYVAGVPEL	nucleocapsid protein,	MHC Binding
306	93437	MRNTIMASK	nucleocapsid protein,	MHC Binding

307	93759	RQKLKDAEK	nucleocapsid protein,	MHC Binding
308	93762	RRAAVSTLE	nucleocapsid protein,	MHC Binding
309	69961	VMGVIGFGF	nucleocapsid protein,	MHC Binding
310	72480	WGKEAVNHF	nucleocapsid protein,	MHC Binding
311	72661	WKAIGAYIL	nucleocapsid protein,nucleoprotein,	MHC Binding
312	72730	WLIEPCKLL	nucleocapsid protein,	MHC Binding
313	74297	YILGFAIPI	nucleocapsid protein,nucleoprotein,	MHC Binding
314	94311	YLRQRQAAL	nucleocapsid protein,	MHC Binding
315	74946	YLTSFVVI	nucleocapsid protein,	MHC Binding
316	75086	YMLSWGKEA	nucleocapsid protein,	MHC Binding
317	94352	YRTAVCGLY	Nucleoprotein,hypothetical protein,nucleocapsid protein,	MHC Binding
318	130714	AAECPFLPKPKVASE	nucleocapsid protein,nucleoprotein,	T Cell
319	130779	DWMDRIEEFLAAECP	nucleocapsid protein,nucleoprotein,	T Cell
320	130796	EEITPGRFRTIACGL	nucleocapsid protein,nucleoprotein,	T Cell
321	149047	FSILQDMRNTI	Nucleoprotein,hypothetical protein,nucleocapsid protein,	T Cell
322	130849	GFFVKDWMDRIEEFL	nucleocapsid protein,nucleoprotein,	T Cell
323	130875	GVIGFGFFVKDWMDR	nucleocapsid protein,nucleoprotein,	T Cell

324	130892	IEEFLAAECPFLPKP	nucleocapsid protein,nucleoprotein,	T Cell
325	130897	ILGFAIPIILKALYM	nucleocapsid protein,nucleoprotein,	T Cell
326	130902	IPIILKALY	nucleocapsid protein,nucleoprotein,	T Cell
327	130903	IPIILKALYMLSTRG	nucleocapsid protein,nucleoprotein,	T Cell
328	130929	KSTLQSRRAAVSTLE	nucleocapsid protein,nucleoprotein,	T Cell
329	130932	KVASEAFMSTNKMYF	nucleocapsid protein,nucleoprotein,	T Cell
330	130948	LKRQLADLVAAQKLA	nucleocapsid protein,nucleoprotein,	T Cell
331	131049	RQTVKDNKGTRIRFK	nucleocapsid protein,nucleoprotein,	T Cell
332	131067	SIDLEEPSGQTADWK	nucleocapsid protein,nucleoprotein,	T Cell
333	131086	SRRAAVSTLETKLGE	nucleocapsid protein,nucleoprotein,	T Cell
334	131090	STMKAEEITPGRFRT	nucleocapsid protein,nucleoprotein,	T Cell
335	68421	VFACAPDRCPPTCIYVA	N protein,	T Cell
336	70789	VRNIMSPVM		nucleocapsid protein,

**Table S3.** Pair of residues, which were mutated to cysteine amino acid.

TLR4-agonist vaccine	Chi3-angle	Energy (kcal/mol)	$\beta$ -defensin vaccine	Chi angle	Energy (kcal/mol)	50S Ribosomal protein L7/L12 vaccine	Chi3-angle	Energy (kcal/mol)
Met19-Lys22	93.8	5.45	Cys18-Cys21	106.89	4.07	Met16-Ala69	-58.77	6.58
Gly28-Gly32	80.65	5.45	Ser22-Lys44	-113.3	7.26	Lys26-Glu33	85.73	1.18
Gly41-Asp46	90.89	4.71	Pro25-Gly37	111.43	2.85	Ala41-Ala45	-88.87	1.5
Asp46-Gly57	-91.92	2.94	Ser34-Gly37	-71.76	3.92	Glu55-Ser61	113.9	1.46
Ser52-Arg55	101.4	5.14	Asn54-Gly68	74.08	4.3	Val65-Ile78	105	1.95
Asp61-Ala64	102.95	1.6	Thr55-Gly66	-58.65	1.99	Leu67-Ile75	111.26	4.87
Thr74-Gly82	116.24	2.93	Thr61-Ala65	-58.42	7.28	Arg82-Gly89	115.16	1.78
Ala75-Lys86	74.54	5.57	Lys87-Tyr94	125.6	5.18	Val85-Leu88	118.05	2.84
Gly97-Gly101	-116.65	7.3	Asp99-Ala102	-75.9	6.36	Ala93-Ala100	-113.98	5.75
Arg110-Val113	119.28	3.07	Gly120-Lys124	121.86	4.57	Lys94-Pro101	122.86	3.7
Ala126-Ser202	114.88	3.18	Gln131-Gly135	67.41	6.6	Ala118-Ala125	-86.91	2.62
Pro132-Ser143	-88.91	1.1	Tyr184-Asn198	114.39	3.55	Met142-Ala150	109.15	3.91
Gly134-Glu140	101.26	5.19	Gly185-Ala202	-78.71	4.4	Pro154-Thr157	109.15	3.91
Gly138-Val149	-115.76	6.32	Pro193-Pro214	93.62	1.12	Pro154-Thr157	124.89	7.26
Gly147-Thr167	-87.26	1.09	Thr199-Lys204	71.69	3.24	Lys179-Tyr1179	96.31	5.2
Val152-Val168	123.82	5.83	Ala209-Lys216	104.4	3.45	Ser175-Arg178	117.23	3.82
Asn160-Gly169	126.76	3.22	Gly215-Ile218	117.21	4.64	Ile188-Gly201	-60.14	2.08
Glu172-Gly175	89.27	4.4	Asp231-Thr244	85.94	2.59	Glu192-Thr197	-84.76	2.42
Gly173-Pro186	114.88	4.14	Glu235-Ala238	115.05	4.73	Gly195-Gly203	112.31	3.41
Asp208-Ser211	103.01	2.54	Tyr241-Asn243	122.58	3.46	Pro202-Val210	110.58	4.31
Ile214-Pro219	114.24	2.42	Leu264-Leu270	121.98	5.25	Ile206-Lys209	123.64	4.45
Gly220-Pro237	-58.29	3.29	Asp279-Glu282	98.01	5.57	Gly240-Thr290	74.96	5.78
Glu227-Asp230	-101.5	3.39	Thr287-Lys291	104.83	5.9	Gly270-Val291	108.97	6.21
Gly238-Pro257	101.6	4.68	-	-	-	Asp306-Gly311	-97.35	1.55
Ser239-Pro255	101.84	3.2	-	-	-	Leu330-Asn333	75.42	6.15
Ser246-Gly254	-91.74	2.57	-	-	-	Ser362-Leu365	123.02	3.16