

**Supplementary Table 1. Peptides from tumor-associated antigens**

Symbol for peptide	Protein	Position of peptide	Amino acid sequence	HLA type
CypB-129	Cyclophilin B	129-138	KLKHYGPGWV	A2, A3sup <sup>a</sup>
Lck-246	p56Lck	246-254	KLVERLGAA	A2
Lck-422	p56Lck	422-430	DVWSFGILL	A2, A3sup
MAP-432	ppMAPkkk	432-440	DLLSHAFFA	A2, A26
WHSC2-103	WHSC2	103-111	ASLDSDPWV	A2, A3sup, A26
HNRPL-501	HNRPL	501-510	NVLHFFNAPL	A2, A26
UBE-43	UBE2V	43-51	RLQEWCSVI	A2
UBE-85	UBE2V	85-93	LIADFLSGL	A2
WHSC2-141	WHSC2	141-149	ILGELREKV	A2
HNRPL-140	HNRPL	140-148	ALVEFEDVL	A2
SART3-302	SART3	302-310	LLQAEAPRL	A2
SART3-309	SART3	309-317	RLAEYQAYI	A2
SART2-93	SART2	93-101	DYSARWNEI	A24
SART3-109	SART3	109-118	VYDYNCHVDL	A24, A3sup, A26
Lck-208	p56Lck	208-216	HYTNASDGL	A24
PAP-213	PAP	213-221	LYCESVHNF	A24
PSA-248	PSA	248-257	HYRKWIKDTI	A24
EGFR-800	EGF-R	800-809	DYVREHKDNI	A24
MRP3-503	MRP3	503-511	LYAWEPSFL	A24
MRP3-1293	MRP3	1293-1302	NYSVRYRPGL	A24
SART2-161	SART2	161-169	AYDFLYNYL	A24
Lck-486	p56Lck	486-494	TFDYLRSVL	A24
Lck-488	p56Lck	488-497	DYLRSVLEDF	A24
PSMA-624	PSMA	624-632	TYSVSFDSL	A24
EZH2-735	EZH2	735-743	KYVGIEREM	A24
PTHrP-102	PTHrP	102-111	RYLTQETNKV	A24
SART3-511	SART3	511-519	WLEYYNLER	A3sup
SART3-734	SART3	734-742	QIRPIFSNR	A3sup
Lck-90	p56Lck	90-99	ILEQSGEWWK	A3sup
Lck-449	p56Lck	449-458	VIQNLERGYR	A3sup
PAP-248	PAP	248-257	GIHKQKEKSR	A3sup

<sup>a</sup>A3sup; HLA-A3 supertype (A3, A11, A31, and A33)

**Supplementary Table 2. Immune responses, tumor markers, and overall survival**

Patient No.	Peptide <sup>a</sup>	IgG response <sup>b</sup>		CTL response <sup>c</sup>		CTL response to CEF <sup>c</sup>		AFP <sup>d</sup>		DCP <sup>d</sup>		OS (days)
		Before	After	Before	After	Before	After	Before	After	Before	After	
1	C-35	7250	7768	0	<u>679</u>							
	Lck-208	98	0	0	0	0	0	3479	<u>671</u>	874	<u>583</u>	141
	PAP-213	176	0	0	0							
	PTHrP-102	84	0	0	<u>1311</u>							
2	C-35	16547	14532	0	<u>130</u>							
	Lck-208	12	0	0	0	0	0	774	901	1820	1820	295
	PAP-213	25	18	0	0							
	PTHrP-102	33	0	0	0							
3	C-35	8959	<u>22289</u>	0	0							
	Lck-246	214	<u>6989</u>	0	0	0	0	49	<u>17</u>	15300	20800	107
	CypB-129	153	171	0	0							
	WHSC2-141	22	20	0	0							
4	C-35	44	<u>106</u>	0	0							
	Lck-208	37	16	0	0	0	0	13300	15700	20008	<u>5326</u>	210
	PSMA-624	30	<u>73</u>	0	0							
	PAP-213	26	<u>711</u>	0	0							
5	C-35	19100	19828	0	<u>1407</u>							
	CypB-129	330	315	0	0	899	<u>1477</u>	238	409	2600	49800	124
	UBE2V-43	39	55	0	<u>698</u>							
	HNRPL-140	270	263	0	0							
6	C-35	14375	NA	0	NA							
	HNRPL-501	713	NA	0	NA	0	NA	2688	NA	7861	NA	76
	ppMAPkkk-432	385	NA	0	NA							
	WHSC2-103	98	NA	0	NA							
7	C-35	3413	3208	0	0							
	MRP3-1293	259	270	0	0	3063	<u>4658</u>	5480	6130	40900	45400	106
	Lck-488	272	289	0	0							
	SART2-93	173	278	0	0							
8	C-35	22945	24550	0	<u>803</u>							
	SART2-93	148	153	0	0	0	0	151	320	384	4055	159
	Lck-488	135	<u>3924</u>	0	<u>79</u>							



	Lck-486	1340	1143	0	0							
18	C-35	15844	16666	0	<u>399</u>							
	SART3-302	3177	<u>24118</u>	0	0	722	<u>1730</u>	616	1779	12	39	129
	Lck-246	1341	1070	0	0							
	UBE2V-43	107	<u>15917</u>	0	0							
19	C-35	23316	23405	0	<u>1506</u>							
	HNRPL-140	398	332	0	0	5167	<u>9082</u>	104	184	51305	303630	155
	WHSC2-103	295	238	0	0							
	SART3-302	211	206	0	0							
20	C-35	19281	18608	0	0	0	<u>680</u>	49	106	3300	8940	300
	WHSC2-103	73	39	0	0							
21	C-35	15075	14541	185	0							
	PSA-248	7774	<u>20174</u>	0	0	0	<u>192</u>	38	<u>34</u>	77	972	345
	SART3-109	7677	12448	0	<u>229</u>							
	SART2-93	439	565	0	0							
22	C-35	15237	NA	0	NA							
	MRP3-1293	201	NA	0	NA	0	NA	498	NA	294280	NA	56
	PAP-213	151	NA	0	NA							
	SART2-93	91	NA	0	NA							
23	C-35	7638	7156	0	<u>193</u>							
	Lck-488	4385	4409	0	<u>163</u>	0	0	2256	7040	33300	73100	145
	MRP3-1293	1712	3065	0	0							
	SART2-93	1009	863	0	0							
24	C-35	25860	25691	0	0							
	SART3-302	16190	14802	0	0	1911	<u>2846</u>	14	<u>10</u>	27900	<u>207</u>	154
	HNRPL-501	51	<u>703</u>	0	<u>745</u>							
	WHSC2-103	48	78	0	<u>495</u>							
25	C-35	8775	15107	0	<u>92</u>							
	SART3-109	11666	11650	0	0	0	0	225	796	3101	26466	164
	Lck-486	2430	2362	0	0							
	SART2-93	199	<u>8252</u>	0	<u>685</u>							
26	C-35	12393	9983	0	<u>71</u>	340	<u>470</u>	1880	2880	972	2540	237
	SART3-734	1336	1491	0	0							
27	C-35	1585	1312	0	0							
	Lck-246	378	292	0	0	2087	1007	254	281	53	<u>22</u>	209
	ppMAPkkk-432	134	110	0	0							

	WHSC2-103	122	113	0	0							
28	C-35	36436	36269	0	0							
	SART3-511	488	529	80	0	0	0	48	<u>36</u>	437	835	481 <sup>e</sup>
	SART3-734	132	185	0	0							
29	C-35	37661	NA	0	NA							
	SART3-109	1130	NA	0	NA	0	NA	10	NA	3950	NA	58
	Lck-488	312	NA	0	NA							
	SART2-93	251	NA	0	NA							
30	C-35	37657	40695	0	<u>364</u>							
	SART2-93	173	285	0	0	869	<u>1401</u>	5413	8253	248	<u>179</u>	483 <sup>e</sup>
	SART3-109	162	<u>1713</u>	0	0							
	Lck-488	101	<u>249</u>	0	0							
31	C-35	20059	19527	0	<u>1288</u>							
	WHSC2-141	44	63	0	0	0	0	4636	9313	17168	56666	245
	CypB-129	41	41	0	0							
	Lck-246	38	40	0	0							
32	C-35	42340	42650	0	<u>1132</u>							
	Lck-488	259	440	0	<u>105</u>	3396	2213	544	990	21749	<u>2394</u>	186
	PAP-213	209	<u>48434</u>	0	<u>490</u>							
	SART2-93	186	<u>398</u>	0	<u>268</u>							
33	C-35	26949	26521	0	0							
	MRP3-1293	192	86	0	0	0	0	9	5	82250	145755	69
	SART2-93	107	108	0	0							
	PSA-248	86	149	0	0							
34	C-35	38919	38897	0	0							
	ppMAPkkk-432	721	765	0	0	2602	<u>3790</u>	1476	1288	162110	<u>85920</u>	517 <sup>e</sup>
	Lck-246	248	281	0	0							
	HNRPL-140	248	226	0	0							
35	C-35	32171	32810	0	<u>236</u>							
	Lck-90	359	367	0	0	0	0	28	<u>22</u>	11	8	374
	Lck-449	173	164	0	<u>1090</u>							
	SART3-734	154	152	0	0							
36	C-35	17909	28156	0	<u>901</u>							
	PAP-213	388	<u>19613</u>	0	<u>710</u>	1795	<u>3994</u>	53	746	11	14	324
	SART2-93	479	445	0	<u>466</u>							
	PSMA-624	223	<u>1039</u>	0	0							

37	C-35	38207	38310	0	0								
	Lck-488	185	130	0	0								
	Lck-486	122	85	0	0	0	0	15	28	236	631	184	
	SART2-93	114	101	0	0								
38	C-35	36429	35672	0	<u>567</u>								
	Lck-488	3059	3572	0	0	3527	<u>6364</u>	133	<u>80</u>	136	143	168 <sup>e</sup>	
	SART2-93	794	295	0	<u>997</u>								
	PSA-248	559	<u>3464</u>	0	0								
39	C-35	87	<u>493</u>	0	0								
	PSA-248	541	<u>10891</u>	0	0	0	<u>323</u>	36	243	118	1020	245 <sup>e</sup>	
	Lck-488	95	112	0	0								
	SART2-93	72	86	0	<u>826</u>								
40	C-35	37761	37889	44	0								
	SART2-93	145	194	0	0	0	<u>2350</u>	4	7	2070	7510	189	
	Lck-488	131	212	0	0								
	PSA-248	85	<u>1029</u>	0	0								
41	C-35	24642	NA	0	NA								
	SART2-93	340	NA	0	NA	0	NA	103000	NA	14500	NA	117	
	Lck-488	175	NA	0	NA								
	MRP3-1293	151	NA	0	NA								
42	C-35	22949	NA	0	NA								
	Lck-488	337	NA	0	NA	0	NA	898	NA	171	NA	77 <sup>e</sup>	
	SART2-93	309	NA	0	NA								
	PSA-248	261	NA	0	NA								

Abbreviations: CTL, cytotoxic T lymphocytes; AFP,  $\alpha$ -fetoprotein; DCP, des- $\gamma$ -carboxy prothrombin, OS, overall survival; NA, not assessed

<sup>a</sup>Antigen peptides used for vaccination.

<sup>b</sup>Values indicate the fluorescence intensity unit (FIU) of plasma IgG reactive with the vaccine peptides before and after vaccination. The augmented IgG responses after vaccination are underlined.

<sup>c</sup>Values indicate the number of spots per  $10^5$  peripheral blood mononuclear cells (PBMCs) reactive with the vaccine peptides or CEF peptides in IFN- $\gamma$  ELISPOT assay before and after vaccination. The augmented T cell responses after vaccination are underlined.

<sup>d</sup>Tumor markers were measured before and after vaccination. The decreased values after vaccination are underlined.

<sup>e</sup>Patients were alive at the last follow-up.

**Supplementary Table 3. Humoral immune responses (IgG subclass)**

Patient No.	Peptide <sup>a</sup>	IgG1 response <sup>b</sup>		IgG2 response <sup>b</sup>		IgG3 response <sup>b</sup>		IgG4 response <sup>b</sup>	
		Before	After	Before	After	Before	After	Before	After
1	C-35	14542	14553	0	0	22	21	38	38
	Lck-208	12	0	0	0	0	0	0	0
	PAP-213	0	<u>33</u>	0	0	0	0	0	0
	PTHrP-102	0	0	26	27	10	0	0	0
2	C-35	23430	22955	787	594	48	43	49	40
	Lck-208	0	0	0	0	0	0	0	0
	PAP-213	20	21	10	<u>20</u>	14	18	0	0
	PTHrP-102	0	0	0	0	0	0	0	0
3	C-35	22238	23946	0	<u>14669</u>	0	<u>10579</u>	50	<u>230</u>
	Lck-246	34	<u>14012</u>	125	<u>2216</u>	22	<u>2802</u>	11	<u>115</u>
	CypB-129	840	<u>4836</u>	0	0	61	89	13	15
	WHSC2-141	56	<u>603</u>	69	106	151	170	51	51
4	C-35	68	<u>231</u>	0	0	0	<u>32</u>	0	0
	Lck-208	109	111	26	<u>54</u>	21	24	0	<u>18</u>
	PSMA-624	34	48	81	<u>1243</u>	0	0	0	<u>16</u>
	PAP-213	33	<u>23399</u>	11	<u>2390</u>	0	<u>7902</u>	0	<u>130</u>
5	C-35	22912	22836	112	<u>368</u>	133	<u>305</u>	60	118
	CypB-129	132	119	26	29	29	23	0	0
	UBE2V-43	54	49	25	22	15	13	0	0
	HNRPL-140	19	16	15	20	74	63	0	0
6	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	HNRPL-501	NA	NA	NA	NA	NA	NA	NA	NA
	ppMAPkkk-432	NA	NA	NA	NA	NA	NA	NA	NA
	WHSC2-103	NA	NA	NA	NA	NA	NA	NA	NA
7	C-35	2882	2239	0	0	11	0	0	0
	MRP3-1293	28	42	21	21	40	38	17	18
	Lck-488	73	64	43	37	124	104	33	25
	SART2-93	30	<u>89</u>	43	65	71	71	30	31

8	C-35	20625	22054	0	0	21	24	19	18
	SART2-93	61	63	73	92	57	60	103	101
	Lck-488	87	<u>2164</u>	77	104	73	96	70	67
	MRP3-1293	44	48	14	24	45	41	0	0
9	C-35	9528	18602	0	<u>234</u>	0	<u>104</u>	0	0
	UBE2V-85	3865	<u>8973</u>	22	<u>78</u>	0	<u>69</u>	0	0
	Lck-422	4260	2754	0	0	0	0	0	0
	UBE2V-43	1594	<u>22835</u>	0	<u>3062</u>	0	<u>2303</u>	0	<u>99</u>
10	C-35	395	<u>2344</u>	0	<u>73</u>	0	<u>895</u>	0	0
	PAP-213	582	<u>21398</u>	32	<u>1120</u>	14	<u>78</u>	0	<u>385</u>
	Lck-486	94	<u>8608</u>	34	<u>271</u>	81	<u>7213</u>	12	<u>102</u>
	Lck-488	89	<u>465</u>	85	82	101	104	35	23
11	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	WHSC2-103	NA	NA	NA	NA	NA	NA	NA	NA
	ppMAPkkk-432	NA	NA	NA	NA	NA	NA	NA	NA
	WHSC2-141	NA	NA	NA	NA	NA	NA	NA	NA
12	C-35	10211	9397	555	634	610	<u>2863</u>	0	0
	SART3-109	654	584	243	114	3052	2459	0	0
	Lck-90	68	101	88	98	40	47	0	<u>10</u>
	HNRPL-501	46	<u>636</u>	61	83	0	<u>57</u>	0	0
13	C-35	4357	<u>15661</u>	32	<u>191</u>	57	<u>277</u>	0	0
	PAP-213	13	<u>23844</u>	480	<u>12524</u>	0	<u>14805</u>	0	<u>247</u>
	SART2-93	22	<u>139</u>	60	66	21	<u>99</u>	0	0
	MRP3-1293	0	<u>118</u>	0	18	0	0	0	0
14	C-35	51	<u>166</u>	0	0	0	0	0	0
	SART3-302	741	<u>4726</u>	103	116	0	0	0	0
	Lck-246	70	54	73	58	0	<u>24</u>	20	19
	SART3-309	18	15	52	43	0	<u>13</u>	0	0
15	C-35	22920	23069	47	40	0	<u>17</u>	0	0
	SART3-109	1016	1372	27	29	12	22	0	0
	Lck-488	115	179	116	131	82	135	322	453

	SART2-93	63	<u>6405</u>	107	<u>644</u>	32	<u>135</u>	232	427
16	C-35	17846	16162	17	12	17	17	62	50
	SART2-93	36	38	76	68	18	22	0	0
	Lck-486	19	23	61	65	0	<u>13</u>	0	0
	EGF-R-800	39	46	30	35	0	0	0	0
17	C-35	7234	6305	117	101	0	<u>16</u>	0	0
	Lck-488	70	102	1455	1187	36	33	24	19
	SART2-161	0	<u>14</u>	1097	793	0	0	0	0
	Lck-486	16	<u>54</u>	1287	969	0	<u>15</u>	0	0
18	C-35	9553	13568	0	<u>26</u>	0	<u>15</u>	0	0
	SART3-302	3476	<u>23874</u>	13	<u>3220</u>	0	<u>199</u>	0	<u>77</u>
	Lck-246	88	130	137	140	80	71	31	24
	UBE2V-43	104	<u>23857</u>	0	<u>15539</u>	0	<u>1031</u>	0	<u>109</u>
19	C-35	23874	23940	583	<u>3016</u>	263	353	33	<u>2551</u>
	HNRPL-140	0	0	0	0	0	0	0	0
	WHSC2-103	0	0	0	0	17	16	15	13
	SART3-302	0	0	0	0	0	13	0	0
20	C-35	0	<u>12211</u>	0	0	0	0	0	0
	WHSC2-103	0	<u>61</u>	40	26	17	0	12	0
21	C-35	17924	18036	45	53	11	15	0	0
	PSA-248	9124	<u>24199</u>	41	<u>157</u>	39	<u>652</u>	15	<u>56</u>
	SART3-109	2527	<u>8589</u>	3889	6330	23	<u>100</u>	24	31
	SART2-93	68	71	413	453	51	52	26	21
22	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	MRP3-1293	NA	NA	NA	NA	NA	NA	NA	NA
	PAP-213	NA	NA	NA	NA	NA	NA	NA	NA
	SART2-93	NA	NA	NA	NA	NA	NA	NA	NA
23	C-35	3376	3192	0	0	0	0	81	92
	Lck-488	5049	5073	79	93	114	134	0	0
	MRP3-1293	14	<u>42</u>	718	1405	0	0	0	0
	SART2-93	44	50	665	607	22	27	11	12

24	C-35	24030	24211	1842	2668	129	187	30	42
	SART3-302	20448	20872	104	184	110	152	14	22
	HNRPL-501	176	<u>409</u>	59	69	81	<u>189</u>	32	48
	WHSC2-103	19	19	56	61	30	49	0	0
25	C-35	6393	11395	0	<u>176</u>	20	<u>91</u>	0	<u>31</u>
	SART3-109	4975	5071	34	55	4093	3865	0	0
	Lck-486	42	56	0	0	553	587	0	0
	SART2-93	57	<u>7873</u>	127	<u>3982</u>	90	148	120	142
26	C-35	5764	3906	0	0	18	14	0	0
	SART3-734	735	873	96	120	65	35	25	11
27	C-35	440	465	29	30	0	<u>10</u>	0	0
	Lck-246	54	61	91	91	41	42	0	<u>11</u>
	ppMAPkkk-432	12	11	36	33	0	0	0	0
	WHSC2-103	23	27	30	29	83	87	0	0
28	C-35	21423	16081	0	0	13	<u>199</u>	11	0
	SART3-511	211	142	30	33	23	21	11	0
	SART3-734	180	147	13	0	85	54	26	20
29	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	SART3-109	NA	NA	NA	NA	NA	NA	NA	NA
	Lck-488	NA	NA	NA	NA	NA	NA	NA	NA
	SART2-93	NA	NA	NA	NA	NA	NA	NA	NA
30	C-35	23354	24117	11	<u>3017</u>	238	<u>7071</u>	73	<u>894</u>
	SART2-93	55	66	89	100	57	66	52	49
	SART3-109	79	<u>1299</u>	0	<u>35</u>	0	<u>38</u>	0	0
	Lck-488	84	146	108	115	78	76	74	53
31	C-35	11578	12255	30	15	12	0	0	0
	WHSC2-141	0	0	20	<u>42</u>	20	<u>63</u>	0	<u>11</u>
	CypB-129	0	0	0	0	0	0	0	0
	Lck-246	0	0	0	0	0	0	0	0
32	C-35	23986	24058	5701	6048	143	158	40	43
	Lck-488	61	<u>204</u>	73	87	75	98	15	28

	PAP-213	50	<u>23097</u>	41	<u>1404</u>	19	<u>4307</u>	0	<u>64</u>
	SART2-93	49	<u>170</u>	76	66	45	83	21	<u>44</u>
33	C-35	12735	11094	0	0	0	0	0	0
	MRP3-1293	131	57	13	0	19	23	74	72
	SART2-93	36	29	71	71	80	69	51	43
	PSA-248	23	29	0	0	0	0	0	0
34	C-35	23382	23208	1072	1073	23573	23635	100	83
	ppMAPkkk-432	0	0	0	<u>13</u>	162	149	0	0
	Lck-246	42	55	57	48	40	47	19	17
	HNRPL-140	131	137	27	32	11	13	0	0
35	C-35	18120	17355	0	0	0	0	12	14
	Lck-90	486	368	79	85	47	33	31	18
	Lck-449	45	40	237	271	45	54	31	20
	SART3-734	28	26	177	216	47	45	30	20
36	C-35	12233	20374	71	<u>149</u>	21	<u>624</u>	0	0
	PAP-213	306	<u>24592</u>	18	<u>18041</u>	14	<u>10662</u>	0	<u>184</u>
	SART2-93	652	691	80	86	59	58	20	20
	PSMA-624	45	<u>851</u>	11	15	147	180	11	11
37	C-35	24640	24636	121	<u>446</u>	2151	2569	33	<u>98</u>
	Lck-488	68	54	58	69	286	220	0	0
	Lck-486	17	16	0	0	31	27	0	0
	SART2-93	24	29	62	58	66	60	0	0
38	C-35	22248	18149	0	<u>15</u>	106	27	431	77
	Lck-488	4481	4064	133	217	653	687	90	45
	SART2-93	0	<u>127</u>	25	<u>110</u>	94	83	14	0
	PSA-248	0	<u>1835</u>	0	<u>30</u>	19	35	0	0
39	C-35	0	<u>230</u>	0	0	0	0	0	<u>17</u>
	PSA-248	254	<u>10053</u>	0	<u>95</u>	0	0	0	0
	Lck-488	42	56	100	88	43	45	16	<u>38</u>
	SART2-93	33	39	72	79	35	38	20	<u>46</u>
40	C-35	24215	24183	23824	23443	178	143	146	145

	SART2-93	43	48	90	74	52	50	14	15
	Lck-488	69	94	111	119	116	110	27	26
	PSA-248	0	<u>26</u>	0	0	0	<u>368</u>	0	0
41	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	SART2-93	NA	NA	NA	NA	NA	NA	NA	NA
	Lck-488	NA	NA	NA	NA	NA	NA	NA	NA
	MRP3-1293	NA	NA	NA	NA	NA	NA	NA	NA
42	C-35	NA	NA	NA	NA	NA	NA	NA	NA
	Lck-488	NA	NA	NA	NA	NA	NA	NA	NA
	SART2-93	NA	NA	NA	NA	NA	NA	NA	NA
	PSA-248	NA	NA	NA	NA	NA	NA	NA	NA

Abbreviation: NA, not assessed

<sup>a</sup>Antigen peptides used for vaccination.

<sup>b</sup>Values indicate the fluorescence intensity unit (FIU) of plasma IgG subclasses reactive with the vaccine peptides before and after vaccination. The augmented IgG responses after vaccination are underlined.