

**Supplement Methods:****Flow cytometry**

Pretreatment and on-treatment PBMC samples were analyzed by flow cytometry at Dana-Farber Cancer Institute. Samples were thawed at 37°C then rapidly washed. The following fluorochrome-conjugated monoclonal antibodies were used in multi-color flow cytometry to identify and characterize T lymphocytes: anti-CD4 (BV510) from BD Biosciences; anti-CXCR5 (PE), anti-PD-1 (PE-Dazzle594), anti-ICOS (PerCP/Cy5.5), anti-CD45RA (FITC), anti-CD45RO (BV650), anti-CD8 (PacBlue), anti-HLA-DR (BV570), anti-CD38 (BV711), anti-CX3CR1 (BV421), anti-CD137 (PE/Cy7), and anti-CD16 (BV785) from BioLegend. Dead cells were identified by using NIR from BioLegend. Anti-CD19 (BV605), anti-CD14 (BV605), and anti-CD15 (BV605) from BioLegend were used as a dump gate. The following fluorochrome-conjugated monoclonal antibodies were used in multi-color flow cytometry to identify and characterize B lymphocytes: anti-PD-L1 (BV650), anti-CD19 (BV711), anti-CD20 (FITC), anti-CD21 (PE), anti-IgD (BV421), anti-CD71 (PerCP/Cy5.5), anti-CD27 (PacBlue), anti-CD38 (PE/Cy7), and anti-CD10 (PE/Dazzle594) from BioLegend. Dead cells were identified by using NIR from BioLegend. Anti-CD3 (BV785), anti-CD14 (BV785), and anti-CD16 (BV785) from BioLegend were used as a dump gate. All stained samples were acquired with a flow cytometer (Sony) and analyzed using FlowJo software (Tree Star, OR, USA).

**Enzyme-linked immunosorbent assay**

Plasma samples were analyzed for presence or absence of E6 HPV antibody by enzyme-linked immunosorbent assay (ELISA). High-binding assay plates (Corning 9018) were coated with coating buffer (20% ELISA Coating Buffer [BioLegend] in PBS). Plates were allowed to coat overnight at 4°C. Plates were subsequently washed with wash buffer (1:2,000 dilution of Tween in PBS) and blocked with assay diluent (20% Assay Diluent A [BioLegend] in PBS) for 1 hour (h) at room temperature (RT). Plates were washed again with wash buffer before addition of 100 µl of samples, diluted at 1:10. Plates were incubated for two hours at RT and then washed with wash buffer. 100 µl of secondary antibody (1:5,000 in assay diluent) was added to all wells (IgG [Southern Biotech 204005]) and incubated for 1 h at RT. After washing with wash buffer, 50 µl of tetramethylbenzidine (Sigma-T8665) was added and incubated

for 3-10 min at RT; then, 50  $\mu$ l of 1 M hydrochloric acid was added to stop the reaction. Optical density values were read as a measure of concentration at 450 nm on a plate reader.

### **Assessment of PDL1 Expression**

Pretreatment tumor biopsies were collected prior to study drug initiation. An archived formalin-fixed, paraffin-embedded tumor sample or a newly obtained biopsy specimen (n=27 with tumor tissue present) was assessed at a central laboratory for PDL1 expression at screening with a laboratory-developed prototype immunohistochemistry assay (QualTek Molecular Laboratories, Goleta, CA) using the 22C3 antibody (Merck & Co., Inc., Kenilworth, NJ). PDL1 positivity was defined as membrane staining of >1% of scorable cells, including both neoplastic cells and contiguous mononuclear inflammatory cells, or the presence of a distinctive interface pattern. Combined Positive Score (CPS) was defined as overall % positive cells expressing PDL1.

Supplement Table: Flow Cytometry Antibodies

<b>T cell antibodies</b>			
<b>Marker</b>	<b>Manufacturer</b>	<b>Cat #</b>	<b>Clone</b>
CD4 (BV510)	BD Biosciences	BDB562970	SK3
CXCR5 (PE)	Biolegend	356904	J252D4
PD-1 (PE-Dazzle594)	Biolegend	367434	NAT105
ICOS (PerCP/Cy5.5)	Biolegend	313518	C398.4A
CD45RA (FITC)	Biolegend	304148	HI100
CD45RO (BV650)	Biolegend	304232	UCHL1
CD8 (PacBlue)	Biolegend	344718	SK1
HLA-DR (BV570)	Biolegend	307638	L243
CD38 (BV711)	Biolegend	303528	HIT2
CX3CR1 (BV421)	Biolegend	341620	2A9-1
CD137 (PE/Cy7)	Biolegend	309818	4B4-1
CD16 (BV785)	Biolegend	302046	3G8
CD14 (BV605)	Biolegend	301834	M5E2
Zombie NIR	Biolegend	423105	N/A
CD19 (BV605)	Biolegend	302244	HIB19
CD15 (BV605)	Biolegend	323032	W6D3
<b>B cell antibodies</b>			
<b>Marker</b>	<b>Manufacturer</b>	<b>Cat #</b>	<b>Clone</b>
PD-L1 (BV650)	Biolegend	329740	29E.2A3
CD19 (BV711)	Biolegend	302244	HIB19
CD20 (FITC)	Biolegend	302304	2H7
CD21 (PE)	Biolegend	354904	Bu32
IgD (BV421)	Biolegend	348226	IA6-2
CD71 (PerCP/Cy5.5)	Biolegend	334114	CY1G4
CD27 (PacBlue)	Biolegend	356414	M-T271
CD38 (PE/Cy7)	Biolegend	356608	HB-7
CD10 (PE/Dazzle594)	Biolegend	312228	HI10a
Zombie NIR	Biolegend	423105	N/A
CD3 (BV785)	Biolegend	317330	OKT3
CD14 (BV785)	Biolegend	367142	63D3
CD16 (BV785)	Biolegend	302046	3G8