Supplemental Table 1. Primers used for PF monoclonal antibody PIGG vector construction.

Antibody	5' primer (heavy chain), SacI site underlined	Primer name	3' primer (heavy chain) endogenous ApaI site underlined	Primer name
PF1-2-6	GAGGAGGAGGAGGAGGAGCTCACTCCCAGGTGCAGCTGGTGCAGTCTGG	PIGG-PX4-Sac	CCTGGCCGGCCTGGCCACTAGTGACCGATGGGCCCTTGGTGGARGC	HSCG1234-B
PF1-2-22	GAGGAGGAGGAGGAGGAGCTCACTCCCAGGTGCAGCTGGTGCAGTCTGG	PIGG-PX4-Sac	CCTGGCCGGCCTGGCCACTAGTGACCGATGGGCCCTTGGTGGARGC	HSCG1234-B
PF1-8-15	GAGGAGGAGGAGGAGGAGCTCACTCCCAGGTGCAGCTGGTGCAGTCTGG	PIGG-PX4-Sac	CCTGGCCGGCCTGGCCACTAGTGACCGATGGGCCCTTGGTGGARGC	HSCG1234-B
Antibody	**5' primer (light chain), HindIII site underlined**	**Primer name**	**3' primer (light chain), overlap to CL5' primer italicized**	**Primer name**
PF1-2-6 (Kappa)	GAGGAGGAGGAGAAGCTTGTTGCTCTGGATCTCTGGTGCCTACGGGGAGCTCCAGATGACCCAGTCTCC	DNK2004-pigg	*GGTGCAGCCACAGTTCGTTT*GATTTCCACCTTGGTCC	DNK2008-pigg
PF1-2-22 (Kappa)	GAGGAGGAGGAGAAGCTTGTTGCTCTGGATCTCTGGTGCCTACGGGGAGCTCCAGATGACCCAGTCTCC	DNK2004-pigg	*GGTGCAGCCACAGTTCGTTT*GATCTCCAGCTTGG	DNK2005-pigg
PF1-8-15 (Lamda)	GAGGAGGAGGAGAAGCTTGTTGCTCTGGATCTCTGGTGCCTACGGG GAGCTCGTGCTGACTCAGCC	DN2036	*GGCAGCCTTGGGCTGACC*GCCGAGGACGGTCAGCTGG	DN2037
	5' primer, CL(Kappa) (PF1-2-6, PF1-2-22)	**Primer name**	**3' primer, CL(Kappa)**	**Primer name**
	CGAACTGTGGCTGCACCATCTGTC	HKC-F	GGCCATGGCTGGTTGGGCAGC	Lead-B
	5' primer, CL(Lambda) (PF1-8-15)	**Primer name**	**3' primer, CL(Lambda)**	**Primer name**
	GGTCAGCCCAAGGCTGCCCCC	HLC –F	CTTCTAGAATTATGAACATTC	DN2035

Abbreviations: PF, pemphigus foliaceus; CL, constant region of the light chain

Supplemental figures

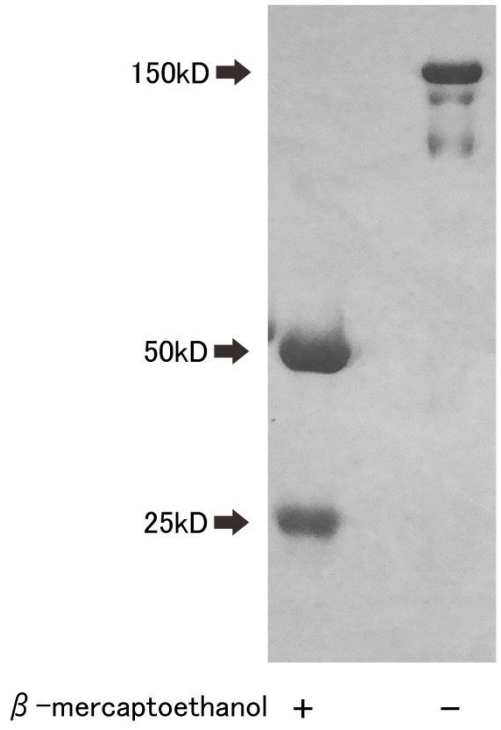

Figure S1. Purified anti-desmoglein 1 (Dsg1) IgG monoclonal antibodies (mAbs) were divalent antibody. Purified anti-Dsg1 IgG mAbs (PF1-8-15) were mixed in Laemmli sample buffer with or without β-mercaptoethanol, then separated by SDS-PAGE and stained by coomassie brilliant blue stain. SDS-PAGE under reducing conditions showed that these purified IgG mAbs produced from the scFvs exhibit two bands, with molecular weights corresponding to the light and heavy chains of IgG. Under non-reduced conditions, the purified IgG were detected as single band, with molecular weight of the divalent IgG.

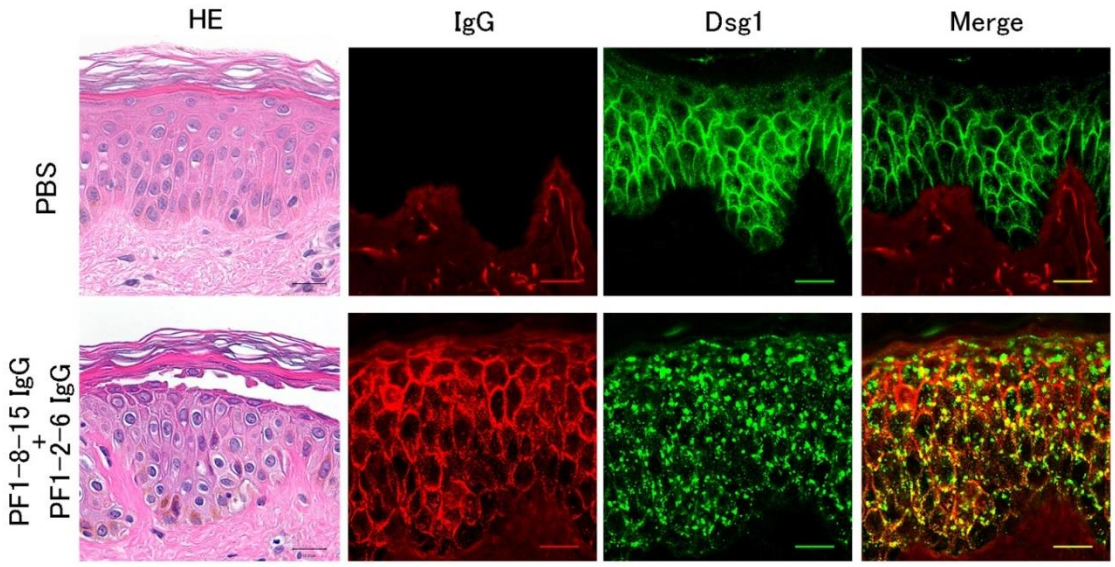

Figure S2. A mixture of pathogenic and non-pathogenic IgG monoclonal antibodies (mAbs) induced Desmoglein 1 (Dsg1) clustering in whole layers of the organ-cultured human skin at 36 hours. A mixture of anti-Dsg1 IgG mAbs were injected into human skin specimens that were then cultured for 36 hours. The skins were harvested for histology after mechanical shear stress by slight friction of epidermis. Histology and direct immunofluorescence of IgG deposits and staining of Dsg1 were captured by confocal microscopy. In PBS, epidermal morphology and Dsg1 distribution were normal with no detectable IgG deposition in the epidermis. In contrast, the mixture injection of PF1-8-15 IgG (50μg) and PF1-2-6 IgG (50μg) (PF1-8-15 IgG + PF1-2-6 IgG) showed granular Dsg1 distribution in the whole layer of epidermis with IgG deposition, in addition to superficial acantholytic blister. Bar = 20 μm.

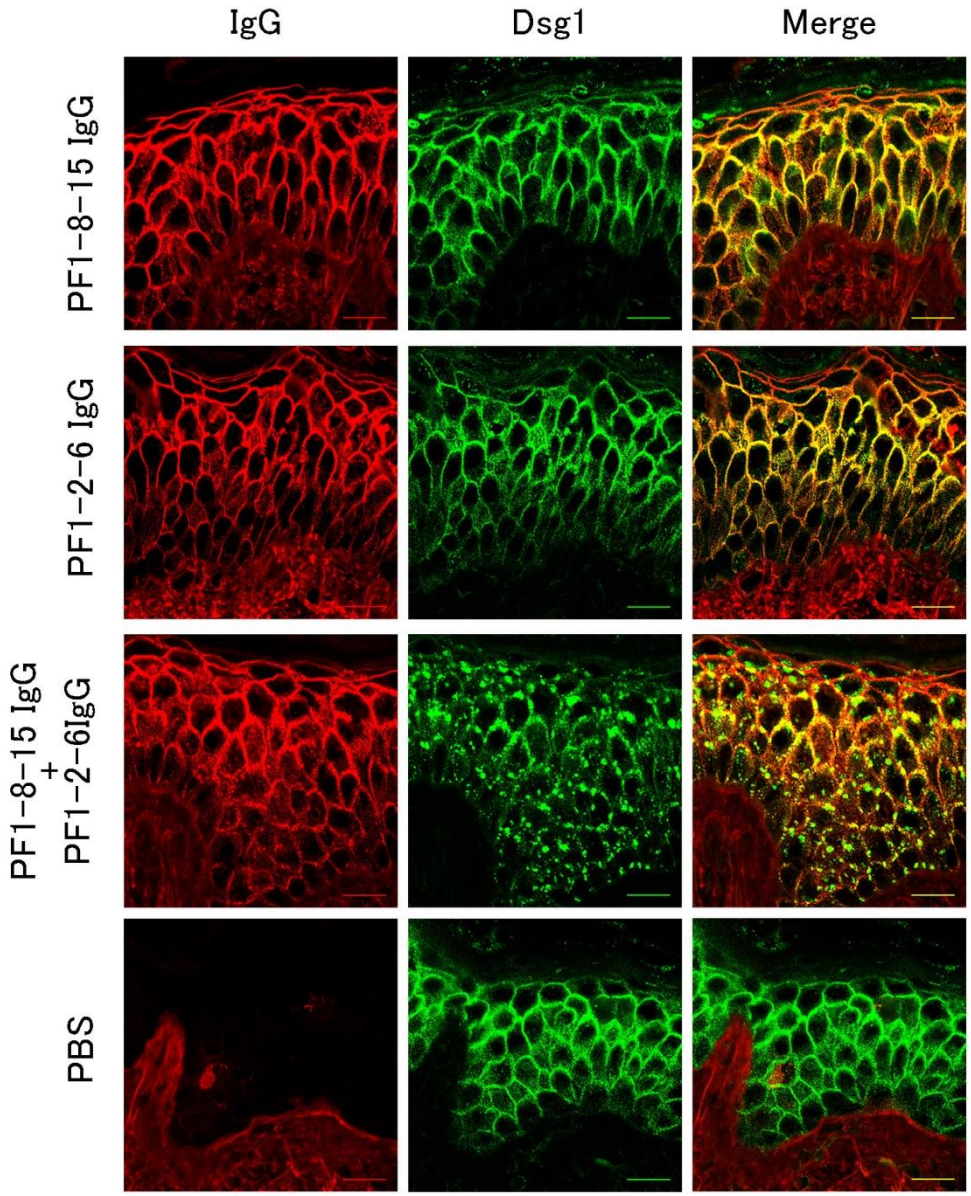

Figure S3. Desmoglein 1 (Dsg1) clustering was observed only when a mixture of pathogenic and non-pathogenic monoclonal antibodies (mAbs) was injected. PF1-8-15 IgG (100μg), PF1-2-6 IgG (100μg) and a mixture of PF1-8-15 IgG (50μg) and PF1-2-6 IgG (50μg) were injected into human skin specimens that were then cultured for 23 hours. Direct immunofluorescence of IgG deposits and staining of Dsg1 were captured by confocal microscopy. Excessive dose of each single mAb injection did not induced Dsg1 clustering. Bar = 20 μm.

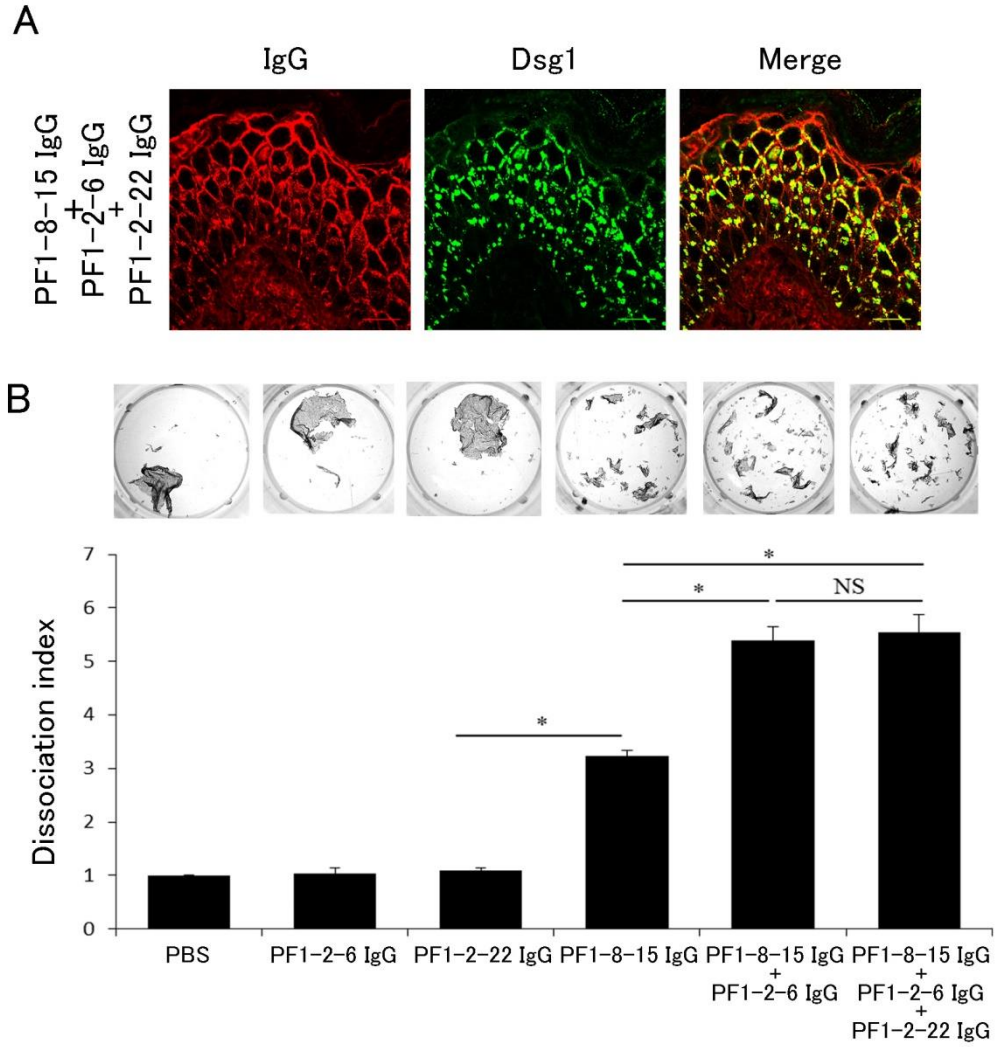

Figure S4. A **mixture of three anti-desmoglein 1 (Dsg1) IgG monoclonal antibodies (mAbs) induced Dsg1 clustering and showed the similar pathogenic activity compared to a mixture of two anti-Dsg1 IgG mAbs. A:** A mixture of PF1-8-15 IgG (50μg), PF1-2-6 IgG (25μg) and PF1-2-22 IgG (25μg) was injected into the human skin specimen that was then cultured for 23 hours. Dsg1 staining showed Dsg1 clustering in the basal and spinous layers. Bar = 20 μm. **B:** Dissociation assay of each monoclonal antibody (mAb) pattern (n = 6 per group). The index of a mixture of PF1-8-15 IgG (50μg/ml), PF1-2-6 IgG (25μg/ml) and PF1-2-22 IgG (25μg/ml) was almost the same as that of a mixture of PF1-8-15 IgG (50μg/ml) and PF1-2-6 IgG (50μg/ml). Photos show the fragments condition of each well. Data are mean ± SEM. *$p<0.05$. NS, not significant.