Supplementary Note

Table 1: Model states representing immune cells and cytokines

Number	State variable	Description
1	Antigen	Antigen
2	nDC	Naïve DC
3	mDC	Myeloid DC
4	GMCSF	GM-CSF
5	pDC	Plasmacytoid DC
6	IL_33	IL-33
7	IL_6	IL-6
8	IL_12	IL-12
9	IL_15	IL-15
10	IL_7	IL-7
11	IFN1	IFN-1
12	IL_1	IL-1
13	IL_2	IL-2
14	IL_4	IL-4
15	IL_10	IL-10
16	TGFbeta	TGF-β
17	IFN_g	IFN-γ
18	naive_CD4	Naïve CD4$^+$ T
19	act_CD4	Active CD4$^+$ T
20	Th2	Th2 Cell
21	iTreg	Induced Treg
22	CD4_CTL	Cytotoxic CD4$^+$ T
23	nTreg	Natural Treg
24	TFH	TFH
25	NK	CD56$^+$ NK
26	act_NK	CD16$^+$ NK
27	Naive_B_cells	Naïve B
28	Act_B_cells	Active B
29	TD_IS_B_cells	T cell-dependent plasma
30	TI_IS_B_cells	T cell-independent plasma
31	IgG4	IgG4

Table 2: Model parameters and corresponding processes

Parameter name	Meaning
k_TI_IS_B_cells_TI_IS_B_cells_m	Carrying capacity for the proliferation of T cell-independent plasma cells
k_TI_IS_B_cells_TI_IS_B_cells_f	Proliferation rate of T cell-independent plasma cells
k_TI_IS_B_cells_IL_10_f	Differentiation rate of active B cells into T cell-independent plasma cells driven by IL-10
k_TI_IS_B_cells_IFN_g_f	Differentiation rate of active B cells into T cell-independent plasma cells driven by IFN-γ
k_TI_IS_B_cells_d	Death rate of T cell-independent plasma cells
k_TI_IS_B_cells_base_f	Basal differentiation rate of active B cells into T cell-independent plasma cells
k_Th2_TGFbeta_m	TGF-β driven inhibition of differentiation of Active CD4 T cells into Th2
k_Th2_m	Carrying capacity for the proliferation of Th2 cells
k_Th2_IL_4_m	Hill coefficient in the differentiation of active CD4 T cells into Th2 driven by IL-4
k_Th2_IL_4_f	Differentiation rate of active CD4 T cells into Th2 driven by IL-4
k_Th2_IL_33_m	Hill coefficient in the differentiation of active CD4 T cells into Th2 driven by IL-33
k_Th2_IL_33_f	Differentiation rate of active CD4 T cells into Th2 driven by IL-33
k_Th2_IL_12_m	IL-12 driven inhibition of differentiation of Active CD4 T cells into Th2
k_Th2_IL_10_m	IL-10 driven inhibition of differentiation of Active CD4 T cells into Th2
k_Th2_f	Proliferation rate of Th2 cells
k_Th2_d	Death rate of Th2 cells
k_TGFbeta_nTreg_mDC_m	Hill coefficient in the secretion of TGF-β by nTreg
k_TGFbeta_nTreg_f	Secretion rate of TGF-β by nTreg
k_TGFbeta_iTreg_f	Secretion rate of TGF-β by iTreg
k_TGFbeta_d	Degradation rate of TGF-β
k_TGFbeta_CD4_CTL_f	Secretion rate of TGF-β by CD4-CTL
k_TFH_nTreg_m	nTreg-driven inhibition of IL-6 secretion by Tfh cells
k_TFH_mDC_f	Differentiation rate of Active CD4 T cells into Tfh
k_TFH_mDC_Antigen_f	Antigen-driven differentiation rate of Active CD4 T cells into Tfh
k_TFH_m	Carrying capacity for the proliferation of Tfh cells
k_TFH_IL_6_m	Hill coefficient in the differentiation of active CD4 T cells into Tfh driven by IL-6
k_TFH_IL_6_f	Differentiation rate of active CD4 T cells into Tfh driven by IL-6
k_TFH_IL_6_d	Consumption rate of IL-6 in the differentiation of active CD4 T cells into Tfh
k_TFH_IFN1_m	Hill coefficient in the differentiation of active CD4 T cells into Tfh driven by IFN-1
k_TFH_IFN1_f	Differentiation rate of active CD4 T cells into Tfh driven by IFN-1
k_TFH_f	Proliferation rate of Tfh cells
k_TFH_d	Death rate of Tfh cells
k_TD_IS_B_cells_TD_IS_B_cells_m	Carrying capacity for the proliferation of T cell-dependent plasma cells
k_TD_IS_B_cells_TD_IS_B_cells_f	Proliferation rate of T cell-dependent plasma cells
k_TD_IS_B_cells_d	Death rate of T cell-dependent plasma cells

Table 2 (continued)

Parameter name	Meaning
k_TD_IS_B_cells_IL_4_f	Differentiation rate of active B cells into T cell-dependent plasma cells driven by IL-4
k_pro_act_NK_IL_12_m	Hill coefficient in the proliferation of active NK cells driven by IL-12
k_pro_act_NK_IL_12_f	Proliferation of active NK cells driven by IL-12
k_pDC_m	Carrying capacity for the proliferation of pDC
k_pDC_f	Proliferation rate of pDC
k_pDC_d	Death rate of pDC
k_pDC_Antigen_f	Differentiation rate of nDC to pDC by antigen
k_nTreg_mDC_m	Hill coefficient in the proliferation of nTreg
k_nTreg_mDC_f	Proliferation rate of nTreg
k_nTreg_m	Carrying capacity for the proliferation of nTreg
k_nTreg_d	Death rate of nTreg
k_NK_m	Carrying capacity for the proliferation of NK cells
k_NK_f	Proliferation rate of NK cells
k_NK_d	Death rate of NK cells
k_nDC_m	Carrying capacity for the proliferation of nDC cells
k_nDC_f	Proliferation rate of nDC cells
k_nDC_d	Death rate of nDC cells
k_naive_CD4_IL_7_m	Hill coefficient in the proliferation of naïve CD4 cells driven by IL-7
k_naive_CD4_IL_7_f	Proliferation of naïve CD4 cells driven by IL-7
k_naive_CD4_IL_7_d	Consumption rate of IL-7 in the Proliferation of naïve CD4 cells
k_naive_CD4_IL_15_m	Hill coefficient in the proliferation of naïve CD4 cells driven by IL-15
k_naive_CD4_IL_15_f	Proliferation of naïve CD4 cells driven by IL-15
k_naive_CD4_IL_15_d	Consumption rate of IL-15 in the Proliferation of naïve CD4 cells
k_naive_CD4_d	Death rate of naïve CD4 cells
k_Naive_B_cells_m	Carrying capacity for the proliferation of naïve B cells
k_Naive_B_cells_f	Proliferation rate of naïve B cells
k_Naive_B_cells_d	Death rate of naïve B cells
k_Naive_B_cells_Antigen_f	Proliferation rate of naïve B cells in the presence of antigen
k_mDC_m	Carrying capacity for the proliferation of mDC cells
k_mDC_IL_10_m	IL-10 driven inhibition of differentiation of nDC into mDC
k_mDC_GMCSF_m	Hill coefficient in the differentiation of nDC into mDC driven by GMCSF
k_mDC_GMCSF_f	Differentiation rate of nDC into mDC driven by GMCSF
k_mDC_GMCSF_d	Consumption rate of GMCSF in the differentiation rate of nDC into mDC
k_mDC_f	Proliferation rate of mDC
k_mDC_d	Death rate of mDC
k_mDC_Antigen_f	Differentiation rate of nDC into mDC
k_iTreg_TGFbeta_m	Hill coefficient in the differentiation of active CD4 cells into iTreg driven by TGF-β
k_iTreg_TGFbeta_f	Differentiation rate of active CD4 cells into iTreg driven by TGF-β
k_iTreg_mDC_f	Differentiation rate of active CD4 cells into iTreg
k_iTreg_mDC_d	Consumption of cytokines in the differentiation of active CD4 cells into iTreg
k_iTreg_m	Carrying capacity for the proliferation of iTreg cells

Table 2 (continued)

Parameter name	Meaning
k_iTreg_IL_10_m	Hill coefficient in the differentiation of active CD4 cells into iTreg driven by IL-10
k_iTreg_IL_10_f	Differentiation rate of active CD4 cells into iTreg driven by IL-10
k_iTreg_IL_1_m	IL-1 driven inhibition of differentiation of active CD4 cells into iTreg
k_iTreg_f	Proliferation rate of iTreg
k_iTreg_d	Death rate of iTreg
k_IL1_mDC_f	Secretion rate of IL-1 by mDC
k_IL_7_f	Production rate of IL-7
k_IL_7_d	Degradation rate of IL-7
k_IL_6_pDC_f	Secretion rate of IL-6 by pDC cells
k_IL_6_mDC_f	Secretion rate of IL-6 by mDC cells
k_IL_6_d	Degradation rate of IL-6
k_IL_4_Th2_f	Secretion rate of IL-4 by Th2
k_IL_4_Th2_Antigen_f	Secretion rate of IL-4 by Th2 in the presence of antigen
k_IL_4_d	Degradation rate of IL-4
k_IL_33_pDC_f	Secretion rate of IL-33 by pDC
k_IL_33_d	Degradation rate of IL-33
k_IL_2_d	Degradation rate of IL-2
k_IL_2_act_CD4_f	Secretion rate of IL-2 by active CD4 cells
k_IL_2_act_CD4_Antigen_f	Secretion rate of IL-2 by active CD4 cells in the presence of antigen
k_IL_15_f	Production rate of IL-15
k_IL_15_d	Degradation rate of IL-15
k_IL_15_Antigen_f	Production rate of IL-15 in the presence of antigen
k_IL_12_mDC_f	Secretion rate of IL-12 by mDC
k_IL_12_d	Degradation rate of IL-12
k_IL_10_nTreg_mDC_m	Hill coefficient in the secretion of IL-10 by nTreg
k_IL_10_nTreg_f	Secretion rate of IL-10 by nTreg
k_IL_10_iTreg_f	Secretion rate of IL-10 by iTreg
k_IL_10_d	Degradation rate of IL-10
k_IL_1_d	Degradation rate of IL-1
k_IFN1_pDC_f	Secretion rate of IFN-1 by pDC
k_IFN1_d	Degradation rate of IFN-1
k_IFN1_CD4_CTL_m	Hill coefficient in the differentiation of active CD4 cells into CD4-CTL driven by IFN-1
k_IFN_g_d	Degradation rate of IFN-γ
k_IFN_g_CD4_CTL_f	Secretion rate of IFN-γ by CD4-CTL
k_IFN_g_act_NK_f	Secretion rate of IFN-γ by active NK cells
k_GMCSF_Th2_f	Secretion rate of GMCSF by Th2
k_GMCSF_Th2_Antigen_f	Secretion rate of GMCSF by Th2 in the presence of antigen
k_GMCSF_d	Degradation rate of GMCSF
k_GMCSF_act_NK_f	Secretion rate of GMCSF by active NK cells
k_CD4_m	Carrying capacity for the proliferation of naïve CD4 T cells
k_CD4_f	Proliferation rate of naïve CD4 T cells
k_CD4_CTL_d	Death rate of CD4-CTL
k_CD4_CTL_CD4_CTL_m	Carrying capacity for the proliferation of CD4-CTL cells
k_CD4_CTL_CD4_CTL_f	Proliferation rate of CD4-CTL cells
k_act_NK_m	Carrying capacity for the proliferation of active NK cells

Table 2 (continued)

Parameter name	Meaning
k_act_NK_IL_2_m	Hill coefficient in the differentiation of NK cells into active NK cells driven by IL-2
k_act_NK_IL_2_f	Differentiation rate of NK cells into active NK cells driven by IL-2
k_act_NK_IL_2_d	Consumption of IL-2 in the differentiation of NK cells into active NK cells
k_act_NK_IL_12_m	Hill coefficient in the differentiation of NK cells into active NK cells driven by IL-12
k_act_NK_IL_12_f	Differentiation rate of NK cells into active NK cells driven by IL-12
k_act_NK_IL_12_d	Consumption of IL-12 in the differentiation of NK cells into active NK cells
k_act_NK_IFN1_m	Hill coefficient in the differentiation of NK cells into active NK cells driven by IFN-1
k_act_NK_IFN1_f	Differentiation rate of NK cells into active NK cells driven by IFN-1
k_act_NK_IFN1_d	Consumption of IFN-1 in the differentiation of NK cells into active NK cells
k_act_NK_IFN_g_m	Hill coefficient in the differentiation of NK cells into active NK cells driven by IFN-γ
k_act_NK_IFN_g_f	Differentiation rate of NK cells into active NK cells driven by IFN-γ
k_act_NK_IFN_g_d	Consumption of IFN-γ in the differentiation of NK cells into active NK cells
k_act_NK_f	Proliferation rate of active NK cells
k_act_NK_d	Death rate of active NK cells
k_act_NK_base_f	Basal differentiation rate of NK cells into active NK cells
k_act_CD4_mDC_m	Hill coefficient in the differentiation of naïve CD4 T cells into active CD4 T cells
k_act_CD4_mDC_f	Differentiation rate of naïve CD4 T cells into active CD4 T cells
k_act_CD4_m	Carrying capacity for the proliferation of active CD4 T cells
k_act_CD4_IL_7_m	Hill coefficient in the proliferation of active CD4 cells driven by IL-7
k_act_CD4_IL_7_f	Proliferation rate of active CD4 cells driven by IL-7
k_act_CD4_IL_7_d	Consumption of IL-7 in the proliferation of active CD4 cells
k_act_CD4_IL_4_d	Consumption of IL-4 in the differentiation of active CD4 T cells into Th2
k_act_CD4_IL_33_d	Consumption of IL-33 in the differentiation of active CD4 T cells into Th2
k_act_CD4_IL_2_m	Hill coefficient in the differentiation of naïve CD4 T cells into active CD4 T cells driven by IL-2
k_act_CD4_IL_2_f	Differentiation rate of naïve CD4 T cells into active CD4 T cells driven by IL-2
k_act_CD4_IL_2_d	Consumption of IL-2 in the differentiation of naïve CD4 T cells into active CD4 T cells
k_act_CD4_IL_15_m	Hill coefficient in the proliferation of active CD4 cells driven by IL-15
k_act_CD4_IL_15_f	Proliferation rate of active CD4 cells driven by IL-15
k_act_CD4_IL_15_d	Consumption of IL-15 in the proliferation of active CD4 cells
k_act_CD4_IFN1_f	Differentiation rate of active CD4 T cells into CD4-CTL cells by IFN-1

Table 2 (continued)

Parameter name	Meaning
k_act_CD4_IFN1_d	Consumption of IFN-1 in the differentiation of active CD4 T cells into CD4-CTL cells
k_act_CD4_f	Proliferation rate of active CD4 T cells
k_act_CD4_d	Death rate of active CD4 T cells
k_act_CD4_CTL_basal_f	Basal differentiation rate of active CD4 T cells into CD4-CTL cells
k_act_CD4_CTL_antigen_f	Differentiation rate of active CD4 T cells into CD4-CTL cells in the presence of antigen
k_Act_B_cells_d	Death rate of active B cells
Act_B_cells_basal_f	Basal differentiation rate of naïve B cells into active B cells
k_Act_B_cells_Antigen_f	Differentiation rate of naïve B cells into active B cells in the presence of antigen
k_Act_B_Act_B_m	Carrying capacity for the proliferation of active B cells
k_Act_B_Act_B_f	Proliferation rate of active B cells
k_Act_B_Act_B_Antigen_f	Proliferation rate of active B cells in the presence of antigen

Table 3: Model reactions

Number	Educt	Product	Rate
1	{}	AntigenDiff	0
2	{}	Antigen	$AntigenDiff$
3	{}	treatment	0
4	{}	nDC	$k\_nDC\_f * nDC * (1 - nDC/k\_nDC\_m)$
5	nDC	mDC	$k\_mDC\_Antigen\_f * Antigen * nDC * k\_mDC\_IL\_10\_m/(k\_mDC\_IL\_10\_m + IL\_10)$
6	nDC	mDC	$k\_mDC\_GMCSF\_f * Antigen * nDC * (GMCSF/(GMCSF + k\_mDC\_GMCSF\_m)) * k\_mDC\_IL\_10\_m/(k\_mDC\_IL\_10\_m + IL\_10)$
7	GMCSF	{}	$k\_mDC\_GMCSF\_d * Antigen * nDC * (GMCSF/(GMCSF + k\_mDC\_GMCSF\_m)) * k\_mDC\_IL\_10\_m/(k\_mDC\_IL\_10\_m + IL\_10)$
8	{}	mDC	$k\_mDC\_f * mDC * (1 - mDC/k\_mDC\_m)$
9	nDC	pDC	$k\_pDC\_Antigen\_f * nDC * Antigen$
10	{}	pDC	$k\_pDC\_f * pDC * (1 - pDC/k\_pDC\_m)$
11	{}	IL_33	$k\_IL\_33\_pDC\_f * pDC$
12	{}	IL_6	$k\_IL\_6\_pDC\_f * pDC$
13	{}	IL_6	$k\_IL\_6\_mDC\_f * mDC$
14	{}	IL_12	$k\_IL\_12\_mDC\_f * mDC$
15	{}	IL_15	$k\_IL\_15\_f$
16	{}	IL_15	$k\_IL\_15\_Antigen\_f * Antigen$
17	{}	IL_7	$k\_IL\_7\_f$
18	{}	IFN1	$k\_IFN1\_pDC\_f * pDC$
19	{}	IL_1	$k\_IL1\_mDC\_f * mDC$
20	{}	IL_2	$k\_IL\_2\_act\_CD4\_f * act\_CD4$
21	{}	IL_2	$k\_IL\_2\_act\_CD4\_Antigen\_f * act\_CD4 * Antigen$
22	{}	IL_4	$k\_IL\_4\_Th2\_f * Th2$
23	{}	IL_4	$k\_IL\_4\_Th2\_Antigen\_f * Th2 * Antigen$
24	{}	GMCSF	$k\_GMCSF\_Th2\_f * Th2$
25	{}	GMCSF	$k\_GMCSF\_Th2\_Antigen\_f * Th2 * Antigen$
26	{}	IL_10	$k\_IL\_10\_iTreg\_f * iTreg$
27	{}	TGFbeta	$k\_TGFbeta\_iTreg\_f * iTreg$
28	{}	TGFbeta	$k\_TGFbeta\_CD4\_CTL\_f * CD4\_CTL$
29	{}	IL_10	$k\_IL\_10\_nTreg\_f * nTreg * mDC/(k\_IL\_10\_nTreg\_mDC\_m + mDC)$
30	{}	TGFbeta	$k\_TGFbeta\_nTreg\_f * nTreg * mDC/(k\_TGFbeta\_nTreg\_mDC\_m + mDC)$
31	{}	IL_6	$k\_IL\_6\_TFH\_f * TFH * k\_TFH\_nTreg\_m/(nTreg + k\_TFH\_nTreg\_m)$
32	{}	IFN_g	$k\_IFN\_g\_CD4\_CTL\_f * CD4\_CTL$
33	{}	IFN_g	$k\_IFN\_g\_act\_NK\_f * act\_NK$
34	{}	GMCSF	$k\_GMCSF\_act\_NK\_f * act\_NK$
35	{}	naive_CD4	$k\_CD4\_f * naive\_CD4 * (1 - naive\_CD4/k\_CD4\_m)$
36	{}	naive_CD4	$naive\_CD4 * (1 - naive\_CD4/k\_CD4\_m) * (k\_naive\_CD4\_IL\_15\_f * IL\_15/(k\_naive\_CD4\_IL\_15\_m + IL\_15))$
37	IL_15	{}	$naive\_CD4 * k\_naive\_CD4\_IL\_15\_d * IL\_15/(k\_naive\_CD4\_IL\_15\_m + IL\_15)$

Table 3 (continued)

Number	Educt	Product	Rate
38	{}	naive_CD4	$k\_naive\_CD4\_IL\_7\_f * (1 - naive\_CD4/k\_CD4\_m) * naive\_CD4 * IL\_7/(k\_naive\_CD4\_IL\_7\_m + IL\_7)$
39	IL_7	{}	$k\_naive\_CD4\_IL\_7\_d * naive\_CD4 * IL\_7/(k\_naive\_CD4\_IL\_7\_m + IL\_7)$
40	naive_CD4	act_CD4	$naive\_CD4 * (k\_act\_CD4\_mDC\_f * mDC/(k\_act\_CD4\_mDC\_m + mDC))$
41	naive_CD4	act_CD4	$naive\_CD4 * (k\_act\_CD4\_IL\_2\_f * IL\_2/(k\_act\_CD4\_IL\_2\_m + IL\_2))$
42	IL_2	{}	$naive\_CD4 * k\_act\_CD4\_IL\_2\_d * IL\_2/(k\_act\_CD4\_IL\_2\_m + IL\_2)$
43	{}	act_CD4	$k\_act\_CD4\_f * act\_CD4 * (1 - act\_CD4/k\_act\_CD4\_m)$
44	{}	act_CD4	$k\_act\_CD4\_IL\_15\_f * act\_CD4 * (1 - act\_CD4/k\_act\_CD4\_m) * IL\_15/(k\_act\_CD4\_IL\_15\_m + IL\_15)$
45	IL_15	{}	$k\_act\_CD4\_IL\_15\_d * act\_CD4 * IL\_15/(k\_act\_CD4\_IL\_15\_m + IL\_15)$
46	{}	act_CD4	$(k\_act\_CD4\_IL\_7\_f * act\_CD4 * (1 - act\_CD4/k\_act\_CD4\_m) * IL\_7/(k\_act\_CD4\_IL\_7\_m + IL\_7))$
47	IL_7	{}	$(k\_act\_CD4\_IL\_7\_d * act\_CD4 * IL\_7/(k\_act\_CD4\_IL\_7\_m + IL\_7))$
48	act_CD4	Th2	$act\_CD4 * k\_Th2\_f * k\_Th2\_TGFbeta\_m/(k\_Th2\_TGFbeta\_m + TGFbeta) * k\_Th2\_IL\_10\_m/(k\_Th2\_IL\_10\_m + IL\_10) * k\_Th2\_IL\_12\_m/(k\_Th2\_IL\_12\_m + IL\_12)$
49	act_CD4	Th2	$act\_CD4 * k\_Th2\_IL\_4\_f * k\_Th2\_TGFbeta\_m/(k\_Th2\_TGFbeta\_m + TGFbeta) * k\_Th2\_IL\_10\_m/(k\_Th2\_IL\_10\_m + IL\_10) * k\_Th2\_IL\_12\_m/(k\_Th2\_IL\_12\_m + IL\_12) * IL\_4/(k\_Th2\_IL\_4\_m + IL\_4)$
50	IL_4	{}	$k\_act\_CD4\_IL\_4\_d * act\_CD4 * IL\_4/(k\_Th2\_IL\_4\_m + IL\_4)$
51	act_CD4	Th2	$act\_CD4 * k\_Th2\_IL\_33\_f * k\_Th2\_TGFbeta\_m/(k\_Th2\_TGFbeta\_m + TGFbeta) * k\_Th2\_IL\_10\_m/(k\_Th2\_IL\_10\_m + IL\_10) * k\_Th2\_IL\_12\_m/(k\_Th2\_IL\_12\_m + IL\_12) * IL\_33/(k\_Th2\_IL\_33\_m + IL\_33)$
52	IL_33	{}	$k\_act\_CD4\_IL\_33\_d * act\_CD4 * IL\_33/(k\_Th2\_IL\_33\_m + IL\_33)$
53	{}	Th2	$k\_Th2\_f * Th2 * (1 - Th2/k\_Th2\_m)$
54	act_CD4	iTreg	$act\_CD4 * k\_iTreg\_mDC\_f * k\_iTreg\_TGFbeta\_f * TGFbeta/(k\_iTreg\_TGFbeta\_m + TGFbeta) * (k\_iTreg\_IL\_1\_m/(k\_iTreg\_IL\_1\_m + IL\_1))$
55	TGFbeta	{}	$act\_CD4 * k\_iTreg\_mDC\_d * k\_iTreg\_TGFbeta\_f * TGFbeta/(k\_iTreg\_TGFbeta\_m + TGFbeta) * (k\_iTreg\_IL\_1\_m/(k\_iTreg\_IL\_1\_m + IL\_1))$
56	act_CD4	iTreg	$act\_CD4 * k\_iTreg\_mDC\_f * (k\_iTreg\_IL\_1\_m/(k\_iTreg\_IL\_1\_m + IL\_1))$

Table 3 (continued)

Number	Educt	Product	Rate
57	act_CD4	iTreg	$act\_CD4 * k\_iTreg\_mDC\_f * k\_iTreg\_IL\_10\_f * (IL\_10/(k\_iTreg\_IL\_10\_m + IL\_10)) * (k\_iTreg\_IL\_1\_m/(k\_iTreg\_IL\_1\_m + IL\_1))$
58	IL_10	{}	$act\_CD4 * k\_iTreg\_mDC\_d * k\_iTreg\_IL\_10\_f * (IL\_10/(k\_iTreg\_IL\_10\_m + IL\_10)) * (k\_iTreg\_IL\_1\_m/(k\_iTreg\_IL\_1\_m + IL\_1))$
59	{}	iTreg	$k\_iTreg\_f * iTreg * (1 - iTreg/k\_iTreg\_m)$
60	act_CD4	CD4_CTL	$act\_CD4 * k\_act\_CD4\_CTL\_basal\_f$
61	act_CD4	CD4_CTL	$act\_CD4 * k\_act\_CD4\_CTL\_antigen\_f * Antigen$
62	act_CD4	CD4_CTL	$k\_act\_CD4\_IFN1\_f * act\_CD4 * IFN1/(k\_IFN1\_CD4\_CTL\_m + IFN1)$
63	IFN1	{}	$k\_act\_CD4\_IFN1\_d * act\_CD4 * IFN1/(k\_IFN1\_CD4\_CTL\_m + IFN1)$
64	{}	CD4_CTL	$k\_CD4\_CTL\_CD4\_CTL\_f * CD4\_CTL * (1 - CD4\_CTL/k\_CD4\_CTL\_CD4\_CTL\_m)$
65	{}	nTreg	$k\_nTreg\_mDC\_f * nTreg * (1 - nTreg/k\_nTreg\_m) * mDC/(k\_nTreg\_mDC\_m + mDC)$
66	act_CD4	TFH	$act\_CD4 * k\_TFH\_mDC\_f$
67	act_CD4	TFH	$act\_CD4 * k\_TFH\_mDC\_Antigen\_f * Antigen$
68	act_CD4	TFH	$k\_TFH\_IFN1\_f * act\_CD4 * IFN1/(k\_TFH\_IFN1\_m + IFN1)$
69	IFN1	{}	$k\_TFH\_IFN1\_f * act\_CD4 * IFN1/(k\_TFH\_IFN1\_m + IFN1)$
70	act_CD4	TFH	$k\_TFH\_IL\_6\_f * act\_CD4 * IL\_6/(k\_TFH\_IL\_6\_m + IL\_6)$
71	IL_6	{}	$k\_TFH\_IL\_6\_d * act\_CD4 * IL\_6/(k\_TFH\_IL\_6\_m + IL\_6)$
72	{}	TFH	$k\_TFH\_f * TFH * (1 - TFH/k\_TFH\_m)$
73	{}	NK	$k\_NK\_f * NK * (1 - NK/k\_NK\_m)$
74	NK	act_NK	$k\_act\_NK\_base\_f * NK$
75	NK	act_NK	$k\_act\_NK\_IL\_12\_f * NK * IL\_12/(IL\_12 + k\_act\_NK\_IL\_12\_m)$
76	IL_12	{}	$k\_act\_NK\_IL\_12\_d * NK * IL\_12/(IL\_12 + k\_act\_NK\_IL\_12\_m)$
77	NK	act_NK	$k\_act\_NK\_IL\_2\_f * NK * IL\_2/(IL\_2 + k\_act\_NK\_IL\_2\_m)$
78	IL_2	{}	$k\_act\_NK\_IL\_2\_d * NK * IL\_2/(IL\_2 + k\_act\_NK\_IL\_2\_m)$
79	NK	act_NK	$k\_act\_NK\_IFN1\_f * NK * IFN1/(IFN1 + k\_act\_NK\_IFN1\_m)$
80	IFN1	{}	$k\_act\_NK\_IFN1\_d * NK * IFN1/(IFN1 + k\_act\_NK\_IFN1\_m)$
81	NK	act_NK	$k\_act\_NK\_IFN\_g\_f * NK * IFN\_g/(IFN\_g + k\_act\_NK\_IFN\_g\_m)$
82	IFN_g	{}	$k\_act\_NK\_IFN\_g\_d * NK * IFN\_g/(IFN\_g + k\_act\_NK\_IFN\_g\_m)$
83	{}	act_NK	$k\_act\_NK\_f * act\_NK * (1 - act\_NK/k\_act\_NK\_m)$
84	{}	act_NK	$k\_act\_NK\_f * act\_NK * (1 - act\_NK/k\_act\_NK\_m) * k\_pro\_act\_NK\_IL\_12\_f * IL\_12/(IL\_12 + k\_pro\_act\_NK\_IL\_12\_m)$

Table 3 (continued)

Number	Educt	Product	Rate
85	IL_12	{}	$k\_act\_NK\_d * act\_NK * k\_pro\_act\_NK\_IL\_12\_f * IL\_12/(IL\_12 + k\_pro\_act\_NK\_IL\_12\_m)$
86	{}	Naive_B_cells	$k\_Naive\_B\_cells\_f * Naive\_B\_cells * (1 - Naive\_B\_cells/k\_Naive\_B\_cells\_m)$
87	{}	Naive_B_cells	$k\_Naive\_B\_cells\_Antigen\_f * Naive\_B\_cells * Antigen * (1 - Naive\_B\_cells/k\_Naive\_B\_cells\_m)$
88	Naive_B_cells	Act_B_cells	$k\_Act\_B\_cells\_basal\_f * Naive\_B\_cells$
89	Naive_B_cells	Act_B_cells	$k\_Act\_B\_cells\_Antigen\_f * Naive\_B\_cells * Antigen$
90	{}	Act_B_cells	$k\_Act\_B\_Act\_B\_f * Act\_B\_cells * (1 - Act\_B\_cells/k\_Act\_B\_Act\_B\_m)$
91	{}	Act_B_cells	$k\_Act\_B\_Act\_B\_Antigen\_f * Act\_B\_cells * Antigen * (1 - Act\_B\_cells/k\_Act\_B\_Act\_B\_m)$
92	Act_B_cells	TD_IS_B_cells	$k\_TD\_IS\_B\_cells\_base\_f * Act\_B\_cells$
93	Act_B_cells	TD_IS_B_cells	$k\_TD\_IS\_B\_cells\_IL\_4\_f * Act\_B\_cells * IL\_4$
94	{}	TD_IS_B_cells	$k\_TD\_IS\_B\_cells\_TD\_IS\_B\_cells\_f * TD\_IS\_B\_cells * (1 - TD\_IS\_B\_cells/k\_TD\_IS\_B\_cells\_TD\_IS\_B\_cells\_m)$
95	Act_B_cells	TI_IS_B_cells	$k\_TI\_IS\_B\_cells\_base\_f * Act\_B\_cells$
96	Act_B_cells	TI_IS_B_cells	$k\_TI\_IS\_B\_cells\_IFN\_g\_f * Act\_B\_cells * IFN\_g$
97	Act_B_cells	TI_IS_B_cells	$k\_TI\_IS\_B\_cells\_IL\_10\_f * Act\_B\_cells * IL\_10$
98	{}	TI_IS_B_cells	$k\_TI\_IS\_B\_cells\_TI\_IS\_B\_cells\_f * TI\_IS\_B\_cells * (1 - TI\_IS\_B\_cells/k\_TI\_IS\_B\_cells\_TI\_IS\_B\_cells\_m)$
99	{}	IgG4	$k\_IgG4\_TI\_IS\_B\_cells\_f * 1e8 * TI\_IS\_B\_cells$
100	{}	IgG4	$k\_IgG4\_TD\_IS\_B\_cells\_f * 1e8 * TD\_IS\_B\_cells$
101	nDC	{}	$k\_nDC\_d * nDC$
102	mDC	{}	$k\_mDC\_d * mDC$
103	GMCSF	{}	$k\_GMCSF\_d * GMCSF$
104	pDC	{}	$k\_pDC\_d * pDC$
105	IL_6	{}	$k\_IL\_6\_d * IL\_6$
106	IL_4	{}	$k\_IL\_4\_d * IL\_4$
107	IL_33	{}	$k\_IL\_33\_d * IL\_33$
108	IFN1	{}	$k\_IFN1\_d * IFN1$
109	IL_12	{}	$k\_IL\_12\_d * IL\_12$
110	IL_15	{}	$k\_IL\_15\_d * IL\_15$
111	IL_7	{}	$k\_IL\_7\_d * IL\_7$
112	naive_CD4	{}	$k\_naive\_CD4\_d * naive\_CD4$
113	act_CD4	{}	$k\_act\_CD4\_d * act\_CD4$
114	IL_2	{}	$k\_IL\_2\_d * IL\_2$
115	IL_1	{}	$k\_IL\_1\_d * IL\_1$
116	Th2	{}	$k\_Th2\_d * Th2$
117	iTreg	{}	$k\_iTreg\_d * iTreg$
118	IL_10	{}	$k\_IL\_10\_d * IL\_10$
119	TGFbeta	{}	$k\_TGFbeta\_d * TGFbeta$
120	CD4_CTL	{}	$k\_CD4\_CTL\_d * CD4\_CTL$
121	nTreg	{}	$k\_nTreg\_d * nTreg$
122	TFH	{}	$k\_TFH\_d * TFH$
123	IFN_g	{}	$k\_IFN\_g\_d * IFN\_g$
124	Naive_B_cells	{}	$k\_Naive\_B\_cells\_d * Naive\_B\_cells$
125	Act_B_cells	{}	$k\_Act\_B\_cells\_d * Act\_B\_cells$

Table 3 (continued)

Number	Educt	Product	Rate
126	TD_IS_B_cells	{}	$k\_TD\_IS\_B\_cells\_d * TD\_IS\_B\_cells$
127	TI_IS_B_cells	{}	$k\_TI\_IS\_B\_cells\_d * TI\_IS\_B\_cells$
128	NK	{}	$k\_NK\_d * NK$
129	act_NK	{}	$k\_act\_NK\_d * act\_NK$
130	IgG4	{}	$k\_IgG4\_d * IgG4$

Model Equations

The set of ordinary differential equations denoting temporal evolution of model states, i.e. immune cells and cytokines, are listed below.

(Eq. 1)

$$\frac{d\,\text{Act\_B\_cells}}{dt} = k_{\text{Act\_B\_cells\_basal\_f}}\,\text{Naive\_B\_cells} + k_{\text{Act\_B\_cells\_Antigen\_f}}\,\text{Naive\_B\_cells}\,\text{Antigen}$$

$$+\, k_{\text{Act\_B\_Act\_B\_f}}\,\text{Act\_B\_cells}\left(1 - \frac{\text{Act\_B\_cells}}{k_{\text{Act\_B\_Act\_B\_m}}}\right)$$

$$+\, k_{\text{Act\_B\_Act\_B\_Antigen\_f}}\,\text{Act\_B\_cells}\,\text{Antigen}\left(1 - \frac{\text{Act\_B\_cells}}{k_{\text{Act\_B\_Act\_B\_m}}}\right)$$

$$-\, k_{\text{TD\_IS\_B\_cells\_base\_f}}\,\text{Act\_B\_cells} - k_{\text{TD\_IS\_B\_cells\_IL\_4\_f}}\,\text{Act\_B\_cells}\,\text{IL\_4}$$

$$-\, k_{\text{TI\_IS\_B\_cells\_base\_f}}\,\text{Act\_B\_cells} - k_{\text{TI\_IS\_B\_cells\_IFN\_g\_f}}\,\text{Act\_B\_cells}\,\text{IFN\_g}$$

$$-\, k_{\text{TI\_IS\_B\_cells\_IL\_10\_f}}\,\text{Act\_B\_cells}\,\text{IL\_10} - k_{\text{Act\_B\_cells\_d}}\,\text{Act\_B\_cells}$$

(Eq. 2)

$$\frac{d\,\text{act\_CD4}}{dt} = \text{naive\_CD4}\,\frac{k_{\text{act\_CD4\_mDC\_f}}\,\text{mDC}}{k_{\text{act\_CD4\_mDC\_m}} + \text{mDC}} + \text{naive\_CD4}\,\frac{k_{\text{act\_CD4\_IL\_2\_f}}\,\text{IL\_2}}{k_{\text{act\_CD4\_IL\_2\_m}} + \text{IL\_2}}$$

$$+\, k_{\text{act\_CD4\_f}}\,\text{act\_CD4}\left(1 - \frac{\text{act\_CD4}}{k_{\text{act\_CD4\_m}}}\right) + k_{\text{act\_CD4\_IL\_15\_f}}\,\text{act\_CD4}\left(1 - \frac{\text{act\_CD4}}{k_{\text{act\_CD4\_m}}}\right)\frac{\text{IL\_15}}{k_{\text{act\_CD4\_IL\_15\_m}} + \text{IL\_15}}$$

$$+\, k_{\text{act\_CD4\_IL\_7\_f}}\,\text{act\_CD4}\left(1 - \frac{\text{act\_CD4}}{k_{\text{act\_CD4\_m}}}\right)\frac{\text{IL\_7}}{k_{\text{act\_CD4\_IL\_7\_m}} + \text{IL\_7}}$$

$$-\, \text{act\_CD4}\,k_{\text{Th2\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}}$$

$$-\, \text{act\_CD4}\,k_{\text{Th2\_IL\_4\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}}$$

$$*\, \frac{\text{IL\_4}}{k_{\text{Th2\_IL\_4\_m}} + \text{IL\_4}}$$

$$-\, \text{act\_CD4}\,k_{\text{Th2\_IL\_33\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}}$$

$$*\, \frac{\text{IL\_33}}{k_{\text{Th2\_IL\_33\_m}} + \text{IL\_33}}$$

$$-\, \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,k_{\text{iTreg\_TGFbeta\_f}}\,\frac{\text{TGFbeta}}{k_{\text{iTreg\_TGFbeta\_m}} + \text{TGFbeta}}\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}}$$

$$-\, \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}}$$

$$-\, \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,k_{\text{iTreg\_IL\_10\_f}}\,\frac{\text{IL\_10}}{k_{\text{iTreg\_IL\_10\_m}} + \text{IL\_10}}\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}} - \text{act\_CD4}\,k_{\text{act\_CD4\_CTL\_basal\_f}}$$

$$-\, \text{act\_CD4}\,k_{\text{act\_CD4\_CTL\_antigen\_f}}\,\text{Antigen}$$

$$-\, k_{\text{act\_CD4\_IFN1\_f}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{IFN1\_CD4\_CTL\_m}} + \text{IFN1}} - \text{act\_CD4}\,k_{\text{TFH\_mDC\_f}}$$

$$-\, \text{act\_CD4}\,k_{\text{TFH\_mDC\_Antigen\_f}}\,\text{Antigen}$$

$$-\, k_{\text{TFH\_IFN1\_f}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{TFH\_IFN1\_m}} + \text{IFN1}} - k_{\text{TFH\_IL\_6\_f}}\,\text{act\_CD4}\,\frac{\text{IL\_6}}{k_{\text{TFH\_IL\_6\_m}} + \text{IL\_6}} - k_{\text{act\_CD4\_d}}\,\text{act\_CD4}$$

$$(\text{Eq. 3}) \quad \begin{aligned} \frac{d\,\text{act\_NK}}{dt} ={}& k_{\text{act\_NK\_base\_f}}\,\text{NK} \\[4pt] &+ k_{\text{act\_NK\_IL\_12\_f}}\,\text{NK}\,\frac{\text{IL\_12}}{\text{IL\_12} + k_{\text{act\_NK\_IL\_12\_m}}} \\[4pt] &+ k_{\text{act\_NK\_IL\_2\_f}}\,\text{NK}\,\frac{\text{IL\_2}}{\text{IL\_2} + k_{\text{act\_NK\_IL\_2\_m}}} \\[4pt] &+ k_{\text{act\_NK\_IFN1\_f}}\,\text{NK}\,\frac{\text{IFN1}}{\text{IFN1} + k_{\text{act\_NK\_IFN1\_m}}} \\[4pt] &+ k_{\text{act\_NK\_IFN\_g\_f}}\,\text{NK}\,\frac{\text{IFN\_g}}{\text{IFN\_g} + k_{\text{act\_NK\_IFN\_g\_m}}} \\[4pt] &+ k_{\text{act\_NK\_f}}\,\text{act\_NK}\left(1 - \frac{\text{act\_NK}}{k_{\text{act\_NK\_m}}}\right) \\[4pt] &+ k_{\text{act\_NK\_f}}\,\text{act\_NK}\left(1 - \frac{\text{act\_NK}}{k_{\text{act\_NK\_m}}}\right) k_{\text{pro\_act\_NK\_IL\_12\_f}}\,\frac{\text{IL\_12}}{\text{IL\_12} + k_{\text{pro\_act\_NK\_IL\_12\_m}}} \\[4pt] &- k_{\text{act\_NK\_d}}\,\text{act\_NK} \end{aligned}$$

$$(\text{Eq. 4}) \quad \frac{d\,\text{Antigen}}{dt} = \text{AntigenDiff}$$

$$(\text{Eq. 5}) \quad \frac{d\,\text{AntigenDiff}}{dt} = 0$$

$$(\text{Eq. 6}) \quad \begin{aligned} \frac{d\,\text{CD4\_CTL}}{dt} ={}& k_{\text{act\_CD4\_CTL\_basal\_f}}\,\text{act\_CD4} + k_{\text{act\_CD4\_CTL\_antigen\_f}}\,\text{act\_CD4\,Antigen} \\[4pt] &+ k_{\text{act\_CD4\_IFN1\_f}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{IFN1\_CD4\_CTL\_m}} + \text{IFN1}} \\[4pt] &+ k_{\text{CD4\_CTL\_CD4\_CTL\_f}}\,\text{CD4\_CTL}\left(1 - \frac{\text{CD4\_CTL}}{k_{\text{CD4\_CTL\_CD4\_CTL\_m}}}\right) - k_{\text{CD4\_CTL\_d}}\,\text{CD4\_CTL} \end{aligned}$$

$$(\text{Eq. 7}) \quad \begin{aligned} \frac{d\,\text{GMCSF}}{dt} ={}& -k_{\text{mDC\_GMCSF\_d}}\,\text{Antigen\,nDC}\,\frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC\_GMCSF\_m}}}\,\frac{k_{\text{mDC\_IL\_10\_m}}}{k_{\text{mDC\_IL\_10\_m}} + \text{IL\_10}} \\[4pt] &+ k_{\text{GMCSF\_Th2\_f}}\,\text{Th2} + k_{\text{GMCSF\_Th2\_Antigen\_f}}\,\text{Th2\,Antigen} + k_{\text{GMCSF\_act\_NK\_f}}\,\text{act\_NK} \\[4pt] &- k_{\text{GMCSF\_d}}\,\text{GMCSF} \end{aligned}$$

$$(\text{Eq. 8}) \quad \begin{aligned} \frac{d\,\text{IFN\_g}}{dt} ={}& k_{\text{IFN\_g\_CD4\_CTL\_f}}\,\text{CD4\_CTL} + k_{\text{IFN\_g\_act\_NK\_f}}\,\text{act\_NK} - k_{\text{act\_NK\_IFN\_g\_d}}\,\text{NK}\,\frac{\text{IFN\_g}}{\text{IFN\_g} + k_{\text{act\_NK\_IFN\_g\_m}}} \\[4pt] &- k_{\text{IFN\_g\_d}}\,\text{IFN\_g} \end{aligned}$$

$$(\text{Eq. 9}) \quad \begin{aligned} \frac{d\,\text{IFN1}}{dt} ={}& k_{\text{IFN1\_pDC\_f}}\,\text{pDC} - k_{\text{act\_CD4\_IFN1\_d}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{IFN1\_CD4\_CTL\_m}} + \text{IFN1}} \\[4pt] &- k_{\text{TFH\_IFN1\_f}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{TFH\_IFN1\_m}} + \text{IFN1}} - k_{\text{act\_NK\_IFN1\_d}}\,\text{NK}\,\frac{\text{IFN1}}{k_{\text{act\_NK\_IFN1\_m}} + \text{IFN1}} \\[4pt] &- k_{\text{IFN1\_d}}\,\text{IFN1} \end{aligned}$$

$$(\text{Eq. 10}) \quad \frac{d\,\text{IL\_1}}{dt} = k_{\text{IL1\_mDC\_f}}\,\text{mDC} - k_{\text{IL\_1\_d}}\,\text{IL\_1}$$

$$\text{(Eq. 11)} \quad \frac{d\text{IL\_10}}{dt} = k_{\text{IL\_10\_iTreg\_f}}\,\text{iTreg} + k_{\text{IL\_10\_nTreg\_f}}\,\text{nTreg}\,\text{mDC}\,\frac{1}{k_{\text{IL\_10\_nTreg\_mDC\_m}} + \text{mDC}}$$
$$- \text{act\_CD4}\,k_{\text{iTreg\_mDC\_d}}\,k_{\text{iTreg\_IL\_10\_f}}\,\frac{\text{IL\_10}}{k_{\text{iTreg\_IL\_10\_m}} + \text{IL\_10}}\,\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}} - k_{\text{IL\_10\_d}}\,\text{IL\_10}$$

$$\text{(Eq. 12)} \quad \frac{d\text{IL\_12}}{dt} = k_{\text{IL\_12\_mDC\_f}}\,\text{mDC} - k_{\text{act\_NK\_IL\_12\_d}}\,\text{NK}\,\frac{\text{IL\_12}}{\text{IL\_12} + k_{\text{act\_NK\_IL\_12\_m}}}$$
$$- k_{\text{act\_NK\_d}}\,\text{act\_NK}\,k_{\text{pro\_act\_NK\_IL\_12\_f}}\,\frac{\text{IL\_12}}{\text{IL\_12} + k_{\text{pro\_act\_NK\_IL\_12\_m}}} - k_{\text{IL\_12\_d}}\,\text{IL\_12}$$

$$\text{(Eq. 13)} \quad \frac{d\text{IL\_15}}{dt} = k_{\text{IL\_15\_f}} + k_{\text{IL\_15\_Antigen\_f}}\,\text{Antigen} - \text{naive\_CD4}\,k_{\text{naive\_CD4\_IL\_15\_d}}\,\frac{\text{IL\_15}}{k_{\text{naive\_CD4\_IL\_15\_m}} + \text{IL\_15}}$$
$$- k_{\text{act\_CD4\_IL\_15\_d}}\,\text{act\_CD4}\,\frac{\text{IL\_15}}{k_{\text{act\_CD4\_IL\_15\_m}} + \text{IL\_15}} - k_{\text{IL\_15\_d}}\,\text{IL\_15}$$

$$\text{(Eq. 14)} \quad \frac{d\text{IL\_2}}{dt} = k_{\text{IL\_2\_act\_CD4\_f}}\,\text{act\_CD4} + k_{\text{IL\_2\_act\_CD4\_Antigen\_f}}\,\text{act\_CD4}\,\text{Antigen}$$
$$- \text{naive\_CD4}\,k_{\text{act\_CD4\_IL\_2\_d}}\,\frac{\text{IL\_2}}{k_{\text{act\_CD4\_IL\_2\_m}} + \text{IL\_2}} - k_{\text{act\_NK\_IL\_2\_d}}\,\text{NK}\,\frac{\text{IL\_2}}{\text{IL\_2} + k_{\text{act\_NK\_IL\_2\_m}}}$$
$$- k_{\text{IL\_2\_d}}\,\text{IL\_2}$$

$$\text{(Eq. 15)} \quad \frac{d\text{IL\_33}}{dt} = k_{\text{IL\_33\_pDC\_f}}\,\text{pDC} - k_{\text{act\_CD4\_IL\_33\_d}}\,\text{act\_CD4}\,\frac{\text{IL\_33}}{k_{\text{Th2\_IL\_33\_m}} + \text{IL\_33}} - k_{\text{IL\_33\_d}}\,\text{IL\_33}$$

$$\text{(Eq. 16)} \quad \frac{d\text{IL\_4}}{dt} = k_{\text{IL\_4\_Th2\_f}}\,\text{Th2} + k_{\text{IL\_4\_Th2\_Antigen\_f}}\,\text{Th2}\,\text{Antigen} - k_{\text{act\_CD4\_IL\_4\_d}}\,\text{act\_CD4}\,\frac{\text{IL\_4}}{k_{\text{Th2\_IL\_4\_m}} + \text{IL\_4}}$$
$$- k_{\text{IL\_4\_d}}\,\text{IL\_4}$$

$$\text{(Eq. 17)} \quad \frac{d\text{IL\_6}}{dt} = k_{\text{IL\_6\_pDC\_f}}\,\text{pDC} + k_{\text{IL\_6\_mDC\_f}}\,\text{mDC} + k_{\text{IL\_6\_TFH\_f}}\,\text{TFH}\,\frac{k_{\text{TFH\_nTreg\_m}}}{\text{nTreg} + k_{\text{TFH\_nTreg\_m}}}$$
$$- k_{\text{TFH\_IL\_6\_d}}\,\text{act\_CD4}\,\frac{\text{IL\_6}}{k_{\text{TFH\_IL\_6\_m}} + \text{IL\_6}} - k_{\text{IL\_6\_d}}\,\text{IL\_6}$$

$$\text{(Eq. 18)} \quad \frac{d\text{IL\_7}}{dt} = k_{\text{IL\_7\_f}} - k_{\text{naive\_CD4\_IL\_7\_d}}\,\text{naive\_CD4}\,\frac{\text{IL\_7}}{k_{\text{naive\_CD4\_IL\_7\_m}} + \text{IL\_7}}$$
$$- k_{\text{act\_CD4\_IL\_7\_d}}\,\text{act\_CD4}\,\frac{\text{IL\_7}}{k_{\text{act\_CD4\_IL\_7\_m}} + \text{IL\_7}} - k_{\text{IL\_7\_d}}\,\text{IL\_7}$$

$$\text{(Eq. 19)} \quad \frac{d\,\text{iTreg}}{dt} = \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,k_{\text{iTreg\_TGFbeta\_f}}\,\frac{\text{TGFbeta}}{k_{\text{iTreg\_TGFbeta\_m}} + \text{TGFbeta}}\,\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}}$$
$$+ \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}}$$
$$+ \text{act\_CD4}\,k_{\text{iTreg\_mDC\_f}}\,k_{\text{iTreg\_IL\_10\_f}}\,\frac{\text{IL\_10}}{k_{\text{iTreg\_IL\_10\_m}} + \text{IL\_10}}\,\frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}}$$
$$+ k_{\text{iTreg\_f}}\,\text{iTreg}\left(1 - \frac{\text{iTreg}}{k_{\text{iTreg\_m}}}\right) - k_{\text{iTreg\_d}}\,\text{iTreg}$$

(Eq. 20)
$$\frac{d\,\mathrm{mDC}}{dt} = k_{\mathrm{mDC\_Antigen\_f}} \, \mathrm{Antigen\,nDC} \, \frac{k_{\mathrm{mDC\_IL\_10\_m}}}{k_{\mathrm{mDC\_IL\_10\_m}} + \mathrm{IL\_10}}$$
$$+ k_{\mathrm{mDC\_GMCSF\_f}} \, \mathrm{Antigen\,nDC} \, \frac{\mathrm{GMCSF}}{\mathrm{GMCSF} + k_{\mathrm{mDC\_GMCSF\_m}}} \, \frac{k_{\mathrm{mDC\_IL\_10\_m}}}{k_{\mathrm{mDC\_IL\_10\_m}} + \mathrm{IL\_10}}$$
$$+ k_{\mathrm{mDC\_f}} \, \mathrm{mDC} \left(1 - \frac{\mathrm{mDC}}{k_{\mathrm{mDC\_m}}}\right) - k_{\mathrm{mDC\_d}} \, \mathrm{mDC}$$

(Eq. 21)
$$\frac{d\,\mathrm{Naive\_B\_cells}}{dt} = k_{\mathrm{Naive\_B\_cells\_f}} \, \mathrm{Naive\_B\_cells} \left(1 - \frac{\mathrm{Naive\_B\_cells}}{k_{\mathrm{Naive\_B\_cells\_m}}}\right)$$
$$+ k_{\mathrm{Naive\_B\_cells\_Antigen\_f}} \, \mathrm{Naive\_B\_cells\,Antigen} \left(1 - \frac{\mathrm{Naive\_B\_cells}}{k_{\mathrm{Naive\_B\_cells\_m}}}\right)$$
$$- k_{\mathrm{Act\_B\_cells\_basal\_f}} \, \mathrm{Naive\_B\_cells} - k_{\mathrm{Act\_B\_cells\_Antigen\_f}} \, \mathrm{Naive\_B\_cells\,Antigen}$$
$$- k_{\mathrm{Naive\_B\_cells\_d}} \, \mathrm{Naive\_B\_cells}$$

(Eq. 22)
$$\frac{d\,\mathrm{naive\_CD4}}{dt} = k_{\mathrm{CD4\_f}} \, \mathrm{naive\_CD4} \left(1 - \frac{\mathrm{naive\_CD4}}{k_{\mathrm{CD4\_m}}}\right)$$
$$+ \mathrm{naive\_CD4} \left(1 - \frac{\mathrm{naive\_CD4}}{k_{\mathrm{CD4\_m}}}\right) k_{\mathrm{naive\_CD4\_IL\_15\_f}} \, \frac{\mathrm{IL\_15}}{k_{\mathrm{naive\_CD4\_IL\_15\_m}} + \mathrm{IL\_15}}$$
$$+ k_{\mathrm{naive\_CD4\_IL\_7\_f}} \, \mathrm{naive\_CD4} \left(1 - \frac{\mathrm{naive\_CD4}}{k_{\mathrm{CD4\_m}}}\right) \frac{\mathrm{IL\_7}}{k_{\mathrm{naive\_CD4\_IL\_7\_m}} + \mathrm{IL\_7}}$$
$$- \mathrm{naive\_CD4} \, \frac{k_{\mathrm{act\_CD4\_mDC\_f}} \, \mathrm{mDC}}{k_{\mathrm{act\_CD4\_mDC\_m}} + \mathrm{mDC}} - \mathrm{naive\_CD4} \, \frac{k_{\mathrm{act\_CD4\_IL\_2\_f}} \, \mathrm{IL\_2}}{k_{\mathrm{act\_CD4\_IL\_2\_m}} + \mathrm{IL\_2}}$$
$$- k_{\mathrm{naive\_CD4\_d}} \, \mathrm{naive\_CD4}$$

(Eq. 23)
$$\frac{d\,\mathrm{nDC}}{dt} = k_{\mathrm{nDC\_f}} \, \mathrm{nDC} \left(1 - \frac{\mathrm{nDC}}{k_{\mathrm{nDC\_m}}}\right)$$
$$- k_{\mathrm{mDC\_Antigen\_f}} \, \mathrm{Antigen\,nDC} \, \frac{k_{\mathrm{mDC\_IL\_10\_m}}}{k_{\mathrm{mDC\_IL\_10\_m}} + \mathrm{IL\_10}}$$
$$- k_{\mathrm{mDC\_GMCSF\_f}} \, \mathrm{Antigen\,nDC} \, \frac{\mathrm{GMCSF}}{\mathrm{GMCSF} + k_{\mathrm{mDC\_GMCSF\_m}}} \, \frac{k_{\mathrm{mDC\_IL\_10\_m}}}{k_{\mathrm{mDC\_IL\_10\_m}} + \mathrm{IL\_10}}$$
$$- k_{\mathrm{pDC\_Antigen\_f}} \, \mathrm{nDC\,Antigen} - k_{\mathrm{nDC\_d}} \, \mathrm{nDC}$$

(Eq. 24)
$$\frac{d\,\mathrm{NK}}{dt} = k_{\mathrm{NK\_f}} \, \mathrm{NK} \left(1 - \frac{\mathrm{NK}}{k_{\mathrm{NK\_m}}}\right) - k_{\mathrm{act\_NK\_base\_f}} \, \mathrm{NK}$$
$$- k_{\mathrm{act\_NK\_IL\_12\_f}} \, \mathrm{NK} \, \frac{\mathrm{IL\_12}}{\mathrm{IL\_12} + k_{\mathrm{act\_NK\_IL\_12\_m}}} - k_{\mathrm{act\_NK\_IL\_2\_f}} \, \mathrm{NK} \, \frac{\mathrm{IL\_2}}{\mathrm{IL\_2} + k_{\mathrm{act\_NK\_IL\_2\_m}}}$$
$$- k_{\mathrm{act\_NK\_IFN1\_f}} \, \mathrm{NK} \, \frac{\mathrm{IFN1}}{\mathrm{IFN1} + k_{\mathrm{act\_NK\_IFN1\_m}}} - k_{\mathrm{act\_NK\_IFN\_g\_f}} \, \mathrm{NK} \, \frac{\mathrm{IFN\_g}}{\mathrm{IFN\_g} + k_{\mathrm{act\_NK\_IFN\_g\_m}}}$$
$$- k_{\mathrm{NK\_d}} \, \mathrm{NK}$$

(Eq. 25)
$$\frac{d\,\mathrm{nTreg}}{dt} = k_{\mathrm{nTreg\_mDC\_f}} \, \mathrm{nTreg} \left(1 - \frac{\mathrm{nTreg}}{k_{\mathrm{nTreg\_m}}}\right) \frac{\mathrm{mDC}}{k_{\mathrm{nTreg\_mDC\_m}} + \mathrm{mDC}} - k_{\mathrm{nTreg\_d}} \, \mathrm{nTreg}$$

(Eq. 26)
$$\frac{d\,\mathrm{pDC}}{dt} = k_{\mathrm{pDC\_Antigen\_f}} \, \mathrm{nDC\,Antigen} + k_{\mathrm{pDC\_f}} \, \mathrm{pDC} \left(1 - \frac{\mathrm{pDC}}{k_{\mathrm{pDC\_m}}}\right) - k_{\mathrm{pDC\_d}} \, \mathrm{pDC}$$

$$\text{(Eq. 27)} \quad \begin{aligned} \frac{d\,\text{TD\_IS\_B\_cells}}{dt} = {}& k_{\text{TD\_IS\_B\_cells\_base\_f}}\,\text{Act\_B\_cells} + k_{\text{TD\_IS\_B\_cells\_IL\_4\_f}}\,\text{Act\_B\_cells}\,\text{IL\_4} \\ & + k_{\text{TD\_IS\_B\_cells\_TD\_IS\_B\_cells\_f}}\,\text{TD\_IS\_B\_cells}\left(1 - \frac{\text{TD\_IS\_B\_cells}}{k_{\text{TD\_IS\_B\_cells\_TD\_IS\_B\_cells\_m}}}\right) \\ & - k_{\text{TD\_IS\_B\_cells\_d}}\,\text{TD\_IS\_B\_cells} \end{aligned}$$

$$\text{(Eq. 28)} \quad \begin{aligned} \frac{d\,\text{TFH}}{dt} = {}& \text{act\_CD4}\,k_{\text{TFH\_mDC\_f}} + \text{act\_CD4}\,k_{\text{TFH\_mDC\_Antigen\_f}}\,\text{Antigen} \\ & + k_{\text{TFH\_IFN1\_f}}\,\text{act\_CD4}\,\frac{\text{IFN1}}{k_{\text{TFH\_IFN1\_m}} + \text{IFN1}} + k_{\text{TFH\_IL\_6\_f}}\,\text{act\_CD4}\,\frac{\text{IL\_6}}{k_{\text{TFH\_IL\_6\_m}} + \text{IL\_6}} \\ & + k_{\text{TFH\_f}}\,\text{TFH}\left(1 - \frac{\text{TFH}}{k_{\text{TFH\_m}}}\right) - k_{\text{TFH\_d}}\,\text{TFH} \end{aligned}$$

$$\text{(Eq. 29)} \quad \begin{aligned} \frac{d\,\text{TGFbeta}}{dt} = {}& k_{\text{TGFbeta\_iTreg\_f}}\,\text{iTreg} + k_{\text{TGFbeta\_CD4\_CTL\_f}}\,\text{CD4\_CTL} \\ & + k_{\text{TGFbeta\_nTreg\_f}}\,\text{nTreg}\,\text{mDC}\,\frac{1}{k_{\text{TGFbeta\_nTreg\_mDC\_m}} + \text{mDC}} \\ & - \text{act\_CD4}\,k_{\text{iTreg\_mDC\_d}}\,k_{\text{iTreg\_TGFbeta\_f}}\,\text{TGFbeta}\,\frac{1}{k_{\text{iTreg\_TGFbeta\_m}} + \text{TGFbeta}} \\ & * \frac{k_{\text{iTreg\_IL\_1\_m}}}{k_{\text{iTreg\_IL\_1\_m}} + \text{IL\_1}} - k_{\text{TGFbeta\_d}}\,\text{TGFbeta} \end{aligned}$$

$$\text{(Eq. 30)} \quad \begin{aligned} \frac{d\,\text{Th2}}{dt} = {}& \text{act\_CD4}\,k_{\text{Th2\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\,\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\,\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}} \\ & + \text{act\_CD4}\,k_{\text{Th2\_IL\_4\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\,\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\,\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}} \\ & * \frac{\text{IL\_4}}{k_{\text{Th2\_IL\_4\_m}} + \text{IL\_4}} \\ & + \text{act\_CD4}\,k_{\text{Th2\_IL\_33\_f}}\,\frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}}\,\frac{k_{\text{Th2\_IL\_10\_m}}}{k_{\text{Th2\_IL\_10\_m}} + \text{IL\_10}}\,\frac{k_{\text{Th2\_IL\_12\_m}}}{k_{\text{Th2\_IL\_12\_m}} + \text{IL\_12}} \\ & * \frac{\text{IL\_33}}{k_{\text{Th2\_IL\_33\_m}} + \text{IL\_33}} \\ & + k_{\text{Th2\_f}}\,\text{Th2}\left(1 - \frac{\text{Th2}}{k_{\text{Th2\_m}}}\right) - k_{\text{Th2\_d}}\,\text{Th2} \end{aligned}$$

$$\text{(Eq. 31)} \quad \frac{d\,\text{IgG4}}{dt} = k_{\text{IgG4\_TI\_IS\_B\_cells\_f}}\,10^8\,\text{TI\_IS\_B\_cells} + k_{\text{IgG4\_TD\_IS\_B\_cells\_f}}\,10^8\,\text{TD\_IS\_B\_cells} - k_{\text{IgG4\_d}}\,\text{IgG4\_d}$$

$$\text{(Eq. 32)} \quad \begin{aligned} \frac{d\,\text{TI\_IS\_B\_cells}}{dt} = {}& k_{\text{TI\_IS\_B\_cells\_base\_f}}\,\text{Act\_B\_cells} + k_{\text{TI\_IS\_B\_cells\_IFN\_g\_f}}\,\text{Act\_B\_cells}\,\text{IFN\_g} \\ & + k_{\text{TI\_IS\_B\_cells\_IL\_10\_f}}\,\text{Act\_B\_cells}\,\text{IL\_10} \\ & + k_{\text{TI\_IS\_B\_cells\_TI\_IS\_B\_cells\_f}}\,\text{TI\_IS\_B\_cells}\left(1 - \frac{\text{TI\_IS\_B\_cells}}{k_{\text{TI\_IS\_B\_cells\_TI\_IS\_B\_cells\_m}}}\right) \\ & - k_{\text{TI\_IS\_B\_cells\_d}}\,\text{TI\_IS\_B\_cells} \end{aligned}$$