

Supplementary Note

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

Supplementary Note 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

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Supplementary Note 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

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Supplementary Note 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

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Supplementary Note 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

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Supplementary Note 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

Supplementary Note Table 3: Model reactions

Number	Educt	Product	Rate
1	{}	AntigenDiff	0
2	{}	Antigen	<i>AntigenDiff</i>
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	{}	$naive_CD4 * k_naive_CD4_IL_15_d * IL_15 / (k_naive_CD4_IL_15_m + IL_15)$

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Supplementary Note 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	$act_CD4 * k_{iTreg.mDC}.f * (k_{iTreg.IL_1.m} / (k_{iTreg.IL_1.m} + IL_1))$

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Supplementary Note 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	$k_act_NK_f * act_NK * (1 - act_NK/k_act_NK_m) * k_pro_act_NK_IL_12_f * IL_12/(IL_12 + k_pro_act_NK_IL_12_m)$

Continued on next page

Supplementary Note 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	{}	$k_Act_B_cells_d * Act_B_cells$

Continued on next page

Supplementary Note 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.

$$\begin{aligned}
 \frac{d \text{Act_B_cells}}{dt} = & k_{\text{Act_B_cells_basal_f}} \text{Naive_B_cells} + k_{\text{Act_B_cells_Antigen_f}} \text{Naive_B_cells Antigen} \\
 & + k_{\text{Act_B_Act_B_f}} \text{Act_B_cells} \left(1 - \frac{\text{Act_B_cells}}{k_{\text{Act_B_Act_B_m}}} \right) \\
 & + k_{\text{Act_B_Act_B_Antigen_f}} \text{Act_B_cells Antigen} \left(1 - \frac{\text{Act_B_cells}}{k_{\text{Act_B_Act_B_m}}} \right) \\
 & - k_{\text{TD_IS_B_cells_base_f}} \text{Act_B_cells} - k_{\text{TD_IS_B_cells_IL_4_f}} \text{Act_B_cells IL_4} \\
 & - k_{\text{TI_IS_B_cells_base_f}} \text{Act_B_cells} - k_{\text{TI_IS_B_cells_IFN_g_f}} \text{Act_B_cells IFN_g} \\
 & - k_{\text{TI_IS_B_cells_IL_10_f}} \text{Act_B_cells IL_10} - k_{\text{Act_B_cells_d}} \text{Act_B_cells} \\
 \end{aligned}
 \quad (\text{Eq. 1})$$

$$\begin{aligned}
 \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}
 \end{aligned}
 \quad (\text{Eq. 2})$$

$$\begin{aligned}
\frac{d \text{act_NK}}{dt} = & k_{\text{act_NK_base_f}} \text{NK} \\
& + k_{\text{act_NK_IL_12_f}} \text{NK} \frac{\text{IL_12}}{\text{IL_12} + k_{\text{act_NK_IL_12_m}}} \\
& + k_{\text{act_NK_IL_2_f}} \text{NK} \frac{\text{IL_2}}{\text{IL_2} + k_{\text{act_NK_IL_2_m}}} \\
& + k_{\text{act_NK_IFN1_f}} \text{NK} \frac{\text{IFN1}}{\text{IFN1} + k_{\text{act_NK_IFN1_m}}} \\
& + k_{\text{act_NK_IFN_g_f}} \text{NK} \frac{\text{IFN_g}}{\text{IFN_g} + k_{\text{act_NK_IFN_g_m}}} \\
& + k_{\text{act_NK_f}} \text{act_NK} \left(1 - \frac{\text{act_NK}}{k_{\text{act_NK_m}}} \right) \\
& + k_{\text{act_NK_f}} \text{act_NK} \left(1 - \frac{\text{act_NK}}{k_{\text{act_NK_m}}} \right) k_{\text{pro_act_NK_IL_12_f}} \frac{\text{IL_12}}{\text{IL_12} + k_{\text{pro_act_NK_IL_12_m}}} \\
& - k_{\text{act_NK_d}} \text{act_NK}
\end{aligned} \tag{Eq. 3}$$

$$\frac{d \text{Antigen}}{dt} = \text{AntigenDiff} \tag{Eq. 4}$$

$$\begin{aligned}
\frac{d \text{AntigenDiff}}{dt} = & 0 \\
\frac{d \text{CD4_CTL}}{dt} = & k_{\text{act_CD4_CTL_basal_f}} \text{act_CD4} + k_{\text{act_CD4_CTL_antigen_f}} \text{act_CD4} \text{Antigen} \\
& + k_{\text{act_CD4_IFN1_f}} \text{act_CD4} \frac{\text{IFN1}}{k_{\text{IFN1_CD4_CTL_m}} + \text{IFN1}} \\
& + k_{\text{CD4_CTL_CD4_CTL_f}} \text{CD4_CTL} \left(1 - \frac{\text{CD4_CTL}}{k_{\text{CD4_CTL_CD4_CTL_m}}} \right) - k_{\text{CD4_CTL_d}} \text{CD4_CTL}
\end{aligned} \tag{Eq. 6}$$

$$\begin{aligned}
\frac{d \text{GMCSF}}{dt} = & - k_{\text{mDC_GMCSF_d}} \text{Antigen nDC} \frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC_GMCSF_m}}} \frac{k_{\text{mDC_IL_10_m}}}{k_{\text{mDC_IL_10_m}} + \text{IL_10}} \\
& + k_{\text{GMCSF_Th2_f}} \text{Th2} + k_{\text{GMCSF_Th2_Antigen_f}} \text{Th2 Antigen} + k_{\text{GMCSF_act_NK_f}} \text{act_NK} \\
& - k_{\text{GMCSF_d}} \text{GMCSF}
\end{aligned} \tag{Eq. 7}$$

$$\begin{aligned}
\frac{d \text{IFN_g}}{dt} = & k_{\text{IFN_g_CD4_CTL_f}} \text{CD4_CTL} + k_{\text{IFN_g_act_NK_f}} \text{act_NK} - k_{\text{act_NK_IFN_g_d}} \text{NK} \frac{\text{IFN_g}}{\text{IFN_g} + k_{\text{act_NK_IFN_g_m}}} \\
& - k_{\text{IFN_g_d}} \text{IFN_g}
\end{aligned} \tag{Eq. 8}$$

$$\begin{aligned}
\frac{d \text{IFN1}}{dt} = & k_{\text{IFN1_pDC_f}} \text{pDC} - k_{\text{act_CD4_IFN1_d}} \text{act_CD4} \frac{\text{IFN1}}{k_{\text{IFN1_CD4_CTL_m}} + \text{IFN1}} \\
& - k_{\text{TFH_IFN1_f}} \text{act_CD4} \frac{\text{IFN1}}{k_{\text{TFH_IFN1_m}} + \text{IFN1}} - k_{\text{act_NK_IFN1_d}} \text{NK} \frac{\text{IFN1}}{k_{\text{act_NK_IFN1_m}} + \text{IFN1}} \\
& - k_{\text{IFN1_d}} \text{IFN1}
\end{aligned} \tag{Eq. 9}$$

$$\frac{d \text{IL_1}}{dt} = k_{\text{IL1_mDC_f}} \text{mDC} - k_{\text{IL1_d}} \text{IL_1} \tag{Eq. 10}$$

$$(Eq. 11) \quad \frac{dIL_{-10}}{dt} = k_{IL_{-10},iTreg,f} iTreg + k_{IL_{-10},nTreg,f} nTreg mDC \frac{1}{k_{IL_{-10},nTreg,mDC,m} + mDC} - act_CD4 k_{iTreg,mDC,d} k_{iTreg,IL_{-10},f} \frac{IL_{-10}}{k_{iTreg,IL_{-10},m} + IL_{-10}} \frac{k_{iTreg,IL_{-1},m}}{k_{iTreg,IL_{-1},m} + IL_{-1}} - k_{IL_{-10},d} IL_{-10}$$

$$(Eq. 12) \quad \frac{dIL_{-12}}{dt} = k_{IL_{-12},mDC,f} mDC - k_{act,NK,IL_{-12},d} NK \frac{IL_{-12}}{IL_{-12} + k_{act,NK,IL_{-12},m}} - k_{act,NK,d} act_NK k_{pro,act,NK,IL_{-12},f} \frac{IL_{-12}}{IL_{-12} + k_{pro,act,NK,IL_{-12},m}} - k_{IL_{-12},d} IL_{-12}$$

$$(Eq. 13) \quad \frac{dIL_{-15}}{dt} = k_{IL_{-15},f} + k_{IL_{-15},Antigen,f} Antigen - naive_CD4 k_{naive,CD4,IL_{-15},d} \frac{IL_{-15}}{k_{naive,CD4,IL_{-15},m} + IL_{-15}} - k_{act,CD4,IL_{-15},d} act_CD4 \frac{IL_{-15}}{k_{act,CD4,IL_{-15},m} + IL_{-15}} - k_{IL_{-15},d} IL_{-15}$$

$$(Eq. 14) \quad \frac{dIL_{-2}}{dt} = k_{IL_{-2},act,CD4,f} act_CD4 + k_{IL_{-2},act,CD4,Antigen,f} act_CD4 Antigen - naive_CD4 k_{act,CD4,IL_{-2},d} \frac{IL_{-2}}{k_{act,CD4,IL_{-2},m} + IL_{-2}} - k_{act,NK,IL_{-2},d} NK \frac{IL_{-2}}{IL_{-2} + k_{act,NK,IL_{-2},m}} - k_{IL_{-2},d} IL_{-2}$$

$$(Eq. 15) \quad \frac{dIL_{-33}}{dt} = k_{IL_{-33},pDC,f} pDC - k_{act,CD4,IL_{-33},d} act_CD4 \frac{IL_{-33}}{k_{Th2,IL_{-33},m} + IL_{-33}} - k_{IL_{-33},d} IL_{-33}$$

$$(Eq. 16) \quad \frac{dIL_{-4}}{dt} = k_{IL_{-4},Th2,f} Th2 + k_{IL_{-4},Th2,Antigen,f} Th2 Antigen - k_{act,CD4,IL_{-4},d} act_CD4 \frac{IL_{-4}}{k_{Th2,IL_{-4},m} + IL_{-4}} - k_{IL_{-4},d} IL_{-4}$$

$$(Eq. 17) \quad \frac{dIL_{-6}}{dt} = k_{IL_{-6},pDC,f} pDC + k_{IL_{-6},mDC,f} mDC + k_{IL_{-6},TFH,f} TFH \frac{k_{TFH,nTreg,m}}{nTreg + k_{TFH,nTreg,m}} - k_{TFH,IL_{-6},d} act_CD4 \frac{IL_{-6}}{k_{TFH,IL_{-6},m} + IL_{-6}} - k_{IL_{-6},d} IL_{-6}$$

$$(Eq. 18) \quad \frac{dIL_{-7}}{dt} = k_{IL_{-7},f} - k_{naive,CD4,IL_{-7},d} naive_CD4 \frac{IL_{-7}}{k_{naive,CD4,IL_{-7},m} + IL_{-7}} - k_{act,CD4,IL_{-7},d} act_CD4 \frac{IL_{-7}}{k_{act,CD4,IL_{-7},m} + IL_{-7}} - k_{IL_{-7},d} IL_{-7}$$

$$(Eq. 19) \quad \frac{d iTreg}{dt} = act_CD4 k_{iTreg,mDC,f} k_{iTreg,TGFbeta,f} \frac{TGFbeta}{k_{iTreg,TGFbeta,m} + TGFbeta} \frac{k_{iTreg,IL_{-1},m}}{k_{iTreg,IL_{-1},m} + IL_{-1}} + act_CD4 k_{iTreg,mDC,f} \frac{k_{iTreg,IL_{-1},m}}{k_{iTreg,IL_{-1},m} + IL_{-1}} + act_CD4 k_{iTreg,mDC,f} k_{iTreg,IL_{-10},f} \frac{IL_{-10}}{k_{iTreg,IL_{-10},m} + IL_{-10}} \frac{k_{iTreg,IL_{-1},m}}{k_{iTreg,IL_{-1},m} + IL_{-1}} + k_{iTreg,f} iTreg \left(1 - \frac{iTreg}{k_{iTreg,m}} \right) - k_{iTreg,d} iTreg$$

$$\begin{aligned}
\frac{d \text{mDC}}{dt} = & k_{\text{mDC_Antigen_f}} \text{Antigen nDC} \frac{k_{\text{mDC_IL_10_m}}}{k_{\text{mDC_IL_10_m}} + \text{IL_10}} \\
& + k_{\text{mDC_GMCSF_f}} \text{Antigen nDC} \frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC_GMCSF_m}}} \frac{k_{\text{mDC_IL_10_m}}}{k_{\text{mDC_IL_10_m}} + \text{IL_10}} \\
& + k_{\text{mDC_f}} \text{mDC} \left(1 - \frac{\text{mDC}}{k_{\text{mDC_m}}} \right) - k_{\text{mDC_d}} \text{mDC}
\end{aligned}
\quad (\text{Eq. 20})$$

$$\begin{aligned}
\frac{d \text{Naive_B_cells}}{dt} = & k_{\text{Naive_B_cells_f}} \text{Naive_B_cells} \left(1 - \frac{\text{Naive_B_cells}}{k_{\text{Naive_B_cells_m}}} \right) \\
& + k_{\text{Naive_B_cells_Antigen_f}} \text{Naive_B_cells} \text{Antigen} \left(1 - \frac{\text{Naive_B_cells}}{k_{\text{Naive_B_cells_m}}} \right) \\
& - k_{\text{Act_B_cells_basal_f}} \text{Naive_B_cells} - k_{\text{Act_B_cells_Antigen_f}} \text{Naive_B_cells} \text{Antigen} \\
& - k_{\text{Naive_B_cells_d}} \text{Naive_B_cells}
\end{aligned}
\quad (\text{Eq. 21})$$

$$\begin{aligned}
\frac{d \text{naive_CD4}}{dt} = & k_{\text{CD4_f}} \text{naive_CD4} \left(1 - \frac{\text{naive_CD4}}{k_{\text{CD4_m}}} \right) \\
& + \text{naive_CD4} \left(1 - \frac{\text{naive_CD4}}{k_{\text{CD4_m}}} \right) k_{\text{naive_CD4_IL_15_f}} \frac{\text{IL_15}}{k_{\text{naive_CD4_IL_15_m}} + \text{IL_15}} \\
& + k_{\text{naive_CD4_IL_7_f}} \text{naive_CD4} \left(1 - \frac{\text{naive_CD4}}{k_{\text{CD4_m}}} \right) \frac{\text{IL_7}}{k_{\text{naive_CD4_IL_7_m}} + \text{IL_7}} \\
& - \text{naive_CD4} \frac{k_{\text{act_CD4_mDC_f}} \text{mDC}}{k_{\text{act_CD4_mDC_m}} + \text{mDC}} - \text{naive_CD4} \frac{k_{\text{act_CD4_IL_2_f}} \text{IL_2}}{k_{\text{act_CD4_IL_2_m}} + \text{IL_2}} \\
& - k_{\text{naive_CD4_d}} \text{naive_CD4}
\end{aligned}
\quad (\text{Eq. 22})$$

$$\begin{aligned}
\frac{d \text{nDC}}{dt} = & k_{\text{nDC_f}} \text{nDC} \left(1 - \frac{\text{nDC}}{k_{\text{nDC_m}}} \right) \\
& - k_{\text{mDC_Antigen_f}} \text{Antigen nDC} \frac{k_{\text{mDC_IL_10_m}}}{k_{\text{mDC_IL_10_m}} + \text{IL_10}} \\
& - k_{\text{mDC_GMCSF_f}} \text{Antigen nDC} \frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC_GMCSF_m}}} \frac{k_{\text{mDC_IL_10_m}}}{k_{\text{mDC_IL_10_m}} + \text{IL_10}} \\
& - k_{\text{pDC_Antigen_f}} \text{nDC} \text{Antigen} - k_{\text{nDC_d}} \text{nDC}
\end{aligned}
\quad (\text{Eq. 23})$$

$$\begin{aligned}
\frac{d \text{NK}}{dt} = & k_{\text{NK_f}} \text{NK} \left(1 - \frac{\text{NK}}{k_{\text{NK_m}}} \right) - k_{\text{act_NK_base_f}} \text{NK} \\
& - k_{\text{act_NK_IL_12_f}} \text{NK} \frac{\text{IL_12}}{\text{IL_12} + k_{\text{act_NK_IL_12_m}}} - k_{\text{act_NK_IL_2_f}} \text{NK} \frac{\text{IL_2}}{\text{IL_2} + k_{\text{act_NK_IL_2_m}}} \\
& - k_{\text{act_NK_IFN1_f}} \text{NK} \frac{\text{IFN1}}{\text{IFN1} + k_{\text{act_NK_IFN1_m}}} - k_{\text{act_NK_IFN_g_f}} \text{NK} \frac{\text{IFN_g}}{\text{IFN_g} + k_{\text{act_NK_IFN_g_m}}} \\
& - k_{\text{NK_d}} \text{NK}
\end{aligned}
\quad (\text{Eq. 24})$$

$$\frac{d \text{nTreg}}{dt} = k_{\text{nTreg_mDC_f}} \text{nTreg} \left(1 - \frac{\text{nTreg}}{k_{\text{nTreg_m}}} \right) \frac{\text{mDC}}{k_{\text{nTreg_mDC_m}} + \text{mDC}} - k_{\text{nTreg_d}} \text{nTreg}
\quad (\text{Eq. 25})$$

$$\frac{d \text{pDC}}{dt} = k_{\text{pDC_Antigen_f}} \text{nDC} \text{Antigen} + k_{\text{pDC_f}} \text{pDC} \left(1 - \frac{\text{pDC}}{k_{\text{pDC_m}}} \right) - k_{\text{pDC_d}} \text{pDC}
\quad (\text{Eq. 26})$$

$$\begin{aligned}
\frac{d \text{TD_IS_B_cells}}{dt} = & k_{\text{TD_IS_B_cells_base_f}} \text{Act_B_cells} + k_{\text{TD_IS_B_cells_IL_4_f}} \text{Act_B_cells IL_4} \\
(\text{Eq. 27}) \quad & + k_{\text{TD_IS_B_cells_TD_IS_B_cells_f}} \text{TD_IS_B_cells} \left(1 - \frac{\text{TD_IS_B_cells}}{k_{\text{TD_IS_B_cells_TD_IS_B_cells_m}}} \right) \\
& - k_{\text{TD_IS_B_cells_d}} \text{TD_IS_B_cells}
\end{aligned}$$

$$\begin{aligned}
\frac{d \text{TFH}}{dt} = & \text{act_CD4 } k_{\text{TFH_mDC_f}} + \text{act_CD4 } k_{\text{TFH_mDC_Antigen_f}} \text{Antigen} \\
(\text{Eq. 28}) \quad & + k_{\text{TFH_IFN1_f}} \text{act_CD4} \frac{\text{IFN1}}{k_{\text{TFH_IFN1_m}} + \text{IFN1}} + k_{\text{TFH_IL_6_f}} \text{act_CD4} \frac{\text{IL_6}}{k_{\text{TFH_IL_6_m}} + \text{IL_6}} \\
& + k_{\text{TFH_f}} \text{TFH} \left(1 - \frac{\text{TFH}}{k_{\text{TFH_m}}} \right) - k_{\text{TFH_d}} \text{TFH}
\end{aligned}$$

$$\begin{aligned}
\frac{d \text{TGFbeta}}{dt} = & k_{\text{TGFbeta_iTreg_f}} \text{iTreg} + k_{\text{TGFbeta_CD4_CTL_f}} \text{CD4_CTL} \\
& + k_{\text{TGFbeta_nTreg_f}} \text{nTreg mDC} \frac{1}{k_{\text{TGFbeta_nTreg_mDC_m}} + \text{mDC}} \\
(\text{Eq. 29}) \quad & - \text{act_CD4 } k_{\text{iTreg_mDC_d}} k_{\text{iTreg_TGFbeta_f}} \text{TGFbeta} \frac{1}{k_{\text{iTreg_TGFbeta_m}} + \text{TGFbeta}} \\
& * \frac{k_{\text{iTreg_IL_1_m}}}{k_{\text{iTreg_IL_1_m}} + \text{IL_1}} - k_{\text{TGFbeta_d}} \text{TGFbeta}
\end{aligned}$$

$$\begin{aligned}
\frac{d \text{Th2}}{dt} = & \text{act_CD4 } k_{\text{Th2_f}} \frac{k_{\text{Th2_TGFbeta_m}}}{k_{\text{Th2_TGFbeta_m}} + \text{TGFbeta}} \frac{k_{\text{Th2_IL_10_m}}}{k_{\text{Th2_IL_10_m}} + \text{IL_10}} \frac{k_{\text{Th2_IL_12_m}}}{k_{\text{Th2_IL_12_m}} + \text{IL_12}} \\
& + \text{act_CD4 } k_{\text{Th2_IL_4_f}} \frac{k_{\text{Th2_TGFbeta_m}}}{k_{\text{Th2_TGFbeta_m}} + \text{TGFbeta}} \frac{k_{\text{Th2_IL_10_m}}}{k_{\text{Th2_IL_10_m}} + \text{IL_10}} \frac{k_{\text{Th2_IL_12_m}}}{k_{\text{Th2_IL_12_m}} + \text{IL_12}} \\
& * \frac{\text{IL_4}}{k_{\text{Th2_IL_4_m}} + \text{IL_4}} \\
& + \text{act_CD4 } k_{\text{Th2_IL_33_f}} \frac{k_{\text{Th2_TGFbeta_m}}}{k_{\text{Th2_TGFbeta_m}} + \text{TGFbeta}} \frac{k_{\text{Th2_IL_10_m}}}{k_{\text{Th2_IL_10_m}} + \text{IL_10}} \frac{k_{\text{Th2_IL_12_m}}}{k_{\text{Th2_IL_12_m}} + \text{IL_12}} \\
& * \frac{\text{IL_33}}{k_{\text{Th2_IL_33_m}} + \text{IL_33}} \\
& + k_{\text{Th2_f}} \text{Th2} \left(1 - \frac{\text{Th2}}{k_{\text{Th2_m}}} \right) - k_{\text{Th2_d}} \text{Th2}
\end{aligned}
(\text{Eq. 30})$$

$$\begin{aligned}
\frac{d \text{IgG4}}{dt} = & k_{\text{IgG4_TI_IS_B_cells_f}} 10^8 \text{TI_IS_B_cells} + k_{\text{IgG4_TD_IS_B_cells_f}} 10^8 \text{TD_IS_B_cells} - k_{\text{IgG4_d}} \text{IgG4_d} \\
\frac{d \text{TI_IS_B_cells}}{dt} = & k_{\text{TI_IS_B_cells_base_f}} \text{Act_B_cells} + k_{\text{TI_IS_B_cells_IFN_g_f}} \text{Act_B_cells IFN_g} \\
& + k_{\text{TI_IS_B_cells_IL_10_f}} \text{Act_B_cells IL_10} \\
(\text{Eq. 32}) \quad & + k_{\text{TI_IS_B_cells_TI_IS_B_cells_f}} \text{TI_IS_B_cells} \left(1 - \frac{\text{TI_IS_B_cells}}{k_{\text{TI_IS_B_cells_TI_IS_B_cells_m}}} \right) \\
& - k_{\text{TI_IS_B_cells_d}} \text{TI_IS_B_cells}
\end{aligned}$$