

## 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- $\beta$
17	IFN_g	IFN- $\gamma$
18	naive_CD4	Naïve CD4 <sup>+</sup> T
19	act_CD4	Active CD4 <sup>+</sup> T
20	Th2	Th2 Cell
21	iTreg	Induced Treg
22	CD4_CTL	Cytotoxic CD4 <sup>+</sup> T
23	nTreg	Natural Treg
24	TFH	TFH
25	NK	CD56 <sup>+</sup> NK
26	act_NK	CD16 <sup>+</sup> 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**

<b>Parameter name</b>	<b>Meaning</b>
k_TLIS_B_cells_TLIS_B_cells_m	Carrying capacity for the proliferation of T cell-independent plasma cells
k_TLIS_B_cells_TLIS_B_cells_f	Proliferation rate of T cell-independent plasma cells
k_TLIS_B_cells_IL_10_f	Differentiation rate of active B cells into T cell-independent plasma cells driven by IL-10
k_TLIS_B_cells_IFN_g_f	Differentiation rate of active B cells into T cell-independent plasma cells driven by IFN- $\gamma$
k_TLIS_B_cells_d	Death rate of T cell-independent plasma cells
k_TLIS_B_cells_base_f	Basal differentiation rate of active B cells into T cell-independent plasma cells
k_Th2_TGFbeta_m	TGF- $\beta$ 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- $\beta$ by nTreg
k_TGFbeta_nTreg_f	Secretion rate of TGF- $\beta$ by nTreg
k_TGFbeta iTreg_f	Secretion rate of TGF- $\beta$ by iTreg
k_TGFbeta_d	Degradation rate of TGF- $\beta$
k_TGFbeta_CD4_CTL_f	Secretion rate of TGF- $\beta$ 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)**

<b>Parameter name</b>	<b>Meaning</b>
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- $\beta$
k iTreg_TGFbeta_f	Differentiation rate of active CD4 cells into iTreg driven by TGF- $\beta$
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)**

<b>Parameter name</b>	<b>Meaning</b>
k iTreg_IL10_m	Hill coefficient in the differentiation of active CD4 cells into iTreg driven by IL-10
k iTreg_IL10_f	Differentiation rate of active CD4 cells into iTreg driven by IL-10
k iTreg_IL1_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_IL7_f	Production rate of IL-7
k_IL7_d	Degradation rate of IL-7
k_IL6_pDC_f	Secretion rate of IL-6 by pDC cells
k_IL6_mDC_f	Secretion rate of IL-6 by mDC cells
k_IL6_d	Degradation rate of IL-6
k_IL4_Th2_f	Secretion rate of IL-4 by Th2
k_IL4_Th2_Antigen_f	Secretion rate of IL-4 by Th2 in the presence of antigen
k_IL4_d	Degradation rate of IL-4
k_IL33_pDC_f	Secretion rate of IL-33 by pDC
k_IL33_d	Degradation rate of IL-33
k_IL2_d	Degradation rate of IL-2
k_IL2_act_CD4_f	Secretion rate of IL-2 by active CD4 cells
k_IL2_act_CD4_Antigen_f	Secretion rate of IL-2 by active CD4 cells in the presence of antigen
k_IL15_f	Production rate of IL-15
k_IL15_d	Degradation rate of IL-15
k_IL15_Antigen_f	Production rate of IL-15 in the presence of antigen
k_IL12_mDC_f	Secretion rate of IL-12 by mDC
k_IL12_d	Degradation rate of IL-12
k_IL10_nTreg_mDC_m	Hill coefficient in the secretion of IL-10 by nTreg
k_IL10_nTreg_f	Secretion rate of IL-10 by nTreg
k_IL10_iTreg_f	Secretion rate of IL-10 by iTreg
k_IL10_d	Degradation rate of IL-10
k_IL1_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- $\gamma$
k_IFN_g_CD4_CTL_f	Secretion rate of IFN- $\gamma$ by CD4-CTL
k_IFN_g_act_NK_f	Secretion rate of IFN- $\gamma$ 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)**

<b>Parameter name</b>	<b>Meaning</b>
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- $\gamma$
k_act_NK_IFN_g_f	Differentiation rate of NK cells into active NK cells driven by IFN- $\gamma$
k_act_NK_IFN_g_d	Consumption of IFN- $\gamma$ 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)**

<b>Parameter name</b>	<b>Meaning</b>
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	$AntigenDiff$
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	{}	$naive\_CD4 * k_{naive\_CD4\_IL\_15\_d} * IL_{15} / (k_{naive\_CD4\_IL\_15\_m} + IL_{15})$

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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	$act\_CD4 * k\_iTreg\_mDC\_f * k\_iTreg\_IL10\_f * (IL10/(k\_iTreg\_IL10\_m + IL10)) * (k\_iTreg\_IL1\_m/(k\_iTreg\_IL1\_m + IL1))$
58	IL10	{}	$act\_CD4 * k\_iTreg\_mDC\_d * k\_iTreg\_IL10\_f * (IL10/(k\_iTreg\_IL10\_m + IL10)) * (k\_iTreg\_IL1\_m/(k\_iTreg\_IL1\_m + IL1))$
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	$k\_TFH\_IL6\_f * act\_CD4 * IL6/(k\_TFH\_IL6\_m + IL6)$
71	IL6	{}	$k\_TFH\_IL6\_d * act\_CD4 * IL6/(k\_TFH\_IL6\_m + IL6)$
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	$k\_act\_NK\_IL12\_f * NK * IL12/(IL12 + k\_act\_NK\_IL12\_m)$
76	IL12	{}	$k\_act\_NK\_IL12\_d * NK * IL12/(IL12 + k\_act\_NK\_IL12\_m)$
77	NK	act_NK	$k\_act\_NK\_IL2\_f * NK * IL2/(IL2 + k\_act\_NK\_IL2\_m)$
78	IL2	{}	$k\_act\_NK\_IL2\_d * NK * IL2/(IL2 + k\_act\_NK\_IL2\_m)$
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	$k\_act\_NK\_f * act\_NK * (1 - act\_NK/k\_act\_NK\_m) * k\_pro\_act\_NK\_IL12\_f * IL12/(IL12 + k\_pro\_act\_NK\_IL12\_m)$

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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	{}	$k_{Act\_B\_cells\_d} * Act\_B\_cells$

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**Supplementary Note Table 3 (continued)**

<b>Number</b>	<b>Educt</b>	<b>Product</b>	<b>Rate</b>
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.

$$\begin{aligned}
 \frac{d \text{Act\_B\_cells}}{dt} = & k_{\text{Act\_B\_cells\_basal\_f}} \text{Naive\_B\_cells} + k_{\text{Act\_B\_cells\_Antigen\_f}} \text{Naive\_B\_cells} \text{Antigen} \\
 & + k_{\text{Act\_B\_Act\_B\_f}} \text{Act\_B\_cells} \left( 1 - \frac{\text{Act\_B\_cells}}{k_{\text{Act\_B\_Act\_B\_m}}} \right) \\
 & + k_{\text{Act\_B\_Act\_B\_Antigen\_f}} \text{Act\_B\_cells} \text{Antigen} \left( 1 - \frac{\text{Act\_B\_cells}}{k_{\text{Act\_B\_Act\_B\_m}}} \right) \\
 & - k_{\text{TD\_IS\_B\_cells\_base\_f}} \text{Act\_B\_cells} - k_{\text{TD\_IS\_B\_cells\_IL\_4\_f}} \text{Act\_B\_cells} \text{IL\_4} \\
 & - k_{\text{TI\_IS\_B\_cells\_base\_f}} \text{Act\_B\_cells} - k_{\text{TI\_IS\_B\_cells\_IFN\_g\_f}} \text{Act\_B\_cells} \text{IFN\_g} \\
 & - k_{\text{TI\_IS\_B\_cells\_IL\_10\_f}} \text{Act\_B\_cells} \text{IL\_10} - k_{\text{Act\_B\_cells\_d}} \text{Act\_B\_cells}
 \end{aligned}
 \tag{Eq. 1}$$

$$\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}
 \tag{Eq. 2}$$

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

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

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

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

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

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

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

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

$$(Eq. 11) \quad \frac{dIL_{10}}{dt} = k_{IL_{10}iTreg\_f} iTreg + k_{IL_{10}nTreg\_f} nTreg mDC \frac{1}{k_{IL_{10}nTreg\_mDC\_m} + mDC} \\ - act\_CD4 k_{iTreg\_mDC\_d} k_{iTreg\_IL_{10}f} \frac{IL_{10}}{k_{iTreg\_IL_{10}m} + IL_{10}} \frac{k_{iTreg\_IL_{10}m}}{k_{iTreg\_IL_{10}m} + IL_{10}} - k_{IL_{10}d} IL_{10}$$

$$(Eq. 12) \quad \frac{dIL_{12}}{dt} = k_{IL_{12}mDC\_f} mDC - k_{act\_NK\_IL_{12}d} NK \frac{IL_{12}}{IL_{12} + k_{act\_NK\_IL_{12}m}} \\ - k_{act\_NK\_d} act\_NK k_{pro\_act\_NK\_IL_{12}f} \frac{IL_{12}}{IL_{12} + k_{pro\_act\_NK\_IL_{12}m}} - k_{IL_{12}d} IL_{12}$$

$$(Eq. 13) \quad \frac{dIL_{15}}{dt} = k_{IL_{15}f} + k_{IL_{15}Antigen\_f} Antigen - naive\_CD4 k_{naive\_CD4\_IL_{15}d} \frac{IL_{15}}{k_{naive\_CD4\_IL_{15}m} + IL_{15}} \\ - k_{act\_CD4\_IL_{15}d} act\_CD4 \frac{IL_{15}}{k_{act\_CD4\_IL_{15}m} + IL_{15}} - k_{IL_{15}d} IL_{15}$$

$$(Eq. 14) \quad \frac{dIL_2}{dt} = k_{IL_2act\_CD4\_f} act\_CD4 + k_{IL_2act\_CD4\_Antigen\_f} act\_CD4 Antigen \\ - naive\_CD4 k_{act\_CD4\_IL_2d} \frac{IL_2}{k_{act\_CD4\_IL_2m} + IL_2} - k_{act\_NK\_IL_2d} NK \frac{IL_2}{IL_2 + k_{act\_NK\_IL_2m}} \\ - k_{IL_2d} IL_2$$

$$(Eq. 15) \quad \frac{dIL_{33}}{dt} = k_{IL_{33}pDC\_f} pDC - k_{act\_CD4\_IL_{33}d} act\_CD4 \frac{IL_{33}}{k_{Th2\_IL_{33}m} + IL_{33}} - k_{IL_{33}d} IL_{33}$$

$$(Eq. 16) \quad \frac{dIL_4}{dt} = k_{IL_4Th2\_f} Th2 + k_{IL_4Th2\_Antigen\_f} Th2 Antigen - k_{act\_CD4\_IL_4d} act\_CD4 \frac{IL_4}{k_{Th2\_IL_4m} + IL_4} \\ - k_{IL_4d} IL_4$$

$$(Eq. 17) \quad \frac{dIL_6}{dt} = k_{IL_6pDC\_f} pDC + k_{IL_6mDC\_f} mDC + k_{IL_6TFH\_f} TFH \frac{k_{TFH\_nTreg\_m}}{nTreg + k_{TFH\_nTreg\_m}} \\ - k_{TFH\_IL_6d} act\_CD4 \frac{IL_6}{k_{TFH\_IL_6m} + IL_6} - k_{IL_6d} IL_6$$

$$(Eq. 18) \quad \frac{dIL_7}{dt} = k_{IL_7f} - k_{naive\_CD4\_IL_7d} naive\_CD4 \frac{IL_7}{k_{naive\_CD4\_IL_7m} + IL_7} \\ - k_{act\_CD4\_IL_7d} act\_CD4 \frac{IL_7}{k_{act\_CD4\_IL_7m} + IL_7} - k_{IL_7d} IL_7$$

$$(Eq. 19) \quad \frac{diTreg}{dt} = act\_CD4 k_{iTreg\_mDC\_f} k_{iTreg\_TGFbeta\_f} \frac{TGFbeta}{k_{iTreg\_TGFbeta\_m} + TGFbeta} \frac{k_{iTreg\_IL_{10}m}}{k_{iTreg\_IL_{10}m} + IL_{10}} \\ + act\_CD4 k_{iTreg\_mDC\_f} \frac{k_{iTreg\_IL_{10}m}}{k_{iTreg\_IL_{10}m} + IL_{10}} \\ + act\_CD4 k_{iTreg\_mDC\_f} k_{iTreg\_IL_{10}f} \frac{IL_{10}}{k_{iTreg\_IL_{10}m} + IL_{10}} \frac{k_{iTreg\_IL_{10}m}}{k_{iTreg\_IL_{10}m} + IL_{10}} \\ + k_{iTreg\_f} iTreg \left( 1 - \frac{iTreg}{k_{iTreg\_m}} \right) - k_{iTreg\_d} iTreg$$

$$\begin{aligned}
\text{(Eq. 20)} \quad \frac{d \text{mDC}}{dt} &= k_{\text{mDC\_Antigen\_f}} \text{Antigen\_nDC} \frac{k_{\text{mDC\_IL\_10\_m}}}{k_{\text{mDC\_IL\_10\_m}} + \text{IL\_10}} \\
&+ k_{\text{mDC\_GMCSF\_f}} \text{Antigen\_nDC} \frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC\_GMCSF\_m}}} \frac{k_{\text{mDC\_IL\_10\_m}}}{k_{\text{mDC\_IL\_10\_m}} + \text{IL\_10}} \\
&+ k_{\text{mDC\_f}} \text{mDC} \left(1 - \frac{\text{mDC}}{k_{\text{mDC\_m}}}\right) - k_{\text{mDC\_d}} \text{mDC}
\end{aligned}$$

$$\begin{aligned}
\text{(Eq. 21)} \quad \frac{d \text{Naive\_B\_cells}}{dt} &= k_{\text{Naive\_B\_cells\_f}} \text{Naive\_B\_cells} \left(1 - \frac{\text{Naive\_B\_cells}}{k_{\text{Naive\_B\_cells\_m}}}\right) \\
&+ k_{\text{Naive\_B\_cells\_Antigen\_f}} \text{Naive\_B\_cells} \text{Antigen} \left(1 - \frac{\text{Naive\_B\_cells}}{k_{\text{Naive\_B\_cells\_m}}}\right) \\
&- k_{\text{Act\_B\_cells\_basal\_f}} \text{Naive\_B\_cells} - k_{\text{Act\_B\_cells\_Antigen\_f}} \text{Naive\_B\_cells} \text{Antigen} \\
&- k_{\text{Naive\_B\_cells\_d}} \text{Naive\_B\_cells}
\end{aligned}$$

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

$$\begin{aligned}
\text{(Eq. 23)} \quad \frac{d \text{nDC}}{dt} &= k_{\text{nDC\_f}} \text{nDC} \left(1 - \frac{\text{nDC}}{k_{\text{nDC\_m}}}\right) \\
&- k_{\text{mDC\_Antigen\_f}} \text{Antigen\_nDC} \frac{k_{\text{mDC\_IL\_10\_m}}}{k_{\text{mDC\_IL\_10\_m}} + \text{IL\_10}} \\
&- k_{\text{mDC\_GMCSF\_f}} \text{Antigen\_nDC} \frac{\text{GMCSF}}{\text{GMCSF} + k_{\text{mDC\_GMCSF\_m}}} \frac{k_{\text{mDC\_IL\_10\_m}}}{k_{\text{mDC\_IL\_10\_m}} + \text{IL\_10}} \\
&- k_{\text{pDC\_Antigen\_f}} \text{nDC} \text{Antigen} - k_{\text{nDC\_d}} \text{nDC}
\end{aligned}$$

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

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

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

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

$$\begin{aligned}
\text{(Eq. 28)} \quad \frac{d \text{TFH}}{dt} &= \text{act\_CD4} k_{\text{TFH\_mDC\_f}} + \text{act\_CD4} k_{\text{TFH\_mDC\_Antigen\_f}} \text{Antigen} \\
&+ k_{\text{TFH\_IFN1\_f}} \text{act\_CD4} \frac{\text{IFN1}}{k_{\text{TFH\_IFN1\_m}} + \text{IFN1}} + k_{\text{TFH\_IL6\_f}} \text{act\_CD4} \frac{\text{IL\_6}}{k_{\text{TFH\_IL6\_m}} + \text{IL\_6}} \\
&+ k_{\text{TFH\_f}} \text{TFH} \left( 1 - \frac{\text{TFH}}{k_{\text{TFH\_m}}} \right) - k_{\text{TFH\_d}} \text{TFH}
\end{aligned}$$

$$\begin{aligned}
\text{(Eq. 29)} \quad \frac{d \text{TGFbeta}}{dt} &= k_{\text{TGFbeta\_iTreg\_f}} \text{iTreg} + k_{\text{TGFbeta\_CD4\_CTL\_f}} \text{CD4\_CTL} \\
&+ k_{\text{TGFbeta\_nTreg\_f}} \text{nTreg\_mDC} \frac{1}{k_{\text{TGFbeta\_nTreg\_mDC\_m}} + \text{mDC}} \\
&- \text{act\_CD4} k_{\text{iTreg\_mDC\_d}} k_{\text{iTreg\_TGFbeta\_f}} \text{TGFbeta} \frac{1}{k_{\text{iTreg\_TGFbeta\_m}} + \text{TGFbeta}} \\
&* \frac{k_{\text{iTreg\_IL1\_m}}}{k_{\text{iTreg\_IL1\_m}} + \text{IL\_1}} - k_{\text{TGFbeta\_d}} \text{TGFbeta}
\end{aligned}$$

$$\begin{aligned}
\text{(Eq. 30)} \quad \frac{d \text{Th2}}{dt} &= \text{act\_CD4} k_{\text{Th2\_f}} \frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}} \frac{k_{\text{Th2\_IL10\_m}}}{k_{\text{Th2\_IL10\_m}} + \text{IL\_10}} \frac{k_{\text{Th2\_IL12\_m}}}{k_{\text{Th2\_IL12\_m}} + \text{IL\_12}} \\
&+ \text{act\_CD4} k_{\text{Th2\_IL4\_f}} \frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}} \frac{k_{\text{Th2\_IL10\_m}}}{k_{\text{Th2\_IL10\_m}} + \text{IL\_10}} \frac{k_{\text{Th2\_IL12\_m}}}{k_{\text{Th2\_IL12\_m}} + \text{IL\_12}} \\
&* \frac{\text{IL\_4}}{k_{\text{Th2\_IL4\_m}} + \text{IL\_4}} \\
&+ \text{act\_CD4} k_{\text{Th2\_IL33\_f}} \frac{k_{\text{Th2\_TGFbeta\_m}}}{k_{\text{Th2\_TGFbeta\_m}} + \text{TGFbeta}} \frac{k_{\text{Th2\_IL10\_m}}}{k_{\text{Th2\_IL10\_m}} + \text{IL\_10}} \frac{k_{\text{Th2\_IL12\_m}}}{k_{\text{Th2\_IL12\_m}} + \text{IL\_12}} \\
&* \frac{\text{IL\_33}}{k_{\text{Th2\_IL33\_m}} + \text{IL\_33}} \\
&+ k_{\text{Th2\_f}} \text{Th2} \left( 1 - \frac{\text{Th2}}{k_{\text{Th2\_m}}} \right) - k_{\text{Th2\_d}} \text{Th2}
\end{aligned}$$

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

$$\begin{aligned}
\text{(Eq. 32)} \quad \frac{d \text{TL\_IS\_B\_cells}}{dt} &= k_{\text{TL\_IS\_B\_cells\_base\_f}} \text{Act\_B\_cells} + k_{\text{TL\_IS\_B\_cells\_IFN\_g\_f}} \text{Act\_B\_cells\_IFN\_g} \\
&+ k_{\text{TL\_IS\_B\_cells\_IL10\_f}} \text{Act\_B\_cells\_IL10} \\
&+ k_{\text{TL\_IS\_B\_cells\_TL\_IS\_B\_cells\_f}} \text{TL\_IS\_B\_cells} \left( 1 - \frac{\text{TL\_IS\_B\_cells}}{k_{\text{TL\_IS\_B\_cells\_TL\_IS\_B\_cells\_m}}} \right) \\
&- k_{\text{TL\_IS\_B\_cells\_d}} \text{TL\_IS\_B\_cells}
\end{aligned}$$