$$
\begin{aligned}
\frac{\mathrm{d}([\text{ABC0,m\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= -V\text{\_Cytosol} \cdot (\text{k\_d\_ABC0, m\_c} \cdot [\text{ABC0, m\_c}]) \\
&\quad -2 \cdot V\text{\_Cytosol} \cdot ((\text{"k\_as\_ABC0, m\_c\_(ABC0, m\_c)"} \cdot [\text{ABC0, m\_c}] \cdot [\text{ABC0, m\_c}] - \text{k\_ds\_ABC0\_c} \cdot [\text{ABC0\_c}])) \\
&\quad +V\text{\_Cytosol} \cdot (\text{k\_tl\_ABC0\_mRNA\_c} \cdot [\text{ABC0\_mRNA\_c}]) \\
\frac{\mathrm{d}([\text{ABC0\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= -V\text{\_Cytosol} \cdot (\text{k\_d\_ABC0\_c} \cdot [\text{ABC0\_c}]) \\
&\quad +V\text{\_Cytosol} \cdot ((\text{"k\_as\_ABC0, m\_c\_(ABC0, m\_c)"} \cdot [\text{ABC0, m\_c}] \cdot [\text{ABC0, m\_c}] - \text{k\_ds\_ABC0\_c} \cdot [\text{ABC0\_c}])) \\
\frac{\mathrm{d}([\text{ABC0\_mRNA\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= +V\text{\_Cytosol} \cdot \left(\frac{\text{k\_ts\_ABC0\_gene,a\_n} \cdot [\text{ABC0\_gene,a\_n}] \cdot \frac{1}{3} \cdot V\text{\_Nucleus}}{V\text{\_Cytosol}}\right) \\
&\quad -V\text{\_Cytosol} \cdot (\text{k\_d\_ABC0\_mRNA\_c} \cdot [\text{ABC0\_mRNA\_c}]) \\
\frac{\mathrm{d}([\text{ABC3\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= +V\text{\_Cytosol} \cdot (\text{k\_tl\_ABC3\_mRNA\_c} \cdot [\text{ABC3\_mRNA\_c}]) \\
&\quad -V\text{\_Cytosol} \cdot (\text{k\_d\_ABC3\_c} \cdot [\text{ABC3\_c}]) \\
\frac{\mathrm{d}([\text{ABC3\_mRNA\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= +V\text{\_Cytosol} \cdot \left(\frac{\text{k\_ts\_ABC3\_gene,a\_n} \cdot [\text{ABC3\_gene,a\_n}] \cdot \frac{1}{3} \cdot V\text{\_Nucleus}}{V\text{\_Cytosol}}\right) \\
&\quad -V\text{\_Cytosol} \cdot (\text{k\_d\_ABC3\_mRNA\_c} \cdot [\text{ABC3\_mRNA\_c}]) \\
\frac{\mathrm{d}([\text{CYP\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= -V\text{\_Cytosol} \cdot (\text{k\_d\_CYP\_c} \cdot [\text{CYP\_c}]) \\
&\quad +V\text{\_Cytosol} \cdot (\text{k\_tl\_CYP\_mRNA\_c} \cdot [\text{CYP\_mRNA\_c}]) \\
\frac{\mathrm{d}([\text{CYP\_mRNA\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= +V\text{\_Cytosol} \cdot \left(\frac{\text{k\_ts\_CYP\_gene,a\_n} \cdot [\text{CYP\_gene,a\_n}] \cdot 5 \cdot V\text{\_Nucleus}}{V\text{\_Cytosol}}\right) \\
&\quad -V\text{\_Cytosol} \cdot (\text{k\_d\_CYP\_mRNA\_c} \cdot [\text{CYP\_mRNA\_c}]) \\
\frac{\mathrm{d}([\text{GCL\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= -V\text{\_Cytosol} \cdot (\text{k\_d\_GCL\_c} \cdot [\text{GCL\_c}]) \\
&\quad +V\text{\_Cytosol} \cdot ((\text{"k\_as\_GCLC\_c\_(GCLM\_c)"} \cdot [\text{GCLM\_c}] \cdot [\text{GCLC\_c}] - \text{k\_ds\_GCL\_c} \cdot [\text{GCL\_c}])) \\
\frac{\mathrm{d}([\text{GCLC\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} &= -V\text{\_Cytosol} \cdot ((\text{"k\_as\_GCLC\_c\_(GCLM\_c)"} \cdot [\text{GCLM\_c}] \cdot [\text{GCLC\_c}] - \text{k\_ds\_GCL\_c} \cdot [\text{GCL\_c}])) \\
&\quad -V\text{\_Cytosol} \cdot (\text{k\_d\_GCLC\_c} \cdot [\text{GCLC\_c}]) \\
&\quad +V\text{\_Cytosol} \cdot (\text{k\_tl\_GCLC\_mRNA\_c} \cdot [\text{GCLC\_mRNA\_c}])
\end{aligned}
$$

$$\frac{d([GCLC\_mRNA\_c] \cdot V\_Cytosol)}{dt} = +V\_Cytosol \cdot \left(\frac{k\_ts\_GCLC\_gene,a\_n \cdot [GCLC\_gene,a\_n] \cdot \frac{1}{3} \cdot V\_Nucleus}{V\_Cytosol}\right)$$

$$-V\_Cytosol \cdot (k\_d\_GCLC\_mRNA\_c \cdot [GCLC\_mRNA\_c])$$

$$\frac{d([GCLM\_c] \cdot V\_Cytosol)}{dt} = -V\_Cytosol \cdot ((\text{"k\_as\_GCLC\_c\_(GCLM\_c)"} \cdot [GCLM\_c] \cdot [GCLC\_c] - k\_ds\_GCL\_c \cdot [GCL\_c]))$$

$$-V\_Cytosol \cdot (k\_d\_GCLM\_c \cdot [GCLM\_c])$$

$$+V\_Cytosol \cdot (k\_tl\_GCLM\_mRNA\_c \cdot [GCLM\_mRNA\_c])$$

$$\frac{d([GCLM\_mRNA\_c] \cdot V\_Cytosol)}{dt} = +V\_Cytosol \cdot \left(\frac{k\_ts\_GCLM\_gene,a\_n \cdot [GCLM\_gene,a\_n] \cdot \frac{1}{3} \cdot V\_Nucleus}{V\_Cytosol}\right)$$

$$-V\_Cytosol \cdot (k\_d\_GCLM\_mRNA\_c \cdot [GCLM\_mRNA\_c])$$

$$\frac{d([GS,m\_c] \cdot V\_Cytosol)}{dt} = -V\_Cytosol \cdot (k\_d\_GS,m\_c \cdot [GS,m\_c])$$

$$-2 \cdot V\_Cytosol \cdot ((\text{"k\_as\_GS,m\_c\_(GS,m\_c)"} \cdot [GS,m\_c] \cdot [GS,m\_c] - k\_ds\_GS\_c \cdot [GS\_c]))$$

$$+V\_Cytosol \cdot (k\_tl\_GS\_mRNA\_c \cdot [GS\_mRNA\_c])$$

$$\frac{d([GS\_c] \cdot V\_Cytosol)}{dt} = -V\_Cytosol \cdot (k\_d\_GS\_c \cdot [GS\_c])$$

$$+V\_Cytosol \cdot ((\text{"k\_as\_GS,m\_c\_(GS,m\_c)"} \cdot [GS,m\_c] \cdot [GS,m\_c] - k\_ds\_GS\_c \cdot [GS\_c]))$$

$$\frac{d([GS\_mRNA\_c] \cdot V\_Cytosol)}{dt} = +V\_Cytosol \cdot \left(\frac{k\_ts\_GS\_gene,a\_n \cdot [GS\_gene,a\_n] \cdot \frac{1}{3} \cdot V\_Nucleus}{V\_Cytosol}\right)$$

$$-V\_Cytosol \cdot (k\_d\_GS\_mRNA\_c \cdot [GS\_mRNA\_c])$$

$$\frac{\mathrm{d}([\text{GSH\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = -V\text{\_Cytosol} \cdot \left(\frac{\text{v\_cs\_GSH\_c} \cdot [\text{GSH\_c}]}{\text{Km\_cs\_GSH\_c} + [\text{GSH\_c}]}\right)$$

$$+V\text{\_Cytosol} \cdot \left(\text{k\_s\_GS\_c} \cdot [\text{GS\_c}] \cdot \frac{\frac{[\text{rGC\_c}]}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}} + \frac{[\text{rGC\_c}]^2}{\text{Km\_s\_1\_rGC\_c\_@GS\_c} \cdot \text{Km\_s\_2\_rGC\_c\_@GS\_c}}}{1 + \frac{2 \cdot [\text{rGC\_c}]}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}} + \frac{[\text{rGC\_c}]^2}{\text{Km\_s\_1\_rGC\_c\_@GS\_c} \cdot \text{Km\_s\_2\_rGC\_c\_@GS\_c}}} \cdot \frac{[\text{Gly\_c}]}{\text{Km\_s\_Gly\_c\_@GS\_c} + [\text{Gly\_c}]} \cdot \frac{[\text{ATP\_c}]}{\text{Km\_s\_ATP\_c\_@GS\_c} + [\text{ATP\_c}]}\right)$$

$$-V\text{\_Cytosol} \cdot \left(\frac{\text{"k\_cj\_X}'\text{\_c\_(GSH\_c)\_@GST\_c"} \cdot [\text{X}'\text{\_c}]}{[\text{X}'\text{\_c}] + [\text{X}'\text{b\_c}]} \cdot [\text{GST\_c}] \cdot \frac{[\text{GSH\_c}]}{\text{Km\_cj\_GSH\_c\_@GST\_c} \cdot \left(1 + \frac{[\text{X}''\text{\_c}]}{\text{Ki\_in\_X}''\text{\_c\_@GST\_c}}\right) + [\text{GSH\_c}]}\right.$$

$$\left.\cdot \frac{[\text{X}'\text{\_c}]}{(\text{Km\_cj\_X}'\text{\_c\_@GST\_c} + [\text{X}'\text{\_c}]) \cdot \left(1 + \frac{[\text{X}''\text{\_c}]}{\text{Ki\_in\_X}''\text{\_c\_@GST\_c}}\right)} \cdot 1\right)$$

$$-V\text{\_Cytosol} \cdot \left(\frac{\text{"k\_cj\_X}'\text{b\_c\_(GSH\_c)\_@GST\_c"} \cdot [\text{X}'\text{b\_c}]}{[\text{X}'\text{b\_c}] + [\text{X}'\text{\_c}]} \cdot [\text{GST\_c}] \cdot \frac{[\text{GSH\_c}]}{\text{Km\_cj\_6\_GSH\_c\_@GST\_c} \cdot \left(1 + \frac{[\text{X}''\text{b\_c}]}{\text{Ki\_in\_X}''\text{b\_c\_@GST\_c}}\right) + [\text{GSH\_c}]}\right.$$

$$\left.\cdot \frac{[\text{X}'\text{b\_c}]}{(\text{Km\_cj\_X}'\text{b\_c\_@GST\_c} + [\text{X}'\text{b\_c}]) \cdot \left(1 + \frac{[\text{X}''\text{b\_c}]}{\text{Ki\_in\_X}''\text{b\_c\_@GST\_c}}\right)} \cdot 1\right)$$

$$\frac{\mathrm{d}([\text{GST,m\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = -V\text{\_Cytosol} \cdot (\text{k\_d\_GST, m\_c} \cdot [\text{GST, m\_c}])$$

$$-2 \cdot V\text{\_Cytosol} \cdot ((\text{"k\_as\_GST, m\_c\_(GST, m\_c)"} \cdot [\text{GST, m\_c}] \cdot [\text{GST, m\_c}] - \text{k\_ds\_GST\_c} \cdot [\text{GST\_c}]))$$

$$+V\text{\_Cytosol} \cdot (\text{k\_tl\_GST\_mRNA\_c} \cdot [\text{GST\_mRNA\_c}])$$

$$\frac{\mathrm{d}([\text{GST\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = -V\text{\_Cytosol} \cdot (\text{k\_d\_GST\_c} \cdot [\text{GST\_c}])$$

$$+V\text{\_Cytosol} \cdot ((\text{"k\_as\_GST, m\_c\_(GST, m\_c)"} \cdot [\text{GST, m\_c}] \cdot [\text{GST, m\_c}] - \text{k\_ds\_GST\_c} \cdot [\text{GST\_c}]))$$

$$\frac{\mathrm{d}([\text{GST\_mRNA\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = +V\text{\_Cytosol} \cdot \left(\frac{\text{k\_ts\_GST\_gene,a\_n} \cdot [\text{GST\_gene,a\_n}] \cdot \frac{1}{3} \cdot V\text{\_Nucleus}}{V\text{\_Cytosol}}\right)$$

$$-V\text{\_Cytosol} \cdot (\text{k\_d\_GST\_mRNA\_c} \cdot [\text{GST\_mRNA\_c}])$$

$$\frac{\mathrm{d}([\text{Keap1,o\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = -V\text{\_Cytosol} \cdot (\text{k\_rd\_Keap1, o\_c} \cdot [\text{Keap1, o\_c}])$$

$$+V\text{\_Cytosol} \cdot ([\text{Keap1\_c}] \cdot (\text{k\_ox\_b\_Keap1\_c} + ([\text{X}'\text{\_c}] + [\text{X}'\text{b\_c}]) \cdot \text{"k\_ox\_Keap1\_c\_(X}'\text{\_c)"}))$$

$$+V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}])$$

$$-V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1, o\_c)"} \cdot [\text{Keap1, o\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}]))$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{Keap1\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = &+V\text{\_Cytosol} \cdot (\text{k\_rd\_Keap1, o\_c} \cdot [\text{Keap1, o\_c}]) \\
&-V\text{\_Cytosol} \cdot ([\text{Keap1\_c}] \cdot (\text{k\_ox\_b\_Keap1\_c} + ([\text{X}'\text{\_c}] + [\text{X}'\text{b\_c}]) \cdot \text{"k\_ox\_Keap1\_c\_(X}'\text{\_c)"})) \\
&+V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2:Keap1\_c} \cdot [\text{Nrf2:Keap1\_c}]) \\
&-V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1\_c)"} \cdot [\text{Keap1\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1\_c} \cdot [\text{Nrf2:Keap1\_c}]))
\end{aligned}
$$

$$
\frac{\mathrm{d}([\text{NR\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = -V\text{\_Cytosol} \cdot ((\text{"k\_as\_X\_c\_(NR\_c)"} \cdot [\text{X\_c}] \cdot [\text{NR\_c}] - \text{k\_ds\_XNR\_c} \cdot [\text{XNR\_c}]))
$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{Nrf2:Keap1,o\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = &-V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}]) \\
&+V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1, o\_c)"} \cdot [\text{Keap1, o\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}])) \\
&-V\text{\_Cytosol} \cdot (\text{k\_rd\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}]) \\
&+V\text{\_Cytosol} \cdot ([\text{Nrf2:Keap1\_c}] \cdot (\text{k\_ox\_b\_Nrf2:Keap1\_c} + ([\text{X}'\text{\_c}] + [\text{X}'\text{b\_c}]) \cdot \text{"k\_ox\_Nrf2:Keap1\_c\_(X}'\text{\_c)"}))
\end{aligned}
$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{Nrf2:Keap1\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = &+V\text{\_Cytosol} \cdot (\text{k\_rd\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}]) \\
&-V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2:Keap1\_c} \cdot [\text{Nrf2:Keap1\_c}]) \\
&+V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1\_c)"} \cdot [\text{Keap1\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1\_c} \cdot [\text{Nrf2:Keap1\_c}])) \\
&-V\text{\_Cytosol} \cdot ([\text{Nrf2:Keap1\_c}] \cdot (\text{k\_ox\_b\_Nrf2:Keap1\_c} + ([\text{X}'\text{\_c}] + [\text{X}'\text{b\_c}]) \cdot \text{"k\_ox\_Nrf2:Keap1\_c\_(X}'\text{\_c)"}))
\end{aligned}
$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{Nrf2\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = &-V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1, o\_c)"} \cdot [\text{Keap1, o\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1, o\_c} \cdot [\text{Nrf2:Keap1, o\_c}])) \\
&-V\text{\_Cytosol} \cdot ((\text{"k\_as\_Nrf2\_c\_(Keap1\_c)"} \cdot [\text{Keap1\_c}] \cdot [\text{Nrf2\_c}] - \text{k\_ds\_Nrf2:Keap1\_c} \cdot [\text{Nrf2:Keap1\_c}])) \\
&-V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2\_c} \cdot [\text{Nrf2\_c}]) \\
&-((\text{k\_tn\_Nrf2\_c} \cdot [\text{Nrf2\_c}] - \text{k\_tn\_Nrf2\_n} \cdot [\text{Nrf2\_n}]) \cdot V\text{\_Nucleus}) \\
&+V\text{\_Cytosol} \cdot (\text{k\_tl\_Nrf2\_mRNA\_c} \cdot [\text{Nrf2\_mRNA\_c}])
\end{aligned}
$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{Nrf2\_mRNA\_c}] \cdot V\text{\_Cytosol})}{\mathrm{d}t} = &+V\text{\_Cytosol} \cdot \left(\frac{\text{k\_ts\_Nrf2\_gene,a\_n} \cdot [\text{Nrf2\_gene,a\_n}] \cdot \frac{1}{3} \cdot V\text{\_Nucleus}}{V\text{\_Cytosol}}\right) \\
&-V\text{\_Cytosol} \cdot (\text{k\_d\_Nrf2\_mRNA\_c} \cdot [\text{Nrf2\_mRNA\_c}] \cdot 1)
\end{aligned}
$$

$$
\begin{aligned}
\frac{d([\text{rGC\_c}]\cdot V\text{\_Cytosol})}{dt} = & -V\text{\_Cytosol}\cdot\Bigg(\text{k\_s\_GS\_c}\cdot[\text{GS\_c}]\cdot\frac{\frac{[\text{rGC\_c}]}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}}+\frac{[\text{rGC\_c}]^{2}}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}\cdot\text{Km\_s\_2\_rGC\_c\_@GS\_c}}}{1+\frac{2\cdot[\text{rGC\_c}]}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}}+\frac{[\text{rGC\_c}]^{2}}{\text{Km\_s\_1\_rGC\_c\_@GS\_c}\cdot\text{Km\_s\_2\_rGC\_c\_@GS\_c}}} \\
& \cdot\frac{[\text{Gly\_c}]}{\text{Km\_s\_Gly\_c\_@GS\_c}+[\text{Gly\_c}]}\cdot\frac{[\text{ATP\_c}]}{\text{Km\_s\_ATP\_c\_@GS\_c}+[\text{ATP\_c}]}\Bigg) \\
& +V\text{\_Cytosol}\cdot\Bigg(\text{k\_s\_GCL\_c}\cdot[\text{GCL\_c}]\cdot\frac{[\text{Cys\_c}]}{\text{Km\_s\_Cys\_c\_@GCL\_c}+[\text{Cys\_c}]} \\
& \cdot\frac{[\text{Glu\_c}]}{\text{Km\_s\_Glu\_c\_@GCL\_c}\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_2'\_GSH\_c\_@GCL\_c}}\right)+[\text{Glu\_c}]\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_1'\_GSH\_c\_@GCL\_c}}\right)} \\
& \cdot\frac{[\text{ATP\_c}]}{\text{Km\_s\_ATP\_c\_@GCL\_c}\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_2\_GSH\_c\_@GCL\_c}}\right)+[\text{ATP\_c}]\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_1\_GSH\_c\_@GCL\_c}}\right)} \\
& +\text{k\_s\_GCLC\_c}\cdot[\text{GCLC\_c}]\cdot\frac{[\text{Cys\_c}]}{\text{Km\_s\_Cys\_c\_@GCLC\_c}+[\text{Cys\_c}]} \\
& \cdot\frac{[\text{Glu\_c}]}{\text{Km\_s\_Glu\_c\_@GCLC\_c}\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_2'\_GSH\_c\_@GCLC\_c}}\right)+[\text{Glu\_c}]\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_1'\_GSH\_c\_@GCLC\_c}}\right)} \\
& \cdot\frac{[\text{ATP\_c}]}{\text{Km\_s\_ATP\_c\_@GCLC\_c}\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_2\_GSH\_c\_@GCLC\_c}}\right)+[\text{ATP\_c}]\cdot\left(\text{P\_s\_rGC\_c}+\frac{[\text{GSH\_c}]}{\text{Ki\_in\_1\_GSH\_c\_@GCLC\_c}}\right)}\Bigg)
\end{aligned}
$$

$$
\begin{aligned}
\frac{d\left([\text{X''\_c}]\cdot V\text{\_Cytosol}\right)}{dt} = & -\left(\frac{\text{k\_tp\_X''\_c\_@ABC3\_c}\cdot[\text{ABC3\_c}]\cdot\frac{[\text{X''\_c}]}{[\text{X''\_c}]+[\text{X''b\_c}]}\cdot[\text{X''\_c}]}{\text{Km\_tp\_X''\_c\_@ABC3\_c}+[\text{X''\_c}]}\cdot V\text{\_Cytosol}\right) \\
& +V\text{\_Cytosol}\cdot\Bigg(\frac{\text{”k\_cj\_X'\_c\_(GSH\_c)\_@GST\_c”}\cdot[\text{X'\_c}]}{[\text{X'\_c}]+[\text{X'b\_c}]}\cdot[\text{GST\_c}]\cdot\frac{[\text{GSH\_c}]}{\text{Km\_cj\_GSH\_c\_@GST\_c}\cdot\left(1+\frac{[\text{X''\_c}]}{\text{Ki\_in\_X''\_c\_@GST\_c}}\right)+[\text{GSH\_c}]} \\
& \cdot\frac{[\text{X'\_c}]}{(\text{Km\_cj\_X'\_c\_@GST\_c}+[\text{X'\_c}])\cdot\left(1+\frac{[\text{X''\_c}]}{\text{Ki\_in\_X''\_c\_@GST\_c}}\right)}\cdot 1\Bigg)
\end{aligned}
$$

$$
\begin{aligned}
\frac{d\left([\text{X''b\_c}]\cdot V\text{\_Cytosol}\right)}{dt} = & -\left(\frac{\text{k\_tp\_X''b\_c\_@ABC3\_c}\cdot[\text{ABC3\_c}]\cdot\frac{[\text{X''b\_c}]}{[\text{X''b\_c}]+[\text{X''\_c}]}\cdot[\text{X''b\_c}]}{\text{Km\_tp\_X''b\_c\_@ABC3\_c}+[\text{X''b\_c}]}\cdot V\text{\_Cytosol}\right) \\
& +V\text{\_Cytosol}\cdot\Bigg(\frac{\text{”k\_cj\_X'b\_c\_(GSH\_c)\_@GST\_c”}\cdot[\text{X'b\_c}]}{[\text{X'b\_c}]+[\text{X'\_c}]}\cdot[\text{GST\_c}]\cdot\frac{[\text{GSH\_c}]}{\text{Km\_cj\_6\_GSH\_c\_@GST\_c}\cdot\left(1+\frac{[\text{X''b\_c}]}{\text{Ki\_in\_X''b\_c\_@GST\_c}}\right)+[\text{GSH\_c}]} \\
& \cdot\frac{[\text{X'b\_c}]}{(\text{Km\_cj\_X'b\_c\_@GST\_c}+[\text{X'b\_c}])\cdot\left(1+\frac{[\text{X''b\_c}]}{\text{Ki\_in\_X''b\_c\_@GST\_c}}\right)}\cdot 1\Bigg)
\end{aligned}
$$

$$\frac{d\left([\text{X}'\_\text{c}]\cdot V\_\text{Cytosol}\right)}{dt} = -V\_\text{Cytosol}\cdot\left(\frac{\text{"k\_cj\_X}'\text{\_c\_(GSH\_c)\_@GST\_c"}\cdot[\text{X}'\_\text{c}]}{[\text{X}'\_\text{c}]+[\text{X}'\text{b\_c}]}\cdot[\text{GST\_c}]\cdot\frac{[\text{GSH\_c}]}{\text{Km\_cj\_GSH\_c\_@GST\_c}\cdot\left(1+\frac{[\text{X}''\_\text{c}]}{\text{Ki\_in\_X}''\text{\_c\_@GST\_c}}\right)+[\text{GSH\_c}]}\right.$$
$$\left.\cdot\frac{[\text{X}'\_\text{c}]}{(\text{Km\_cj\_X}'\text{\_c\_@GST\_c}+[\text{X}'\_\text{c}])\cdot\left(1+\frac{[\text{X}''\_\text{c}]}{\text{Ki\_in\_X}''\text{\_c\_@GST\_c}}\right)}\cdot 1\right)$$
$$+V\_\text{Cytosol}\cdot\left(\frac{\text{k\_ox\_X\_c\_@CYP\_c}\cdot[\text{CYP\_c}]\cdot[\text{X\_c}]}{\text{Km\_ox\_X\_c\_@CYP\_c}+[\text{X\_c}]}\right)$$

$$\frac{d\left([\text{X}'\text{b\_c}]\cdot V\_\text{Cytosol}\right)}{dt} = -V\_\text{Cytosol}\cdot\left(\frac{\text{"k\_cj\_X}'\text{b\_c\_(GSH\_c)\_@GST\_c"}\cdot[\text{X}'\text{b\_c}]}{[\text{X}'\text{b\_c}]+[\text{X}'\_\text{c}]}\cdot[\text{GST\_c}]\cdot\frac{[\text{GSH\_c}]}{\text{Km\_cj\_6\_GSH\_c\_@GST\_c}\cdot\left(1+\frac{[\text{X}''\text{b\_c}]}{\text{Ki\_in\_X}''\text{b\_c\_@GST\_c}}\right)+[\text{GSH\_c}]}\right.$$
$$\left.\cdot\frac{[\text{X}'\text{b\_c}]}{(\text{Km\_cj\_X}'\text{b\_c\_@GST\_c}+[\text{X}'\text{b\_c}])\cdot\left(1+\frac{[\text{X}''\text{b\_c}]}{\text{Ki\_in\_X}''\text{b\_c\_@GST\_c}}\right)}\cdot 1\right)$$
$$+V\_\text{Cytosol}\cdot(\text{k\_pr\_b})$$

$$\frac{d([\text{X\_c}]\cdot V\_\text{Cytosol})}{dt} = -((\text{k\_df\_1\_X\_c}\cdot[\text{X\_c}]-\text{k\_df\_X\_n}\cdot[\text{X\_n}])\cdot V\_\text{Nucleus})$$
$$-V\_\text{Cytosol}\cdot\left(\frac{\text{k\_ox\_X\_c\_@CYP\_c}\cdot[\text{CYP\_c}]\cdot[\text{X\_c}]}{\text{Km\_ox\_X\_c\_@CYP\_c}+[\text{X\_c}]}\right)$$
$$-\left(\frac{\text{k\_tp\_X\_c\_@ABC0\_c}\cdot[\text{ABC0\_c}]\cdot[\text{X\_c}]}{\text{Km\_tp\_X\_c\_@ABC0\_c}+[\text{X\_c}]}\cdot V\_\text{Cytosol}\right)$$
$$+((\text{k\_df\_X\_e}\cdot[\text{X\_e}]-\text{k\_df\_2\_X\_c}\cdot[\text{X\_c}])\cdot V\_\text{Cytosol})$$
$$-V\_\text{Cytosol}\cdot((\text{"k\_as\_X\_c\_(NR\_c)"}\cdot[\text{X\_c}]\cdot[\text{NR\_c}]-\text{k\_ds\_XNR\_c}\cdot[\text{XNR\_c}]))$$

$$\frac{d([\text{XNR\_c}]\cdot V\_\text{Cytosol})}{dt} = +V\_\text{Cytosol}\cdot((\text{"k\_as\_X\_c\_(NR\_c)"}\cdot[\text{X\_c}]\cdot[\text{NR\_c}]-\text{k\_ds\_XNR\_c}\cdot[\text{XNR\_c}]))$$
$$-((\text{k\_tn\_XNR\_c}\cdot[\text{XNR\_c}]-\text{k\_tn\_XNR\_n}\cdot[\text{XNR\_n}])\cdot V\_\text{Nucleus})$$

$$\frac{d\left([\text{X}''\_\text{e}]\cdot V\_\text{Extracellular}\right)}{dt} = +\left(\frac{\text{k\_tp\_X}''\text{\_c\_@ABC3\_c}\cdot[\text{ABC3\_c}]\cdot\frac{[\text{X}''\_\text{c}]}{[\text{X}''\_\text{c}]+[\text{X}''\text{b\_c}]}\cdot[\text{X}''\_\text{c}]}{\text{Km\_tp\_X}''\text{\_c\_@ABC3\_c}+[\text{X}''\_\text{c}]}\cdot V\_\text{Cytosol}\right)$$

$$\frac{d\left([\text{X}''\text{b\_e}]\cdot V\_\text{Extracellular}\right)}{dt} = +\left(\frac{\text{k\_tp\_X}''\text{b\_c\_@ABC3\_c}\cdot[\text{ABC3\_c}]\cdot\frac{[\text{X}''\text{b\_c}]}{[\text{X}''\text{b\_c}]+[\text{X}''\_\text{c}]}\cdot[\text{X}''\text{b\_c}]}{\text{Km\_tp\_X}''\text{b\_c\_@ABC3\_c}+[\text{X}''\text{b\_c}]}\cdot V\_\text{Cytosol}\right)$$

$$\frac{d([\text{ABC0\_ARE\_n}]\cdot V\_\text{Nucleus})}{dt} = -V\_\text{Nucleus}\cdot\left(\text{"k\_as\_Nrf2:Maf\_n\_(ABC0\_ARE\_n)"}\cdot[\text{ABC0\_ARE\_n}]\cdot[\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(ABC0\_ARE\_n)"}}\right.$$
$$\left.-\text{k\_ds\_ABC0\_NMA\_n}\cdot[\text{ABC0\_NMA\_n}]\right)$$

$$\frac{d([ABC0\_DRE\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot (("k\_as\_XNRT\_n\_(ABC0\_DRE\_n)" \cdot [XNRT\_n] \cdot [ABC0\_DRE\_n] - k\_ds\_ABC0\_XNRTD\_n \cdot [ABC0\_XNRTD\_n]))$$

$$\frac{d([ABC0\_gene{,}a\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot \big(k\_a\_b\_ABC0\_gene,i\_n \cdot [ABC0\_gene,i\_n] + "k\_a\_ABC0\_gene,i\_n\_(ABC0\_NMA\_n)" \cdot [ABC0\_gene,i\_n] \cdot [ABC0\_NMA\_n]$$
$$+ "k\_a\_ABC0\_gene,i\_n\_(ABC0\_XNRTD\_n)" \cdot [ABC0\_gene,i\_n] \cdot [ABC0\_XNRTD\_n] - k\_i\_ABC0\_gene,a\_n \cdot [ABC0\_gene,a\_n]\big)$$

$$\frac{d([ABC0\_gene{,}i\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot \big(k\_a\_b\_ABC0\_gene,i\_n \cdot [ABC0\_gene,i\_n] + "k\_a\_ABC0\_gene,i\_n\_(ABC0\_NMA\_n)" \cdot [ABC0\_gene,i\_n] \cdot [ABC0\_NMA\_n]$$
$$+ "k\_a\_ABC0\_gene,i\_n\_(ABC0\_XNRTD\_n)" \cdot [ABC0\_gene,i\_n] \cdot [ABC0\_XNRTD\_n] - k\_i\_ABC0\_gene,a\_n \cdot [ABC0\_gene,a\_n]\big)$$

$$\frac{d([ABC0\_NMA\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot \Big("k\_as\_Nrf2{:}Maf\_n\_(ABC0\_ARE\_n)" \cdot [ABC0\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{"H\_as\_Nrf2{:}Maf\_n\_(ABC0\_ARE\_n)"}$$
$$- k\_ds\_ABC0\_NMA\_n \cdot [ABC0\_NMA\_n]\Big)$$

$$\frac{d([ABC0\_XNRTD\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot (("k\_as\_XNRT\_n\_(ABC0\_DRE\_n)" \cdot [XNRT\_n] \cdot [ABC0\_DRE\_n] - k\_ds\_ABC0\_XNRTD\_n \cdot [ABC0\_XNRTD\_n]))$$

$$\frac{d([ABC3\_ARE\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot \Big("k\_as\_Nrf2{:}Maf\_n\_(ABC3\_ARE\_n)" \cdot [ABC3\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{"H\_as\_Nrf2{:}Maf\_n\_(ABC3\_ARE\_n)"}$$
$$- k\_ds\_ABC3\_NMA\_n \cdot [ABC3\_NMA\_n]\Big)$$

$$\frac{d([ABC3\_DRE\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot (("k\_as\_XNRT\_n\_(ABC3\_DRE\_n)" \cdot [XNRT\_n] \cdot [ABC3\_DRE\_n] - k\_ds\_ABC3\_XNRTD\_n \cdot [ABC3\_XNRTD\_n]))$$

$$\frac{d([ABC3\_gene{,}a\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot \big(k\_a\_b\_ABC3\_gene,i\_n \cdot [ABC3\_gene,i\_n] + "k\_a\_ABC3\_gene,i\_n\_(ABC3\_NMA\_n)" \cdot [ABC3\_gene,i\_n] \cdot [ABC3\_NMA\_n]$$
$$+ "k\_a\_ABC3\_gene,i\_n\_(ABC3\_XNRTD\_n)" \cdot [ABC3\_gene,i\_n] \cdot [ABC3\_XNRTD\_n] - k\_i\_ABC3\_gene,a\_n \cdot [ABC3\_gene,a\_n]\big)$$

$$\frac{d([ABC3\_gene{,}i\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot \big(k\_a\_b\_ABC3\_gene,i\_n \cdot [ABC3\_gene,i\_n] + "k\_a\_ABC3\_gene,i\_n\_(ABC3\_NMA\_n)" \cdot [ABC3\_gene,i\_n] \cdot [ABC3\_NMA\_n]$$
$$+ "k\_a\_ABC3\_gene,i\_n\_(ABC3\_XNRTD\_n)" \cdot [ABC3\_gene,i\_n] \cdot [ABC3\_XNRTD\_n] - k\_i\_ABC3\_gene,a\_n \cdot [ABC3\_gene,a\_n]\big)$$

$$\frac{d([ABC3\_NMA\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot \Big("k\_as\_Nrf2{:}Maf\_n\_(ABC3\_ARE\_n)" \cdot [ABC3\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{"H\_as\_Nrf2{:}Maf\_n\_(ABC3\_ARE\_n)"}$$
$$- k\_ds\_ABC3\_NMA\_n \cdot [ABC3\_NMA\_n]\Big)$$

$$\frac{d([ABC3\_XNRTD\_n]\cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot (("k\_as\_XNRT\_n\_(ABC3\_DRE\_n)" \cdot [XNRT\_n] \cdot [ABC3\_DRE\_n] - k\_ds\_ABC3\_XNRTD\_n \cdot [ABC3\_XNRTD\_n]))$$

$$\frac{d([CYP\_DRE\_n]\cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot \Big("k\_as\_XNRT\_n\_(CYP\_DRE\_n)" \cdot [CYP\_DRE\_n] \cdot [XNRT\_n]^{"H\_as\_XNRT\_n\_(CYP\_DRE\_n)"}$$
$$- k\_ds\_CYP\_XNRTD\_n \cdot [CYP\_XNRTD\_n]\Big)$$

$$\frac{d([\text{CYP\_gene,a\_n}] \cdot V\text{\_Nucleus})}{dt} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_CYP\_gene, i\_n} \cdot [\text{CYP\_gene, i\_n}] + \text{"k\_a\_CYP\_gene, i\_n\_(CYP\_XNRTD\_n)"} \cdot [\text{CYP\_gene, i\_n}] \cdot [\text{CYP\_XNRTD\_n}] - \text{k\_i\_CYP\_gene, a\_n} \cdot [\text{CYP\_gene, a\_n}]\big)$$

$$\frac{d([\text{CYP\_gene,i\_n}] \cdot V\text{\_Nucleus})}{dt} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_CYP\_gene, i\_n} \cdot [\text{CYP\_gene, i\_n}] + \text{"k\_a\_CYP\_gene, i\_n\_(CYP\_XNRTD\_n)"} \cdot [\text{CYP\_gene, i\_n}] \cdot [\text{CYP\_XNRTD\_n}] - \text{k\_i\_CYP\_gene, a\_n} \cdot [\text{CYP\_gene, a\_n}]\big)$$

$$\frac{d([\text{CYP\_XNRTD\_n}] \cdot V\text{\_Nucleus})}{dt} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_XNRT\_n\_(CYP\_DRE\_n)"} \cdot [\text{CYP\_DRE\_n}] \cdot [\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(CYP\_DRE\_n)"}} - \text{k\_ds\_CYP\_XNRTD\_n} \cdot [\text{CYP\_XNRTD\_n}]\Big)$$

$$\frac{d([\text{GCLC\_ARE\_n}] \cdot V\text{\_Nucleus})}{dt} = -V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"} \cdot [\text{GCLC\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"}} - \text{k\_ds\_GCLC\_NMA\_n} \cdot [\text{GCLC\_NMA\_n}]\Big)$$

$$\frac{d([\text{GCLC\_gene,a\_n}] \cdot V\text{\_Nucleus})}{dt} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GCLC\_gene, i\_n} \cdot [\text{GCLC\_gene, i\_n}] + \text{"k\_a\_GCLC\_gene, i\_n\_(GCLC\_NMA\_n)"} \cdot [\text{GCLC\_gene, i\_n}] \cdot [\text{GCLC\_NMA\_n}] - \text{k\_i\_GCLC\_gene, a\_n} \cdot [\text{GCLC\_gene, a\_n}]\big)$$

$$\frac{d([\text{GCLC\_gene,i\_n}] \cdot V\text{\_Nucleus})}{dt} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GCLC\_gene, i\_n} \cdot [\text{GCLC\_gene, i\_n}] + \text{"k\_a\_GCLC\_gene, i\_n\_(GCLC\_NMA\_n)"} \cdot [\text{GCLC\_gene, i\_n}] \cdot [\text{GCLC\_NMA\_n}] - \text{k\_i\_GCLC\_gene, a\_n} \cdot [\text{GCLC\_gene, a\_n}]\big)$$

$$\frac{d([\text{GCLC\_NMA\_n}] \cdot V\text{\_Nucleus})}{dt} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"} \cdot [\text{GCLC\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"}} - \text{k\_ds\_GCLC\_NMA\_n} \cdot [\text{GCLC\_NMA\_n}]\Big)$$

$$\frac{d([\text{GCLM\_ARE\_n}] \cdot V\text{\_Nucleus})}{dt} = -V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"} \cdot [\text{GCLM\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"}} - \text{k\_ds\_GCLM\_NMA\_n} \cdot [\text{GCLM\_NMA\_n}]\Big)$$

$$\frac{d([\text{GCLM\_gene,a\_n}] \cdot V\text{\_Nucleus})}{dt} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GCLM\_gene, i\_n} \cdot [\text{GCLM\_gene, i\_n}] + \text{"k\_a\_GCLM\_gene, i\_n\_(GCLM\_NMA\_n)"} \cdot [\text{GCLM\_gene, i\_n}] \cdot [\text{GCLM\_NMA\_n}] - \text{k\_i\_GCLM\_gene, a\_n} \cdot [\text{GCLM\_gene, a\_n}]\big)$$

$$\frac{d([\text{GCLM\_gene,i\_n}] \cdot V\text{\_Nucleus})}{dt} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GCLM\_gene, i\_n} \cdot [\text{GCLM\_gene, i\_n}] + \text{"k\_a\_GCLM\_gene, i\_n\_(GCLM\_NMA\_n)"} \cdot [\text{GCLM\_gene, i\_n}] \cdot [\text{GCLM\_NMA\_n}] - \text{k\_i\_GCLM\_gene, a\_n} \cdot [\text{GCLM\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{GCLM\_NMA\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"} \cdot [\text{GCLM\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"}}$$
$$-\text{k\_ds\_GCLM\_NMA\_n} \cdot [\text{GCLM\_NMA\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{GS\_ARE\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"} \cdot [\text{GS\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"}}$$
$$-\text{k\_ds\_GS\_NMA\_n} \cdot [\text{GS\_NMA\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{GS\_gene,a\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GS\_gene, i\_n} \cdot [\text{GS\_gene, i\_n}] + \text{"k\_a\_GS\_gene, i\_n\_(GS\_NMA\_n)"} \cdot [\text{GS\_gene, i\_n}] \cdot [\text{GS\_NMA\_n}]$$
$$-\text{k\_i\_GS\_gene, a\_n} \cdot [\text{GS\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{GS\_gene,i\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GS\_gene, i\_n} \cdot [\text{GS\_gene, i\_n}] + \text{"k\_a\_GS\_gene, i\_n\_(GS\_NMA\_n)"} \cdot [\text{GS\_gene, i\_n}] \cdot [\text{GS\_NMA\_n}]$$
$$-\text{k\_i\_GS\_gene, a\_n} \cdot [\text{GS\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{GS\_NMA\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"} \cdot [\text{GS\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"}} - \text{k\_ds\_GS\_NMA\_n} \cdot [\text{GS\_NMA\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{GST\_ARE\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"} \cdot [\text{GST\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"}}$$
$$-\text{k\_ds\_GST\_NMA\_n} \cdot [\text{GST\_NMA\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{GST\_DRE\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_XNRT\_n\_(GST\_DRE\_n)"} \cdot [\text{GST\_DRE\_n}] \cdot [\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(GST\_DRE\_n)"}}$$
$$-\text{k\_ds\_GST\_XNRTD\_n} \cdot [\text{GST\_XNRTD\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{GST\_gene,a\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GST\_gene, i\_n} \cdot [\text{GST\_gene, i\_n}] + \text{"k\_a\_GST\_gene, i\_n\_(GST\_NMA\_n)"} \cdot [\text{GST\_gene, i\_n}] \cdot [\text{GST\_NMA\_n}]$$
$$+\text{"k\_a\_GST\_gene, i\_n\_(GST\_XNRTD\_n)"} \cdot [\text{GST\_gene, i\_n}] \cdot [\text{GST\_XNRTD\_n}] - \text{k\_i\_GST\_gene, a\_n} \cdot [\text{GST\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{GST\_gene,i\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_GST\_gene, i\_n} \cdot [\text{GST\_gene, i\_n}] + \text{"k\_a\_GST\_gene, i\_n\_(GST\_NMA\_n)"} \cdot [\text{GST\_gene, i\_n}] \cdot [\text{GST\_NMA\_n}]$$
$$+\text{"k\_a\_GST\_gene, i\_n\_(GST\_XNRTD\_n)"} \cdot [\text{GST\_gene, i\_n}] \cdot [\text{GST\_XNRTD\_n}] - \text{k\_i\_GST\_gene, a\_n} \cdot [\text{GST\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{GST\_NMA\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"} \cdot [\text{GST\_ARE\_n}] \cdot [\text{Nrf2:Maf\_n}]^{\text{"H\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"}}$$
$$-\text{k\_ds\_GST\_NMA\_n} \cdot [\text{GST\_NMA\_n}]\Big)$$

$$\frac{d([GST\_XNRTD\_n] \cdot V\_Nucleus)}{dt} = +V\_Nucleus \cdot \Big(\text{"k\_as\_XNRT\_n\_(GST\_DRE\_n)"} \cdot [GST\_DRE\_n] \cdot [XNRT\_n]^{\text{"H\_as\_XNRT\_n\_(GST\_DRE\_n)"}}$$
$$-k\_ds\_GST\_XNRTD\_n \cdot [GST\_XNRTD\_n]\Big)$$
$$\frac{d([Maf\_n] \cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot ((\text{"k\_as\_Nrf2\_n\_(Maf\_n)"} \cdot [Maf\_n] \cdot [Nrf2\_n] - k\_ds\_Nrf2{:}Maf\_n \cdot [Nrf2{:}Maf\_n]))$$
$$\frac{d([NR\_n] \cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot ((\text{"k\_as\_X\_n\_(NR\_n)"} \cdot [NR\_n] \cdot [X\_n] - k\_ds\_XNR\_n \cdot [XNR\_n]))$$
$$\frac{d([Nrf2{:}Maf\_n] \cdot V\_Nucleus)}{dt} = -2 \cdot V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(ABC3\_ARE\_n)"} \cdot [ABC3\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(ABC3\_ARE\_n)"}}$$
$$-k\_ds\_ABC3\_NMA\_n \cdot [ABC3\_NMA\_n]\Big)$$
$$-3 \cdot V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"} \cdot [GCLC\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLC\_ARE\_n)"}}$$
$$-k\_ds\_GCLC\_NMA\_n \cdot [GCLC\_NMA\_n]\Big)$$
$$-3 \cdot V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"} \cdot [GCLM\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(GCLM\_ARE\_n)"}}$$
$$-k\_ds\_GCLM\_NMA\_n \cdot [GCLM\_NMA\_n]\Big)$$
$$-2 \cdot V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"} \cdot [GS\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(GS\_ARE\_n)"}} - k\_ds\_GS\_NMA\_n \cdot [GS\_NMA\_n]\Big)$$
$$-2 \cdot V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"} \cdot [GST\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(GST\_ARE\_n)"}} - k\_ds\_GST\_NMA\_n \cdot [GST\_NMA\_n]\Big)$$
$$+V\_Nucleus \cdot ((\text{"k\_as\_Nrf2\_n\_(Maf\_n)"} \cdot [Maf\_n] \cdot [Nrf2\_n] - k\_ds\_Nrf2{:}Maf\_n \cdot [Nrf2{:}Maf\_n]))$$
$$-V\_Nucleus \cdot \Big(\text{"k\_as\_Nrf2:Maf\_n\_(ABC0\_ARE\_n)"} \cdot [ABC0\_ARE\_n] \cdot [Nrf2{:}Maf\_n]^{\text{"H\_as\_Nrf2:Maf\_n\_(ABC0\_ARE\_n)"}}$$
$$-k\_ds\_ABC0\_NMA\_n \cdot [ABC0\_NMA\_n]\Big)$$
$$-V\_Nucleus \cdot ((\text{"k\_as\_Nrf2:Maf\_n\_(Nrf2\_ARE\_n)"} \cdot [Nrf2{:}Maf\_n] \cdot [Nrf2\_ARE\_n] - k\_ds\_Nrf2\_NMA\_n \cdot [Nrf2\_NMA\_n]))$$
$$\frac{d([Nrf2\_ARE\_n] \cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot ((\text{"k\_as\_Nrf2:Maf\_n\_(Nrf2\_ARE\_n)"} \cdot [Nrf2{:}Maf\_n] \cdot [Nrf2\_ARE\_n] - k\_ds\_Nrf2\_NMA\_n \cdot [Nrf2\_NMA\_n]))$$
$$\frac{d([Nrf2\_DRE\_n] \cdot V\_Nucleus)}{dt} = -V\_Nucleus \cdot \Big(\text{"k\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"} \cdot [Nrf2\_DRE\_n] \cdot [XNRT\_n]^{\text{"H\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"}}$$
$$-k\_ds\_Nrf2\_XNRTD\_n \cdot [Nrf2\_XNRTD\_n]\Big)$$

$$\frac{\mathrm{d}([\text{Nrf2\_gene,a\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_Nrf2\_gene, i\_n} \cdot [\text{Nrf2\_gene, i\_n}] + \text{"k\_a\_Nrf2\_gene, i\_n\_(Nrf2\_NMA\_n)"} \cdot [\text{Nrf2\_gene, i\_n}] \cdot [\text{Nrf2\_NMA\_n}]$$

$$+ \text{"k\_a\_Nrf2\_gene, i\_n\_(Nrf2\_XNRTD\_n)"} \cdot [\text{Nrf2\_gene, i\_n}] \cdot [\text{Nrf2\_XNRTD\_n}] - \text{k\_i\_Nrf2\_gene, a\_n} \cdot [\text{Nrf2\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{Nrf2\_gene,i\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot \big(\text{k\_a\_b\_Nrf2\_gene, i\_n} \cdot [\text{Nrf2\_gene, i\_n}] + \text{"k\_a\_Nrf2\_gene, i\_n\_(Nrf2\_NMA\_n)"} \cdot [\text{Nrf2\_gene, i\_n}] \cdot [\text{Nrf2\_NMA\_n}]$$

$$+ \text{"k\_a\_Nrf2\_gene, i\_n\_(Nrf2\_XNRTD\_n)"} \cdot [\text{Nrf2\_gene, i\_n}] \cdot [\text{Nrf2\_XNRTD\_n}] - \text{k\_i\_Nrf2\_gene, a\_n} \cdot [\text{Nrf2\_gene, a\_n}]\big)$$

$$\frac{\mathrm{d}([\text{Nrf2\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot ((\text{"k\_as\_Nrf2\_n\_(Maf\_n)"} \cdot [\text{Maf\_n}] \cdot [\text{Nrf2\_n}] - \text{k\_ds\_Nrf2:Maf\_n} \cdot [\text{Nrf2:Maf\_n}]))$$

$$+ ((\text{k\_tn\_Nrf2\_c} \cdot [\text{Nrf2\_c}] - \text{k\_tn\_Nrf2\_n} \cdot [\text{Nrf2\_n}]) \cdot V\text{\_Nucleus})$$

$$-V\text{\_Nucleus} \cdot (\text{k\_d\_Nrf2\_n} \cdot [\text{Nrf2\_n}])$$

$$\frac{\mathrm{d}([\text{Nrf2\_NMA\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot ((\text{"k\_as\_Nrf2:Maf\_n\_(Nrf2\_ARE\_n)"} \cdot [\text{Nrf2:Maf\_n}] \cdot [\text{Nrf2\_ARE\_n}] - \text{k\_ds\_Nrf2\_NMA\_n} \cdot [\text{Nrf2\_NMA\_n}]))$$

$$\frac{\mathrm{d}([\text{Nrf2\_XNRTD\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = +V\text{\_Nucleus} \cdot \Big(\text{"k\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"} \cdot [\text{Nrf2\_DRE\_n}] \cdot [\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"}}$$

$$-\text{k\_ds\_Nrf2\_XNRTD\_n} \cdot [\text{Nrf2\_XNRTD\_n}]\Big)$$

$$\frac{\mathrm{d}([\text{NT\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = -V\text{\_Nucleus} \cdot ((\text{"k\_as\_XNR\_n\_(NT\_n)"} \cdot [\text{XNR\_n}] \cdot [\text{NT\_n}] - \text{k\_ds\_XNRT\_n} \cdot [\text{XNRT\_n}]))$$

$$\frac{\mathrm{d}([\text{X\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = + ((\text{k\_df\_1\_X\_c} \cdot [\text{X\_c}] - \text{k\_df\_X\_n} \cdot [\text{X\_n}]) \cdot V\text{\_Nucleus})$$

$$-V\text{\_Nucleus} \cdot ((\text{"k\_as\_X\_n\_(NR\_n)"} \cdot [\text{NR\_n}] \cdot [\text{X\_n}] - \text{k\_ds\_XNR\_n} \cdot [\text{XNR\_n}]))$$

$$\frac{\mathrm{d}([\text{XNR\_n}] \cdot V\text{\_Nucleus})}{\mathrm{d}t} = + ((\text{k\_tn\_XNR\_c} \cdot [\text{XNR\_c}] - \text{k\_tn\_XNR\_n} \cdot [\text{XNR\_n}]) \cdot V\text{\_Nucleus})$$

$$+V\text{\_Nucleus} \cdot ((\text{"k\_as\_X\_n\_(NR\_n)"} \cdot [\text{NR\_n}] \cdot [\text{X\_n}] - \text{k\_ds\_XNR\_n} \cdot [\text{XNR\_n}]))$$

$$-V\text{\_Nucleus} \cdot ((\text{"k\_as\_XNR\_n\_(NT\_n)"} \cdot [\text{XNR\_n}] \cdot [\text{NT\_n}] - \text{k\_ds\_XNRT\_n} \cdot [\text{XNRT\_n}]))$$

$$
\begin{aligned}
\frac{\mathrm{d}([\text{XNRT\_n}]\cdot V\text{\_Nucleus})}{\mathrm{d}t} \quad = \quad & -V\text{\_Nucleus}\cdot((\text{"k\_as\_XNRT\_n\_(ABC3\_DRE\_n)"}\cdot[\text{XNRT\_n}]\cdot[\text{ABC3\_DRE\_n}]-\text{k\_ds\_ABC3\_XNRTD\_n}\cdot[\text{ABC3\_XNRTD\_n}]))\\
& -2\cdot V\text{\_Nucleus}\cdot\Big(\text{"k\_as\_XNRT\_n\_(CYP\_DRE\_n)"}\cdot[\text{CYP\_DRE\_n}]\cdot[\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(CYP\_DRE\_n)"}}\\
& -\text{k\_ds\_CYP\_XNRTD\_n}\cdot[\text{CYP\_XNRTD\_n}]\Big)\\
& -2\cdot V\text{\_Nucleus}\cdot\Big(\text{"k\_as\_XNRT\_n\_(GST\_DRE\_n)"}\cdot[\text{GST\_DRE\_n}]\cdot[\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(GST\_DRE\_n)"}}\\
& -\text{k\_ds\_GST\_XNRTD\_n}\cdot[\text{GST\_XNRTD\_n}]\Big)\\
& -2\cdot V\text{\_Nucleus}\cdot\Big(\text{"k\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"}\cdot[\text{Nrf2\_DRE\_n}]\cdot[\text{XNRT\_n}]^{\text{"H\_as\_XNRT\_n\_(Nrf2\_DRE\_n)"}}\\
& -\text{k\_ds\_Nrf2\_XNRTD\_n}\cdot[\text{Nrf2\_XNRTD\_n}]\Big)\\
& -V\text{\_Nucleus}\cdot((\text{"k\_as\_XNRT\_n\_(ABC0\_DRE\_n)"}\cdot[\text{XNRT\_n}]\cdot[\text{ABC0\_DRE\_n}]-\text{k\_ds\_ABC0\_XNRTD\_n}\cdot[\text{ABC0\_XNRTD\_n}]))\\
& +V\text{\_Nucleus}\cdot((\text{"k\_as\_XNR\_n\_(NT\_n)"}\cdot[\text{XNR\_n}]\cdot[\text{NT\_n}]-\text{k\_ds\_XNRT\_n}\cdot[\text{XNRT\_n}]))
\end{aligned}
$$