

# B[Z VcY YZVi] d[V\Zci#WhZY edej aVi'dch

<gVcXZhXd Fj XX'dc^F] ^æe I ] db Vh

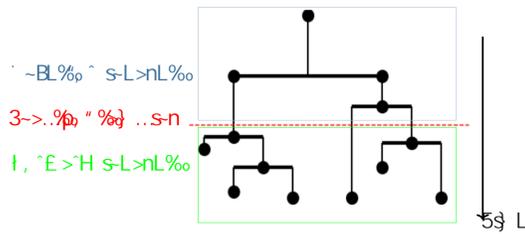
: ZeVgb Zci d[ C Vi] Zb Vi Xh" b eZgVa9daZ\Z BdcYdc" J A

## 7igdyj Xi'dc

1 Y>- N's-n BL Y> n", E "p %B'YBs> ", Y-HL^%o-Hs-n  
 "pL Hf->} %o NBL ... ..Y> , ~-%%Bp >%o %B', AL%o-H  
 B>-BL^ BL %o 5pL Lc, Y , ~ , N> BL B, } } Y-s L%o%o  
 %o, ~n%>QLB'LH A% "pL pL"L^, nL-Ls%> " > %onL BL  
 LcL : L>L s">L^L%bHs-p, E "pL LQLB", NBL ", BL  
 C>sAss%>, ~H'Yn "L>"} L~" B>- AL } , HL LH>-H...L  
 HB'LH

### 3", Bp>%B s-L>nL Hf->} %B'o

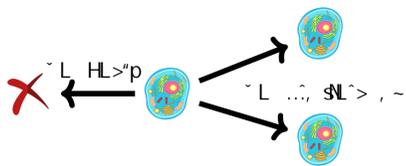
5pL C>sAss%> " > %onL BL LcL B>- AL "BLHA>By",  
 s">L~> " > %s%o%o%L >nL, ^ BL BfBL %onL 3YBp s">L~  
 ~> " > %s%o-B'L>%o E s'p } L L>Hs-n ", >nL C>sAss%>  
 >B', %o%L>nL%o



5pL %o} ..s-n, N"pL ... ..Y> , ~ , ~>n%L~ } L H, L%o, "  
 ... C>HL s-N } > , ~ , ~N'Y'L >-H...Lc% Y%o%>sAss%>s-  
 %oL N^E>H >-H >-BL%o^ s-L>nL%o%o L^L %o%L tYl%o  
 , ~ %o%o ... %o%L ", Bp>B'L^sL N^E>H >-H >-BL%o^  
 sL } L s > BL ... ..Y> , ~ Y-HL^ "L>"} L~"

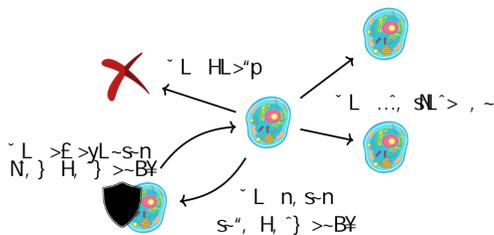
### / Y'n "L>"} L~"

^ L %o%L "L^, nL-Ls%> %o } ..>B' %o%o , ~ H'Yn L] Bf-Bf  
 E p%o %B'YBs> ", ... C>HL } , ^L LQLB cL } LHs> "L>  
 } L~" / Y's-n >"L>"} L~" BL %o%L " >nL^LH A% "pL H'Yn  
 >-H "pL Lc, Y , ~ , N"pL BL ... ..Y> , ~ %o%L cL~ A% "E,  
 " >-%o, ~%o



### / , } >-Bf s-A'L>%B>-BL^

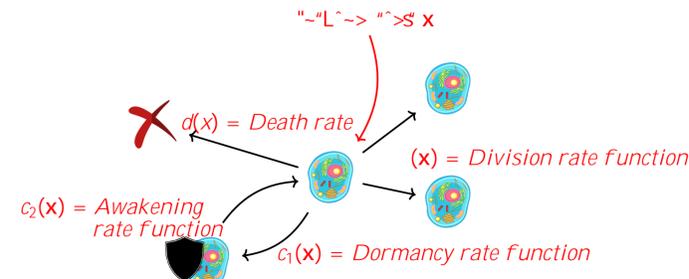
5pL AYsHs-n A, Bf%o NB>-BL^ LapsAs> E %HL C>sAss%>  
 ^ } , ~n pL "L^, nL-L, Y%o%Y } , ^ BL ... ..Y> , ~%o%L sps-...s  
 } >Y A'L>%oB>-BL^ "Y } , ^ BL %o%o%o%o "pL N } , NBL  
 Y> H, } >-Bf 5pL %o H, } >- BL %o%L "LN>B", ^%> ,  
 B>-BL^ "pL">..%o%o-HALB, } L L~^ %pLH N , E s-n B>-BL^  
 "L>"} L~" %o%L Y's-n "pL B>-BL^ "pL">..%o%o pL "Y } , ^ BL %o  
 } >Y ..L^N } HQL "L~" " >-%o, ~%o



^ >-BL^ BL %B>- AL } , HL LH>%s-Hc%Y>%E p, B>- HL  
 Hf...s>L >-H B, ~cL^ s", > H, } >- %o%L E pL "L^ pL%  
 ^L%o%Y~ >E >yl-s-n 5pL H, } >-Bf %o%L Y%o%Y %o%>Ln%  
 N^ "pL BL %o, L%o%L "pL H'Yn "L>"} L~"

## 7cVani Xvab Zi] dYh

: L s~", HfBL > ~, cL %o Bp>%oB } , HL E pL "L BL %o%L  
 ^L...L%o%L "LH A% >nL~" %E p, ..L^N } " >-%o, ~%o%L  
 %o%L ~%o%L ", >- s">L~> B, ~ ~Y, Y%o%o%L x E p%o s-  
 B'L>%o%o%L sp } L  
 5, >BB, Y~" "pL B, ~ ~Y, Y%o%L "L^, nL-Ls%> "pL %o%o%L  
 >AY-H>-BL >L HL%o%LALH A% %o Bp>%oB N~B, ~%o  
 5pL ^>L, NL>Bp " >-%o, ~ %o%L ~> N~B, ~ , N"pL s-  
 "L~> " > %s", N"pL BL Y-HL^, s-n "pL " >-%o, ~%o  
 fln/ , } >-Bf s-A'L>%oB>-BL^



E p%o %B'YBs> , E %o%o%o, E ^sL >nL-L^> } >%o%L L tY> , ~ , N  
 "pL N~B, ~> ... A>Ass%> P[n1, n2, t] E pL "L^ pL N~B  
 , ~%o%L (x) >-H n2(x) ^L...L%o%L "pL BL >AY-H>-BL%o%L sp  
 s">L~> %o%L x s- "pL ~, ~ H, } >-> ~-H H, } >-> %o%L  
 ^L%o%L cL %

$$\frac{P[n_1, n_2, t]}{t} = \int_0^Z \frac{n_1(x) P[n_1, n_2, t] dx}{Z} + \int_0^Z \frac{n_2(x) P[n_1, n_2, t] dx}{Z} + \int_0^Z \frac{(x) ( \frac{+1}{2}(x) \frac{-2}{1}(0) - 1) n_1(x) P[n_1, n_2, t] dx}{Z} + \int_0^Z \frac{d(x) ( \frac{+1}{2}(x) - 1) n_1(x) P[n_1, n_2, t] dx}{Z} + \int_0^Z \frac{c_1(x) ( \frac{-1}{2}(x) \frac{+1}{1}(0) - 1) n_1(x) P[n_1, n_2, t] dx}{Z} + \int_0^Z \frac{c_2(x) ( \frac{+1}{2}(x) \frac{-1}{1}(0) - 1) n_2(x) P[n_1, n_2, t] dx}{Z}$$

>-H ^L...L%o%L "pL N~B, ~> %o%L... ..L^> , ^  
 $i^m(x_0) P[n_1, n_2, t] = P[n_i + m (x - x_0), n_{i+1}, t]$

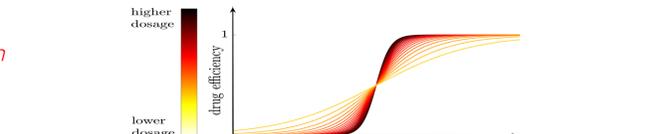
5pL } >%o%L L tY> , ~ B>- AL ^L%o%L LHs> tY~B, ~>  
 / L^c> cL fl tY> , ~ N^ "pL nL-L^> ~n N~B, ~>  
 E p%o B>- AL } >-s.Y>"LH Y%o%o >nL-L^> %LH  
 Bp>B'L^ %o%L Bf^cL%o%L L^p, H%o%o, A">s-s-N } > , ~  
 >A, Y" "pL %o Bp>%oB } , } L~" %o%L ~B, ~ ... A>Ass%>  
 >-H s-L>nL%o%L %o%L AY , ~%o

^ , ~Bf%o%o ~%o  
 ) >"pL } > B> } , HL s-n tY>~ " > cL %o...LHs%o%o  
 "pL L] Bf-Bf, N'Yn "L>"} L~" %o%o  
 : L...LHs%o "pL L%o%L ~BL, N>H'Yn H, %o  
 "pL%o H N^ B } ...L^L y s-s-n, NB>-BL^ BL  
 ... ..Y> , ~  
 , Y~s-%o%o%o...%>~ , " , ~%> , B>-BL^ AY" B>-  
 L tY> %AL >... %LH", ..L^%o%L ~BL s-  
 >- } %B, As ^L%o%L ~BL

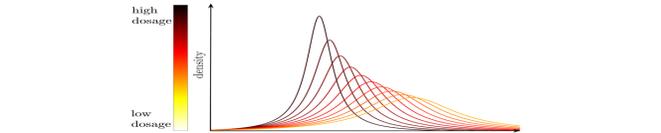
## HZhj ah

5pL HLcL , ..LH >-> %B } L^p, HA, Y-HLH E sp >%o%L , N  
 %o%L Y> , ~ >n, ^sp } %o%L , E %o%L , A">s-s-B } ..L^L Bp>  
 >B'L^s> , ~ , NBL ... ..Y> , ~%o%L-HL^ "L>"} L~"  
 " ~ "pL N , E s-n "pL "L>L^L... ^LH "pL } >-s- ^L%o%L  
 n>Hs-n BL ... ..Y> , ~ Hf->} %o%L-HL^ H'Yn "L>"} L~"  
 %o%L ~> %s >-H "pL A'L>%oB>-BL^ H, } >-Bf %o%L ~> %s  
 2L%o%L "H'Yn "L>"} L~"

5pL >-> %B } >-H ~Y } L^s> ^L%o%L %o%L , E " , H'>E >  
 tY>~ " > cL ... %Y^L ^Ln>Hs-n H'Yn "L>"} L~" L] Bf-Bf  
 s > BL ... ..Y> , ~  
 5pL L] Bf-Bf , N "pL H'Yn "L>"} L~" >...^ , >BpL%o%L  
 >%o%L ... Bc>Yl%o%L ^ E pL ~ "pL H'Yn H, %o%L s- p%o%L

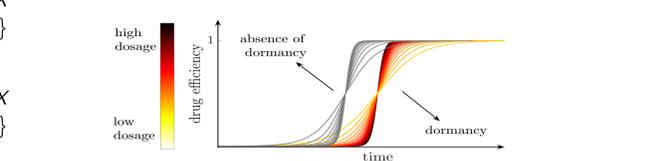


5pL H%o%L AY , ~ , Nys s-n } L%o%L p%o%L AS%o%L , E L^ >-H N^  
 "pL ..L>y E s'p , E L^ H, %onL

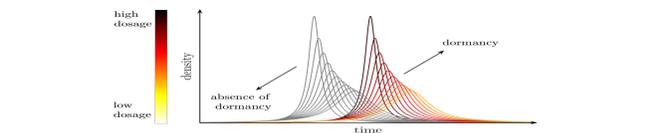


^ , ^L, cL^ s- "pL , ~n  
 "L>"} L~" } L%o%L E L  
 %o%L E "p>" %o%L L H, %onL%o  
 > , E > B } ..L^L y s-s-n  
 , N "pL ... ..Y> , ~ E p%L  
 "pL^ L>H , ~%> , >  
 N>B , ~> y s-s-n

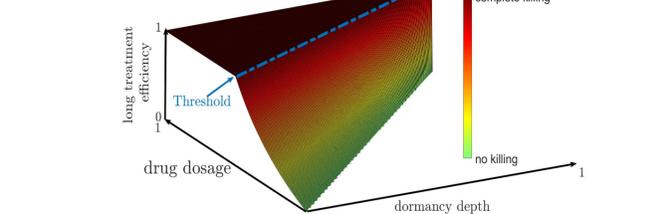
2L%o%L "H'Yn "L>"} L~" s>H, } >-> B>-BL^ BL ... ..Y  
 > , ~  
 ^ %o%L "pL H'Yn "L>"} L~" %o%L ~> %s "pL >-> %B } L^p, H%o  
 > , E " , , A">s- %o%L cL^ > s-%o%L %o%L n>Hs-n "pL "L> , ~ AL  
 "E L~ B>-BL^ BL %ALp>C%o%L Y^ >-H H, } >-Bf 5pL H'Yn  
 L] Bf-Bf %o%L E LH H, E ~ A% "pL H, } >-Bf



/ , } >-Bf >%o%L ..Y%o%L N^ "pL "pL ..L>y%o%L p%o%L LH A%  
 "pL y s-s-n } L%o%L %o%L AY , ~



" ~ "pL , ~n "L>"} L~" } L%o%L E L %o%L E LH >-> %B } %> "p>  
 L %o%L T-sL H'Yn H, %o%L A, cL E p%o%L E L , A%o%L B }  
 ..L^L y s-s-n E p%L , E L^ H'Yn H, %o%L n%L %o%L , N>B  
 , ~> y s-s-n ^YBs> %> " >-%o%L ~ H, } >-Bf s-B'L>%o%L p%o%L  
 "pL %o%L H E p%L "pL L%o%L ~BL, NLL...H, } >-> BL %o%L A,  
 %o%L %o%L



7X^ cdl aZY\b ZcihOj] Zl dg l Vh hj eedgZY Whi] Z ; F1 H9 9ZciZg[dgC Vi] Zb Vi Xhd[FgZXh'dc >ZVa] 9VgZ \g/ci D^d ; F%oD& \*+( /% ZV ; FHi 9 : l F hX] da/g] e id <F^  
 VcY V J AH?<j ij gZ BZVYZgh <Zadl h] e \g/ci D^d C H%& &' . \*( /% Zid F l

Imperial College London

UKRI UK Research and Innovation

CMPH Centre for Mathematics of Precision Healthcare

- [X] XX'dc ^&6 b eZgVa% X\$ ^
- e\$] db Vh6 b eZgVa% X\$ ^
- I ] db Vh \gdj e l ZWh^Z
- <gVcXZhXd Fj XX'dc^F] ZWh^Z