Interface Focus

A model for the optimization of anti-inflammatory treatment with Chemerin

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S5: Matlab code developed for analysing the anti-inflammatory potential of chemerin

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function main


%% Defining inputs for Inflammation

% Time of simulations

tspan=0:96;

% IC
Z=100;
C1=0;
C2=5.17e-3;
N=0.1075;
A=0;
M=0.07725;
Ch=1.921294389;
C15=0;
G=0;


y0=[Z;C1;C2;N;A;M;Ch;C15;G];

%% Simulation for Control data

ceta=0;
alpha=2;

options = odeset('RelTol',1e-6,'AbsTol',1e-6);
[t_1,y_c]=ode23s(@(t,y)Inflammation(t,y,ceta,alpha),tspan,y0,options);
%% Simulation for chemerin intervention

% Injection parameters
ceta=500;
alpha=2;

options = odeset('RelTol',1e-6,'AbsTol',1e-6);
[t_2,y_I]=ode23s(@(t,y)Inflammation(t,y,ceta,alpha),tspan,y0,options);


end

function dy=Inflammation(time,y,ceta,alpha)

% Syntax:   [Acute_Inflammation]= ChemerinIntervention(time,IC)
%
% Inputs:
```

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%   - time - duration of simulation (experiments lasted 96 hours)
%   - Ic - Initial conditions for ODE
%   - ceta - Concentration of chemerin injected (Concentration of injection
% pilot study concentration injected was 500 ug ml^-1)
%   - alpha -  Time of injection (for data fitting alpha= 2 hours)
%
% Outputs:
%   - dy - acute inflammation kinetics when  500 ug ml-1 of chemerin are
%   injected 2 hours after inflammation is triggered by injecting zymosan
%   into the    - dy - acute inflammation kinetics when  500 ug ml-1 of
chemerin are
%   injected 2 hours after inflammation is triggered by injecting zymosan
%   into the peritoneum
%
% Example: none
%
% Other m-files required: none
% Subfunctions: none
% MAT-files required: none
%
% PROJECT: Creating the first mathematical model of acute inflammation in
% the presence of an intervention based on experimental work performed at
% the Sir William Dunn Department of Physiology at Oxford University where
% the potential of the cytokine chemerin as an anti-inflammatory chemokine
% is tested using an in vivo rat peritonitis triggered by injection of
% zymosan inflammatory model.

%
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%********** MODEL PARAMETERS
Z=y(1);
C1=y(2);
C2=y(3);
N=y(4);
A=y(5);
M=y(6);
Ch=y(7);
C15=y(8);
G=y(9);

%********** MODEL PARAMETERS

% % Fitted parameters (Table 3)
kpn = 2.012717e+00;
kpm = 1.284739e+00;
Vc1z = 2.860316e+00;
kc1z = 1.001833e-03;
knc15 = 1.632325e-01;
kng = 6.258848e-03;
kzg = 1.218345e-03;
Vnc1 = 4.859184e+00;
knc1 = 1.027289e+01;
Vac1 = 1.306627e-03;
kac1 = 3.552644e-01;
kac15 = 2.631185e-03;
kag = 2.818834e-02;
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Vc1n = 2.649584e+00;
kan = 1.150754e-03;
kpa = 3.410737e-03;
kc15 = 1.199422e-03;
kc2m = 5.182210e-01;
kchm = 1.000026e-03;
ym = 1.985602e-02;
Vc15 = 2.686652e-01;
kmc15 = 1.694775e-01;
kg = 3.552573e-03;
Vnch = 2.330998e+00;
knch = 1.931876e-02;
Vach = 5.887266e-03;
kach = 5.735711e-02;
Vnc2 = 1.898505e-03;
knc2 = 1.073158e+00;
Vac2 = 2.674877e+01;
kzc15 = 1.560110e+01;
kac2 = 2.500315e-02;
ya = 1.749645e-03;
wnch = 2.127776e+00;
wach = 2.769183e-01;
wnc2 = 1.621473e-03;
wac2 = 4.999912e+00;
wnc1 = 4.992308e+00;
wac1 = 2.321023e+00;
wng = 3.430762e+00;
wag = 1.736326e+00;
wac15 = 1.819250e-02;
wnc15 = 4.394601e-03;
wzg = 1.048423e+00;
wzc15 = 3.801701e-01;
kchz = 1.099048e+00;
Vchz = 3.150024e+00;

% % Parameters found in the literature (Table 2)
yn=6.3e-2;
yc1=8.3e-1;
yc15=8.3e-1;
yg=8.3e-1;
ych=8.3e-1;
yc2=8.3e-1;

% %  Parameters derived from the data (Section 5.1)
Nmax=9;
Mmax=4;

% % Parameters that define the injection step function (Section 4.5.5)

% speed of step function
beta=30;

%********** MODEL REACTIONS

J1_Ch=Vchz*(Z/kchz)/(1+Z/kchz);

J2=kan*N;

J3_N_C2=Vnc2*(N^wnc2/(knc2^wnc2+N^wnc2));
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```
J3_A_C2=Vac2*(A^wac2/(kac2^wac2+A^wac2));

J3_N_Ch=Vnch*(N^wnch/(knch^wnch+N^wnch));

J3_A_Ch=Vach*(A^wach/(kach^wach+A^wach));

J4=Vc1n*(C1)*(1-N/Nmax);

J5=(kc2m*C2+kchm*Ch)*(1-M/Mmax);

J6=kpn*Z*N+kpm*Z*M;

J7=M*A*(kpa)*(1+C15/kc15);

J8=kg*J7;

J9=Vc15*(Ch/(kmc15+Ch))*M;

J10=Vc1z*(Z/kc1z)/(1+Z/kc1z)*((1)/(1+C15^wzc15/kzc15^wzc15))*((1)/(1+G^wzg/
kzg^wzg));

J11_N_C1=Vnc1*(N^wnc1/(knc1^wnc1+N^wnc1))*((1)/(1+C15^wnc15/knc15^wnc15))*(
(1)/(1+G^wng/kng^wng));

J11_A_C1=Vac1*(A^wac1/(kac1^wac1+A^wac1))*((1)/(1+C15^wac15/kac15^wac15))*(
(1)/(1+G^wag/kag^wag));

J12=ceta*beta*exp(-beta*(time-alpha))*(1/(exp(-beta*(time-alpha))+1)^2);

J13_C1=yc1*C1;

J13_A=ya*A;

J13_C2=yc2*C2;

J13_N=yn*N;

J13_M=ym*M;

J13_Ch=ych*Ch;

J13_G=yg*G;

J13_C15=yc15*C15;


%********** MODEL STATES

d_C1=J10+J11_N_C1+J11_A_C1-J13_C1;
d_Z=-J6;
d_C2=J3_N_C2+J3_A_C2-J13_C2;
d_N=J4-J2-J13_N;
d_A=J2-J7-J13_A;
d_M=J5-J13_M;
d_Ch=J1_Ch+J3_N_Ch+J3_A_Ch-J9-J13_Ch+J12;
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```
d_C15=J9-J13_C15;
d_G=J8-J13_G;


dy=[d_Z;d_C1;d_C2;d_N;d_A;d_M;d_Ch;d_C15;d_G];
end
```