```
function out = Matlab_Code_from_Comsol_prototype
%
% Matlab_Code_from_Comsol_prototype.m
%
% Model exported on Dec 19 2024, 11:09 by COMSOL 5.2.1.152.

import com.comsol.model.*
import com.comsol.model.util.*

model = ModelUtil.create('Model');

model.modelPath('C:\Users\mkouts03\Desktop\Matlab Code');

model.label('New 4T1_Breast Cancer_Ketotifen-Sonopermeation-Doxil-
ICIs_prototype.mph');

model.comments(('Untitled\n\n'));

model.param.set('aa', '1.55e-4[m^2/d]');

model.modelNode.create('comp1');

model.geom.create('geom1', 3);

model.func.create('rn1', 'Random');
model.func.create('step1', 'Step');
model.func.create('step2', 'Step');
model.func.create('step24', 'Step');
model.func.create('step25', 'Step');
model.func.create('step26', 'Step');
model.func.create('rect1', 'Rectangle');
model.func.create('rect2', 'Rectangle');
model.func.create('step27', 'Step');
model.func.create('step28', 'Step');
model.func.create('rect3', 'Rectangle');
model.func.create('rect4', 'Rectangle');
model.func.create('rect5', 'Rectangle');
model.func.create('rect6', 'Rectangle');
model.func.create('step29', 'Step');
model.func.create('step30', 'Step');
model.func('rn1').set('uniformrange', '0.5');
model.func('rn1').set('mean', '1');
model.func('step1').model('comp1');
model.func('step1').set('funcname', 'dose1n');
model.func('step1').set('smooth', '86400[s]');
model.func('step1').set('location', '19[d]');
model.func('step2').model('comp1');
model.func('step2').set('funcname', 'dose2n');
model.func('step2').set('smooth', '86400[s]');
model.func('step2').set('location', '22[d]');
model.func('step24').model('comp1');
model.func('step24').label('Step 3');
model.func('step24').set('funcname', 'dose1');
model.func('step24').set('smooth', '86400[s]');
model.func('step24').set('location', '19[d]');
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model.func('step25').model('comp1');
model.func('step25').label('Step 4');
model.func('step25').set('funcname', 'dose2');
model.func('step25').set('smooth', '86400[s]');
model.func('step25').set('location', '22[d]');
model.func('step26').model('comp1');
model.func('step26').label('Step 24');
model.func('step26').set('funcname', 'step1');
model.func('step26').set('smooth', '0.001');
model.func('step26').set('location', '0.00045');
model.func('rect1').model('comp1');
model.func('rect1').set('upper', '20[d]');
model.func('rect1').set('lower', '19[d]');
model.func('rect1').set('smooth', '77760[s]');
model.func('rect2').model('comp1');
model.func('rect2').set('upper', '23[d]');
model.func('rect2').set('lower', '22[d]');
model.func('rect2').set('smooth', '77760[s]');
model.func('step27').model('comp1');
model.func('step27').label('Step 25');
model.func('step27').set('funcname', 'step25');
model.func('step27').set('to', '30e3[Pa]');
model.func('step27').set('smooth', '172800[s]');
model.func('step27').set('from', '60e3[Pa]');
model.func('step27').set('location', '16.5[d]');
model.func('step28').model('comp1');
model.func('step28').label('Step 26');
model.func('step28').set('funcname', 'step26');
model.func('step28').set('to', '11e3[Pa]');
model.func('step28').set('smooth', '172800[s]');
model.func('step28').set('from', '21e3[Pa]');
model.func('step28').set('location', '16.5[d]');
model.func('rect3').model('comp1');
model.func('rect3').active(false);
model.func('rect3').set('upper', '21[d]');
model.func('rect3').set('lower', '18[d]');
model.func('rect3').set('smooth', '172800[s]');
model.func('rect4').model('comp1');
model.func('rect4').active(false);
model.func('rect4').set('upper', '24[d]');
model.func('rect4').set('lower', '21[d]');
model.func('rect4').set('smooth', '172800[s]');
model.func('rect5').model('comp1');
model.func('rect5').active(false);
model.func('rect5').set('upper', '21[d]');
model.func('rect5').set('lower', '18[d]');
model.func('rect5').set('smooth', '172800[s]');
model.func('rect6').model('comp1');
model.func('rect6').active(false);
model.func('rect6').set('upper', '24[d]');
model.func('rect6').set('lower', '21[d]');
model.func('rect6').set('smooth', '172800[s]');
model.func('step29').model('comp1');
model.func('step29').set('to', '7.523e-14[(m^3*s)/(kg)]');
model.func('step29').set('smooth', '172800[s]');
model.func('step29').set('from', '7.523e-16[(m^3*s)/(kg)]');
model.func('step29').set('location', '16.5[d]');
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model.func('step30').model('comp1');
model.func('step30').set('to', '7.523e-14[(m^3*s)/(kg)]');
model.func('step30').set('smooth', '172800[s]');
model.func('step30').set('from', '7.523e-16[(m^3*s)/(kg)]');
model.func('step30').set('location', '16.5[d]');

model.mesh.create('mesh1', 'geom1');

model.geom('geom1').create('sph1', 'Sphere');
model.geom('geom1').feature('sph1').set('r', '900e-6');
model.geom('geom1').create('blk1', 'Block');
model.geom('geom1').feature('blk1').set('size', {'0.005' '0.005'
'0.005'});
model.geom('geom1').create('int1', 'Intersection');
model.geom('geom1').feature('int1').selection('input').set({'blk1'
'sph1'});
model.geom('geom1').create('blk2', 'Block');
model.geom('geom1').feature('blk2').set('size', {'0.1' '0.1' '0.1'});
model.geom('geom1').create('uni1', 'Union');
model.geom('geom1').feature('uni1').selection('input').set({'blk2'
'int1'});
model.geom('geom1').run;

model.variable.create('var1');
model.variable('var1').model('comp1');
model.variable('var1').set('solid.kappa',
'2*solid.muLame*(1+poissonr)/(3*(1-2*poissonr))');
model.variable('var1').set('ri', 'sqrt(x^2+y^2+z^2)');
model.variable('var1').set('phi', 'atan2(y,x)');
model.variable('var1').set('th', 'acos(z/ri)');
model.variable('var1').set('Smat11', '2*solid.Ji*d(Wmat,solid.Cl11)');
model.variable('var1').set('Smat12', 'solid.Ji*d(Wmat,solid.Cl12)');
model.variable('var1').set('Smat13', 'solid.Ji*d(Wmat,solid.Cl13)');
model.variable('var1').set('Smat22', '2*solid.Ji*d(Wmat,solid.Cl22)');
model.variable('var1').set('Smat23', 'solid.Ji*d(Wmat,solid.Cl23)');
model.variable('var1').set('Smat33', '2*solid.Ji*d(Wmat,solid.Cl33)');
model.variable('var1').set('smat11',
'(Smat11*(solid.Fdlx1)^2+Smat22*(solid.Fdlx2)^2+2*Smat23*solid.Fdlx2*so
lid.Fdlx3+Smat33*(solid.Fdlx3)^2+2*solid.Fdlx1*(Smat12*solid.Fdlx2+Smat
13*solid.Fdlx3))/solid.J');
model.variable('var1').set('smat12',
'(solid.Fdlx1*(Smat11*solid.Fdly1+Smat12*solid.Fdly2+Smat13*solid.Fdly3
)+solid.Fdlx2*(Smat12*solid.Fdly1+Smat22*solid.Fdly2+Smat23*solid.Fdly3
)+solid.Fdlx3*(Smat13*solid.Fdly1+Smat23*solid.Fdly2+Smat33*solid.Fdly3
))/solid.J');
model.variable('var1').set('smat13',
'(solid.Fdlx1*(Smat11*solid.Fdlz1+Smat12*solid.Fdlz2+Smat13*solid.Fdlz3
)+solid.Fdlx2*(Smat12*solid.Fdlz1+Smat22*solid.Fdlz2+Smat23*solid.Fdlz3
)+solid.Fdlx3*(Smat13*solid.Fdlz1+Smat23*solid.Fdlz2+Smat33*solid.Fdlz3
))/solid.J');
model.variable('var1').set('smat22',
'(Smat11*(solid.Fdly1)^2+Smat22*(solid.Fdly2)^2+2*Smat23*solid.Fdly2*so
lid.Fdly3+Smat33*(solid.Fdly3)^2+2*solid.Fdly1*(Smat12*solid.Fdly2+Smat
13*solid.Fdly3))/solid.J');
model.variable('var1').set('smat23',
'(solid.Fdly1*(Smat11*solid.Fdlz1+Smat12*solid.Fdlz2+Smat13*solid.Fdlz3
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)+solid.Fdly2*(Smat12*solid.Fdlz1+Smat22*solid.Fdlz2+Smat23*solid.Fdlz3
)+solid.Fdly3*(Smat13*solid.Fdlz1+Smat23*solid.Fdlz2+Smat33*solid.Fdlz3
))/solid.J');
model.variable('var1').set('smat33',
'(Smat11*(solid.Fdlz1)^2+Smat22*(solid.Fdlz2)^2+2*Smat23*solid.Fdlz2*so
lid.Fdlz3+Smat33*(solid.Fdlz3)^2+2*solid.Fdlz1*(Smat12*solid.Fdlz2+Smat
13*solid.Fdlz3))/solid.J');
model.variable('var1').set('smatrr',
'smat33*cos(th)*cos(th)+smat11*cos(phi)*cos(phi)*sin(th)*sin(th)+smat13
*cos(phi)*sin(2*th)+2*smat12*cos(phi)*sin(th)*sin(th)*sin(phi)+smat23*s
in(2*th)*sin(phi)+smat22*sin(th)*sin(th)*sin(phi)*sin(phi)');
model.variable('var1').set('smattt',
'smat11*cos(th)*cos(th)*cos(phi)*cos(phi)+smat33*sin(th)*sin(th)-
smat13*cos(phi)*sin(2*th)-
smat23*sin(2*th)*sin(phi)+smat22*cos(th)*cos(th)*sin(phi)*sin(phi)+smat
12*cos(th)*cos(th)*sin(2*phi)');
model.variable('var1').set('smatpp', 'smat22*cos(phi)*cos(phi)-
2*smat12*cos(phi)*sin(phi)+smat11*sin(phi)*sin(phi)');
model.variable('var1').set('srr',
'solid.sz*cos(th)*cos(th)+solid.sx*cos(phi)*cos(phi)*sin(th)*sin(th)+so
lid.sxz*cos(phi)*sin(2*th)+2*solid.sxy*cos(phi)*sin(th)*sin(th)*sin(phi
)+solid.syz*sin(2*th)*sin(phi)+solid.sy*sin(th)*sin(th)*sin(phi)*sin(ph
i)');
model.variable('var1').set('stt',
'solid.sx*cos(th)*cos(th)*cos(phi)*cos(phi)+solid.sz*sin(th)*sin(th)-
solid.sxz*cos(phi)*sin(2*th)-
solid.syz*sin(2*th)*sin(phi)+solid.sy*cos(th)*cos(th)*sin(phi)*sin(phi)
+solid.sxy*cos(th)*cos(th)*sin(2*phi)');
model.variable('var1').set('spp', 'solid.sy*cos(phi)*cos(phi)-
2*solid.sxy*cos(phi)*sin(phi)+solid.sx*sin(phi)*sin(phi)');
model.variable('var1').set('smatbulk', '(smatrr+smattt+smatpp)/3');
model.variable('var1').set('sbulk', '(srr+stt+spp)/3');
model.variable('var1').set('Wmat', '0.5*(solid.muLame*(solid.I1CIel-
3)+solid.kappa*(solid.Jel-1)^2)');
model.variable.create('var6');
model.variable('var6').model('comp1');
model.variable('var6').set('uof', '-khy*d(p,x)/(1-phis)+ut');
model.variable('var6').set('vof', '-khy*d(p,y)/(1-phis)+vt');
model.variable('var6').set('wof', '-khy*d(p,z)/(1-phis)+wt');
model.variable('var6').set('Perox', 'Dox/Lwv');
model.variable('var6').set('Rn', 'Qstan-Kel*cn-
(d(uof,x)+d(vof,y)+d(wof,z))*cn');
model.variable('var6').set('Rfn', '(aldoxn*Kel*cn)-Kint*cfn-
(d(uof,x)+d(vof,y)+d(wof,z))*cfn');
model.variable('var6').set('Rint', 'Kint*cfn-
(d(ut,x)+d(vt,y)+d(wt,z))*cint-Kdeg*cint');
model.variable('var6').set('Do', '(KbT*Tabs*24*3600)/(6*pi*Vis*rs)',
'the diffusion coefficient of a particle in free solution at 310K,
given by the Stokes-Einstein');
model.variable('var6').set('Lpn', '(gama*ro*ro)/(8*Vis*Lwv)', 'The
hydraulic conductivity was calculated from the expression (Deen
1987):');
model.variable('var6').set('lamda1', 'rs/ro', 'ratio of radious');
model.variable('var6').set('Fi', '(1-lamda)^2', 'the partition
coefficient');
model.variable('var6').set('sinte', '9*(pi^2)*(2^0.5)/((1-
lamda)^(2.5))/4');
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model.variable('var6').set('skt11', '-(73/60)*(1-lamda)');
model.variable('var6').set('skt12', '(77.293/50.400)*((1-lamda)^2)');
model.variable('var6').set('skt1', 'skt11+skt12');
model.variable('var6').set('skt21', '-22.5083');
model.variable('var6').set('skt22', '-5.6117*lamda');
model.variable('var6').set('skt23', '-0.3363*lamda^2');
model.variable('var6').set('skt24', '-1.216*lamda^3');
model.variable('var6').set('skt25', '1.647*lamda^4');
model.variable('var6').set('skt2', 'skt21+skt22+skt23+skt24+skt25');
model.variable('var6').set('kt', 'sinte*(1+skt1)+skt2');
model.variable('var6').set('sks11', '(7/60)*(1-lamda)');
model.variable('var6').set('sks12', '(-2.227/50.400)*((1-lamda)^2)');
model.variable('var6').set('sks1', 'sks11+sks12');
model.variable('var6').set('sks21', '4.0180');
model.variable('var6').set('sks22', '-3.9788*lamda');
model.variable('var6').set('sks23', '-1.9215*lamda^2');
model.variable('var6').set('sks24', '4.392*lamda^3');
model.variable('var6').set('sks25', '5.006*lamda^4');
model.variable('var6').set('sks2', 'sks21+sks22+sks23+sks24+sks25');
model.variable('var6').set('ks', 'sinte*(1+sks1)+sks2');
model.variable('var6').set('H', '6*pi*Fi/kt', 'hydrodynamic
interactions');
model.variable('var6').set('W', '(Fi*(2-Fi)*ks/(2*kt))*(lamda1<1)',
'electrostatic interactions');
model.variable('var6').set('sf', '1-W', 'reflection coefficient');
model.variable('var6').set('Per', '((gama*H*Do)/Lwv)*(lamda1<1)',
'Permeability');
model.variable('var6').set('Qsta', 'Per*Sv*(Civ-cf)+Lpn*Sv*(pv-p)*(1-
sf)*Civ', 'Starling approximation');
model.variable('var6').set('lamda', 'lamda1*(lamda1<1)', 'is the ratio
of the drug size to the vessel wall pore size');
model.variable('var6').set('Vis1n', 'Vis*24*3600');
model.variable('var6').set('Civ1n', 'dose1n(t[1/s])*(exp(-(t-
19[d])/(2[d]))[mol/m^3])');
model.variable('var6').set('Civ2n', 'dose2n(t[1/s])*(exp(-(t-
22[d])/(2[d]))[mol/m^3])');
model.variable('var6').set('Civn', '(Civ1n+Civ2n)/1500');
model.variable('var6').set('Surfn', 'exp(-
0.2*cint*0.023/0.0172[mol/m^3])', 'exp(-
0.2*cint*0.023/0.0172[mol/m^3])');
model.variable('var6').set('Surfcscn', 'exp(-
(0.5/17)*cint*0.023/0.0172[mol/m^3])', 'exp(-
(0.5/17)*cint*0.023/0.0172[mol/m^3])');
model.variable('var6').set('Sfnn', '2*((Surfn*Surf)-
0.50)*(((Surfn*Surf)-0.50)>=0)', '2*((Surfn*Surf)-0.50)*(((Surfn*Surf)-
0.50)>=0)');
model.variable('var6').set('Sfncscn', '2*((Surfcscn*Surfcsc)-
0.50)*(((Surfcscn*Surfcsc)-0.50)>=0)', '2*((Surfcscn*Surfcsc)-
0.50)*(((Surfcscn*Surfcsc)-0.50)>=0)');
model.variable('var6').set('Rf', '-
(d(uof,x)+d(vof,y)+d(wof,z))*cf+Qsta-Kdegi*cf');
model.variable('var6').set('Don', '(KbT*Tabs*24*3600)/(6*pi*Vis*rsn)',
'diffusion coefficient of a particle in free solution at 310K, given by
the Stokes-Einstein relationship');
model.variable('var6').set('lamda1n', 'rsn/ro');
model.variable('var6').set('Fin', '(1-lamdan)^2');
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model.variable('var6').set('Civ1', 'dose1(t[1/s])*(exp(-(t-
19[d])/(1[d]))[mol/m^3])', 'dose1(t[1/s])*(delta*cfmax*exp(-log(2)*((t-
19[d])/(td)))[mol/m^3])');
model.variable('var6').set('Civ2', 'dose2(t[1/s])*(exp(-(t-
22[d])/(1[d]))[mol/m^3])', 'dose2(t[1/s])*(delta*cfmax*exp(-log(2)*((t-
22[d])/(td)))[mol/m^3])');
model.variable('var6').set('Civ', '(Civ1+Civ2)/60');
model.variable('var6').set('Surf', 'exp(-
10*cf*0.023/0.0172[mol/m^3])');
model.variable('var6').set('Surfcsc', 'exp(-
0.089*cf*0.023/0.0172[mol/m^3])');
model.variable('var6').set('sinten', '9*(pi^2)*(2^0.5)/((1-
lamdan)^(2.5))/4');
model.variable('var6').set('skt11n', '-(73/60)*(1-lamdan)');
model.variable('var6').set('skt12n', '(77.293/50.400)*((1-lamdan)^2)');
model.variable('var6').set('skt1n', 'skt11n+skt12n');
model.variable('var6').set('skt21n', '-22.5083');
model.variable('var6').set('skt22n', '-5.6117*lamdan');
model.variable('var6').set('skt23n', '-0.3363*lamdan^2');
model.variable('var6').set('skt24n', '-1.216*lamdan^3');
model.variable('var6').set('skt25n', '1.647*lamdan^4');
model.variable('var6').set('skt2n',
'skt21n+skt22n+skt23n+skt24n+skt25n');
model.variable('var6').set('ktn', 'sinten*(1+skt1n)+skt2n');
model.variable('var6').set('sks11n', '(7/60)*(1-lamdan)');
model.variable('var6').set('sks12n', '(-2.227/50.400)*((1-lamdan)^2)');
model.variable('var6').set('sks1n', 'sks11n+sks12n');
model.variable('var6').set('sks21n', '4.0180');
model.variable('var6').set('sks22n', '-3.9788*lamdan');
model.variable('var6').set('sks23n', '-1.9215*lamdan^2');
model.variable('var6').set('sks24n', '4.392*lamdan^3');
model.variable('var6').set('sks25n', '5.006*lamdan^4');
model.variable('var6').set('sks2n',
'sks21n+sks22n+sks23n+sks24n+sks25n');
model.variable('var6').set('ksn', 'sinten*(1+sks1n)+sks2n');
model.variable('var6').set('Hn', '6*pi*Fin/ktn');
model.variable('var6').set('Wn', '(Fin*(2-
Fin)*ksn/(2*ktn))*(lamda1n<1)');
model.variable('var6').set('sfn', '1-Wn');
model.variable('var6').set('Pern', '((gama*Hn*Don)/Lwv)*(lamda1n<1)');
model.variable('var6').set('Qstan', 'Pern*Sv*(Civn-cn)+Lpn*Sv*(pv-
p)*(1-sfn)*Civn');
model.variable('var6').set('lamdan', 'lamda1n*(lamda1n<1)');
model.variable.create('var7');
model.variable('var7').model('comp1');
model.variable('var7').set('cvox', '0.2 [mol/m^3]');
model.variable('var7').set('Lwv', '5e-6[m]', 'vessel wall thickness');
model.variable('var7').set('pv', '3000[Pa]', '4000 [Pa]');
model.variable('var7').set('gama', '1E-4', 'analogue of pores,1E-5,
surface area of vessel wall occupied by pores');
model.variable('var7').set('Vis', '7e-4[Pa*s]', 'Viscosity,4e-
3[Pa*s]');
model.variable('var7').set('Tabs', '310.0[K]', 'Absolute temperature');
model.variable('var7').set('KbT', '1.38e-23[(m^2*kg)/(s^2*K)]',
'Boltzman Constant');
model.variable('var7').set('rsn', '50e-9[m]', 'Drug size');
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model.variable('var7').set('Ce', '0.01[mol/m^3]', 'concetration of
receptors');
model.variable('var7').set('Kint', '3.7[1/d]', 'internalization
constant');
model.variable('var7').set('Koff', '691.2[1/d]', 'unbinding constant');
model.variable('var7').set('Kon', '1.296e6[m^3/(mol*d)]', 'binding
contant for high affinity');
model.variable('var7').set('fivf', '0.06', 'Volume fraction');
model.variable('var7').set('Kel', '0.181[1/d]', 'chemotherapy  release
rate (nanotherapy)');
model.variable('var7').set('aldoxn', '10000');
model.variable('var7').set('Dn', '8.64e-8[m^2/d]');
model.variable('var7').set('Dfn', '8.64e-6[m^2/d]');
model.variable('var7').set('Kdeg', '0.02[1/h]', '0.01[1/d],
0.02[1/h]=0.48[1/d]');
model.variable('var7').set('Dint', '0[m^2/d]');
model.variable('var7').set('rs', '6.35e-9[m]', 'the radius of the
antibody (anti-PD-L1) used in immunotherapy');
model.variable('var7').set('delta', '0.12', 'Effectiveness of immune
checkpoint inhibitor (Durvalumab)  (ICI only)');
model.variable('var7').set('cfmax', '10[mg/kg]', 'maximun concentration
(ICI only)');
model.variable('var7').set('td', '21[d]', 'Half-life of immune
checkpoint inhibitor (Durvalumab) in the body');
model.variable('var7').set('Df', '8.64e-7[m^2/d]');
model.variable.create('var2');
model.variable('var2').model('comp1');
model.variable('var2').set('poissonr', '0.45');
model.variable('var2').set('solid.muLame', 'step25(t[1/s])[Pa]',
'step25(t[1/s])[Pa],60e3 [Pa]');
model.variable('var2').set('khy', 'step29(t[1/s])[(m^3*s)/(kg)]',
'step29(t[1/s])[(m^3*s)/(kg)],6.5e-11[m^2/(Pa*d)]');
model.variable('var2').set('Dox', '1.78e-9[m^2/s]');
model.variable('var2').set('Aox', '2200[mol/(m^3*d)]', 'oxygen uptake
parameter');
model.variable('var2').set('kox', '0.00464[mol/(m^3)]', 'oxygen uptake
parameter');
model.variable('var2').set('Sv', '(Svin*dd0*ec)*(dd0>=0)',
'(Svin*dd0*ec)*(dd0>=0)');
model.variable('var2').set('dd0', 'G7+G8', '((-2e-
10)*Tumc/(4*pi*(ri^2)))+1');
model.variable('var2').set('Svin', '19000[1/m]*(1-
(rect1(t[1/s])+rect2(t[1/s])))+(3*19000[1/m])*rect1(t[1/s])+(3*19000[1/
m])*rect2(t[1/s])', '19000[1/m]*(1-
(rect1(t[1/s])))+(3*19000[1/m])*rect1(t[1/s]),7000-(7000/(250E-9))*(ro-
400E-9)');
model.variable('var2').set('loxc', '0.54[1/d]');
model.variable('var2').set('Koxc', '0.0083 [mole/m^3]');
model.variable('var2').set('lp', '2.7e-12[m/(Pa*s)]');
model.variable('var2').set('T0in', '500', 'initial tumor cell
concentration');
model.variable('var2').set('cnk', '(3.23e-7[1/d])*T0in', 'fractional
tumor cell kill by nk cels');
model.variable('var2').set('dt8', '1.43[1/d]', 'tumor cell kill by
t8');
model.variable('var2').set('limt8', '1.36', 'exponent of cell kill by
t8');
```

```
model.variable('var2').set('st8', '2.73', 'steepness coefficient of
t8');
model.variable('var2').set('snkcon', '(1.3e4[1/d])/T0in', 'constant
source of nk');
model.variable('var2').set('fdrnk0', '0.0412[1/d]', 'death rate of
nk');
model.variable('var2').set('grrnk0', '0.025[1/d]', 'nk cel
recruitment');
model.variable('var2').set('hscnk', '(2.02e7)/(T0in^2)', 'steepness
coefficient of nk');
model.variable('var2').set('pirnk', '(1e-7[1/d])*T0in', 'nk cell
inactivation rate');
model.variable('var2').set('mdrt80', '0.02[1/d]', 'death rate of t8');
model.variable('var2').set('jrrt80', '0.0375[1/d]', 't8 cell
recruitment');
model.variable('var2').set('ksct8', '(2e7)/(T0in^2)', 'steepness
coefficient of t8 recruitment');
model.variable('var2').set('qirt8', '(3.42e-10[1/d])*T0in', 't8
inactivation rate');
model.variable('var2').set('rst8', '(1.1e-7[1/d])*T0in', 'stimulation
of t8');
model.variable('var2').set('tn', 't-4');
model.variable('var2').set('lreg', '100[1/d]');
model.variable('var2').set('mtreg', '0.02[1/d]');
model.variable('var2').set('ptc', '0.55[1/d]', 'transition from tumor
cells to stem cells');
model.variable('var2').set('ptcd', '0[1/d]', 'transition from tumor
cells to stem cells after drug');
model.variable('var2').set('pct', '1[1/d]', 'transition from tumor
cells to stem cells');
model.variable('var2').set('pctd', '0.96[1/d]', 'transition from tumor
cells to stem cells after drug');
model.variable('var2').set('pti', '0.21[1/d]', 'transition from tumor
cells to induced cells');
model.variable('var2').set('ptid', '1[1/d]', 'transition from tumor
cells to induced cells after drug');
model.variable('var2').set('pit', '1[1/d]', 'transition to tumor cells
from induced cells');
model.variable('var2').set('pitd', '0.98[1/d]', 'transition to tumor
cells from induced cells after drug');
model.variable('var2').set('pci', '0.58[1/d]', 'transition from stem
cells to induced cells');
model.variable('var2').set('pcid', '0[1/d]', 'transition from stem
cells to induced cells after drug');
model.variable('var2').set('pic', '0.96[1/d]', 'transition to stem
cells from induced cells');
model.variable('var2').set('picd', '0.38[1/d]', 'transition to stem
cells from induced cells after drug');
model.variable('var2').set('gtreg', '0.0375[1/d]');
model.variable('var2').set('rcd4', '(1E-15)*500[1/d]');
model.variable('var2').set('lm2CD8', '-0.14286[1/d]*M2+1.3214[1/d]');
model.variable('var2').set('lm2Nk', '-100[1/d]*M2+8[1/d]');
model.variable('var2').set('scd4', '150[1/d]');
model.variable('var2').set('mcd4', '0.02[1/d]');
model.variable('var2').set('recd4', '0.03[1/d]');
model.variable('var2').set('Cd4max', '45');
model.variable('var2').set('grm1ex', '0.0002[1/(d^2)]*t-0.005[1/d]');
```

```
model.variable('var2').set('grm1', 'grm1ex*oxrate');
model.variable('var2').set('mm1', '0.02[1/d]');
model.variable('var2').set('grm2', 'grm1ex+(1-oxrate)*1.05*grm1ex');
model.variable('var2').set('mm2', '0.02[1/d]');
model.variable('var2').set('b1', '2280[1/h]');
model.variable('var2').set('m1', '4.56*100[1/h]');
model.variable('var2').set('a10', '1e-3[uM]');
model.variable('var2').set('b2', '18240[1/h]');
model.variable('var2').set('m2', '4.56*100[1/h]');
model.variable('var2').set('a20', '1e-3[uM]');
model.variable('var2').set('Dvegf', '3.1e-7[cm^2/s]');
model.variable('var2').set('l10', '6.8e-9[1/s]');
model.variable('var2').set('l11', '4[cm/(s)]/1000000');
model.variable('var2').set('l13', '4e-5[1/s]/10000');
model.variable('var2').set('T0', '1e-3[g/cm^3]');
model.variable('var2').set('Cvegf0', '1e-3[g/cm^3]');
model.variable('var2').set('Decn', '1e-7[cm^2/s]*1e-4');
model.variable('var2').set('l2', '1e-5[cm^3/(g*s)]*1e3');
model.variable('var2').set('l4', '1e-9[cm/(s)]');
model.variable('var2').set('xn', '(10[cm^5/(g*s)])/(100000*10)');
model.variable('var2').set('s1', '1e3[1/uM]');
model.variable('var2').set('s2', '1e3[1/uM]');
model.variable('var2').set('aD', '1');
model.variable('var2').set('bD', '1');
model.variable('var2').set('G7', '1*(sbulk>-18.68[kPa])');
model.variable('var2').set('G8',
'1.5888*exp(0.0313[1/kPa]*sbulk)*(sbulk<=-18.68[kPa])');
model.variable('var2').set('lm1', '3[1/d]');
model.variable('var2').set('alpha', '1');
model.variable('var2').set('beta', '1');
model.variable('var2').set('Kdegi', '0[1/h]');
model.variable('var2').set('ro', '100[nm]*(1-
(rect1(t[1/s])+rect2(t[1/s])))+G12*rect1(t[1/s])+G12*rect2(t[1/s])',
'100[nm]*(1-(rect1(t[1/s])))+G12*rect1(t[1/s])');
model.variable('var2').set('G12', '(-
14977.9087*(pac)^2[1/(MPa)^2]+8208.3947*(pac)[1/MPa]-69.0722)[nm]');
model.variable('var2').set('pac', '(MI*sqrt(fr[1/MHz]))[MPa]',
'Mechanical Index');
model.variable('var2').set('MI', '0.34');
model.variable('var2').set('fr', '2[MHz]', 'frequency of transducer');
model.variable('var2').set('taf',
'2*(((pl*mil)*(pi*frr)^(3))^(1/2)*((etam^2)/rmicro))', 'shear wave
stresses-354.91[Pa]');
model.variable('var2').set('pl', '1000[kg/m^3]', 'the density of the
blood surrounding the microbubble');
model.variable('var2').set('mil', '0.001[(kg/(m*s^2))*s]', 'the
viscosity of the blood');
model.variable('var2').set('etam', '0.2e-6[m]', 'the displacement
amplitude of the bubble wall');
model.variable('var2').set('rmicro', '2e-6[m]', 'the radius of the
microbubble');
model.variable('var2').set('frr', '2e6[1/s]', 'frequency of
transducer');
model.variable('var2').set('pr', '-3e-
06*taf^2[1/(Pa)^2]+0.0067*taf[1/(Pa)]+0.2533', 'proliferation of ECs');
model.variable('var2').set('ap', '-3e-
05*taf^2[1/(Pa)^2]+0.0126*taf[1/(Pa)]+0.6666', 'apoptosis of ECs');
```

```
model.variable('var2').set('fec', '(l2*step1(ecc)*Cvegfn*Cvegf0*ec)*(
1-(rect1(t[1/s])+rect2(t[1/s])))+G14*rect1(t[1/s])+G14*rect2(t[1/s])-
((l4*step1(ecc)*Svhh*ec*ec)*( 1-
(rect1(t[1/s])+rect2(t[1/s])))+G15*rect1(t[1/s])+G15*rect2(t[1/s]))',
'reaction term of ECs');
model.variable('var2').set('G14',
'(l2*step1(ecc)*Cvegfn*Cvegf0*ec)*(pr)', 'proliferation of the reaction
term of ECs');
model.variable('var2').set('G15', '(l4*step1(ecc)*Svhh*ec*ec)*(ap)',
'apoptosis of the reaction term of ECs');
model.variable('var2').selection.geom('geom1', 3);
model.variable('var2').selection.set((1));
model.variable.create('var3');
model.variable('var3').model('comp1');
model.variable('var3').set('poissonr', '0.2');
model.variable('var3').set('solid.muLame', 'step26(t[1/s])[Pa]', '21e3
[Pa],step26(t[1/s])[Pa]');
model.variable('var3').set('khy', 'step30(t[1/s])[(m^3*s)/(kg)]',
'6.5e-11[m^2/(Pa*d)], step30(t[1/s])[(m^3*s)/(kg)]');
model.variable('var3').set('Dox', '1.79e-9 [m^2/s]');
model.variable('var3').set('Tumc', '0');
model.variable('var3').set('Sv', '7000[1/m]');
model.variable('var3').set('lg', '1');
model.variable('var3').set('phis', '0.3');
model.variable('var3').set('lp', '2.7e-12 [m/(Pa*s)]');
model.variable('var3').set('lpSv', '3.75e-4 [1/(Pa*s)]');
model.variable('var3').set('ro', '7e-9[m]');
model.variable('var3').set('Kdegi', '0.002[1/h]', 'degradation rate
constant of free antibody for immunotherapy/ is the rate at which the
drug exits through the lymphatic vessels (host)');
model.variable('var3').selection.geom('geom1', 3);
model.variable('var3').selection.set((2));
model.variable.create('var4');
model.variable('var4').model('comp1');
model.variable('var4').set('Rox', '-
((Aox*cox)/(kox+cox))*(Totcel)+Perox*Sv*(cvox-cox)');
model.variable('var4').set('fg',
'((Tumc/Totcel)*Rtumcfg+(Csc/Totcel)*Rcscfg+(IndC/Totcel)*Rindfg)*lg/3'
);
model.variable('var4').set('Rtumc', 'Grox*Sfnn-cnknew*Nkcel*Tumc-
Dfck+pct*Csc+pic*IndC-ptc*Tumc-pti*Tumc-lm1*M1*Tumc');
model.variable('var4').set('Grox', '(loxc*cox)/(cox+Koxc)');
model.variable('var4').set('fphis', 'Qs-phis*(uXt+vYt+wZt)-
(ut*d(phis,X)+vt*d(phis,Y)+wt*d(phis,Z))');
model.variable('var4').set('fp', 'Qs+Qf');
model.variable('var4').set('Qf', '-(uXt+vYt+wZt)+(lp*Sv)*(pv-p)');
model.variable('var4').set('Qs',
'(Tumc/Totcel)*Rtumc+(Csc/Totcel)*Rcsc+(IndC/Totcel)*Rind');
model.variable('var4').set('Rcsc', 'acsc*Groxsc*Sfncscn*Csc-
0.14*cnknew*Nkcel*Csc-0.14*Dfckcsc+ptc*Tumc+pic*IndC-pct*Csc-pci*Csc');
model.variable('var4').set('Rind', 'aind*Groxsc*Sfncscn*IndC-
0.14*cnknew*Nkcel*IndC-0.14*Dfckind+pti*Tumc+pci*Csc-pit*IndC-
pic*IndC');
model.variable('var4').set('Rnk', 'snkcon-
fdrnk*Nkcel+(grrnk0*(Tumc^2)*Nkcel)/(hscnk+(Tumc^2))-pirnk*Nkcel*Tumc-
lreg*Nkcel*Tregs+lm2Nk*Nkcel*M2');
```

```
model.variable('var4').set('Rt8im', '-
mdrt8*T8imcel+(jrrt80*(Dfck^2)*T8imcel)/(ksct8+(Dfck^2))-
qirt8*T8imcel*Tumc+rst8*Nkcel*Tumc-
lreg*T8imcel*Tregs+rcd4*Cd4*T8imcel+lm2CD8*M2*T8imcel');
model.variable('var4').set('Rtreg', 'gtreg*Tregs-
(beta*(t>=19[d])+1)*mtreg*Tregs');
model.variable('var4').set('Totcel', 'Tumc+Csc+IndC');
model.variable('var4').set('oxrate', 'cox/0.2[mol/m^3]');
model.variable('var4').set('mdrt8', 'mdrt80+(1-oxrate)*1.025*mdrt80');
model.variable('var4').set('fdrnk', 'fdrnk0+(1-oxrate)*1.025*fdrnk0');
model.variable('var4').set('acsc', '1+(1-oxrate)*1.05');
model.variable('var4').set('cnknew', 'cnk+10*oxrate*cnk');
model.variable('var4').set('dt8new', 'dt8+4*oxrate*dt8');
model.variable('var4').set('aind', '0.5+(1-oxrate)*1.05');
model.variable('var4').set('Dfckind',
'(alpha*(t>=19[d])+1)*(dt8new*((T8imcel/IndC)^limt8)*IndC/(st8+(T8imcel
/IndC)^limt8))');
model.variable('var4').set('Dfckcsc',
'(alpha*(t>=19[d])+1)*(dt8new*((T8imcel/Csc)^limt8)*Csc/(st8+(T8imcel/C
sc)^limt8))');
model.variable('var4').set('Dfck',
'(alpha*(t>=19[d])+1)*(dt8new*((T8imcel/Tumc)^limt8)*Tumc/(st8+(T8imcel
/Tumc)^limt8))');
model.variable('var4').set('Groxsc', '0.452e-5[1/d]');
model.variable('var4').set('phis', '0.5');
model.variable('var4').set('Rcd4', 'scd4+recd4*Cd4*(1-(Cd4/Cd4max))-
mcd4*Cd4');
model.variable('var4').set('Rmacro1', 'grm1*M1-mm1*M1');
model.variable('var4').set('Rmacro2', 'grm2*M2-
mm2*M2+rm2vegf*M2*Cvegf');
model.variable('var4').set('Ra2', '(b2*1e-11[mole/m^2]*ec*Sv*Ga/a20)/2-
m2*a2');
model.variable('var4').set('Rvegf',
'(l10*Ga*Tumc*T0*T0in*oxrate/Cvegf0)-l11*ec*70[1/cm]*Cvegf-
l13*Cvegf+rcd4vegf*Cd4*Cvegf');
model.variable('var4').set('rcd4vegf', '-0.0004[1/d]*Cd4+0.04[1/d]');
model.variable('var4').set('rm2vegf', '0.00437[1/(d^2)]*t-0.011[1/d]');
model.variable('var4').set('Svhh', '70[1/cm]');
model.variable('var4').set('Dec', '(Decn*(1+s1*a1*a10)^-
aD)*((1+s2*a2*a20)^bD)');
model.variable('var4').set('Cvegfn', '0.01');
model.variable('var4').set('ec', '0.6');
model.variable('var4').set('Ra1', '((b1*1e-
10[mole/m^2]*Ga*ec*Sv/a10)+m1*(1-a1))/2');
model.variable('var4').set('Ga', '2-oxrate');
model.variable('var4').set('Rtumcfg', 'Grox*Sfnn-cnknew*Nkcel*Tumc-
lm1*M1*Tumc');
model.variable('var4').set('Rcscfg', 'acsc*Groxsc*Sfncscn*Csc-
0.14*cnknew*Nkcel*Csc');
model.variable('var4').set('Rindfg', 'aind*Groxsc*Sfncscn*IndC-
0.14*cnknew*Nkcel*IndC');
model.variable('var4').selection.geom('geom1', 3);
model.variable('var4').selection.set((1));
model.variable.create('var5');
model.variable('var5').model('comp1');
model.variable('var5').set('Rox', 'Perox*Sv*(cvox-cox)');
model.variable('var5').set('fp', 'Qs+Qf');
```

```
model.variable('var5').set('Qs', '0[1/d]');
model.variable('var5').set('Qf', '-(uXt+vYt+wZt)+(lp*Sv)*(pv-p)-
lpSv*(p-pi)');
model.variable('var5').selection.geom('geom1', 3);
model.variable('var5').selection.set((2));

model.physics.create('solid', 'SolidMechanics', 'geom1');
model.physics('solid').create('hmm1', 'HyperelasticModel', 3);
model.physics('solid').feature('hmm1').selection.set([1 2]);
model.physics('solid').create('bl1', 'BodyLoad', 3);
model.physics('solid').feature('bl1').selection.set([1 2]);
model.physics('solid').create('roll1', 'Roller', 2);
model.physics('solid').feature('roll1').selection.set([1 2 3 4 5 8]);
model.physics.create('Oxygen', 'DilutedSpecies', 'geom1');
model.physics('Oxygen').identifier('Oxygen');
model.physics('Oxygen').field('concentration').field('cox');
model.physics('Oxygen').field('concentration').component({'cox'});
model.physics('Oxygen').create('reac1', 'Reactions', 3);
model.physics('Oxygen').feature('reac1').selection.all;
model.physics.create('Growth', 'DomainODE', 'geom1');
model.physics('Growth').identifier('Growth');
model.physics('Growth').field('dimensionless').field('lg');
model.physics('Growth').field('dimensionless').component({'lg'});
model.physics('Growth').selection.set((1));
model.physics.create('phisolid', 'DomainODE', 'geom1');
model.physics('phisolid').identifier('phisolid');
model.physics('phisolid').field('dimensionless').field('phis1');
model.physics('phisolid').field('dimensionless').component({'phis1'});
model.physics('phisolid').selection.set((1));
model.physics.create('pressure', 'ConvectionDiffusionEquation',
'geom1');
model.physics('pressure').identifier('pressure');
model.physics('pressure').field('dimensionless').field('p');
model.physics('pressure').create('dir1', 'DirichletBoundary', 2);
model.physics('pressure').feature('dir1').selection.set([7 9 10]);
model.physics.create('Nk_cells', 'DomainODE', 'geom1');
model.physics('Nk_cells').identifier('Nk_cells');
model.physics('Nk_cells').field('dimensionless').field('Nkcel');
model.physics('Nk_cells').field('dimensionless').component({'Nkcel'});
model.physics('Nk_cells').selection.set((1));
model.physics.create('CD8T_cells', 'DomainODE', 'geom1');
model.physics('CD8T_cells').identifier('CD8T_cells');
model.physics('CD8T_cells').field('dimensionless').field('T8imcel');
model.physics('CD8T_cells').field('dimensionless').component({'T8imcel'
});
model.physics('CD8T_cells').selection.set((1));
model.physics.create('Tregulators_cells', 'DomainODE', 'geom1');
model.physics('Tregulators_cells').identifier('Tregulators_cells');
model.physics('Tregulators_cells').field('dimensionless').field('Tregs'
);
model.physics('Tregulators_cells').field('dimensionless').component({'T
regs'});
model.physics('Tregulators_cells').selection.set((1));
model.physics.create('nanoparticle', 'DilutedSpecies', 'geom1');
model.physics('nanoparticle').identifier('nanoparticle');
model.physics('nanoparticle').field('concentration').field('cn');
model.physics('nanoparticle').field('concentration').component({'cn'});
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model.physics('nanoparticle').create('reac1', 'Reactions', 3);
model.physics('nanoparticle').feature('reac1').selection.all;
model.physics.create('free', 'DilutedSpecies', 'geom1');
model.physics('free').identifier('free');
model.physics('free').field('concentration').field('cfn');
model.physics('free').field('concentration').component({'cfn'});
model.physics('free').create('reac1', 'Reactions', 3);
model.physics('free').feature('reac1').selection.all;
model.physics.create('internalized', 'DilutedSpecies', 'geom1');
model.physics('internalized').identifier('internalized');
model.physics('internalized').field('concentration').field('cint');
model.physics('internalized').field('concentration').component({'cint'}
);
model.physics('internalized').create('reac1', 'Reactions', 3);
model.physics('internalized').feature('reac1').selection.all;
model.physics.create('free2', 'DilutedSpecies', 'geom1');
model.physics('free2').identifier('free2');
model.physics('free2').field('concentration').field('cf');
model.physics('free2').field('concentration').component({'cf'});
model.physics('free2').create('reac1', 'Reactions', 3);
model.physics('free2').feature('reac1').selection.all;
model.physics.create('CD4_cells', 'DomainODE', 'geom1');
model.physics('CD4_cells').identifier('CD4_cells');
model.physics('CD4_cells').field('dimensionless').field('Cd4');
model.physics('CD4_cells').field('dimensionless').component({'Cd4'});
model.physics('CD4_cells').selection.set((1));
model.physics.create('TAMS_M1', 'DomainODE', 'geom1');
model.physics('TAMS_M1').identifier('TAMS_M1');
model.physics('TAMS_M1').field('dimensionless').field('M1');
model.physics('TAMS_M1').field('dimensionless').component({'M1'});
model.physics('TAMS_M1').selection.set((1));
model.physics.create('TAMS_M2', 'DomainODE', 'geom1');
model.physics('TAMS_M2').identifier('TAMS_M2');
model.physics('TAMS_M2').field('dimensionless').field('M2');
model.physics('TAMS_M2').field('dimensionless').component({'M2'});
model.physics('TAMS_M2').selection.set((1));
model.physics.create('Ang1', 'DomainODE', 'geom1');
model.physics('Ang1').identifier('Ang1');
model.physics('Ang1').field('dimensionless').field('a1');
model.physics('Ang1').field('dimensionless').component({'a1'});
model.physics('Ang1').selection.set((1));
model.physics.create('Ang2', 'DomainODE', 'geom1');
model.physics('Ang2').identifier('Ang2');
model.physics('Ang2').field('dimensionless').field('a2');
model.physics('Ang2').field('dimensionless').component({'a2'});
model.physics('Ang2').selection.set((1));
model.physics.create('VEGF', 'ConvectionDiffusionEquation', 'geom1');
model.physics('VEGF').identifier('VEGF');
model.physics('VEGF').field('dimensionless').field('Cvegf');
model.physics('VEGF').selection.set((1));
model.physics.create('endothelial_cells',
'ConvectionDiffusionEquation', 'geom1');
model.physics('endothelial_cells').identifier('endothelial_cells');
model.physics('endothelial_cells').field('dimensionless').field('ecc');
model.physics('endothelial_cells').selection.set((1));
model.physics('endothelial_cells').create('cfeq1',
'CoefficientFormPDE', 3);
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```
model.physics('endothelial_cells').feature('cfeq1').selection.all;
model.physics.create('Tumc', 'ConvectionDiffusionEquation', 'geom1');
model.physics('Tumc').identifier('Tumc');
model.physics('Tumc').field('dimensionless').field('Tumc');
model.physics('Tumc').selection.set((1));
model.physics.create('Csc', 'ConvectionDiffusionEquation', 'geom1');
model.physics('Csc').identifier('Csc');
model.physics('Csc').field('dimensionless').field('Csc');
model.physics('Csc').selection.set((1));
model.physics.create('IndC', 'ConvectionDiffusionEquation', 'geom1');
model.physics('IndC').identifier('IndC');
model.physics('IndC').field('dimensionless').field('IndC');
model.physics('IndC').selection.set((1));

model.mesh('mesh1').create('ftet1', 'FreeTet');
model.mesh('mesh1').create('ftet2', 'FreeTet');
model.mesh('mesh1').feature('ftet1').selection.geom('geom1', 3);
model.mesh('mesh1').feature('ftet1').selection.set((1));
model.mesh('mesh1').feature('ftet1').create('size1', 'Size');
model.mesh('mesh1').feature('ftet2').selection.geom('geom1', 3);
model.mesh('mesh1').feature('ftet2').selection.set((2));
model.mesh('mesh1').feature('ftet2').create('size1', 'Size');

model.result.table.create('tbl1', 'Table');
model.result.table.create('tbl2', 'Table');
model.result.table.create('tbl3', 'Table');

model.variable('var1').label('1,2Stress');
model.variable('var6').label('1,2EQ');
model.variable('var7').label('1,2Constant');
model.variable('var2').label('1Constant');
model.variable('var3').label('2Constant');
model.variable('var4').label('1EQ');
model.variable('var5').label('2EQ');

model.physics('solid').prop('ShapeProperty').set('valueType', 'real');
model.physics('solid').prop('ShapeProperty').set('order_displacement',
'2');
model.physics('solid').feature('hmm1').set('MaterialModel',
'userDefined');
model.physics('solid').feature('hmm1').set('Ws', 'Wmat');
model.physics('solid').feature('hmm1').set('rho', '1000');
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.F
iil11', {'1/lg'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.F
iil33', {'1/lg'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.F
iil22', {'1/lg'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l11', {'2*solid.Ji*d(solid.Ws,solid.Cl11)'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l12', {'solid.Ji*d(solid.Ws,solid.Cl12)'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l13', {'solid.Ji*d(solid.Ws,solid.Cl13)'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l22', {'solid.Ji*2*d(solid.Ws,solid.Cl22)'});
```

```
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l23', {'solid.Ji*d(solid.Ws,solid.Cl23)'});
model.physics('solid').feature('hmm1').featureInfo('info').set('solid.S
l33', {'solid.Ji*2*d(solid.Ws,solid.Cl33)'});
model.physics('solid').feature('bl1').set('FperVol', {'-d(p,x)'; '-
d(p,y)'; '-d(p,z)'});
model.physics('Oxygen').prop('AdvancedSettings').set('ConvectiveTerm',
'cons');
model.physics('Oxygen').feature('cdm1').set('u', {'uof'; 'vof';
'wof'});
model.physics('Oxygen').feature('cdm1').set('D_cox', {'Dox'; '0'; '0';
'0'; 'Dox'; '0'; '0'; '0'; 'Dox'});
model.physics('Oxygen').feature('reac1').set('R_cox', 'Rox');
model.physics('Growth').prop('ShapeProperty').set('valueType', 'real');
model.physics('Growth').prop('ShapeProperty').set('shapeFunctionType',
'shlag');
model.physics('Growth').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('Growth').feature('dode1').set('f', 'fg');
model.physics('Growth').feature('init1').set('lg', '1');
model.physics('phisolid').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('phisolid').feature('dode1').set('f', 'fphis');
model.physics('phisolid').feature('init1').set('phis1', '0.3');
model.physics('pressure').prop('ShapeProperty').set('valueType',
'real');
model.physics('pressure').prop('Units').set('DependentVariableQuantity'
, 'pressure');
model.physics('pressure').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('pressure').feature('cdeq1').set('f', 'fp');
model.physics('pressure').feature('cdeq1').set('c', {'khy' '0' '0' '0'
'khy' '0' '0' '0' 'khy'});
model.physics('pressure').feature('cdeq1').set('da', '0');
model.physics('Nk_cells').label('Domain ODEs and DAEs 6.1');
model.physics('Nk_cells').prop('ShapeProperty').set('valueType',
'real');
model.physics('Nk_cells').prop('ShapeProperty').set('shapeFunctionType'
, 'shlag');
model.physics('Nk_cells').prop('Units').set('CustomSourceTermUnit',
'1/d');
model.physics('Nk_cells').feature('dode1').set('f', 'Rnk');
model.physics('CD8T_cells').label('Domain ODEs and DAEs 7');
model.physics('CD8T_cells').prop('ShapeProperty').set('valueType',
'real');
model.physics('CD8T_cells').prop('ShapeProperty').set('shapeFunctionTyp
e', 'shlag');
model.physics('CD8T_cells').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('CD8T_cells').feature('dode1').set('f', 'Rt8im');
model.physics('Tregulators_cells').label('Domain ODEs and DAEs 8');
model.physics('Tregulators_cells').prop('ShapeProperty').set('valueType
', 'real');
model.physics('Tregulators_cells').prop('ShapeProperty').set('shapeFunc
tionType', 'shlag');
model.physics('Tregulators_cells').prop('Units').set('CustomSourceTermU
nit', '1/s');
```

```
model.physics('Tregulators_cells').feature('dode1').set('f', 'Rtreg');
model.physics('Tregulators_cells').feature('init1').set('Tregs',
'0.01');
model.physics('nanoparticle').feature('cdm1').set('u', {'uof'; 'vof';
'wof'});
model.physics('nanoparticle').feature('cdm1').set('D_cn', {'Dn'; '0';
'0'; '0'; 'Dn'; '0'; '0'; '0'; 'Dn'});
model.physics('nanoparticle').feature('reac1').set('R_cn', 'Rn');
model.physics('free').prop('MassConsistentStabilization').set('glim_mas
s', '(0.1[mol/m^3])/tds2.helem');
model.physics('free').feature('cdm1').set('u', {'uof'; 'vof'; 'wof'});
model.physics('free').feature('cdm1').set('D_cfn', {'Dfn'; '0'; '0';
'0'; 'Dfn'; '0'; '0'; '0'; 'Dfn'});
model.physics('free').feature('reac1').set('R_cfn', 'Rfn');
model.physics('internalized').prop('MassConsistentStabilization').set('
glim_mass', '(0.1[mol/m^3])/tds3.helem');
model.physics('internalized').feature('cdm1').set('u', {'ut'; 'vt';
'wt'});
model.physics('internalized').feature('cdm1').set('D_cint', {'Dint';
'0'; '0'; '0'; 'Dint'; '0'; '0'; '0'; 'Dint'});
model.physics('internalized').feature('reac1').set('R_cint', 'Rint');
model.physics('free2').label('Immunotherapy');
model.physics('free2').feature('cdm1').set('u', {'uof'; 'vof'; 'wof'});
model.physics('free2').feature('cdm1').set('D_cf', {'Df'; '0'; '0';
'0'; 'Df'; '0'; '0'; '0'; 'Df'});
model.physics('free2').feature('reac1').set('R_cf', 'Rf');
model.physics('CD4_cells').label('Domain ODEs and DAEs 9');
model.physics('CD4_cells').prop('ShapeProperty').set('valueType',
'real');
model.physics('CD4_cells').prop('ShapeProperty').set('shapeFunctionType
', 'shlag');
model.physics('CD4_cells').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('CD4_cells').feature('dode1').set('f', 'Rcd4');
model.physics('TAMS_M1').label('Domain ODEs and DAEs 10');
model.physics('TAMS_M1').prop('ShapeProperty').set('valueType',
'real');
model.physics('TAMS_M1').prop('ShapeProperty').set('shapeFunctionType',
'shlag');
model.physics('TAMS_M1').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('TAMS_M1').feature('dode1').set('f', 'Rmacro1');
model.physics('TAMS_M1').feature('init1').set('M1', '0.01');
model.physics('TAMS_M2').label('Domain ODEs and DAEs 11');
model.physics('TAMS_M2').prop('ShapeProperty').set('valueType',
'real');
model.physics('TAMS_M2').prop('ShapeProperty').set('shapeFunctionType',
'shlag');
model.physics('TAMS_M2').prop('Units').set('CustomSourceTermUnit',
'1/s');
model.physics('TAMS_M2').feature('dode1').set('f', 'Rmacro2');
model.physics('TAMS_M2').feature('init1').set('M2', '0.01');
model.physics('Ang1').label('Domain ODEs and DAEs 12');
model.physics('Ang1').prop('ShapeProperty').set('valueType', 'real');
model.physics('Ang1').prop('ShapeProperty').set('shapeFunctionType',
'shlag');
model.physics('Ang1').prop('Units').set('CustomSourceTermUnit', '1/s');
```

```
model.physics('Ang1').feature('dode1').set('f', 'Ra1');
model.physics('Ang2').label('Domain ODEs and DAEs 13');
model.physics('Ang2').prop('ShapeProperty').set('valueType', 'real');
model.physics('Ang2').prop('ShapeProperty').set('shapeFunctionType',
'shlag');
model.physics('Ang2').prop('Units').set('CustomSourceTermUnit', '1/s');
model.physics('Ang2').feature('dode1').set('f', 'Ra2');
model.physics('VEGF').prop('ShapeProperty').set('valueType', 'real');
model.physics('VEGF').prop('Units').set('CustomSourceTermUnit', '1/s');
model.physics('VEGF').feature('cdeq1').set('f', 'Rvegf');
model.physics('VEGF').feature('cdeq1').set('c', {'Dvegf' '0' '0' '0'
'Dvegf' '0' '0' '0' 'Dvegf'});
model.physics('endothelial_cells').prop('ShapeProperty').set('valueType
', 'real');
model.physics('endothelial_cells').prop('Units').set('CustomSourceTermU
nit', '1/s');
model.physics('endothelial_cells').feature('init1').set('ecc', '0.5');
model.physics('endothelial_cells').feature('cfeq1').set('c', {'Dec' '0'
'0' '0' 'Dec' '0' '0' '0' 'Dec'});
model.physics('endothelial_cells').feature('cfeq1').set('f', 'fec');
model.physics('endothelial_cells').feature('cfeq1').set('al', {'-
(xn)*d(Cvegf,x)*Cvegf0' '-(xn)*d(Cvegf,y)*Cvegf0' '-
(xn)*d(Cvegf,x)*Cvegf0'});
model.physics('Tumc').label('Cancer Cells');
model.physics('Tumc').prop('ShapeProperty').set('valueType', 'real');
model.physics('Tumc').prop('Units').set('CustomSourceTermUnit', '1/s');
model.physics('Tumc').feature('cdeq1').set('f', 'Rtumc');
model.physics('Tumc').feature('cdeq1').set('c', {'1.5e-11' '0' '0' '0'
'1.5e-11' '0' '0' '0' '1.5e-11'});
model.physics('Tumc').feature('init1').set('Tumc', '0.96');
model.physics('Csc').label('Stem Cancer Cells');
model.physics('Csc').prop('ShapeProperty').set('valueType', 'real');
model.physics('Csc').prop('Units').set('CustomSourceTermUnit', '1/s');
model.physics('Csc').feature('cdeq1').set('f', 'Rcsc');
model.physics('Csc').feature('cdeq1').set('c', {'1.5e-11' '0' '0' '0'
'1.5e-11' '0' '0' '0' '1.5e-11'});
model.physics('Csc').feature('init1').set('Csc', '0.02');
model.physics('IndC').label('Induced Cancer Cells');
model.physics('IndC').prop('ShapeProperty').set('valueType', 'real');
model.physics('IndC').prop('Units').set('CustomSourceTermUnit', '1/s');
model.physics('IndC').feature('cdeq1').set('f', 'Rind');
model.physics('IndC').feature('cdeq1').set('c', {'1.5e-11' '0' '0' '0'
'1.5e-11' '0' '0' '0' '1.5e-11'});
model.physics('IndC').feature('init1').set('IndC', '0.02');

model.mesh('mesh1').feature('size').set('hauto', 2);
model.mesh('mesh1').feature('ftet1').feature('size1').set('hauto', 4);
model.mesh('mesh1').feature('ftet2').feature('size1').set('hauto', 6);
model.mesh('mesh1').run;

model.frame('material1').sorder(1);

model.result.table('tbl1').comments('Volume Integration 1 (8)');
model.result.table('tbl2').comments('Volume Integration 1 (8)');
model.result.table('tbl3').comments('Volume Integration 1 (8)');
```

```
model.physics('solid').feature('hmm1').set('rho_mat', 'userdef');

model.study.create('std1');
model.study('std1').create('time', 'Transient');

model.sol.create('sol1');
model.sol('sol1').study('std1');
model.sol('sol1').attach('std1');
model.sol('sol1').create('st1', 'StudyStep');
model.sol('sol1').create('v1', 'Variables');
model.sol('sol1').create('t1', 'Time');
model.sol('sol1').feature('t1').create('se1', 'Segregated');
model.sol('sol1').feature('t1').create('fc1', 'FullyCoupled');
model.sol('sol1').feature('t1').feature('se1').create('ss1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('ss2',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('ll1',
'LowerLimit');
model.sol('sol1').feature('t1').feature('se1').create('tds1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('tds21',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('tds31',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('dode1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('dode21',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('dode31',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('dode32',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('dode33',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq2',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq3',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq21',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq31',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('Cancer_Cells1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('Stem_cells1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('Induced_Cells1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('Tumc1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('Tumc2',
'SegregatedStep');
```

```
model.sol('sol1').feature('t1').feature('se1').create('cdeq22',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('cdeq32',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('tds32',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').create('free1',
'SegregatedStep');
model.sol('sol1').feature('t1').feature('se1').feature.remove('ssDef');
model.sol('sol1').feature('t1').feature.remove('fcDef');

model.result.dataset.create('dset2', 'Solution');
model.result.dataset.create('cpt1', 'CutPoint3D');
model.result.dataset.create('cpt3', 'CutPoint3D');
model.result.dataset.create('cpt2', 'CutPoint3D');
model.result.dataset.create('cln1', 'CutLine3D');
model.result.dataset('cpt3').set('data', 'dset2');
model.result.numerical.create('int1', 'IntVolume');
model.result.numerical('int1').selection.set((1));
model.result.numerical('int1').set('probetag', 'none');
model.result.create('pg7', 'PlotGroup1D');
model.result.create('pg25', 'PlotGroup1D');
model.result.create('pg77', 'PlotGroup1D');
model.result.create('pg32', 'PlotGroup1D');
model.result.create('pg8', 'PlotGroup1D');
model.result.create('pg24', 'PlotGroup1D');
model.result.create('pg19', 'PlotGroup1D');
model.result.create('pg68', 'PlotGroup1D');
model.result.create('pg69', 'PlotGroup1D');
model.result.create('pg70', 'PlotGroup1D');
model.result.create('pg71', 'PlotGroup1D');
model.result.create('pg1', 'PlotGroup3D');
model.result.create('pg10', 'PlotGroup3D');
model.result.create('pg107', 'PlotGroup3D');
model.result.create('pg37', 'PlotGroup1D');
model.result.create('pg38', 'PlotGroup1D');
model.result.create('pg101', 'PlotGroup1D');
model.result('pg7').create('ptgr1', 'PointGraph');
model.result('pg25').create('lngr1', 'LineGraph');
model.result('pg77').create('ptgr1', 'PointGraph');
model.result('pg32').create('lngr1', 'LineGraph');
model.result('pg8').create('ptgr1', 'PointGraph');
model.result('pg19').create('ptgr1', 'PointGraph');
model.result('pg68').create('ptgr1', 'PointGraph');
model.result('pg69').create('ptgr1', 'PointGraph');
model.result('pg70').create('ptgr1', 'PointGraph');
model.result('pg71').create('ptgr1', 'PointGraph');
model.result('pg1').create('vol1', 'Volume');
model.result('pg1').create('vol2', 'Volume');
model.result('pg1').create('vol3', 'Volume');
model.result('pg1').create('vol4', 'Volume');
model.result('pg1').create('vol5', 'Volume');
model.result('pg1').create('vol6', 'Volume');
model.result('pg10').create('vol1', 'Volume');
model.result('pg107').create('vol1', 'Volume');
model.result('pg107').feature('vol1').set('data', 'dset1');
model.result('pg37').create('lngr1', 'LineGraph');
```

```
model.result('pg38').create('ptgr1', 'PointGraph');
model.result('pg101').create('ptgr1', 'PointGraph');
model.result.export.create('plot1', 'Plot');
model.result.export.create('plot2', 'Plot');
model.result.export.create('plot3', 'Plot');

model.study('std1').feature('time').set('plotfreq', 'tsteps');
model.study('std1').feature('time').set('rtol', '0.0001');
model.study('std1').feature('time').set('rtolactive', true);
model.study('std1').feature('time').set('tlist', 'range(0,0.5,26)');
model.study('std1').feature('time').set('plot', 'on');
model.study('std1').feature('time').set('plotgroup', 'pg10');
model.study('std1').feature('time').set('tunit', 'd');

model.sol('sol1').attach('std1');
model.sol('sol1').feature('v1').set('clist', {'range(0,0.5,26)'});
model.sol('sol1').feature('v1').feature('comp1_u').set('scalemethod',
'manual');
model.sol('sol1').feature('v1').feature('comp1_u').set('scaleval', '1e-
2*0.17320508075688776');
model.sol('sol1').feature('v1').feature('comp1_cn').label('comp1.cn');
model.sol('sol1').feature('v1').feature('comp1_cfn').label('comp1.cfn')
;
model.sol('sol1').feature('v1').feature('comp1_cint').label('comp1.cint
');
model.sol('sol1').feature('v1').feature('comp1_cf').label('comp1.cf');
model.sol('sol1').feature('t1').set('rtol', '0.0001');
model.sol('sol1').feature('t1').set('plot', 'on');
model.sol('sol1').feature('t1').set('atoludotactive', {'comp1_cox'
'off' 'comp1_lg' 'off' 'comp1_p' 'off' 'comp1_phis1' 'off' 'comp1_u'
'off'  ...
'comp1_Nkcel' 'off' 'comp1_T8imcel' 'off' 'comp1_Tregs' 'off'
'comp1_Cd4' 'off' 'comp1_M1' 'off'  ...
'comp1_M2' 'off' 'comp1_a1' 'off' 'comp1_a2' 'off' 'comp1_Cvegf' 'off'
'comp1_ecc' 'off'  ...
'comp1_Tumc' 'off' 'comp1_Csc' 'off' 'comp1_IndC' 'off' 'comp1_cn'
'off' 'comp1_cfn' 'off'  ...
'comp1_cint' 'off' 'comp1_cf' 'off'});
model.sol('sol1').feature('t1').set('maxstepbdfactive', true);
model.sol('sol1').feature('t1').set('plotfreq', 'tsteps');
model.sol('sol1').feature('t1').set('tlist', 'range(0,0.5,26)');
model.sol('sol1').feature('t1').set('atoludot', {'comp1_cox' '1e-3'
'comp1_lg' '1e-3' 'comp1_p' '1e-3' 'comp1_phis1' '1e-3' 'comp1_u' '1e-
3'  ...
'comp1_Nkcel' '1e-3' 'comp1_T8imcel' '1e-3' 'comp1_Tregs' '1e-3'
'comp1_Cd4' '1e-3' 'comp1_M1' '1e-3'  ...
'comp1_M2' '1e-3' 'comp1_a1' '1e-3' 'comp1_a2' '1e-3' 'comp1_Cvegf'
'1e-3' 'comp1_ecc' '1e-3'  ...
'comp1_Tumc' '1e-3' 'comp1_Csc' '1e-3' 'comp1_IndC' '1e-3' 'comp1_cn'
'1e-3' 'comp1_cfn' '1e-3'  ...
'comp1_cint' '1e-3' 'comp1_cf' '1e-3'});
model.sol('sol1').feature('t1').set('plotgroup', 'pg10');
model.sol('sol1').feature('t1').set('tunit', 'd');
model.sol('sol1').feature('t1').set('maxstepbdf', '0.25');
model.sol('sol1').feature('t1').set('eventtol', '0.001');
```

```
model.sol('sol1').feature('t1').set('atolmethod', {'comp1_cox' 'global'
'comp1_lg' 'global' 'comp1_p' 'global' 'comp1_phis1' 'global' 'comp1_u'
'global'  ...
'comp1_Nkcel' 'global' 'comp1_T8imcel' 'global' 'comp1_Tregs' 'global'
'comp1_Cd4' 'global' 'comp1_M1' 'global'  ...
'comp1_M2' 'global' 'comp1_a1' 'global' 'comp1_a2' 'global'
'comp1_Cvegf' 'global' 'comp1_ecc' 'global'  ...
'comp1_Tumc' 'global' 'comp1_Csc' 'global' 'comp1_IndC' 'global'
'comp1_cn' 'global' 'comp1_cfn' 'global'  ...
'comp1_cint' 'global' 'comp1_cf' 'global'});
model.sol('sol1').feature('t1').set('fieldselection', 'comp1_cox');
model.sol('sol1').feature('t1').set('atol', {'comp1_cox' '1e-3'
'comp1_lg' '1e-3' 'comp1_p' '1e-3' 'comp1_phis1' '1e-3' 'comp1_u' '1e-
3'  ...
'comp1_Nkcel' '1e-3' 'comp1_T8imcel' '1e-3' 'comp1_Tregs' '1e-3'
'comp1_Cd4' '1e-3' 'comp1_M1' '1e-3'  ...
'comp1_M2' '1e-3' 'comp1_a1' '1e-3' 'comp1_a2' '1e-3' 'comp1_Cvegf'
'1e-3' 'comp1_ecc' '1e-3'  ...
'comp1_Tumc' '1e-3' 'comp1_Csc' '1e-3' 'comp1_IndC' '1e-3' 'comp1_cn'
'1e-3' 'comp1_cfn' '1e-3'  ...
'comp1_cint' '1e-3' 'comp1_cf' '1e-3'});
model.sol('sol1').feature('t1').feature('dDef').set('linsolver',
'pardiso');
model.sol('sol1').feature('t1').feature('dDef').set('pardmtsolve',
false);
model.sol('sol1').feature('t1').feature('se1').active(false);
model.sol('sol1').feature('t1').feature('se1').feature('ss1').set('segv
ar', {'comp1_p' 'comp1_u'});
model.sol('sol1').feature('t1').feature('se1').feature('ss2').set('segv
ar', {'comp1_cox' 'comp1_phis1' 'comp1_lg' 'comp1_Nkcel'
'comp1_T8imcel' 'comp1_Tregs'});
model.sol('sol1').feature('t1').feature('se1').feature('ss2').set('subd
amp', '0.7');
model.sol('sol1').feature('t1').feature('se1').feature('ss2').set('subj
tech', 'onevery');
model.sol('sol1').feature('t1').feature('se1').feature('ll1').set('lowe
rlimit', 'comp1.Tumc 0');
model.sol('sol1').feature('t1').feature('se1').feature('dode1').set('se
gvar', {'comp1_Cd4'});
model.sol('sol1').feature('t1').feature('se1').feature('dode21').set('s
egvar', {'comp1_M1'});
model.sol('sol1').feature('t1').feature('se1').feature('dode31').set('s
egvar', {'comp1_M2'});
model.sol('sol1').feature('t1').feature('se1').feature('dode32').set('s
egvar', {'comp1_a1'});
model.sol('sol1').feature('t1').feature('se1').feature('dode33').set('s
egvar', {'comp1_a2'});
model.sol('sol1').feature('t1').feature('se1').feature('cdeq1').set('se
gvar', {'comp1_Cvegf'});
model.sol('sol1').feature('t1').feature('se1').feature('cdeq2').set('se
gvar', {'comp1_ecc'});
model.sol('sol1').feature('t1').feature('se1').feature('Tumc2').set('se
gvar', {'comp1_Tumc'});
model.sol('sol1').feature('t1').feature('se1').feature('cdeq22').set('s
egvar', {'comp1_Csc'});
model.sol('sol1').feature('t1').feature('se1').feature('cdeq32').set('s
egvar', {'comp1_IndC'});
```

```
model.sol('sol1').feature('t1').feature('fc1').active(true);
model.sol('sol1').feature('t1').feature('fc1').set('dtech', 'auto');
% model.sol('sol1').runAll;
%
% model.result.dataset('dset1').set('frametype', 'spatial');
% model.result.dataset('cpt1').label('Cut Point 3D 1 (in tumor) 1');
% model.result.dataset('cpt1').set('pointx', 'range(1.0e-6,1.0e-6,1.0e-
6)');
% model.result.dataset('cpt1').set('pointy', 'range(1.0e-6,1.0e-6,1.0e-
6)');
% model.result.dataset('cpt1').set('pointz', 'range(1.0e-6,1.0e-6,1.0e-
6)');
% model.result.dataset('cpt3').label('Cut Point 3D 1 (in tumor) 2');
% model.result.dataset('cpt3').set('pointvar', 'cpt1n');
% model.result.dataset('cpt3').set('pointx', 'range(250e-6,250e-6,250e-
6)');
% model.result.dataset('cpt3').set('pointy', 'range(250e-6,250e-6,250e-
6)');
% model.result.dataset('cpt3').set('pointz', 'range(250e-6,250e-6,250e-
6)');
% model.result.dataset('cpt2').label('Cut Point 3D 2 (out of tumor)');
% model.result.dataset('cpt2').set('pointx', 'range(0.01,0.01,0.01)');
% model.result.dataset('cpt2').set('pointy', 'range(0.01,0.01,0.01)');
% model.result.dataset('cpt2').set('pointz', 'range(0.01,0.01,0.01)');
% model.result.dataset('cln1').set('genpoints', {'0.0' '0.0' '0.0';
'0.05001' '0.05001' '0.05001'});
% model.result.numerical('int1').set('table', 'tbl3');
% model.result.numerical('int1').set('descr', {'8'});
% model.result.numerical('int1').set('unit', {'mm^3'});
% model.result.numerical('int1').set('expr', {'8'});
% model.result.numerical('int1').setResult;
% model.result('pg7').label('cox_point graph');
% model.result('pg7').set('data', 'cpt1');
% model.result('pg7').set('xlabelactive', true);
% model.result('pg7').set('title', 'Model Rn');
% model.result('pg7').set('ylabelactive', true);
% model.result('pg7').set('ylabel', 'cox (mol/m^3)');
% model.result('pg7').set('xlabel', 'Time (d)');
% model.result('pg7').set('titletype', 'manual');
% model.result('pg7').feature('ptgr1').set('descr', 'Concentration');
% model.result('pg7').feature('ptgr1').set('unit', 'mol/m^3');
% model.result('pg7').feature('ptgr1').set('expr', 'cox');
% model.result('pg25').label('cox_line graph');
% model.result('pg25').set('data', 'cln1');
% model.result('pg25').set('xlabelactive', true);
% model.result('pg25').set('ylabelactive', true);
% model.result('pg25').set('ylabel', 'cox (mol/m<sup>3</sup>)');
% model.result('pg25').set('xlabel', 'Arc length');
% model.result('pg25').feature('lngr1').set('unit', 'mol/m^3');
% model.result('pg25').feature('lngr1').set('title', 'Model Rn');
% model.result('pg25').feature('lngr1').set('descr', 'Concentration');
% model.result('pg25').feature('lngr1').set('titletype', 'manual');
% model.result('pg25').feature('lngr1').set('expr', 'cox');
% model.result('pg25').feature('lngr1').set('resolution', 'normal');
% model.result('pg77').label('Sv_point graph');
% model.result('pg77').set('data', 'cpt1');
% model.result('pg77').set('xlabelactive', true);
```

```
% model.result('pg77').set('title', 'Model Rn');
% model.result('pg77').set('ylabelactive', true);
% model.result('pg77').set('ylabel', 'Sv (1/m)');
% model.result('pg77').set('xlabel', 'Time (d)');
% model.result('pg77').set('titletype', 'manual');
% model.result('pg77').feature('ptgr1').set('descr',
'(Svin*dd0*ec)*(dd0>=0)');
% model.result('pg77').feature('ptgr1').set('unit', '1/m');
% model.result('pg77').feature('ptgr1').set('expr', 'Sv');
% model.result('pg32').label('Sv_line graph');
% model.result('pg32').set('data', 'cln1');
% model.result('pg32').set('xlabel', 'Arc length');
% model.result('pg32').set('xlabelactive', false);
% model.result('pg32').feature('lngr1').set('legend', true);
% model.result('pg32').feature('lngr1').set('unit', '1/m');
% model.result('pg32').feature('lngr1').set('descr', '');
% model.result('pg32').feature('lngr1').set('expr', 'Sv');
% model.result('pg32').feature('lngr1').set('descr', '');
% model.result('pg32').feature('lngr1').set('resolution', 'normal');
% model.result('pg8').label('Pore radius_point graph');
% model.result('pg8').set('data', 'cpt1');
% model.result('pg8').set('xlabelactive', true);
% model.result('pg8').set('ylabelactive', true);
% model.result('pg8').set('ylabel', 'ro');
% model.result('pg8').set('xlabel', 'Time (d)');
% model.result('pg8').feature('ptgr1').set('descr', 'rn1(1)*150e-9
[m]');
% model.result('pg8').feature('ptgr1').set('expr', 'ro');
% model.result('pg8').feature('ptgr1').set('descr', 'rn1(1)*150e-9
[m]');
% model.result('pg24').label('solid.muLame_line graph');
% model.result('pg24').set('data', 'cln1');
% model.result('pg24').set('xlabelactive', true);
% model.result('pg24').set('ylabelactive', true);
% model.result('pg24').set('ylabel', 'Shear Modulus (Pa)');
% model.result('pg24').set('xlabel', 'Arc length');
% model.result('pg19').label('Tumor Cells_point graph');
% model.result('pg19').set('data', 'cpt1');
% model.result('pg19').set('ylabel', 'Dependent variable Tumc (1)');
% model.result('pg19').set('xlabel', 'Time (d)');
% model.result('pg19').set('xlabelactive', false);
% model.result('pg19').set('ylabelactive', false);
% model.result('pg19').feature('ptgr1').set('descr', 'Dependent
variable Tumc');
% model.result('pg19').feature('ptgr1').set('unit', '1');
% model.result('pg19').feature('ptgr1').set('expr', 'Tumc');
% model.result('pg68').label('Cancer Stem Cells_point graph');
% model.result('pg68').set('data', 'cpt1');
% model.result('pg68').set('ylabel', 'Dependent variable Csc (1)');
% model.result('pg68').set('xlabel', 'Time (d)');
% model.result('pg68').set('xlabelactive', false);
% model.result('pg68').set('ylabelactive', false);
% model.result('pg68').feature('ptgr1').set('descr', 'Dependent
variable Csc');
% model.result('pg68').feature('ptgr1').set('unit', '1');
% model.result('pg68').feature('ptgr1').set('expr', 'Csc');
% model.result('pg69').label('Induced Cancer Cells_point graph');
```

```
% model.result('pg69').set('data', 'cpt1');
% model.result('pg69').set('ylabel', 'Dependent variable IndC (1)');
% model.result('pg69').set('xlabel', 'Time (d)');
% model.result('pg69').set('xlabelactive', false);
% model.result('pg69').set('ylabelactive', false);
% model.result('pg69').feature('ptgr1').set('descr', 'Dependent
variable IndC');
% model.result('pg69').feature('ptgr1').set('unit', '1');
% model.result('pg69').feature('ptgr1').set('expr', 'IndC');
% model.result('pg70').label('Total Cells_point graph');
% model.result('pg70').set('data', 'cpt1');
% model.result('pg70').set('xlabel', 'Time (d)');
% model.result('pg70').set('xlabelactive', false);
% model.result('pg70').feature('ptgr1').set('descr', '');
% model.result('pg70').feature('ptgr1').set('unit', '1');
% model.result('pg70').feature('ptgr1').set('expr', 'Totcel');
% model.result('pg71').label('Pressure_point graph');
% model.result('pg71').set('data', 'cpt1');
% model.result('pg71').set('xlabelactive', true);
% model.result('pg71').set('ylabelactive', true);
% model.result('pg71').set('ylabel', 'Pressure- p (Pa)');
% model.result('pg71').set('xlabel', 'Time (d)');
% model.result('pg71').feature('ptgr1').set('descr', 'Dependent
variable p');
% model.result('pg71').feature('ptgr1').set('unit', 'Pa');
% model.result('pg71').feature('ptgr1').set('expr', 'p');
% model.result('pg1').label('Stress (solid)');
% model.result('pg1').set('looplevel', {'1'});
% model.result('pg1').feature('vol1').label('solid.J');
% model.result('pg1').feature('vol1').set('descr', 'Volume ratio');
% model.result('pg1').feature('vol1').set('unit', '1');
% model.result('pg1').feature('vol1').set('expr', 'solid.J');
% model.result('pg1').feature('vol1').set('resolution', 'normal');
% model.result('pg1').feature('vol2').label('solid');
% model.result('pg1').feature('vol2').set('descr', 'Dependent variable
phis');
% model.result('pg1').feature('vol2').set('unit', '');
% model.result('pg1').feature('vol2').set('expr', 'phis');
% model.result('pg1').feature('vol2').set('descr', 'Dependent variable
phis');
% model.result('pg1').feature('vol2').set('resolution', 'normal');
% model.result('pg1').feature('vol3').label('pressure');
% model.result('pg1').feature('vol3').set('descr', 'Dependent variable
p');
% model.result('pg1').feature('vol3').set('unit', 'Pa');
% model.result('pg1').feature('vol3').set('expr', 'p');
% model.result('pg1').feature('vol3').set('resolution', 'normal');
% model.result('pg1').feature('vol4').label('oxygen');
% model.result('pg1').feature('vol4').set('descr', 'Concentration');
% model.result('pg1').feature('vol4').set('unit', 'mol/m^3');
% model.result('pg1').feature('vol4').set('expr', 'cox');
% model.result('pg1').feature('vol4').set('resolution', 'normal');
% model.result('pg1').feature('vol5').label('drug');
% model.result('pg1').feature('vol5').set('descr', 'Concentration');
% model.result('pg1').feature('vol5').set('unit', 'mol/m^3');
% model.result('pg1').feature('vol5').set('expr', 'cint');
% model.result('pg1').feature('vol5').set('resolution', 'normal');
```

```
% model.result('pg1').feature('vol6').set('descr', 'Dependent variable
M2');
% model.result('pg1').feature('vol6').set('unit', '1');
% model.result('pg1').feature('vol6').set('expr', 'M2');
% model.result('pg1').feature('vol6').set('resolution', 'normal');
% model.result('pg10').label('Growth');
% model.result('pg10').feature('vol1').label('lg');
% model.result('pg10').feature('vol1').set('descr', 'Dependent variable
lg');
% model.result('pg10').feature('vol1').set('unit', '1');
% model.result('pg10').feature('vol1').set('expr', 'lg');
% model.result('pg10').feature('vol1').set('solrepresentation',
'solnum');
% model.result('pg10').feature('vol1').set('resolution', 'normal');
% model.result('pg107').set('looplevel', {'1'});
% model.result('pg107').feature('vol1').set('descr', 'Concentration');
% model.result('pg107').feature('vol1').set('looplevel', {'1'});
% model.result('pg107').feature('vol1').set('unit', 'mol/m^3');
% model.result('pg107').feature('vol1').set('expr', 'cfn');
% model.result('pg107').feature('vol1').set('resolution', 'normal');
% model.result('pg37').label('sbulk_line graph');
% model.result('pg37').set('data', 'cln1');
% model.result('pg37').set('xlabel', 'Arc length');
% model.result('pg37').set('xlabelactive', false);
% model.result('pg37').feature('lngr1').set('unit', 'N/m^2');
% model.result('pg37').feature('lngr1').set('descr', '');
% model.result('pg37').feature('lngr1').set('expr', 'sbulk');
% model.result('pg37').feature('lngr1').set('resolution', 'normal');
% model.result('pg38').label('sbulk_point graph');
% model.result('pg38').set('data', 'cpt1');
% model.result('pg38').set('xlabel', 'Time (d)');
% model.result('pg38').set('xlabelactive', false);
% model.result('pg38').feature('ptgr1').set('descr', '');
% model.result('pg38').feature('ptgr1').set('unit', 'N/m^2');
% model.result('pg38').feature('ptgr1').set('expr', 'sbulk');
% model.result('pg101').label('khy_in the host');
% model.result('pg101').set('data', 'cpt1');
% model.result('pg101').set('xlabelactive', true);
% model.result('pg101').set('ylabelactive', true);
% model.result('pg101').set('ylabel', 'khy');
% model.result('pg101').set('xlabel', 'Time (d)');
% model.result('pg101').feature('ptgr1').set('descr',
'step29(t[1/s])[m^2/(Pa*d)],6.5e-11[m^2/(Pa*d)]');
% model.result('pg101').feature('ptgr1').set('unit', 'm^3*s/kg');
% model.result('pg101').feature('ptgr1').set('title', 'Model Rn');
% model.result('pg101').feature('ptgr1').set('titletype', 'manual');
% model.result('pg101').feature('ptgr1').set('expr', 'khy');
% model.result('pg101').feature('ptgr1').set('descr',
'step29(t[1/s])[m^2/(Pa*d)],6.5e-11[m^2/(Pa*d)]');
% model.result.export('plot1').set('header', false);
% model.result.export('plot1').set('filename',
'C:\Users\fmpekr01\Desktop\New folder\Kerbel_Drug_4.txt');
% model.result.export('plot2').set('plotgroup', 'pg24');
% model.result.export('plot2').set('filename',
'C:\Users\mkouts03\Desktop\Brand New 4T1_Breast Cancer\8 Ketotifen-
Sonopermeation-Doxil_ICIs\solid.muLame_19thday.txt');
% model.result.export('plot3').set('plotgroup', 'pg32');
```

```
% model.result.export('plot3').set('plot', 'lngr1');
% model.result.export('plot3').set('filename',
'C:\Users\mkouts03\Desktop\Brand New 4T1_Breast Cancer\8 Ketotifen-
Sonopermeation-Doxil_ICIs\Sv_19thday.txt');
%
%
model.label('New4T1_BreastCancer_Ketotifen_Sonopermeation_Doxil_ICIs_pr
ototype.mph');
%
% model.result('pg7').run;

mphsave('comsol_file.mph')
out = model;
```