# CVS Ursino Initiation

## 1. Capillary Module initialisation

*to add to Checkini*

*cap = capillary, art = artery, ven = vein, tcap = tissue capillary (before tissue oxygenation, entering the organ), tc = tissue capillary (after oxygenation, leaving the organ)*

```
Vcap= 1/9*CO;   Vart = 2/9*CO;    Vven=2/3*CO;      % Blood volumes
Vcap = [Vcap*0.05 Vcap*0.01 Vcap*0.01 Vcap*0.10 Vcap*0.83];

n = [1 1 1 1 1];

CtcapO2 = CaO2;
CtcapCO2 = CaCO2;
CtcapN2 = CaN2;
CtcapGas5 = CaGas5;

PtcapCO2 = PaCO2*n;
PtcapO2 = PaO2*n;
StcapO2 = SaO2*n;
HCO3tcap = HCO3a*n;

CtcO2 = CaO2;
CtcCO2 = CaCO2;
CtcN2 = CaN2;
CtcGas5 = CaGas5;
```

diff = the difference btw arterial blood gas content and tissue capillary blood gas content (when leaving the organ).

```
diff_O2 = 0;
diff_CO2 = 0;
diff_N2 = 0;
diff_Gas5 = 0;
```

## 2. Multiple tissue Module initialisation

*to add to Checkini*

*Here the flows used to compute the blood gas equilibrations are set: Flv = Flow left ventricle, Frv = Flow right ventricle, Fsa = Flow systemic artery, Fsas = Flow systemic arterioles, Fsv = Fow systemic vein, Fsvs = Flow systemic venules.*

```
Ntiss = 5;              % number of tissue compartments
VCO2_actual = VCO2;

S_Flv = 2.2222;
S_Frv = 1.0954;
```

```
S_Fsa = 8.1034;
S_Fsas = [12.4134    8.2799    9.7566    7.9250    3.0706];
S_Fsv = 46.4224;
S_Fsvs = [12.7115    8.5191    9.9985    8.0745    3.1179];

CO_Fsa = 4.4485e+03;    % HR*Fsa*60;
CO_Flv = 4.4485e+03;
CO_Frv = 4.4485e+03;
CO_Fsv = 4.4485e+03;
CO_SA = 1.0e+03 *[1.3324    0.8887    1.0472    0.8506    0.3296];
CO_SV = 1.0e+03 *[1.3324    0.8887    1.0472    0.8506    0.3296];
```

## 3. CVS Initiation

Here the Pressures, Volumes, Capacitances and Flows are initiated

### 3.1 Pressure initiation [mmHg]

The pressures are set in a way that the mean systemic filling pressure (MSFP, when CO=0) is equal to 8 mmHg.

```
Ppa = 14.2255;
Plungs1 = 14.1046;
Ppv = 10.0935;
Psa = 104.5452;
Psa1 = 104.2459;
Psa2 = 104.2459;
Psa3 = 104.2459;
Psa4 = 104.2459;
Psa5 = 104.2459;
Psv1 = 13.4925;
Psv2 = 13.1870;
Psv3 = 13.4764;
Psv4 = 13.6674;
Psv5 = 13.8341;
Psv = 12.6038;
Ppl = 0;
Pra = 8.5856;
Pla = 9.3762;
Plv = 10.6870;
Prv1 = 10.1969;
```

### 3.2 Flows [ml.s-1]

```
Flungs1 = 44.8891;
Fpv = 128.0915;
Fpa = 5.2575;
Fsa1 = 21.2836;
Fsa2 = 14.1947;
Fsa3 = 16.7286;
Fsa4 = 13.5867;
Fsa5 = 5.2638;
```

```
Fsv1 = 22.2180;
Fsv2 = 15.3482;
Fsv3 = 17.4521;
Fsv4 = 14.1812;
Fsv5 = 5.4926;
Fsv = 80.3632;
Fsa = 4.9892;
Fra = 0;
Frv1 = 0;
Fla = 0;
Flv = 0;
dFpa_m = 1.0e-03 *[-0.3629   -0.3632   -0.3637   -0.3641   -0.3647   -0.3652   -0.3657   -0.366
dFsa_m = 1.0e-04 *[-0.9734   -0.9734   -0.9734   -0.9734   -0.9733   -0.9733   -0.9733   -0.973
```

### 3.3 Cardiac chambers Parameter

```
T = 1/HR;
T1 = 0.33*T;
T2 = 0.45*T;
Ta = 0.8*T;     %0.8*T
D = T/20;       %0.04

Elvsysc = 2.5;  % 2.5, 2.95, 4
Ervsysc = 1;    % 1, 1.75
Elamin = 0.2;   % 0.2, 0.4
Elamax = 0.3;   % 0.3, 0.5
Eramin = 0.2;
Eramax = 0.3;

Plv0 = 1;       % 0.6
Prv0 = 1;       % 0.65; %1
Blv = 0.02;     % 0.2
Brv = 0.02;     % 0.2
phi_v = 0;

Vlv0 = 15;  % 10
Vrv0 = 40;  % 40
Vla0 = 5;  % 25
Vra0 = 5;  % 25

Rra = 0.001;
Rrv = 0.001;
Rla = 0.002;
Rlv = 0.002;
```

***Dialated Cardiomyopathy***

```
% Elvsysc = 0.9;
% Plv0 = 0.65;
% Vlv0 = 25;
```

***Stem cell treated patients***

```
% Elvsysc = 1.37;
% Plv0 = 0.65;
% Vlv0 = 19;
```

## 3.4 Parameters systemic Vein (thorax)

The thoracic vein collapses if the intraplueral pressure is high enough enabling the venous return

```
D1 = 0.3855;          % mmHg (9)
K1 = 0.15;            % mmHg/ml (9)
Vusv = 130;           % 130;% ml (9)
D2 = -5;              % mmHg (9)
K2 = 0.4;             % mmHg (9)
Vsv_min = 50;         % ml (9)
Kxp = 2;              % mmHg (49)
Kxv = 8;              % ml (49)
KR = 0.001;           % mmHg·s·ml-1 (9)
Vsv_max = 350;        % 350 ml (9)
Rsv_0 = 0.025;        % mmHg·s·ml-1 (9)
```

## 3.5 Compliance [ml/mmHg]

```
Cpa = 0.76;
Clungs1 = 5.7014+0.0986;
Cpv = 25.37;
Csa = 0.28;
Csa1 = 1.0788;
Csa2 = 1.1532;
Csa3 = 0.8184;
Csa4 = 0.5208;
Csa5 = 0.1488;

% Csv1 = 1.4;
% Csv2 = 4.2777;
% Csv3 = 1.0997;
% Csv4 = 0.7497;
% Csv5 = 0.2499;

Csv1 = 14;
Csv2 = 42.777;
Csv3 = 10.997;
Csv4 = 7.497;
Csv5 = 2.499;
Csv = 20;
```

## 3.6 Unstressed volume [ml]

The total unstressed volume for Vtotal = 5300 ml

```
Vupa = 0;
Vulungs1 = 78.05;
Vupv = 77.46;
Vusa = 0;
Vusa1 = 98.76 ;
Vusa2 = 201.28;
Vusa3 = 77.61;
Vusa4 = 52.91;
Vusa5 = 17.60;
Vusv1 = 469.99;
Vusv2 = 1052.89;
Vusv3 = 369.15;
Vusv4 = 216.12;
Vusv5 = 72.04;
Vusv = 95.36;

VuTot = Vupa+Vulungs1+Vupv+Vusa+Vusa1+Vusa2+Vusa3+Vusa4+Vusa5+Vusv+Vusv1+Vusv2+Vusv3+Vusv4+Vusv
```

### 3.7 Resistance [mmHg.s/ml]

```
Rpa = 0.023;
Rlungs1 = 1/(1/0.0909+1/5.2588);
Rpv = 0.0056;

Rsa = 0.06;   %R_ao = 0.05;0.06;

RSA = 0.9;
Rsa1 = 2.783*RSA;  % 36%
Rsa2 = 4.187*RSA;  % 24%
Rsa3 = 3.541*RSA;  % 28%
Rsa4 = 11.209*RSA;  % 9%
Rsa5 = 33.140*RSA;  % 3%

R = [2.49,1.655,2.106,19.71,6.6667];
Rsv1 = 0.04;
Rsv2 = 0.038;
Rsv3 = 0.05;
Rsv4 = 0.075;
Rsv5 = 0.224;
Rsv = 0.05;
```

### 3.8 Inertance [mmHg.s^2/ml]

```
Lsa = 0.22e-3; %L_ao = 1e-5; 0.22e-3
Lpa = 0.18e-3;
```

### 3.9 Initial volumes

```
Vpa = Ppa*Cpa+Vupa;
Vlungs1 = Plungs1*Clungs1+Vulungs1;
Vpv = Ppv*Cpv+Vupv;

Vsa = Psa*Csa+Vusa;
Vsa1 = Psa1*Csa1+Vusa1;
Vsa2 = Psa2*Csa2+Vusa2;
Vsa3 = Psa3*Csa3+Vusa3;
Vsa4 = Psa4*Csa4+Vusa4;
Vsa5 = Psa5*Csa5+Vusa5;

Vsa1_ini = Vsa1;
Vsa2_ini = Vsa2;
Vsa3_ini = Vsa3;
Vsa4_ini = Vsa4;
Vsa5_ini = Vsa5;

Vsv1 = Psv1*Csv1+Vusv1;
Vsv2 = Psv2*Csv2+Vusv2;
Vsv3 = Psv3*Csv3+Vusv3;
Vsv4 = Psv4*Csv4+Vusv4;
Vsv5 = Psv5*Csv5+Vusv5;
Vsv = Psv*Csv+Vusv;

Vla = 40;
Vlv = 120;
Vra = 50;
Vrv1 = 130;

Vtotal = Vpa+Vlungs1+Vpv+Vra+Vla+Vlv+Vrv1+Vsa+Vsa1+Vsa2+Vsa3+Vsa4+Vsa5+Vsv+Vsv1+Vsv2+Vsv3+Vsv4+
```

## 4. Counters, loops

```
Xi = 1;
Xr = 1;
index_counter = 1;
index = 1;
ModelTime = 0;
CVS_counter = 1;

SamplingInterval_CVS = 0.1;         % Real-time interval in RespCalcs miliseconds
TimeInMs = 60000;                   % for convertin minutes into miliseconds
h3 = (SamplingInterval_CVS/TimeInMs); % h1 is in minute and used in CVSmodelling.m
h2 = 60.*h3;
```