Reproducing the vesicle recycling model from Sara et al 2005

This notebook implements the differential equations for the model of spontaneous synaptic vesicle recycling. The model is based on single pool with four states and in the article fitted against experimental observation with tagged/dyed vesicles.

The original description can be found at **Sara et al 2005. An Isolated Pool of Vesicles Recycles at Rest and Drives Spontaneous Neurotransmission. Neuron 45/4**: Figure 5 and Experimental Procedures ("Modeling Spontaneous Synaptic Vesicle Recycling").

```
PlotlyBackend()
```

The model as in the article describes a single pool with four states:

- s0, dye-loaded vesicles
- s1, mobilized vesicles
- s2, empty vesicles
- s3, recycled and mixed empty vesicles

with parameters

- α rate of mobilization
- β rate of recycling
- δ rate of dye loss;

Note, that Julia is one (1) indexed, the equations in the article are 0 (zero) indexed:

```
sara_spon_recycle! (generic function with 1 method)
```

Next we define the parameters and initial values for the model. Here we use given values in the model description at the Experimental procedures and Fig 5.

Note that the parameter values (p below) have contradicting values in the article text:

α (rate of mobilization) is set to 0.0008 s^{-1}. The motivation given is that this is 1 vesicle release per 120 sec. This, however, would lead to an α of 1/120 = 0.0083 (Caption text of Figure 5 in the article). Also the updated release rate (for 8mM of extracellular Ca) - 1 vesicle every 60 sec (0.0166) - does not correspond to the given value of 0.0016

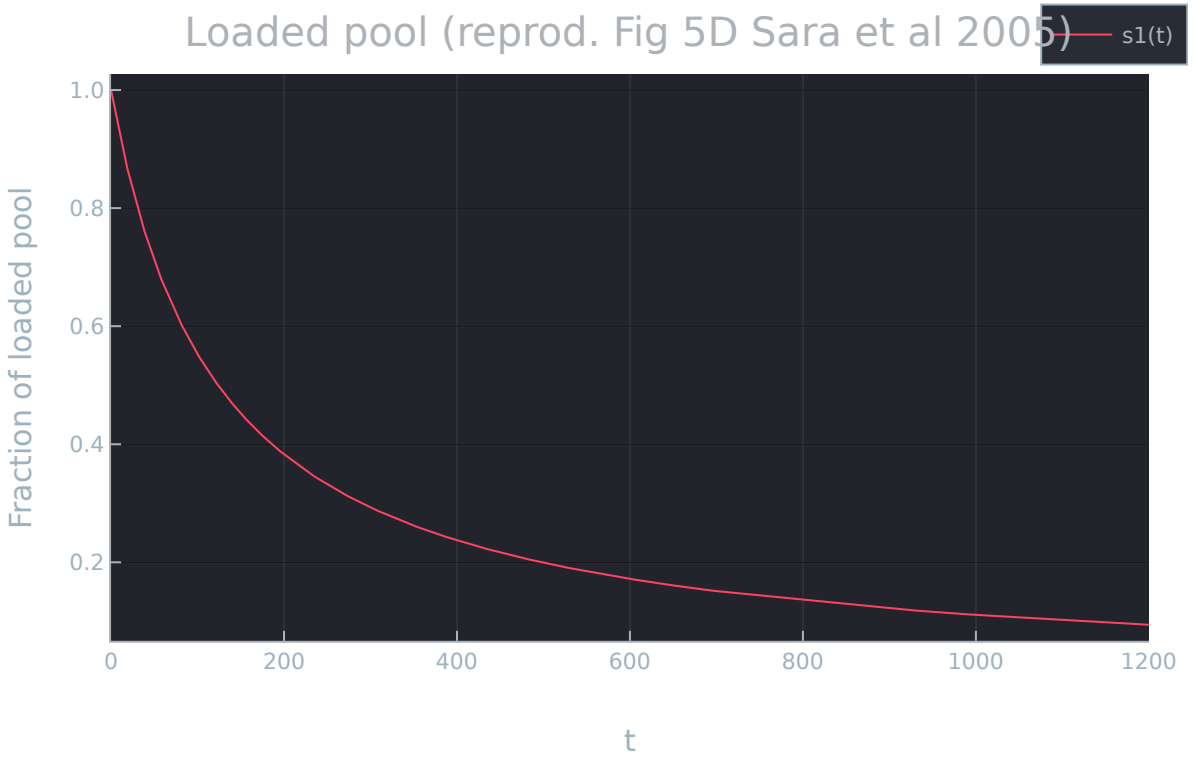
set α (rate of mobilization) to 0.008

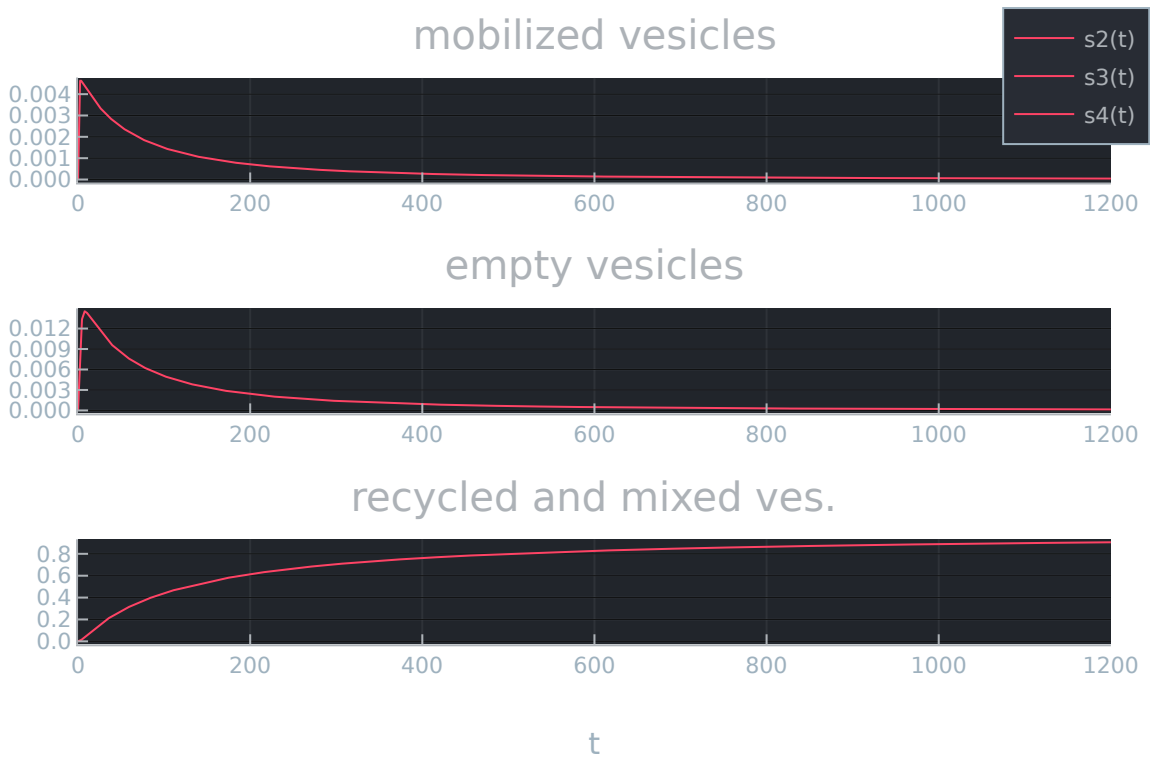
set β (rate of recycling) to 0.5

set δ (rate of dye loss) to 1.67

```
(α = 0.008, β = 0.5, δ = 1.67)
```

Next we setup the ODE solver and solve with the given parameters




mobilized vesicles
s2(t)
s3(t)
s4(t)
0.004
0.003
0.002
0.001
0.000
0
200
400
600
800
1000
1200
empty vesicles
0.012
0.009
0.006
0.003
0.000
0
200
400
600
800
1000
1200
recycled and mixed ves.
0.8
0.6
0.4
0.2
0.0
0
200
400
600
800
1000
1200
t