March 11, 2003

JCNS review raised the question that the serial resistivity is too high, and the Eleak for soma is also too negative.

1. Serial conductance (original design as in Multi5.txt)

Axon conpartment: diameter 5 um, length 50 um.

```
        M = length/Area
          = 50 um /(PI * 2.5 um * 2.5 um)
          = 8e4 / (PI cm)
          = 2.55e4 / cm
```

Let Ri = 100 Ocm, M = 2.5e4 / cm, then

```
        R = Ri * M = 100 * 2.5e4 = 2.5e6 O
        G = 1/ R = 0.4e-6 S = 0.4 uS
```

In the simulation, we use G = 0.02 uS, the equivalent Ri is

```
        Ri = R/M
           = 1 / (G * M)
           = 1 / (0.02e-6 * 2.5e4)
           = 2e3 Ocm
```

This is a little bit high but it is not too bad.

Now let Ri = 2 kOcm, between axon compartments,

```
        G = 1 / (Ri * M) = 1 / (2000 * 8e4/PI) = 1.96e-8 S
          .= 0.02 uS

soma:
        d = 20 um, l = 45 um
        M = 45 um / (PI * 10 um * 10 um) = 4.5e3/(PI cm)
        G = 1 / (Ri * M) = 1 /(2000 * 4.5e3/PI) = 3.49e-7 S
          .= 0.35 uS

microville:
        d = 20 um, l = 20 um
        M = 20 um / (PI * 10 um * 10 um) = 2000/(PI cm)
        G = 1 / (Ri * M) = 1 /(2000 * 2000/PI) = 7.85e-7 S
          .= 0.78 uS
terminal:
        d = 10 um, l = 30 um
        M = 30 um / (PI * 5 um * 5 um) = 1.2e4/(PI cm)
        G = 1 / (Ri * M) = 1 /(2000 * 1.2e4/PI) = 1.309e-7 S
          .= 0.13 uS

mv2soma         2 / (1/0.78 + 1/0.35) = 0.483 uS
soma2axona      2 / (1/0.35 + 1/0.02) = 0.0378 uS
axon                    0.02 uS
axonc2term      2 / (1/0.02 + 1/0.13) = 0.0347 uS
```

2. Values used in original paper submitted to JCNS

```
        microvillus-soma:       0.483 uS
        soma-axon A:            0.0378 uS
        axon A-axon B:          0.03 uS
        axon B-axon C:          0.03 uS
        axon C-terminal:        0.0347 uS
```

So the values for axon was increased from 0.02 uS to 0.03 uS, which corresponds to ~1.3 kOcm

3. New values using 1.3 kOcm

```
        microvillus-soma:       0.725 uS
        soma-axon A:            0.0567 uS
        axon A-axon B:          0.03 uS
        axon B-axon C:          0.03 uS
        axon C-terminal:        0.052 uS
```

4. Change soma Eleak from -98 to -78 mV

Now w2d-jcnsr1, use snnap80a2.jar, which have initial conditions for [Ca], so the Ca.ion files need to be changed to add IV.

Results

1. V5.2d and V8.0a2 show slight difference

parameter file: w2d, copied to w2d-jcnsr1
A1-A3: difference is at the end of "light stimulus". V7.0 and V8.0a2 behave similarly.

2. Change Eleak from -98 to -78 mV

B1: spike rate increases in both SR portion and stimulated portion.
    spikes are also wider.

3. Now use new conductance values

B2: spike rate still high and spike is wide.
B2a: change Eleak back to -98 mV. No SR, but stimulated portion seems normal.

4. Change gleak with soma Eleak -78 mV

B3: gleak axon A 4.5e-4, close to normal, still higher stimulated rate
B4: xa gleak 4e-4, soma gleak 2.25e-4, SR 1.1 Hz, slightly higher stimulated rate

B5: soma leak 2.75e-4, -78 mV
    xa leak, 4e-4, -78 mV
    ca.A tmin 0.03
    soma cat 1.75e-3 --> 1.5e-3, same as the rest
  SR > 1 Hz, simulated OK, but recovery not good (due to IKca ?). when soma Ikca changed from 0.0004 to 0.00036, two spikes at the end, a sign of faster recovery.

B6: soma/mv leak 2.5e-4, -78 mV
    xa leak, 4.5e-4, -78 mV
    xb, xc, term leak 2e-4, -78 mV

```
    ca.A tmin 0.0225, tmax 0.6
    soma cat 1.75e-3 --> 1.5e-3, same as the rest
    SR higher (~1.35 Hz), stimulated rate OK
B6a: Dr.B tmax/tmin changed from 0.5/0.15 to 1.0/0.3, only slight decrease in
  SR; change Dr from 0.12 to 0.15 also kills SR
B6b: as B6a, Dr changed from 0.12 to 0.13 S/cm2, SR 1.25 HZ

B7: soma/mv leak 2.5e-4, -78 mV
    xa leak, 4.5e-4, -78 mV
    xb, xc, term leak 2e-4, -78 mV
    ca.A tmin 0.02, tmax 0.6
    soma cat 1.75e-3 --> 1.5e-3, same as the rest
    Dr.B tmax/tmin kept as before (0.5/0.15), but gK,V changed from 0.12
        to 0.14 in all compartments
    (use IV for Ca.ion, 18/14/8 for soma/term/axon) no, to keep up with paper
    At this condition, the spike does not recover after stimulation, then
        changed cat.B h from -40 mV to -39.5 mV, allow more time for ICa,T to
        develop, and SR recovered after "stimulation" (but SR too fast!)

   cat.B h 40 --> 39.25 (data 37.4)
   cat.A s 12 --> 11.5 (data 8.9)

Save this parameter set as s1
```