LECTURE 2

A. Identifying Swimmy neurons

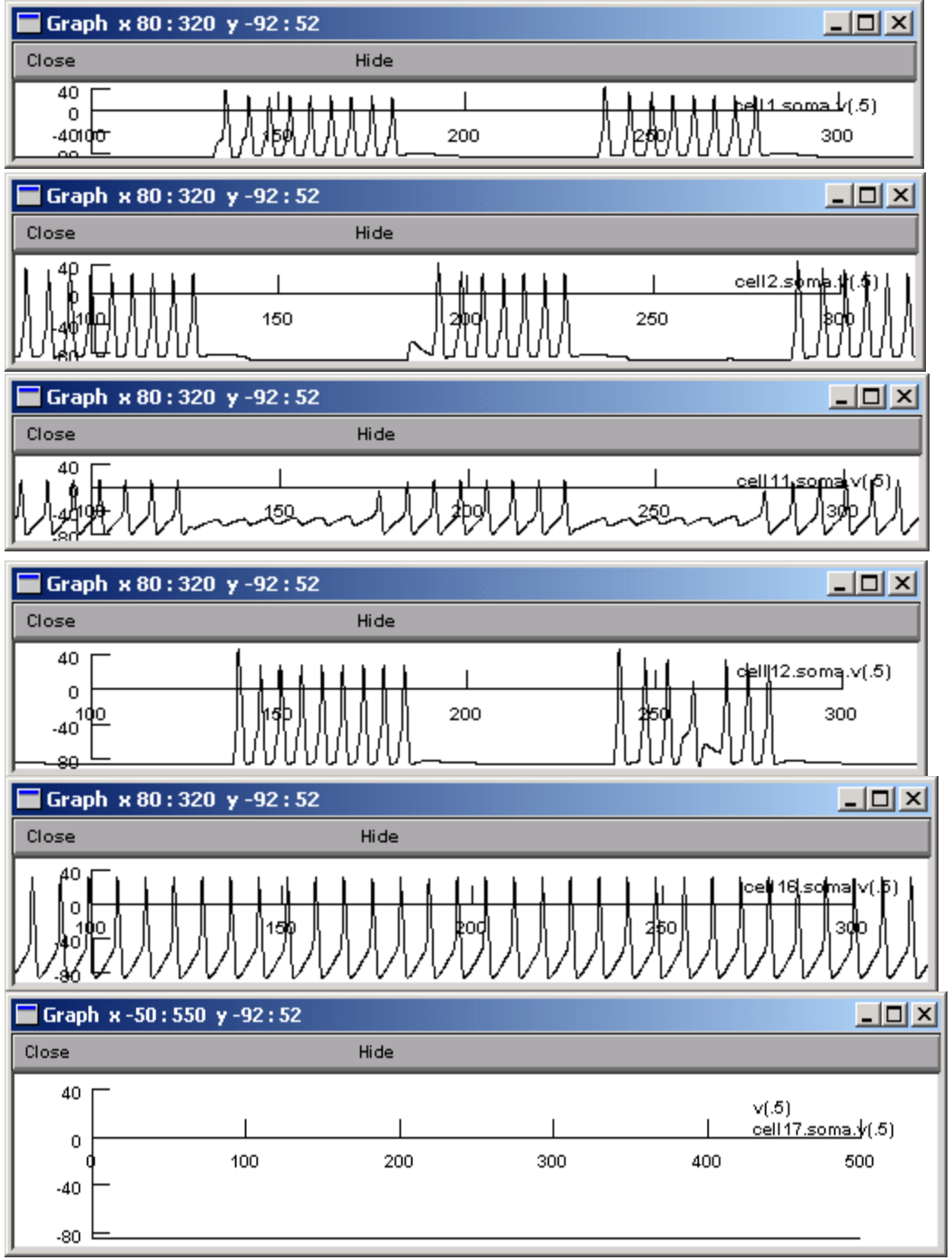
B. Finding E and I inputs to cells 1 and 2

C. Reason correlation and synaptic delay not enough to prove direct connection

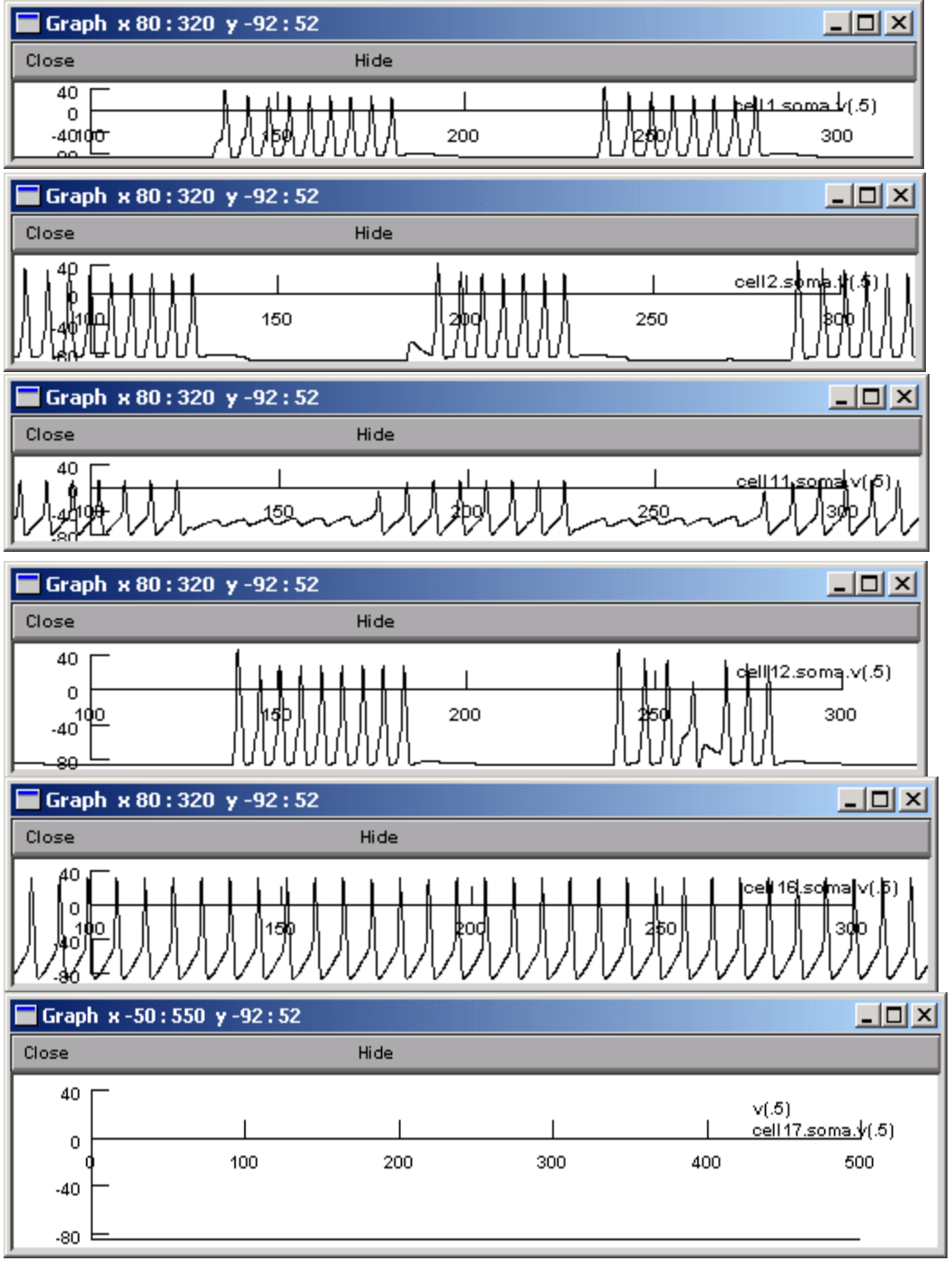
D. Underlying mechanism behind oscillations—possibilities

E. Quiz answers.

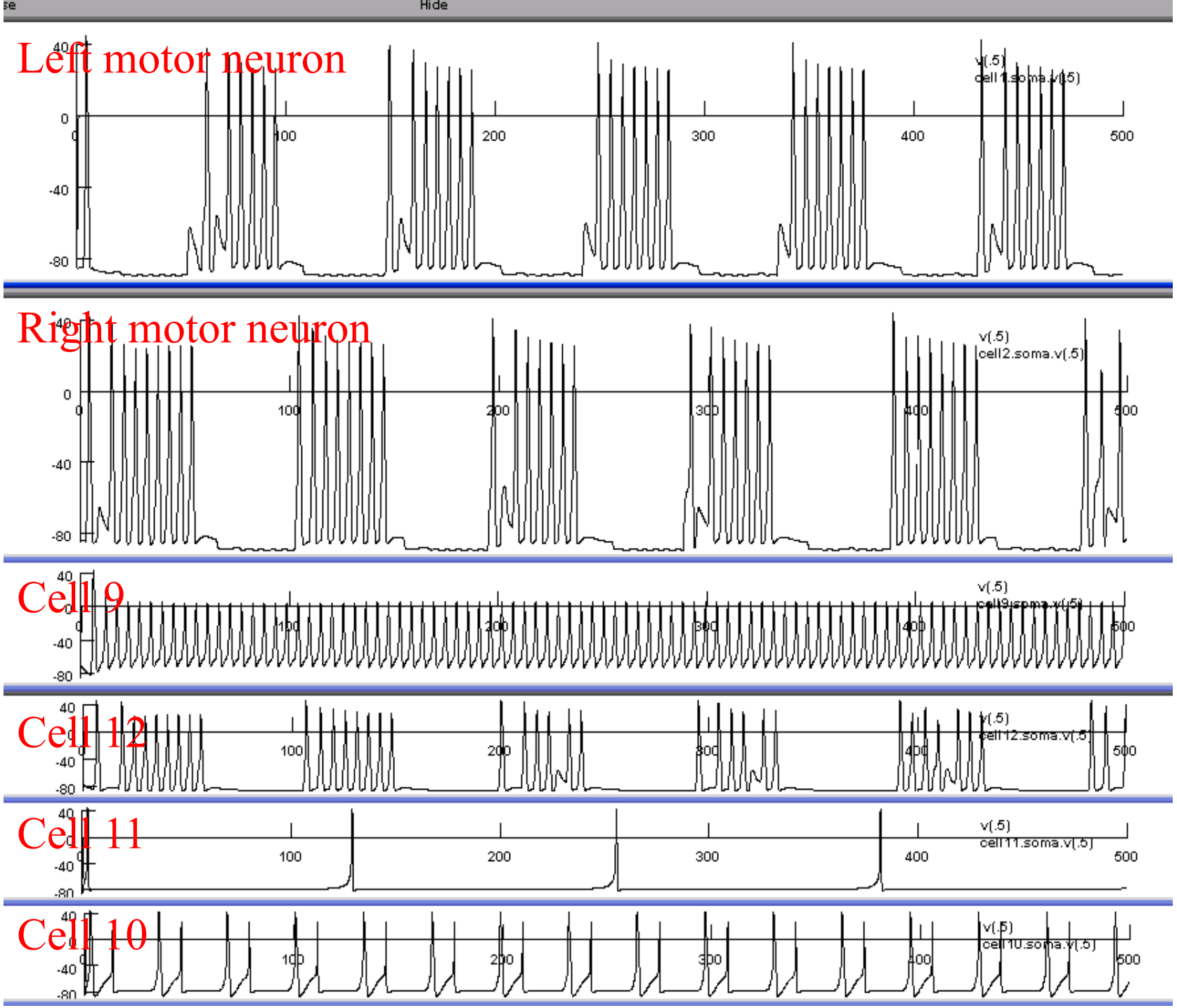
F. Underlying mechanism behind oscillations—finding generators and followers as a 1st step.



Some of Swimmy's neurons participate in the swimming behavior but some do not.



Neurons that show a similar rhythmic pattern as the motor neurons are good candidates.


Hide
Left motor neuron
v(.5)
cell1.soma.v(.5)
Right motor neuron
v(.5)
cell2.soma.v(.5)
Cell 9
v(.5)
cell9.soma.v(.5)
Cell 12
v(.5)
cell12.soma.v(.5)
Cell 11
v(.5)
cell11.soma.v(.5)
Cell 10
v(.5)
cell10.soma.v(.5)
40
0
-40
-80
0
100
200
300
400
500

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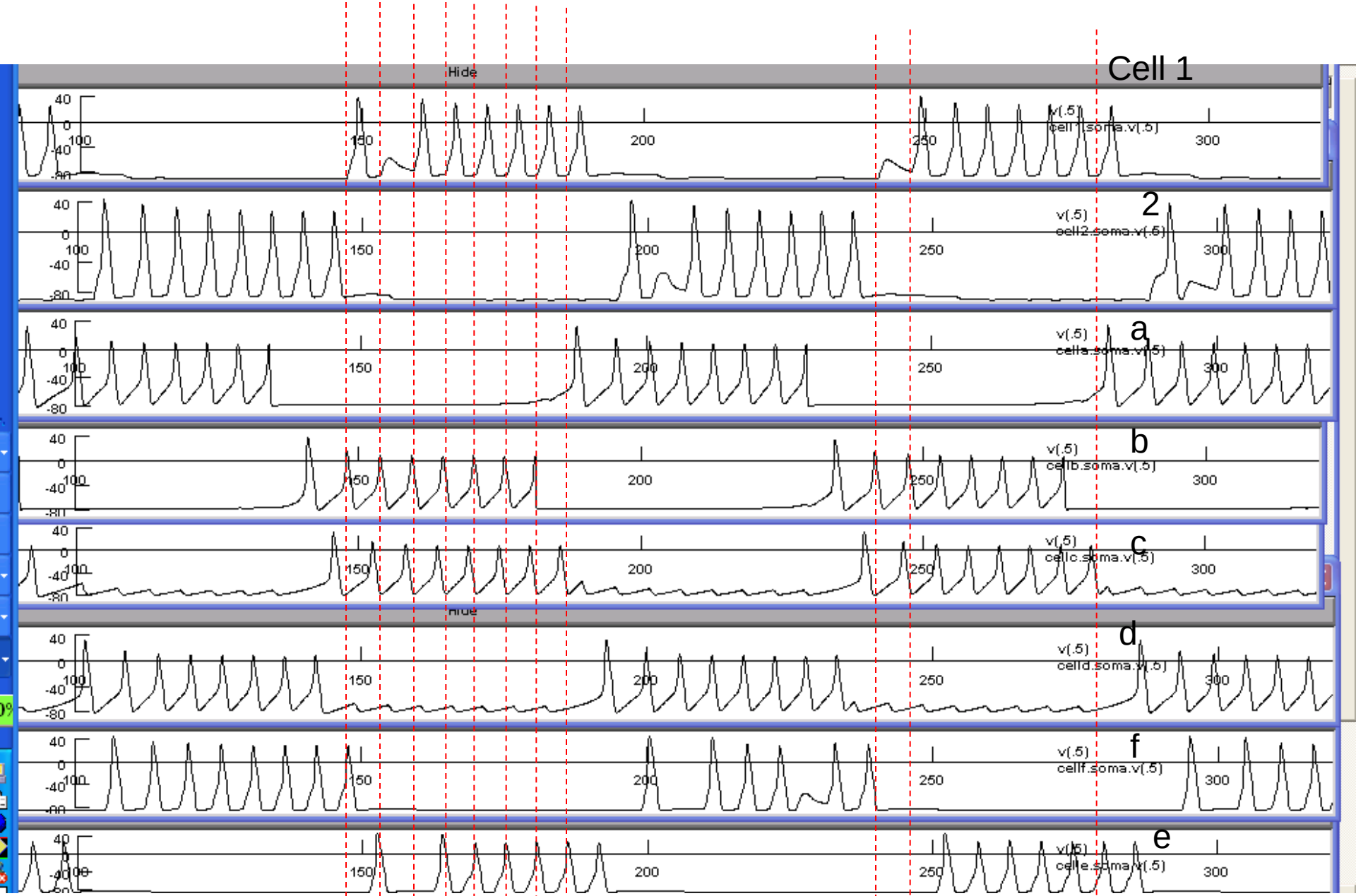
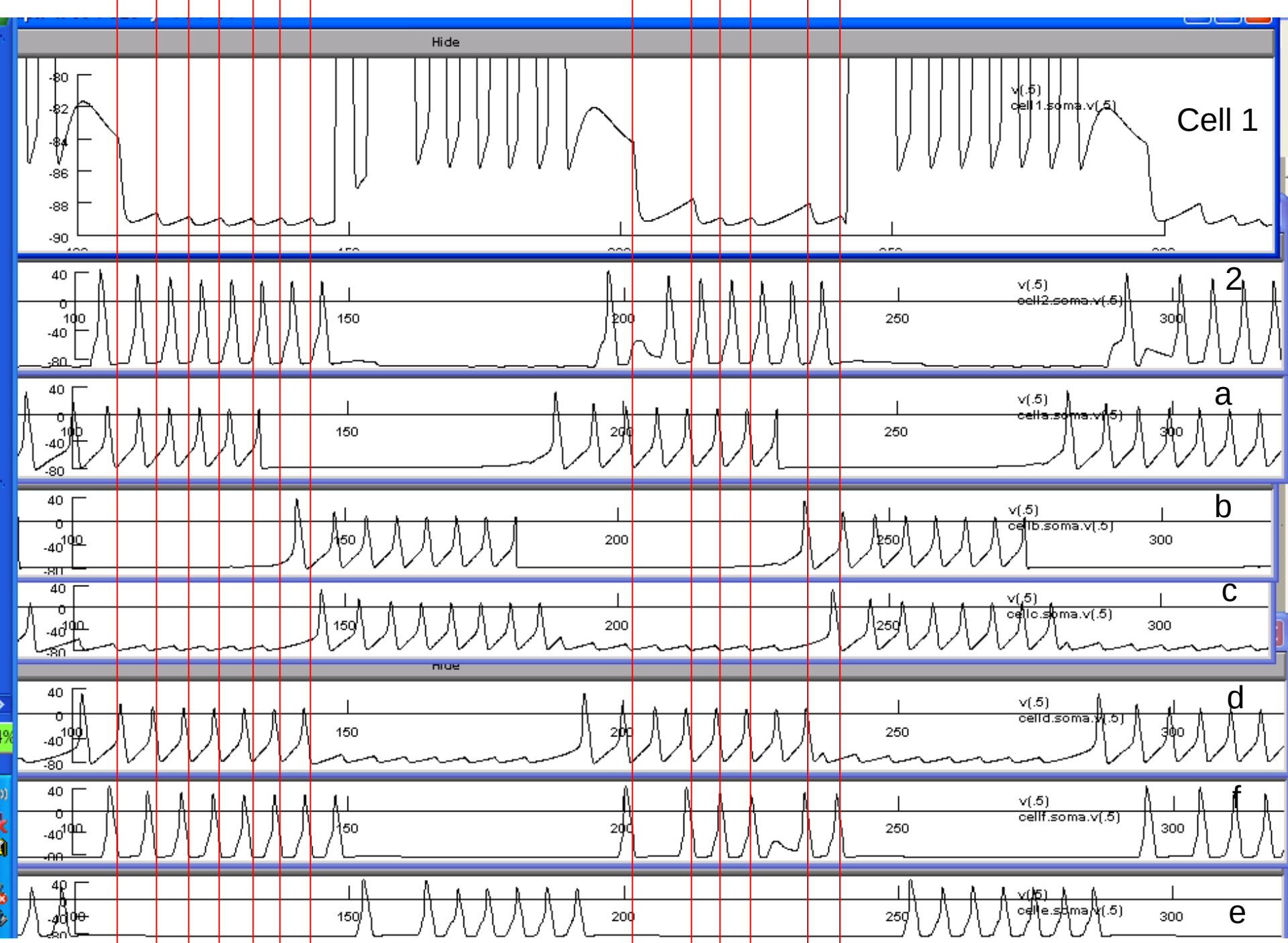
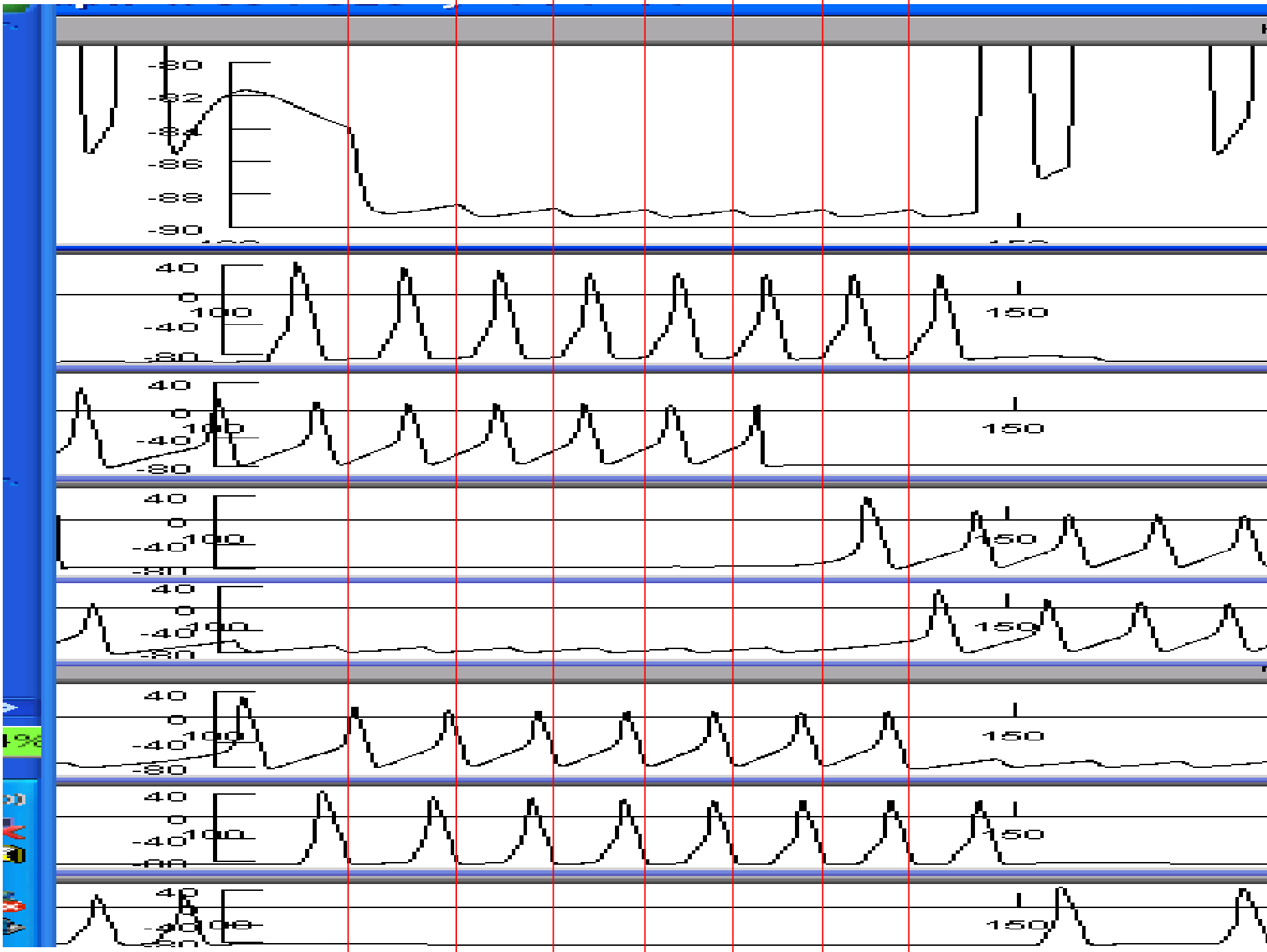
Finding excitor of cell 1




Hide
Cell 1
v(.5)
cell1.soma.v(.5)
2
v(.5)
cell2.soma.v(.5)
a
v(.5)
cella.soma.v(.5)
b
v(.5)
cellb.soma.v(.5)
c
v(.5)
cellc.soma.v(.5)
Hide
d
v(.5)
celld.soma.v(.5)
f
v(.5)
cellf.soma.v(.5)
e
v(.5)
celle.soma.v(.5)


-80
-82
-84
-86
-88
-90
40
0
-40
-80
100
150

LECTURE 2

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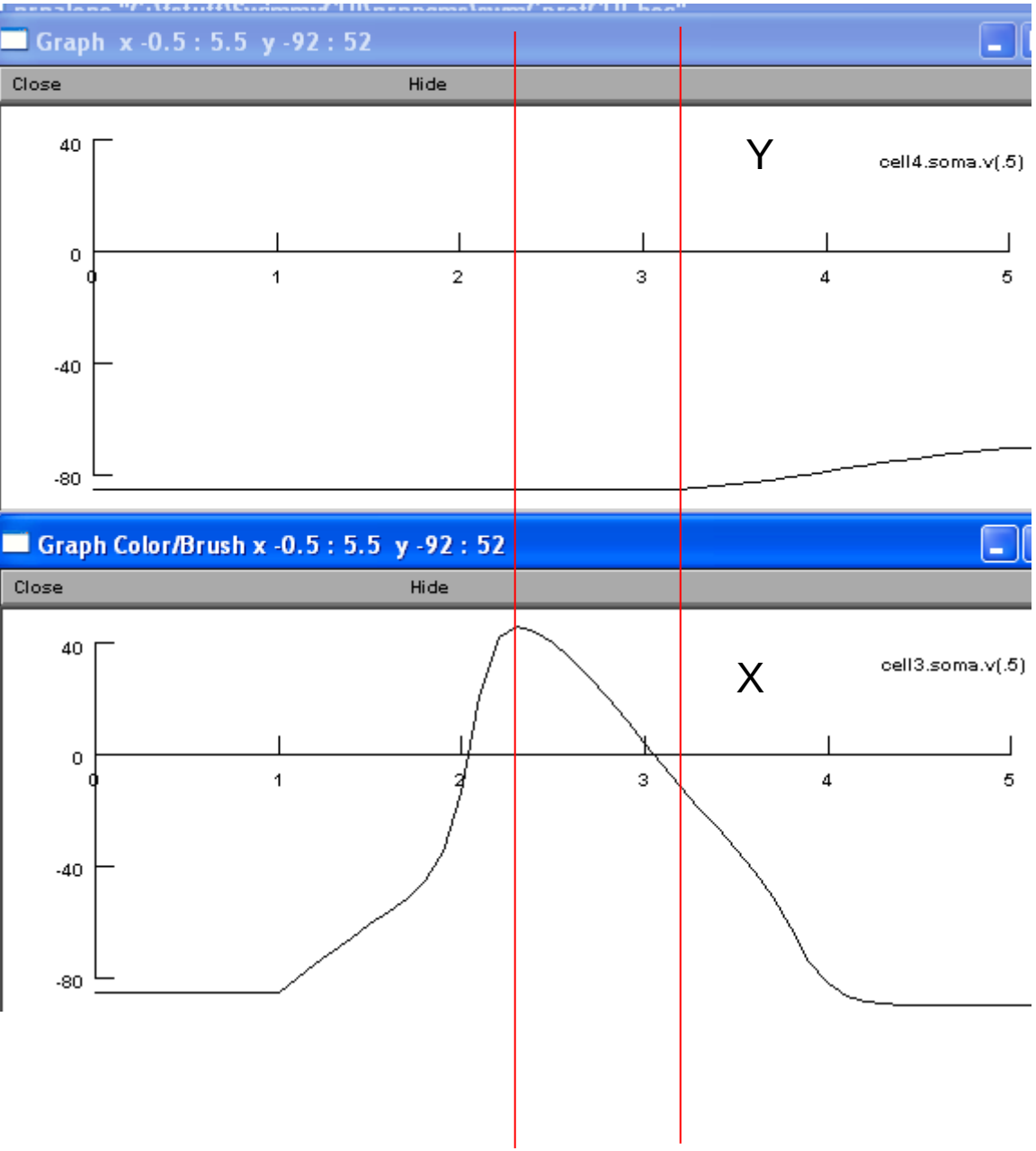
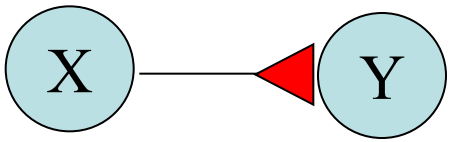
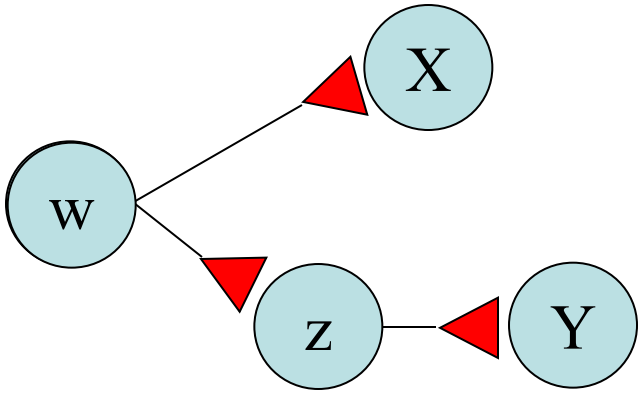
Spontaneous activity





OR



?

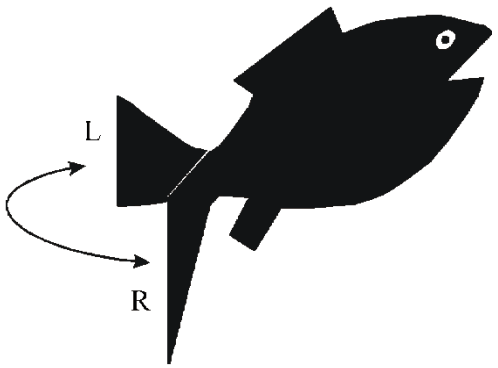
Lab 2 Objectives

(1) Determine what the circuit is: find all the cells that belong in the circuit.

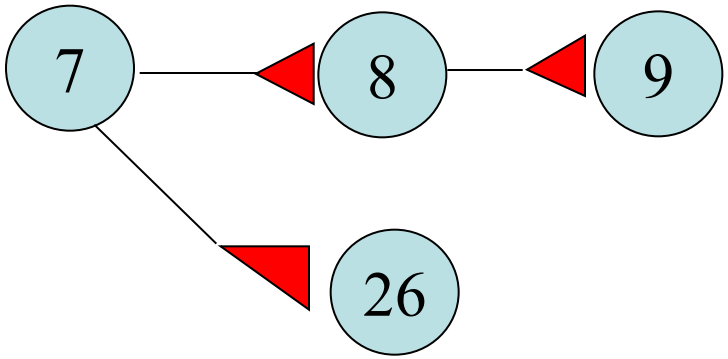
(2) Prove how they are connected.

(3) Determine how the circuit functions: find out how the circuit functions by determining the nature of the cells.

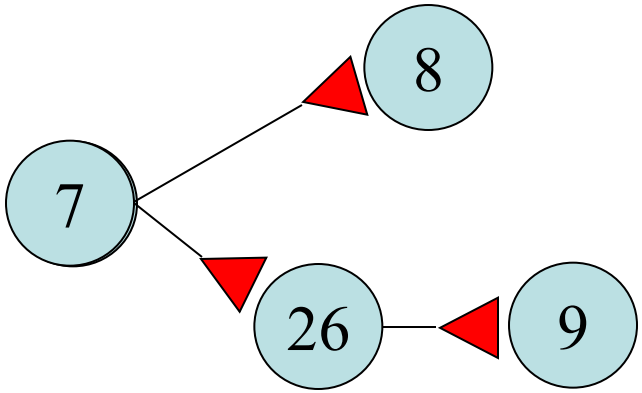
Swimmy

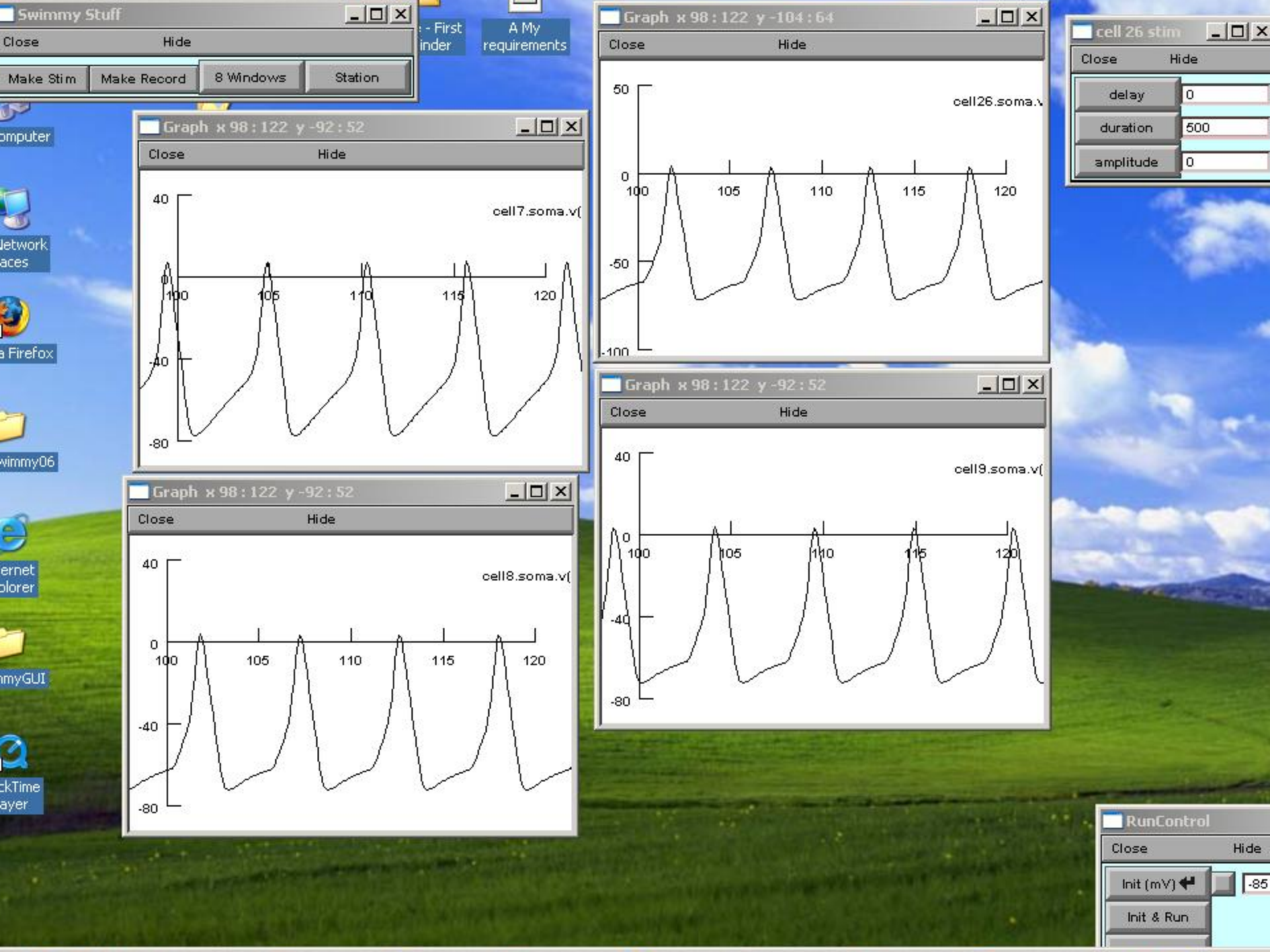


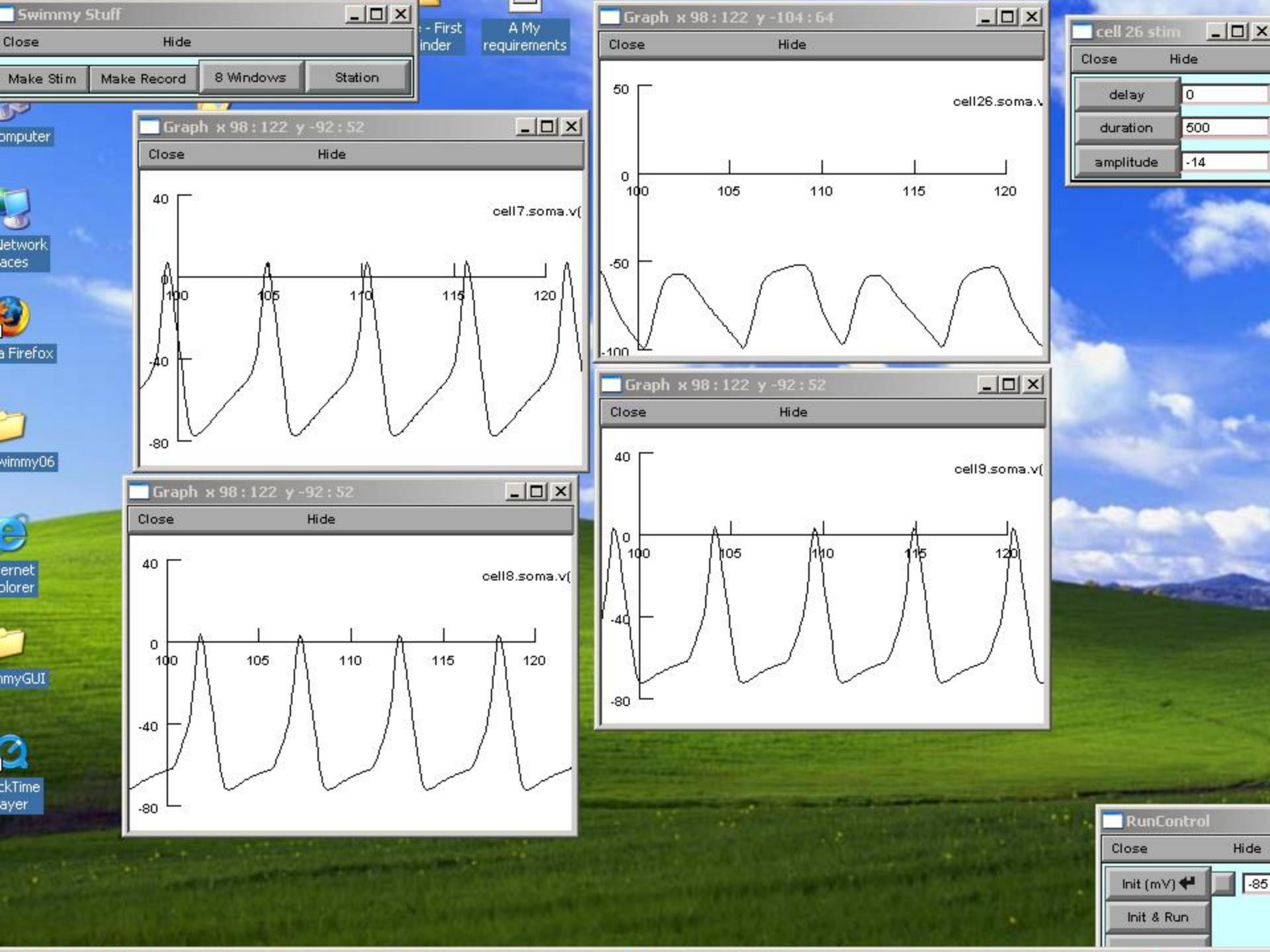
How do you determine the interconnections among neurons?

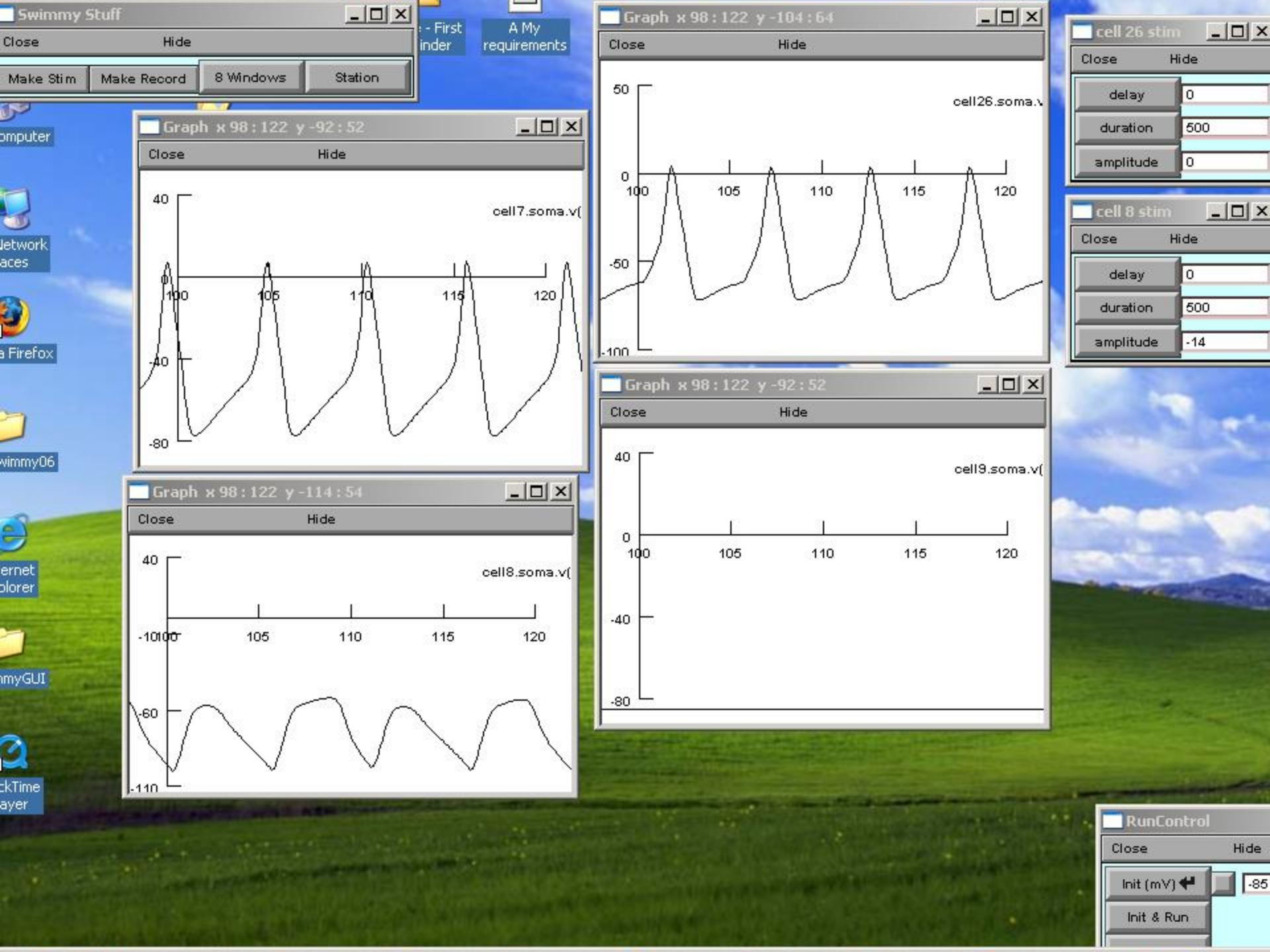


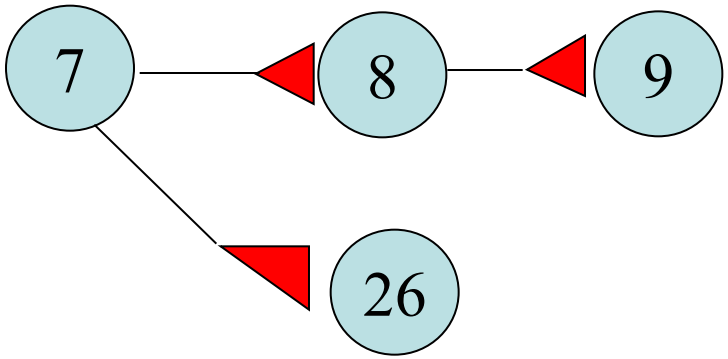
OR




Swimmy Stuff
Close
Hide
Make Stim
Make Record
8 Windows
Station
A My requirements
Graph x 98 : 122 y -92 : 52
Close
Hide
cell7.soma.v(
40
0
-40
-80
100
105
110
115
120
Graph x 98 : 122 y -104 : 64
cell26.soma.v
50
0
-50
-100
cell 26 stim
delay
0
duration
500
amplitude
0
Graph x 98 : 122 y -92 : 52
cell8.soma.v(
Graph x 98 : 122 y -92 : 52
cell9.soma.v(
RunControl
Init (mV)
-85
Init & Run


Swimmy Stuff
Close
Hide
Make Stim
Make Record
8 Windows
Station
A My requirements
Graph x 98 : 122 y -92 : 52
Close
Hide
cell7.soma.v(
40
0
-40
-80
100
105
110
115
120
Graph x 98 : 122 y -104 : 64
cell26.soma.v
50
0
-50
-100
cell 26 stim
delay
0
duration
500
amplitude
-14
Graph x 98 : 122 y -92 : 52
cell8.soma.v(
Graph x 98 : 122 y -92 : 52
cell9.soma.v(
RunControl
Init (mV)
-85
Init & Run


Swimmy Stuff
Close
Hide
Make Stim
Make Record
8 Windows
Station
A My requirements
Graph x 98 : 122 y -92 : 52
Close
Hide
cell7.soma.v(
40
0
-40
-80
100
105
110
115
120
Graph x 98 : 122 y -104 : 64
cell26.soma.v
50
0
-50
-100
Graph x 98 : 122 y -92 : 52
cell9.soma.v(
Graph x 98 : 122 y -114 : 54
cell8.soma.v(
-60
-110
cell 26 stim
delay
0
duration
500
amplitude
0
cell 8 stim
-14
RunControl
Init (mV)
-85
Init & Run



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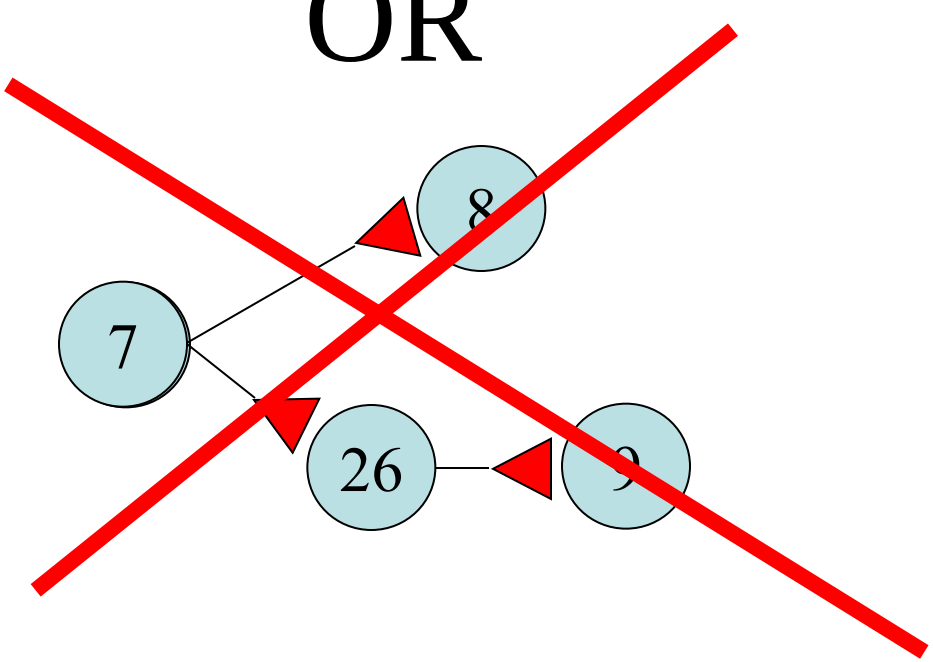
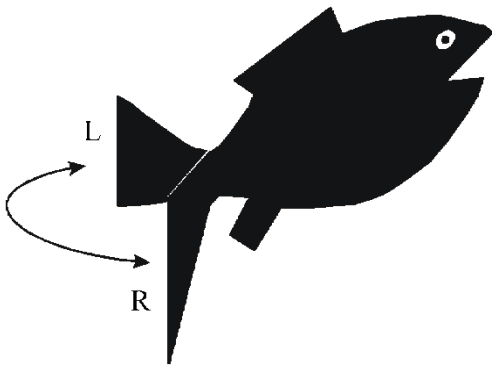
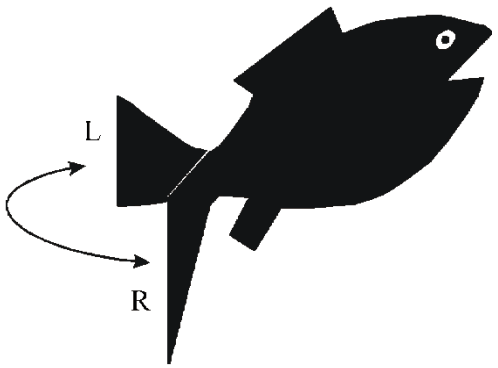


Swimmy

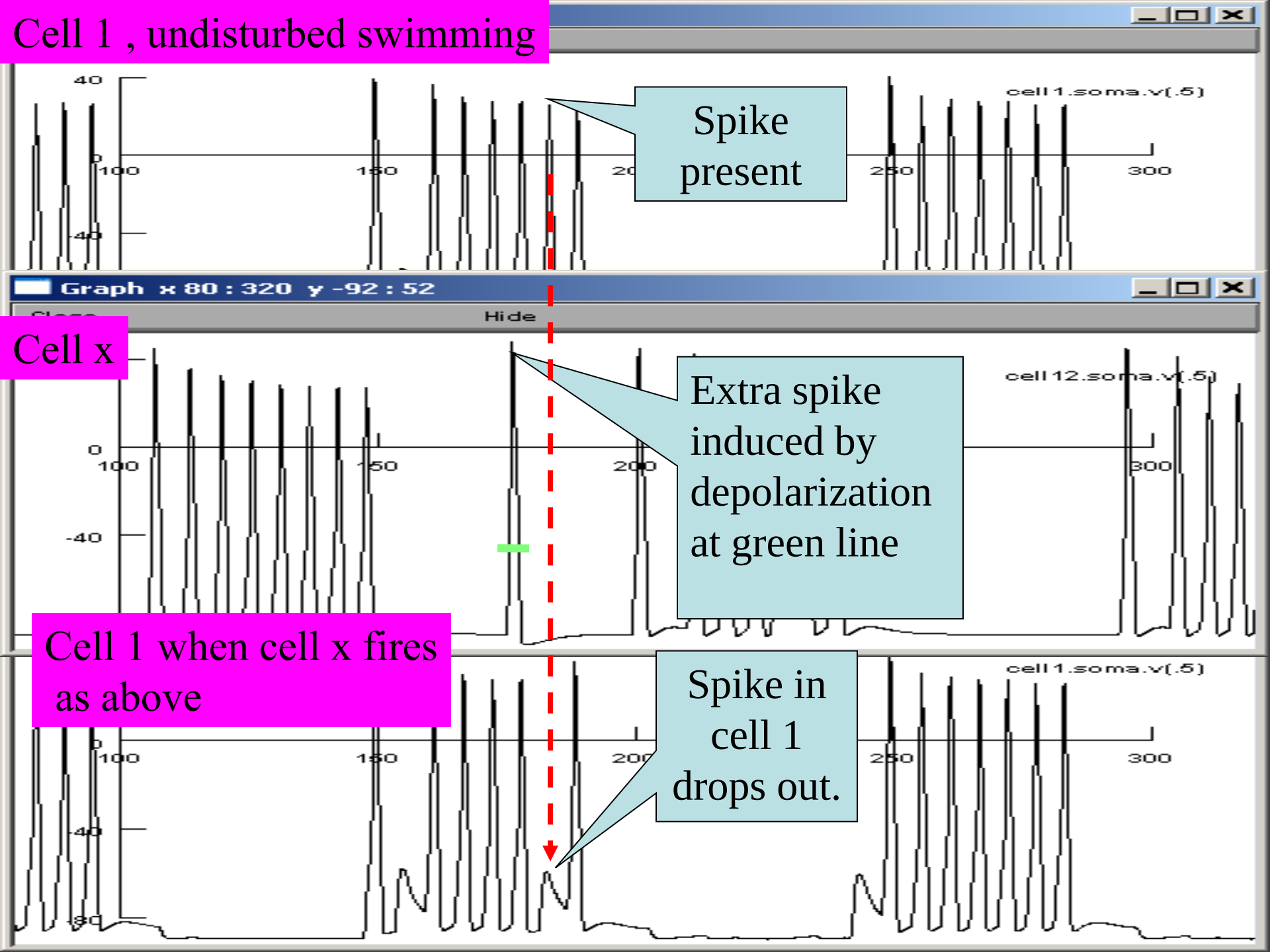


So a 1 msec delay may not absolutely ensure a monosynaptic connection. Correlation is not causation.

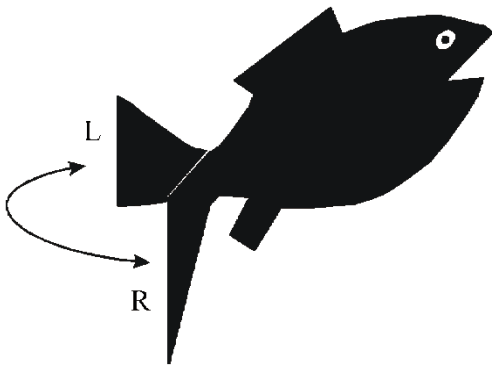
Swimmy



You can also induce action potentials where there were none and note post-synaptic changes.


Cell 1 , undisturbed swimming
Spike present
cell1.soma.v(.5)
Graph x 80 : 320 y -92 : 52
Hide
Cell x
Extra spike induced by depolarization at green line
cell12.soma.v(.5)
Cell 1 when cell x fires as above
Spike in cell 1 drops out.
cell1.soma.v(.5)

Swimmy



To establish a monosynaptic connection, you should:

1) Show a 1 msec delay between the peak of an AP and start of a PSP.

2)Show effects of presynaptic manipulation and postsynaptic results.

3) Proper controls for #2 above.

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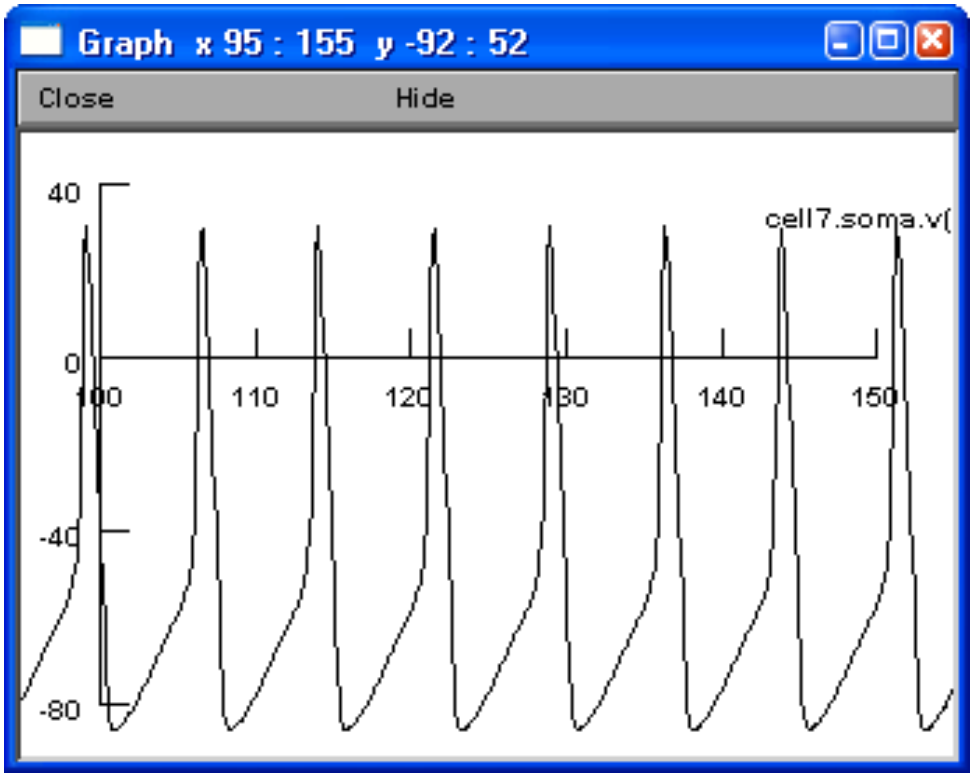
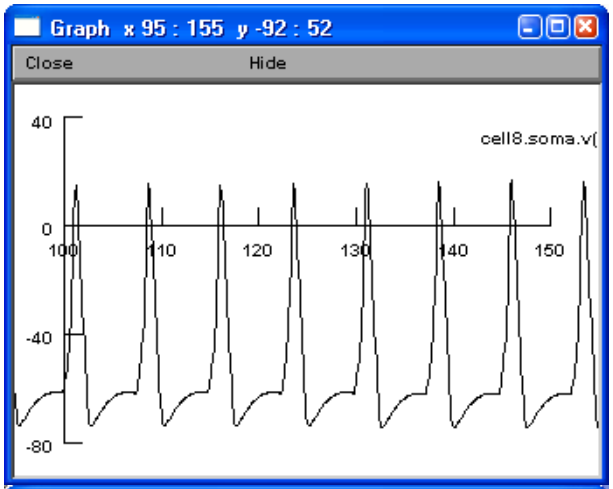
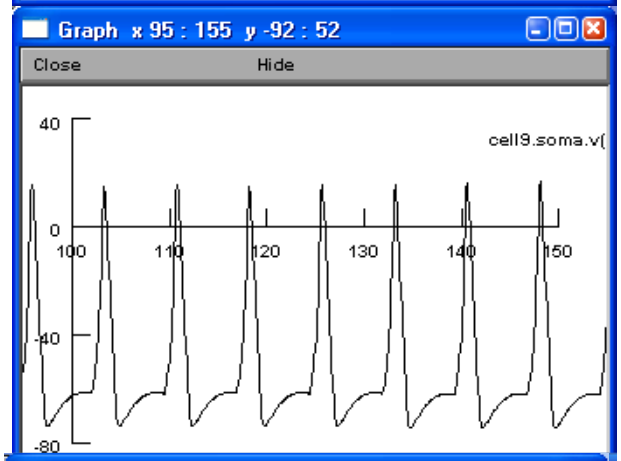
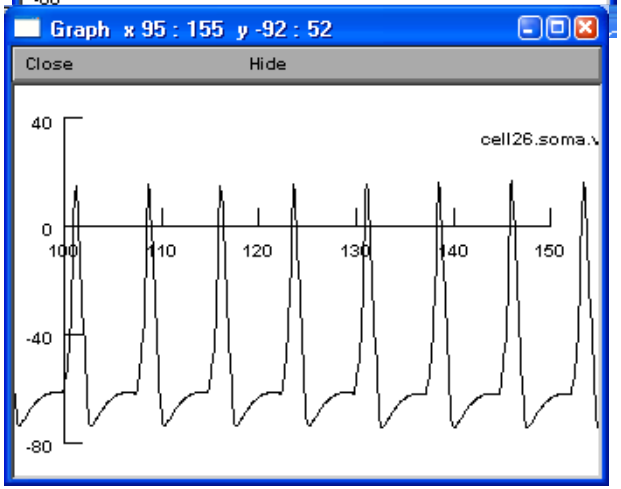
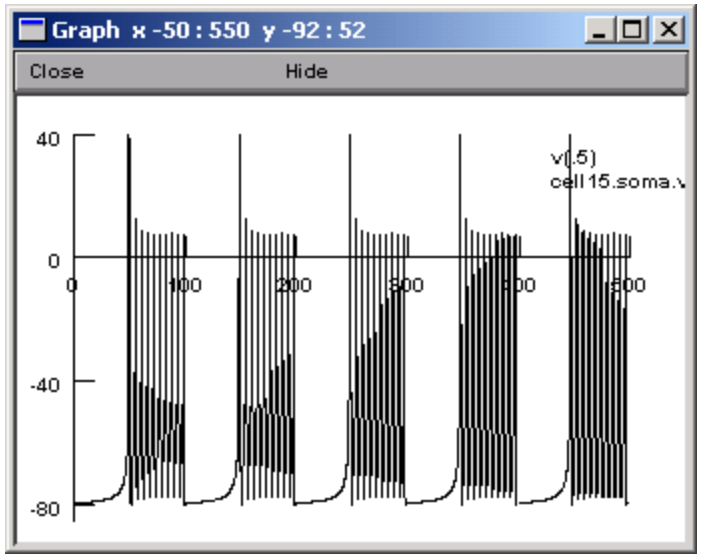


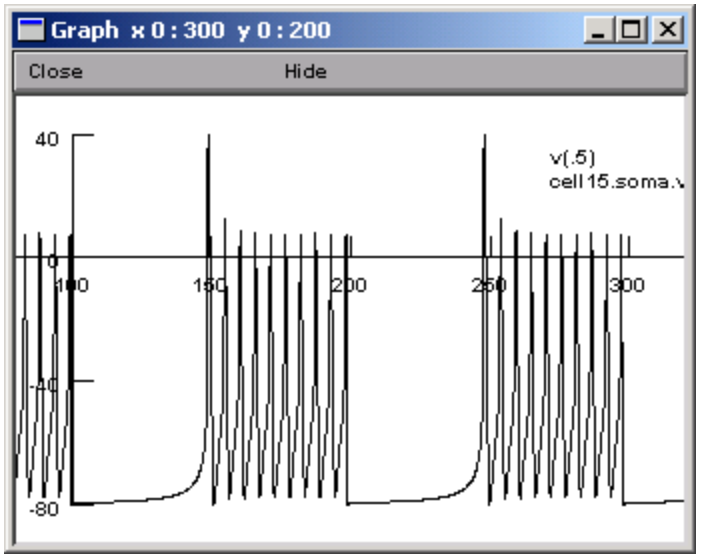
Cell 7 is endogenously tonic.
What about cells 8, 9, & 26?



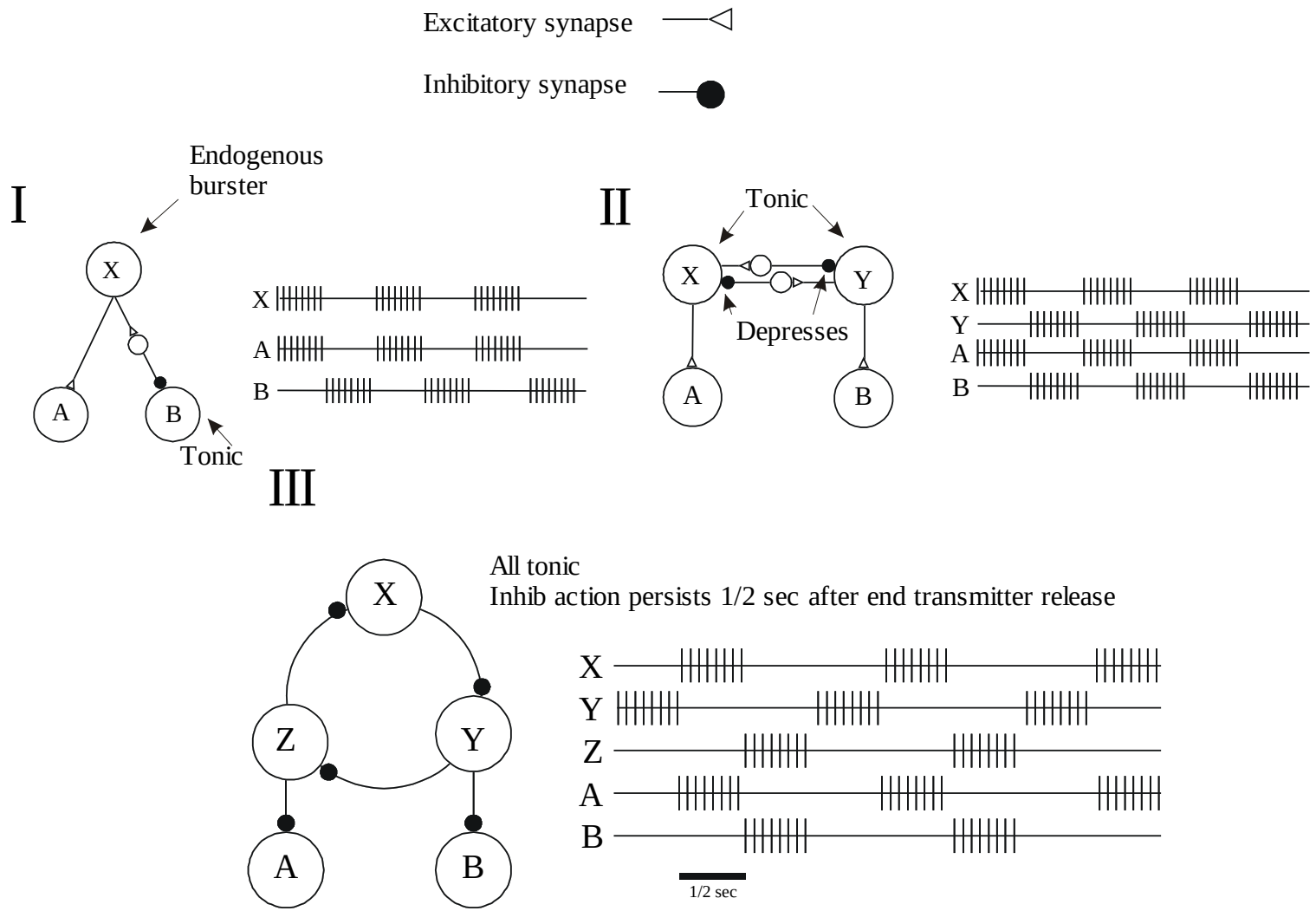




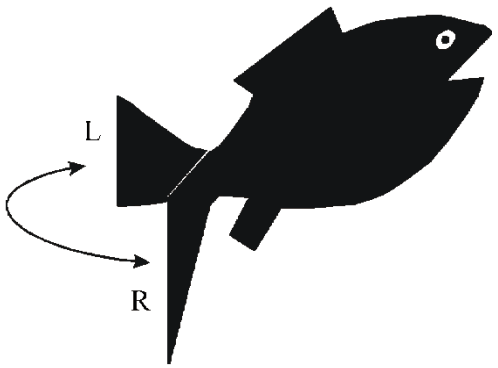




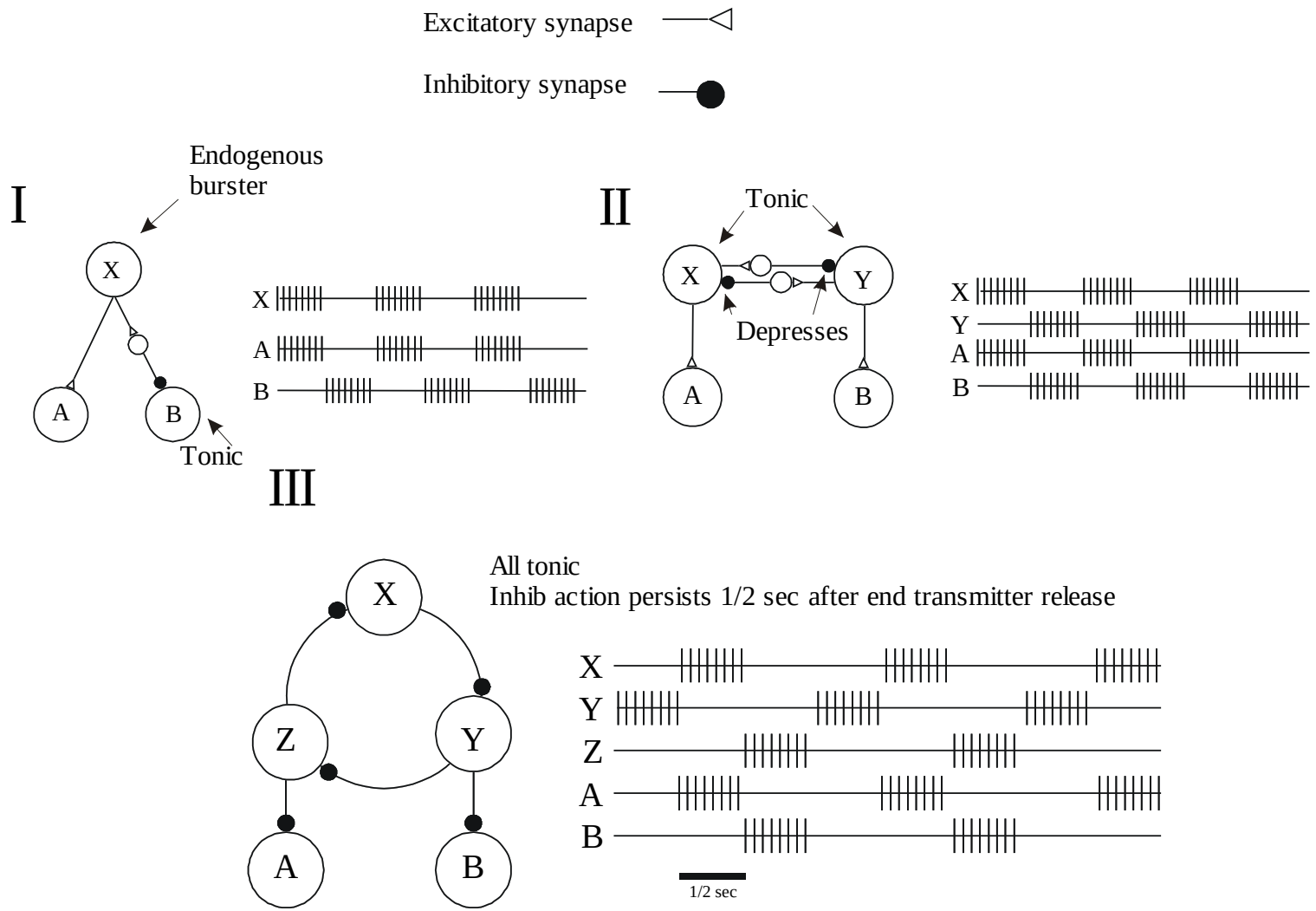
Another type of cell with intrinsic activity is a *Spontaneous burster.* This pattern of activity is not produced By other cells driving it.


Excitatory synapse
Inhibitory synapse
I
Endogenous burster
X
A
B
Tonic
X
A
B
II
Tonic
X
Y
Depresses
A
B
X
Y
A
B
III
X
Z
Y
A
B
All tonic
Inhib action persists 1/2 sec after end transmitter release
X
Y
Z
A
B
1/2 sec

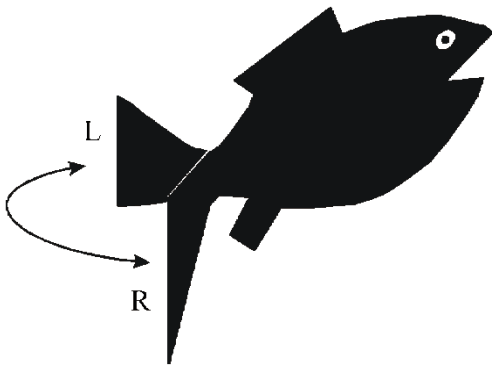
Swimmy



What is the mechanism
of oscillation?

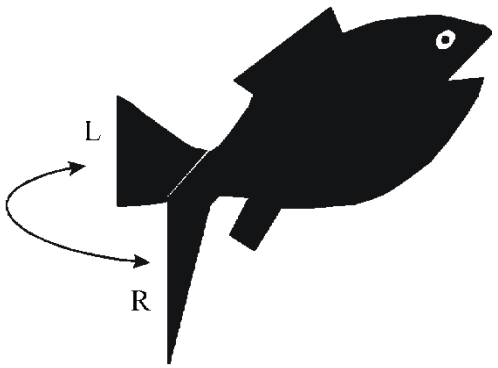

Excitatory synapse
Inhibitory synapse
I
Endogenous burster
X
A
B
Tonic
X
A
B
II
Tonic
X
Y
Depresses
A
B
X
Y
A
B
III
X
Z
Y
A
B
All tonic
Inhib action persists 1/2 sec after end transmitter release
X
Y
Z
A
B
1/2 sec

Swimmy

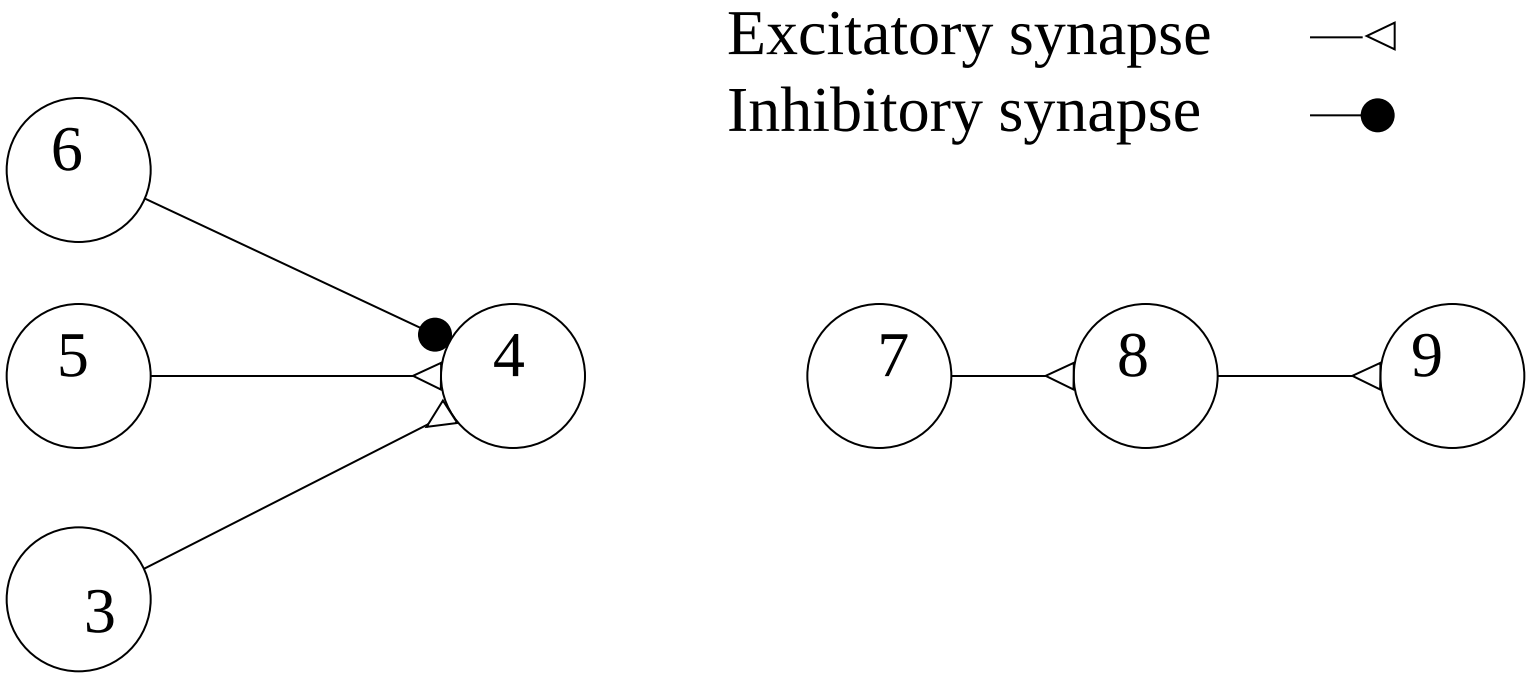


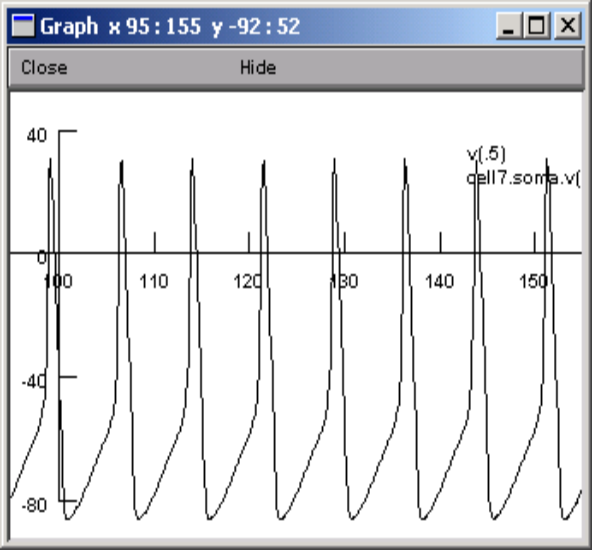
To decide what kind of oscillator is working in SWIMMY one must first identify generators of the rhythm vs followers of the rhythm.

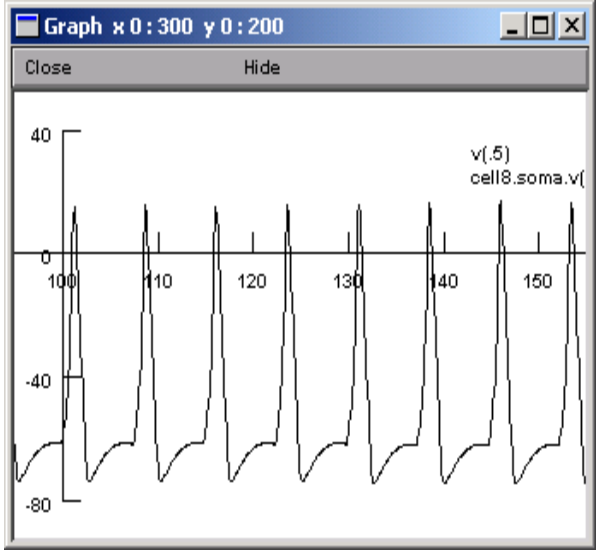
Swimmy

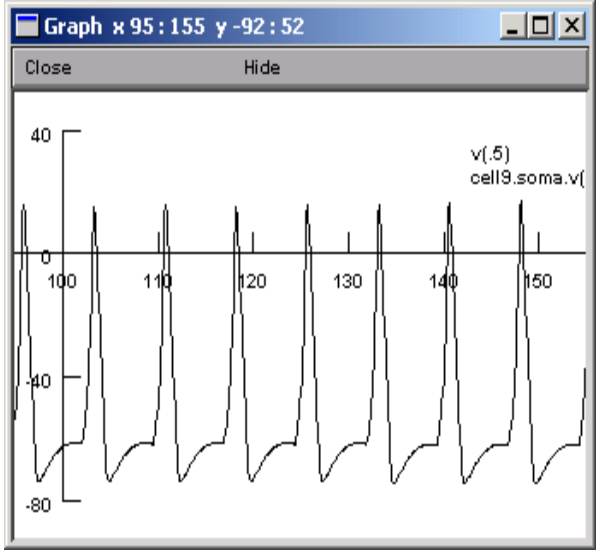


Consider cells 7, 8, & 9.
Which was the generator and were the followers of the rhythm?


Excitatory synapse
Inhibitory synapse
6
5
3
4
7
8
9



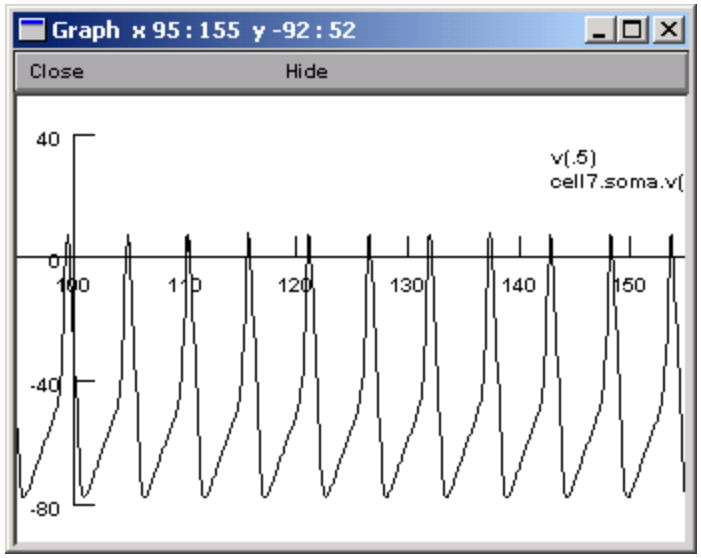


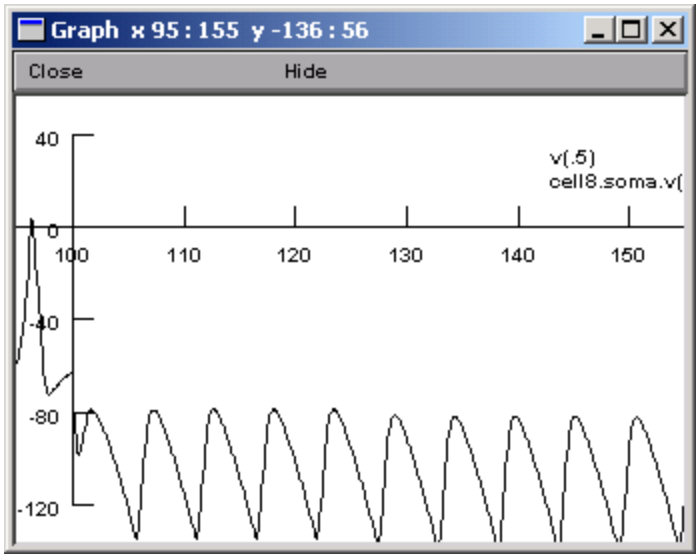


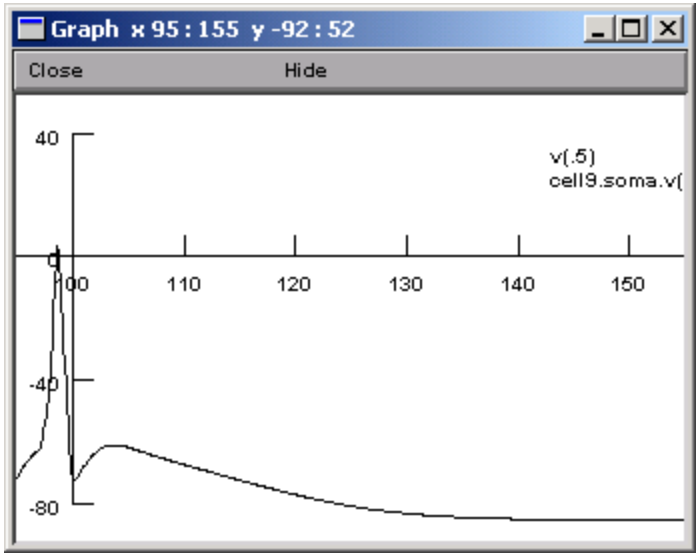
Cell 7 is tonically active.

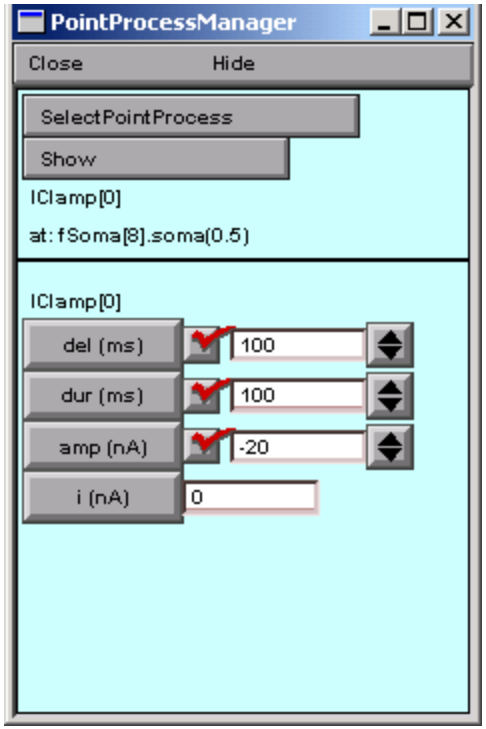
Are cells 8 & 9 tonically active?

How can you tell?

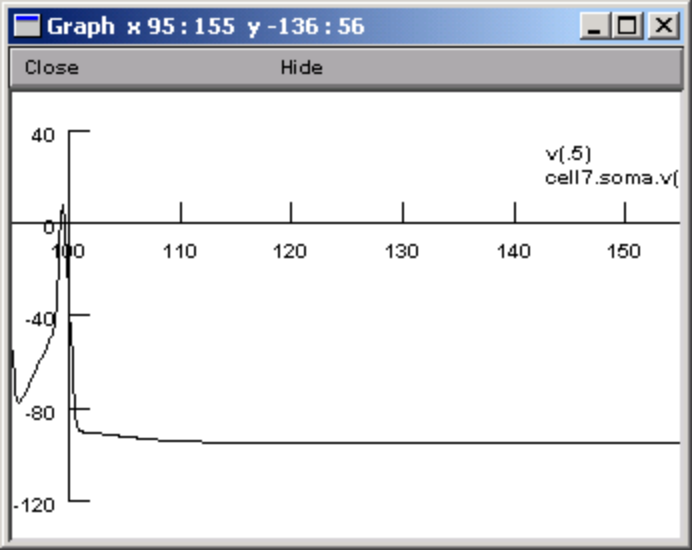


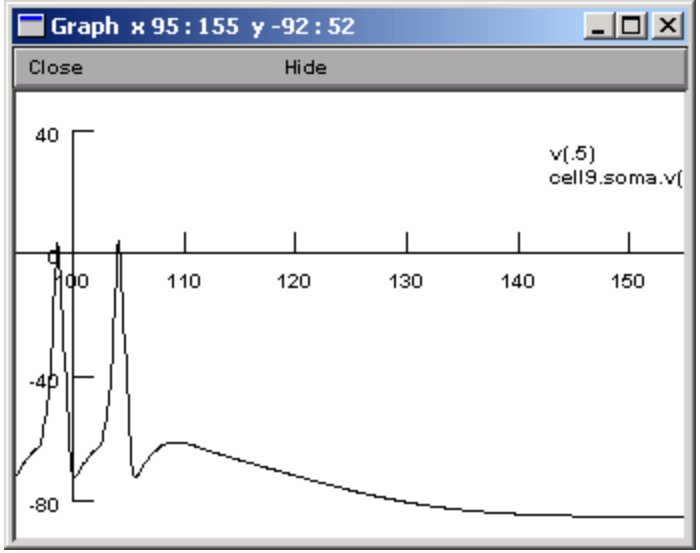


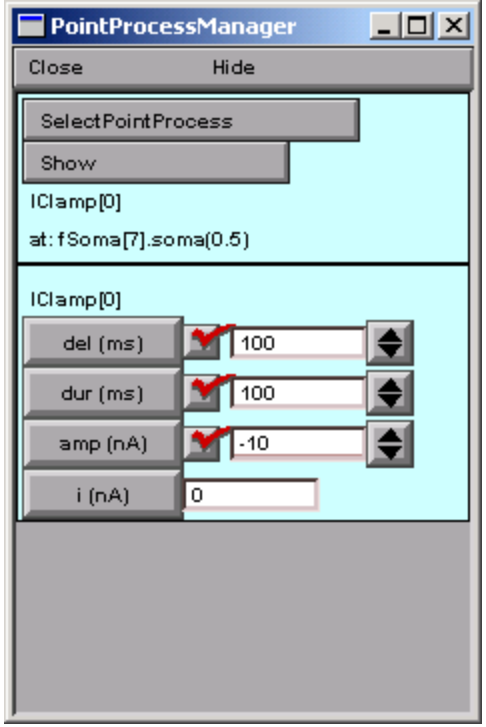


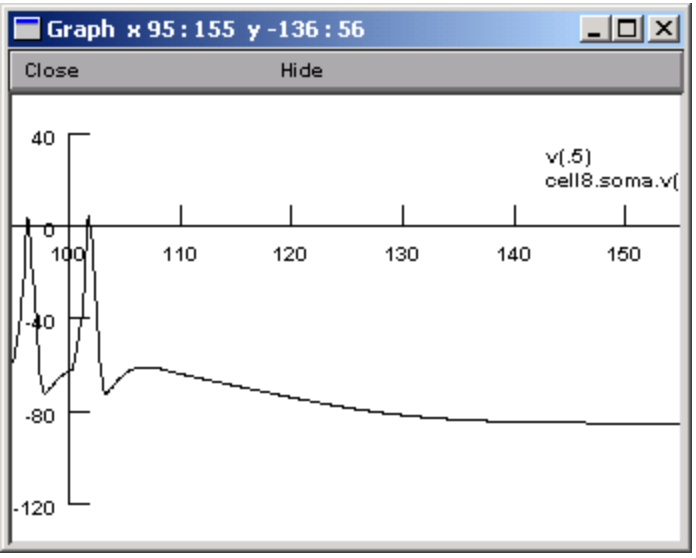


Hyperpolarizing cell 8

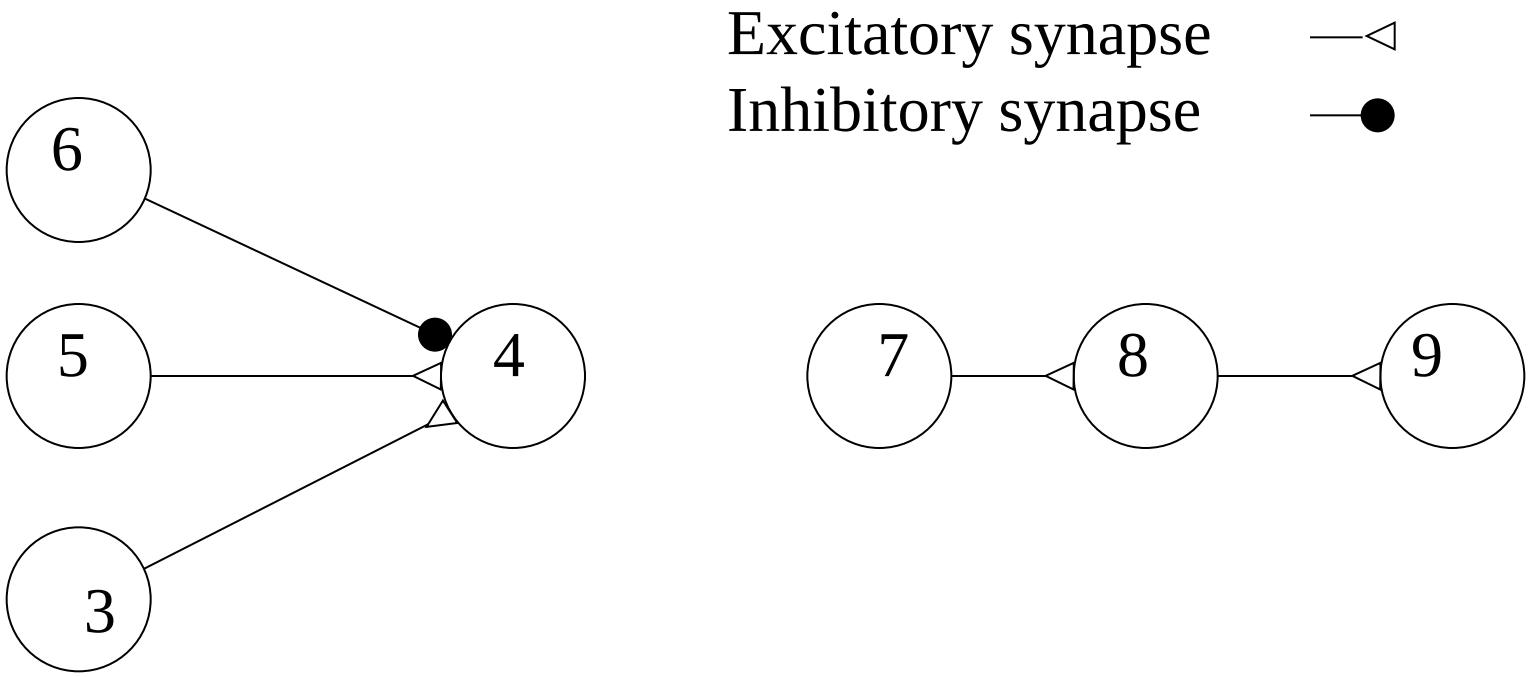




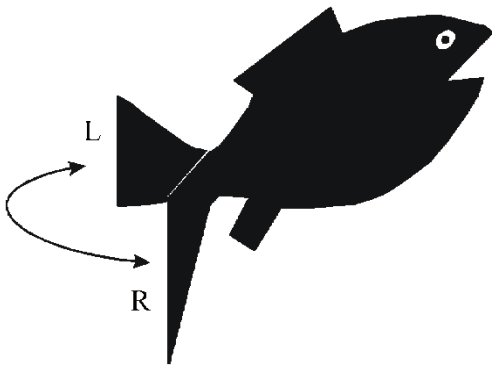




Hyperpolarizing cell 7

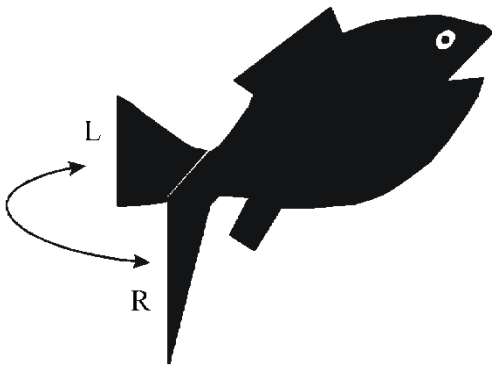

Excitatory synapse
Inhibitory synapse
6
5
3
4
7
8
9

Swimmy



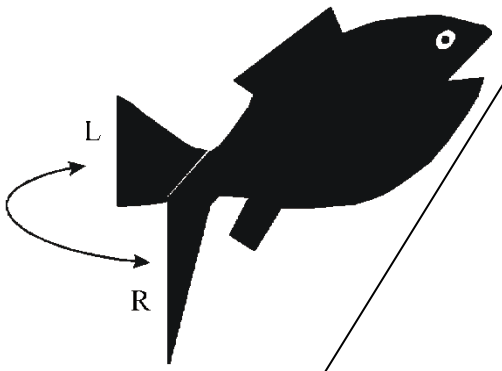
Disrupting a generator(s) will cause the pattern of activity to collapse. A collapse may not necessarily mean a flatline as we saw in 7-8-9.

Swimmy



Figuring out how the circuit works, including what mechanism of oscillation depends on the properties of neurons.

Swimmy



Neurons in my swimming circuit can come in 3 flavors: tonically active (endogenously tonic), endogenous bursters, and cells that have NO endogenous properties (but are driven by other cells).

LECTURE 2

A. Identifying Swimmy neurons

B. Finding E and I inputs to cells 1 and 2

C. Reason correlation and synaptic delay not enough to prove direct connection

D. Underlying mechanism behind oscillations—possibilities

E. Quiz answers.

F. Underlying mechanism behind oscillations—finding generators and followers as a 1st step.