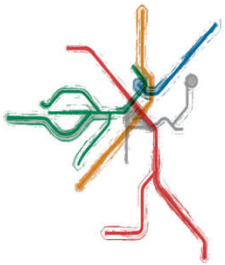
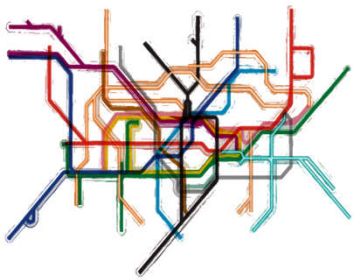
Neuronal Networks

- **So far**: the building blocks of neurons/networks
  - ion channels
  - resting potential
  - action potential
  - synapses
- **Now**: we build a network
  - networks in the thalamus
  - the importance of time (i.e. brain rhythms)

Boston



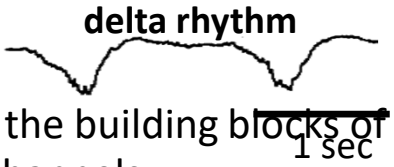
London



DC

Neuronal Networks

Brain Rhythms



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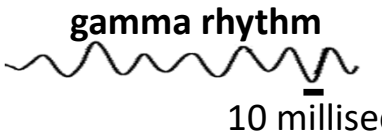
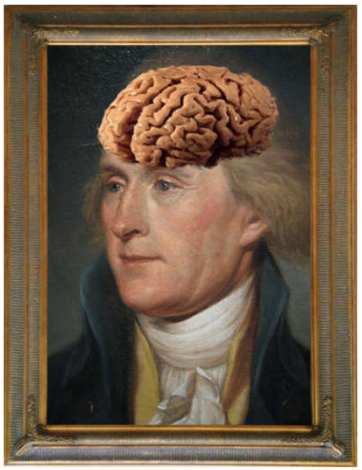
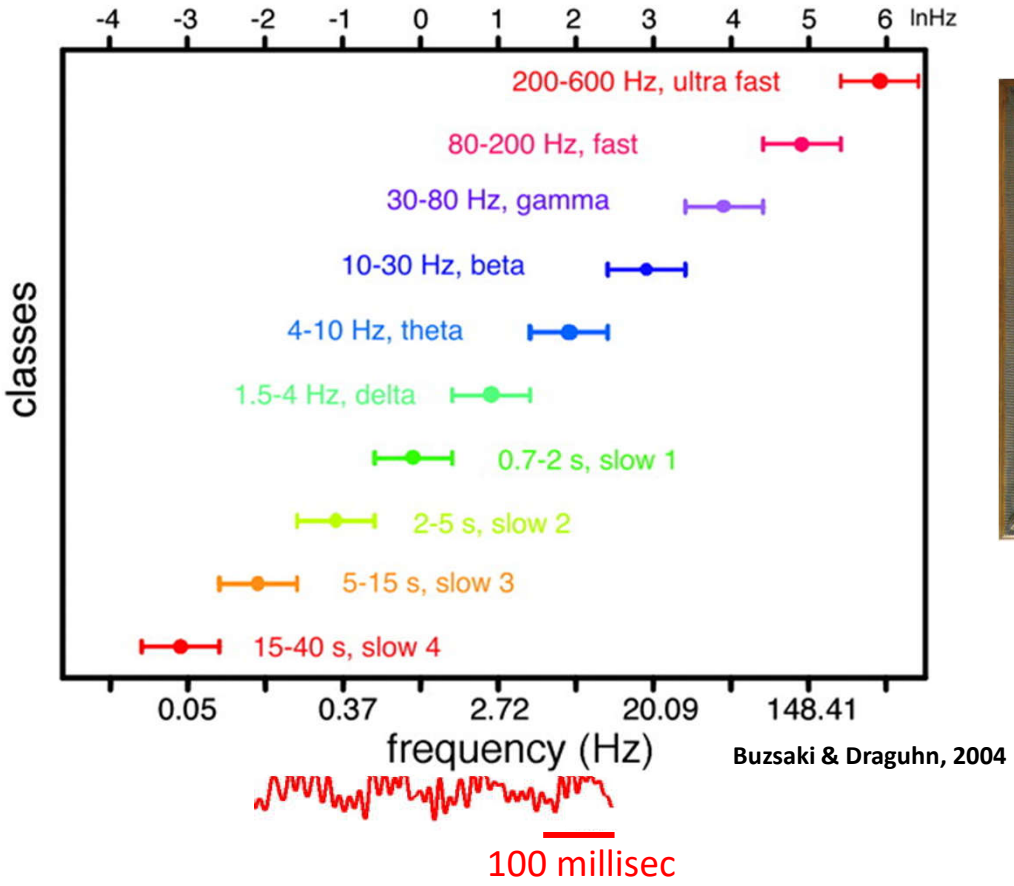


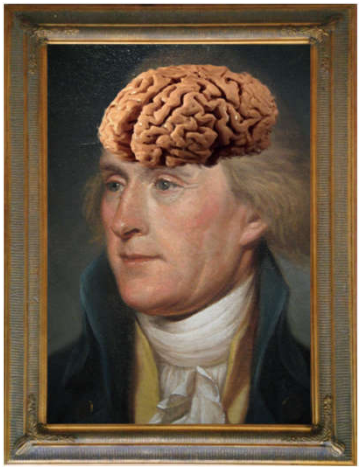


Neuronal Networks

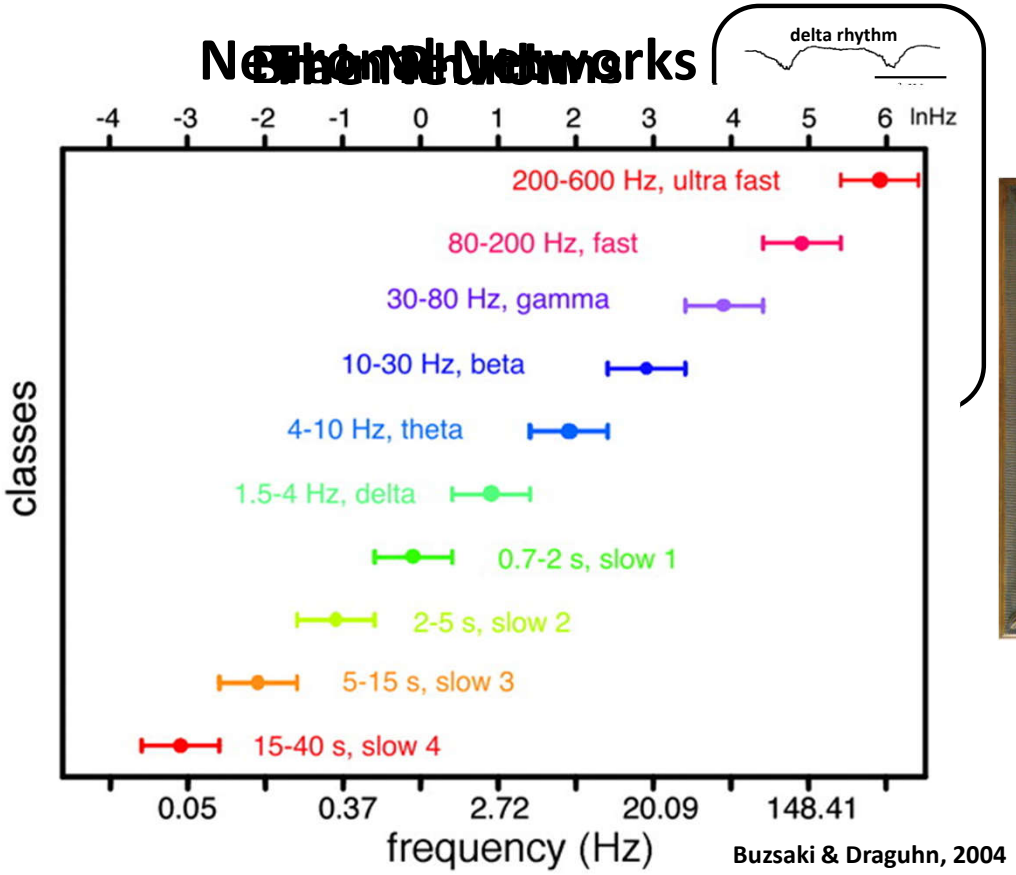
Brain Rhythms



Buzsaki & Draguhn, 2004



Neuronal Networks



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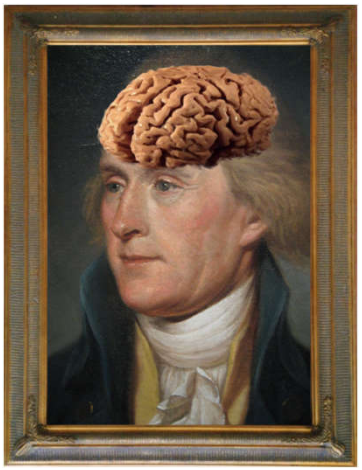
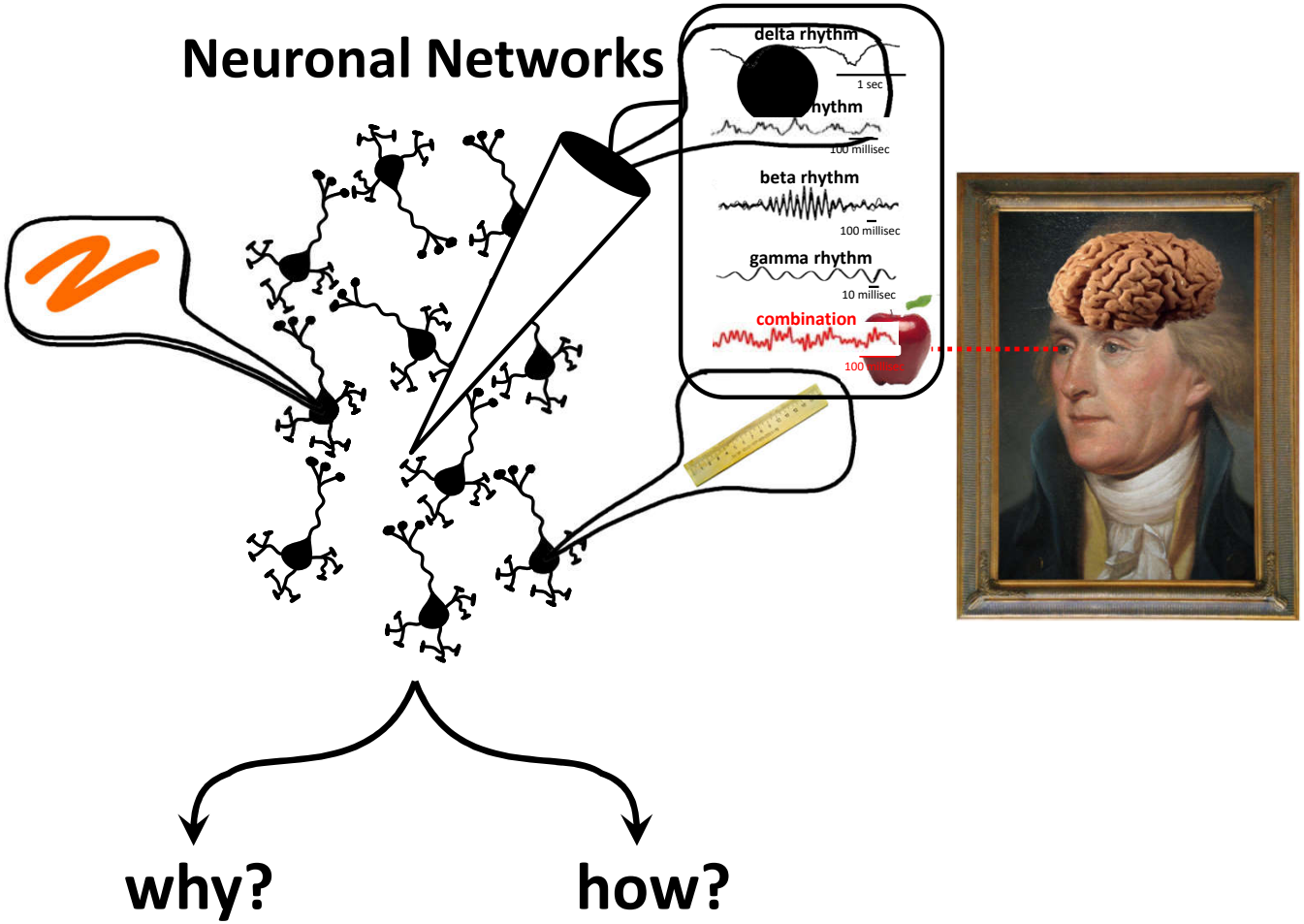
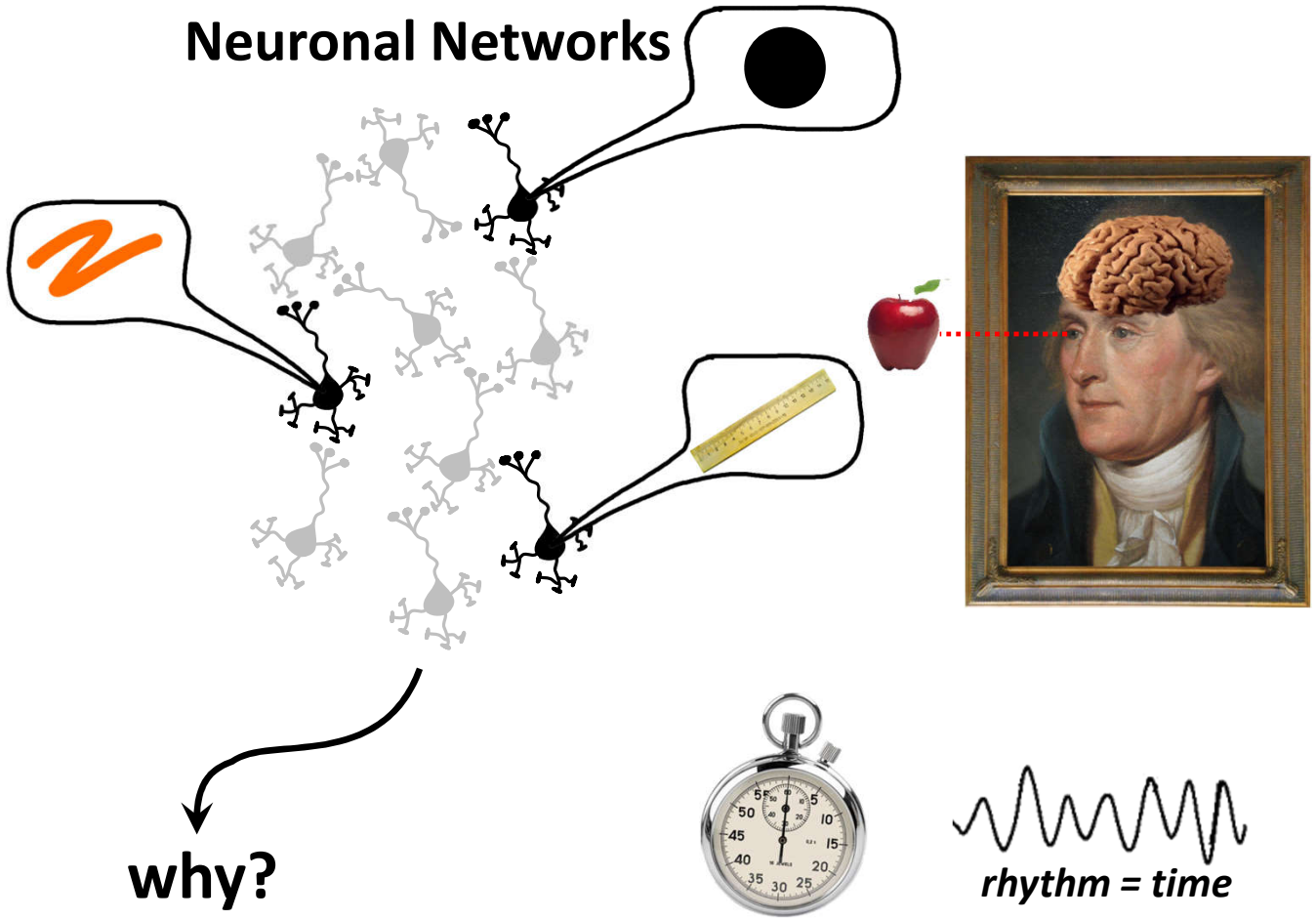


why? **how?**

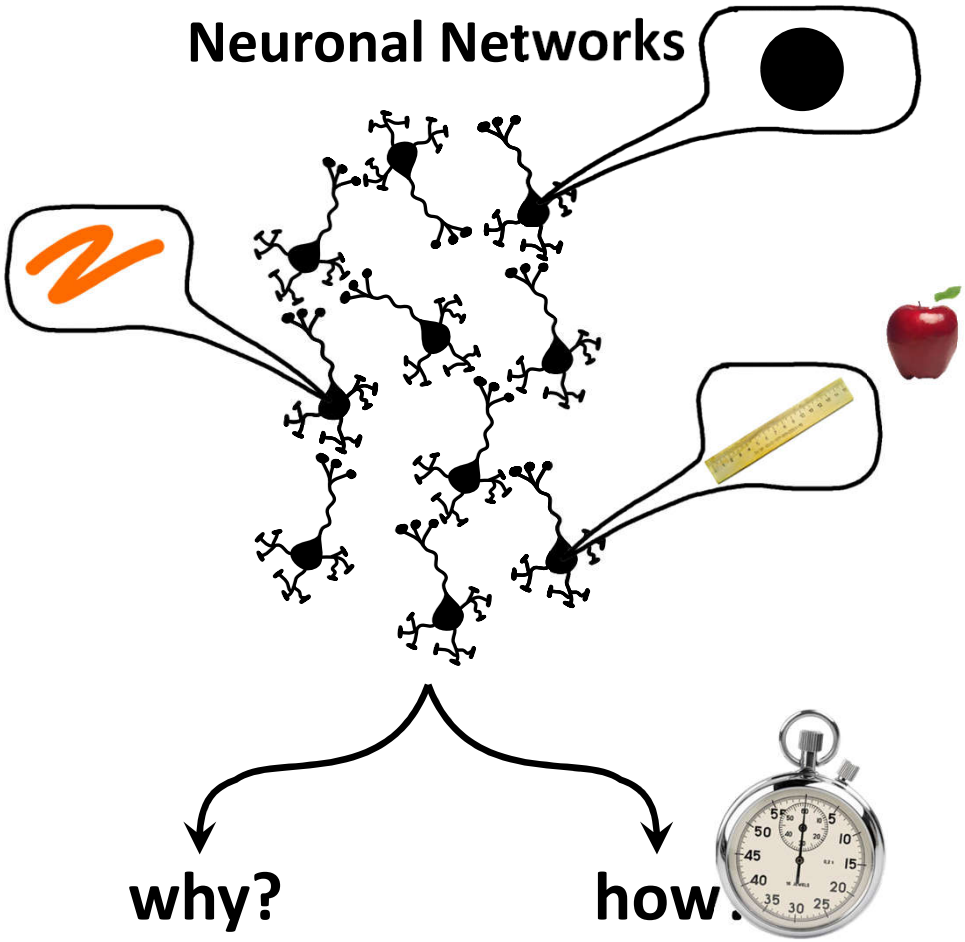
Neuronal Networks

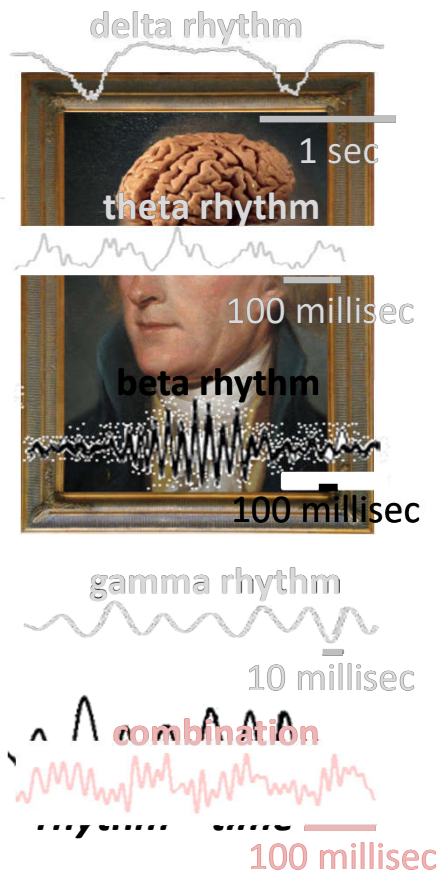


Neuronal Networks



Neuronal Networks

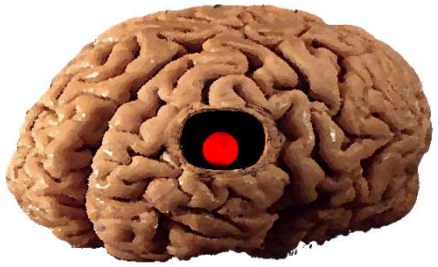




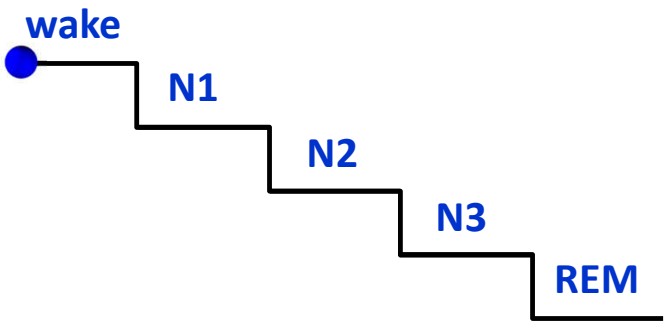
Neuronal Networks

Neuronal Networks

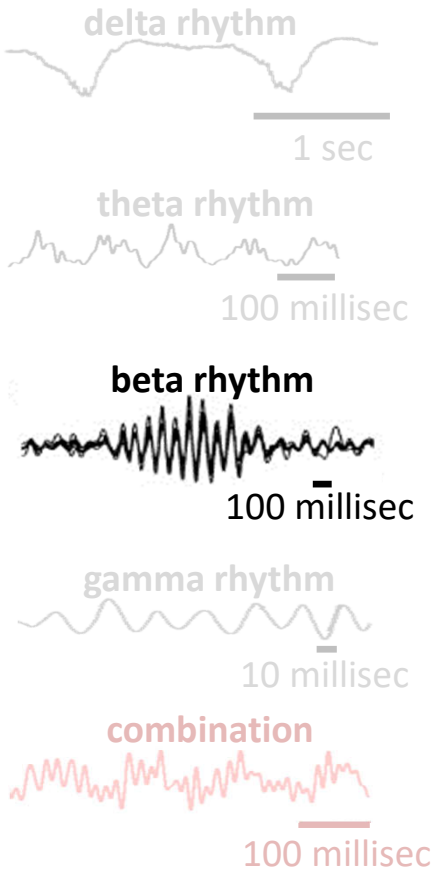
Brain



Sleep Stages



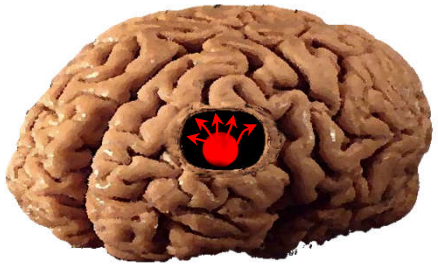
Brain Rhythms



Neuronal Networks

Brain

thalamus



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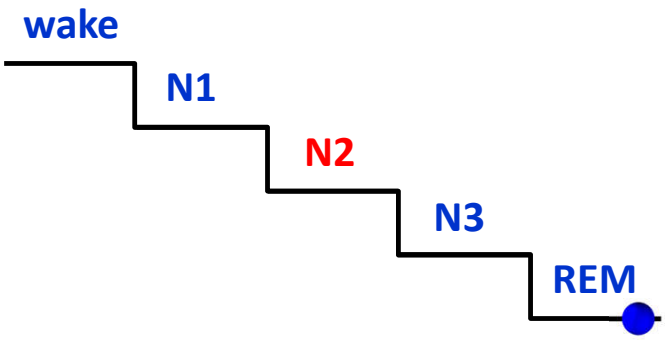

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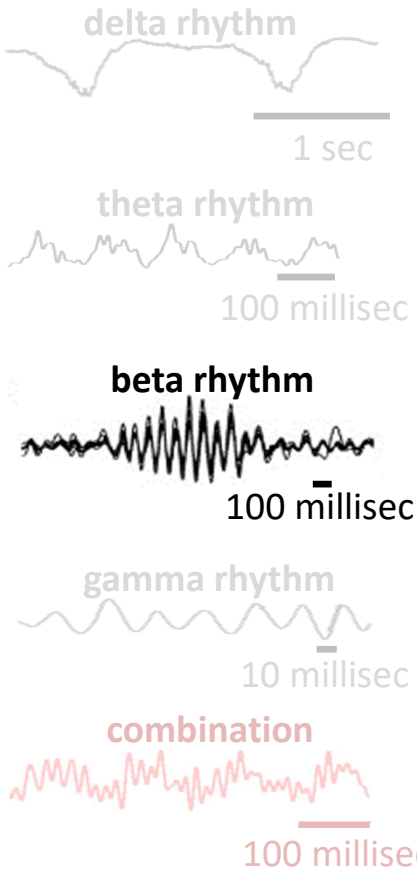
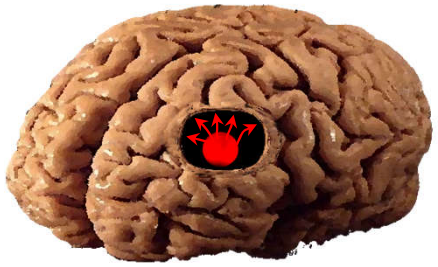


Neuronal Networks

Brain

thalamus



Brain Rhythms

delta rhythm

1 sec

theta rhythm

100 millisec

beta rhythm

100 millisec

gamma rhythm

10 millisec

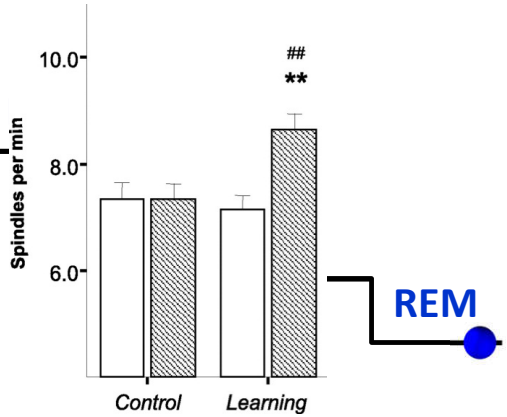
combination

100 millisec

Sleep Spindles

wake

REM

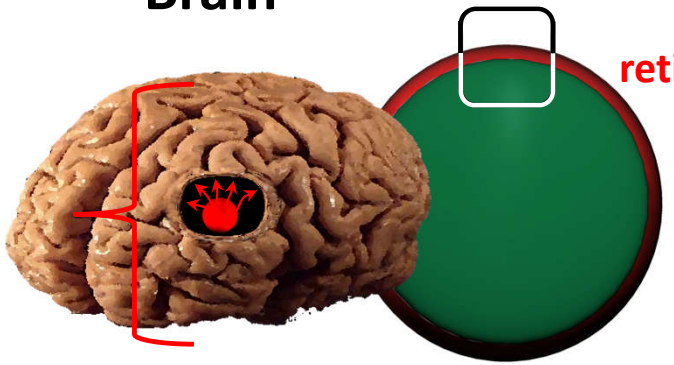


Eschenko et al., 2006

Neuronal Networks

Brain

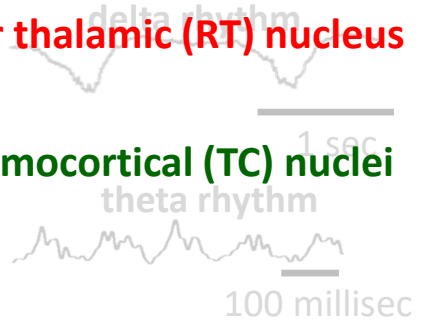
thalamus



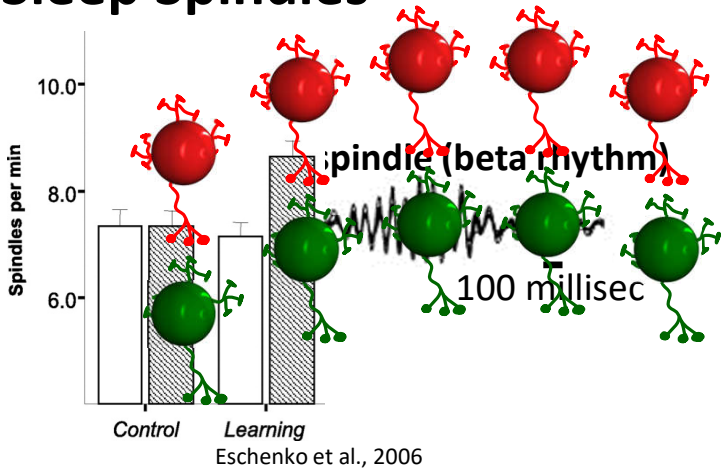
reticular thalamic (RT) nucleus

thalamocortical (TC) nuclei

Brain Rhythms



Sleep Spindles



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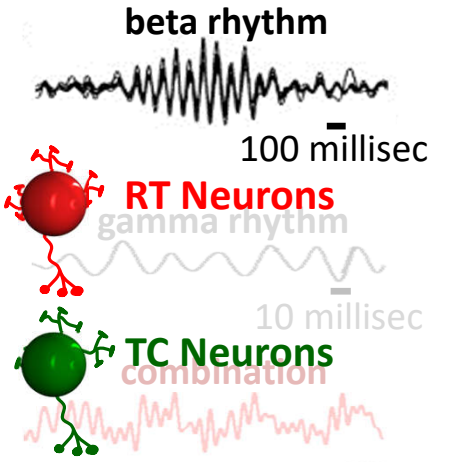
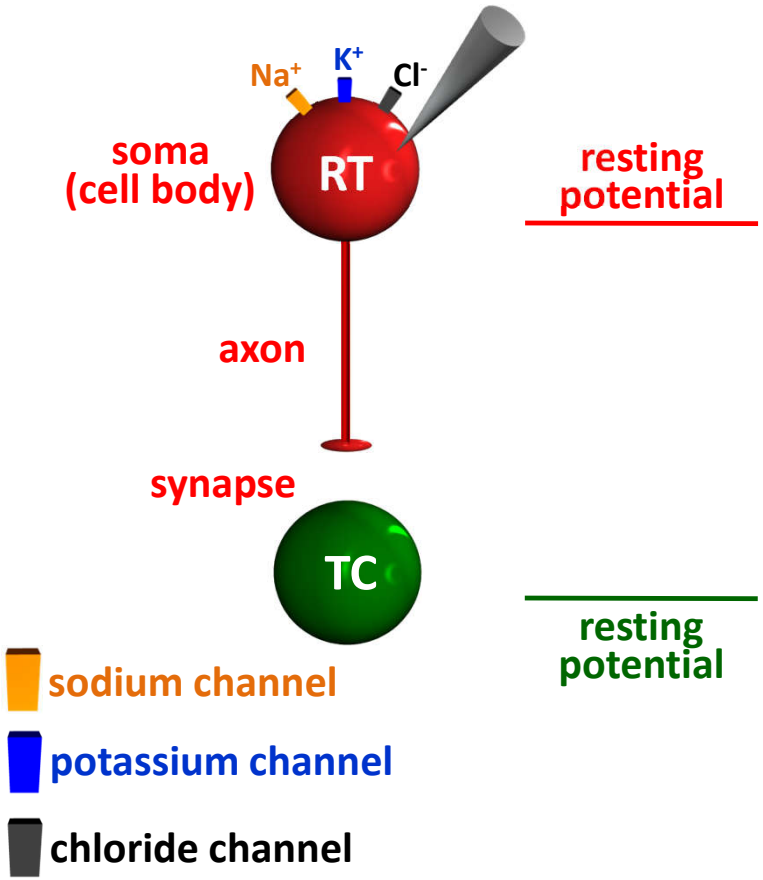


Spindle Circuit



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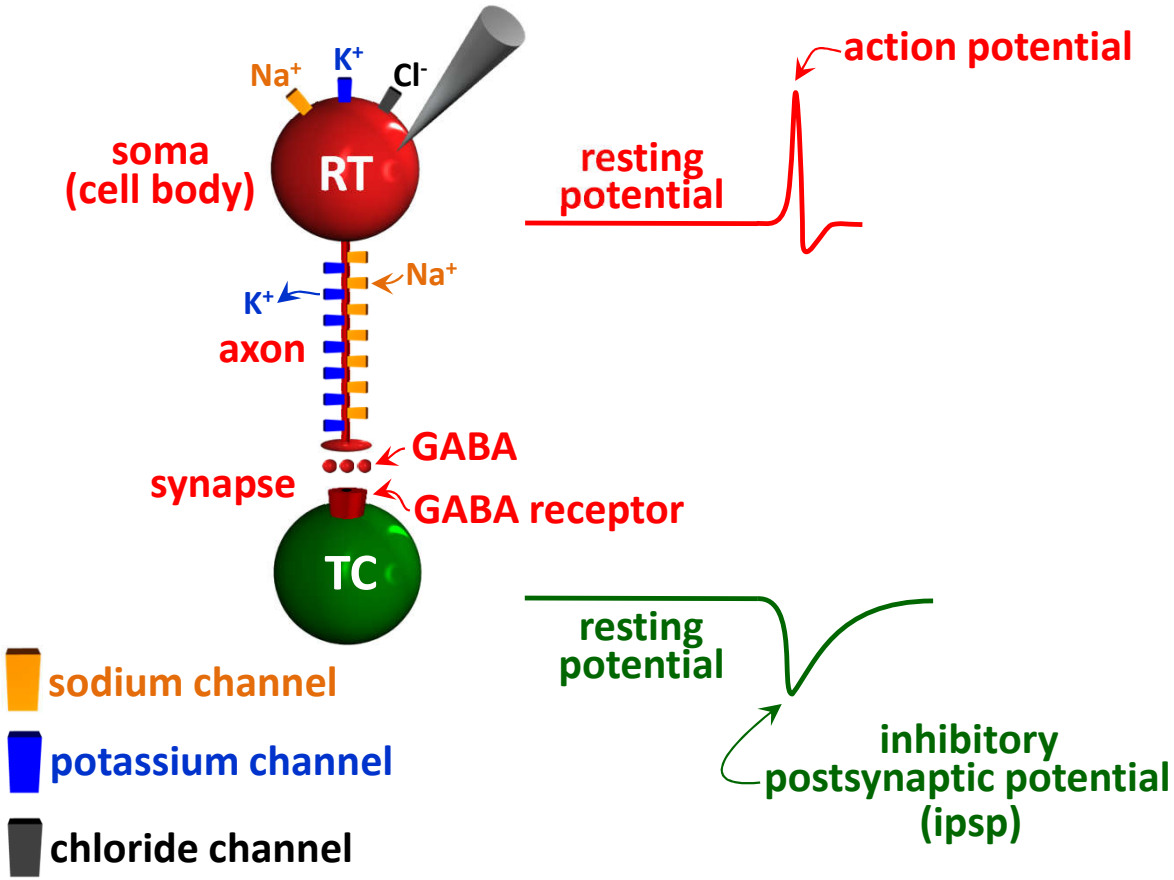

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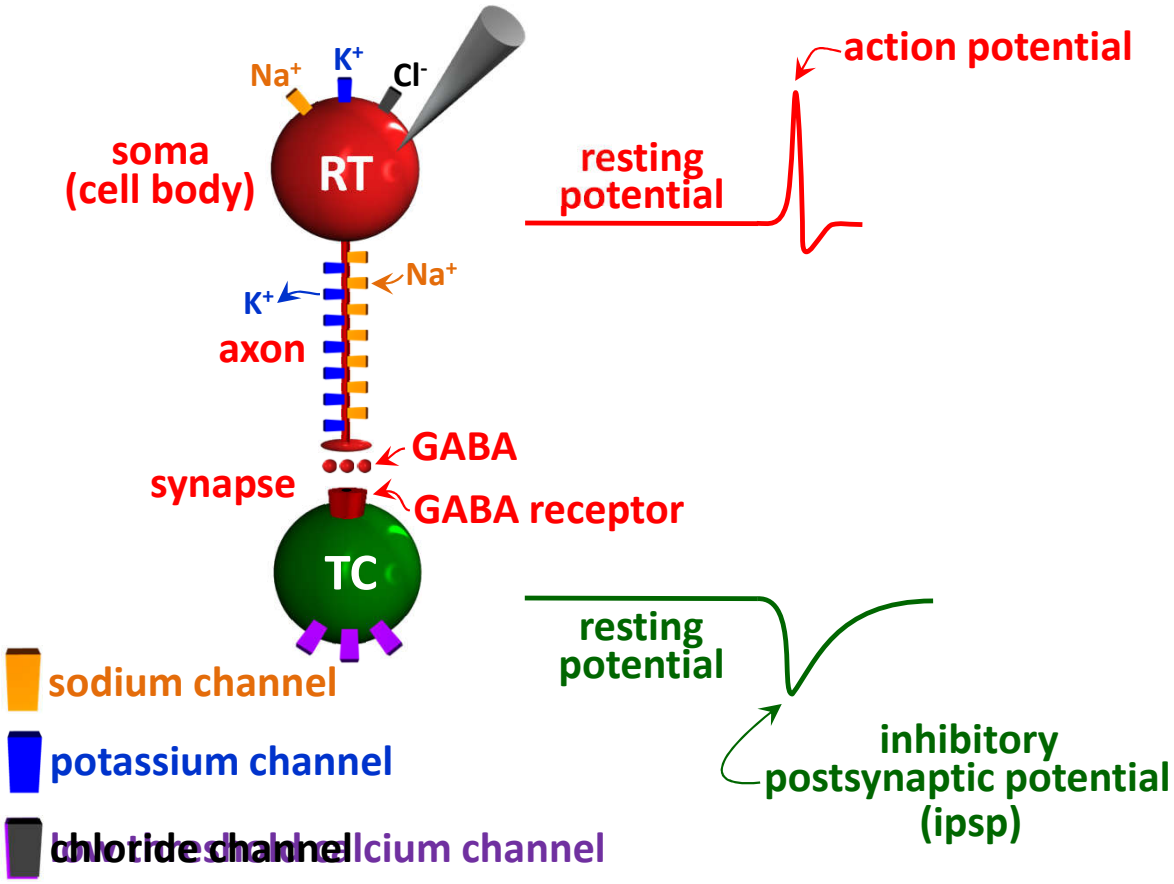

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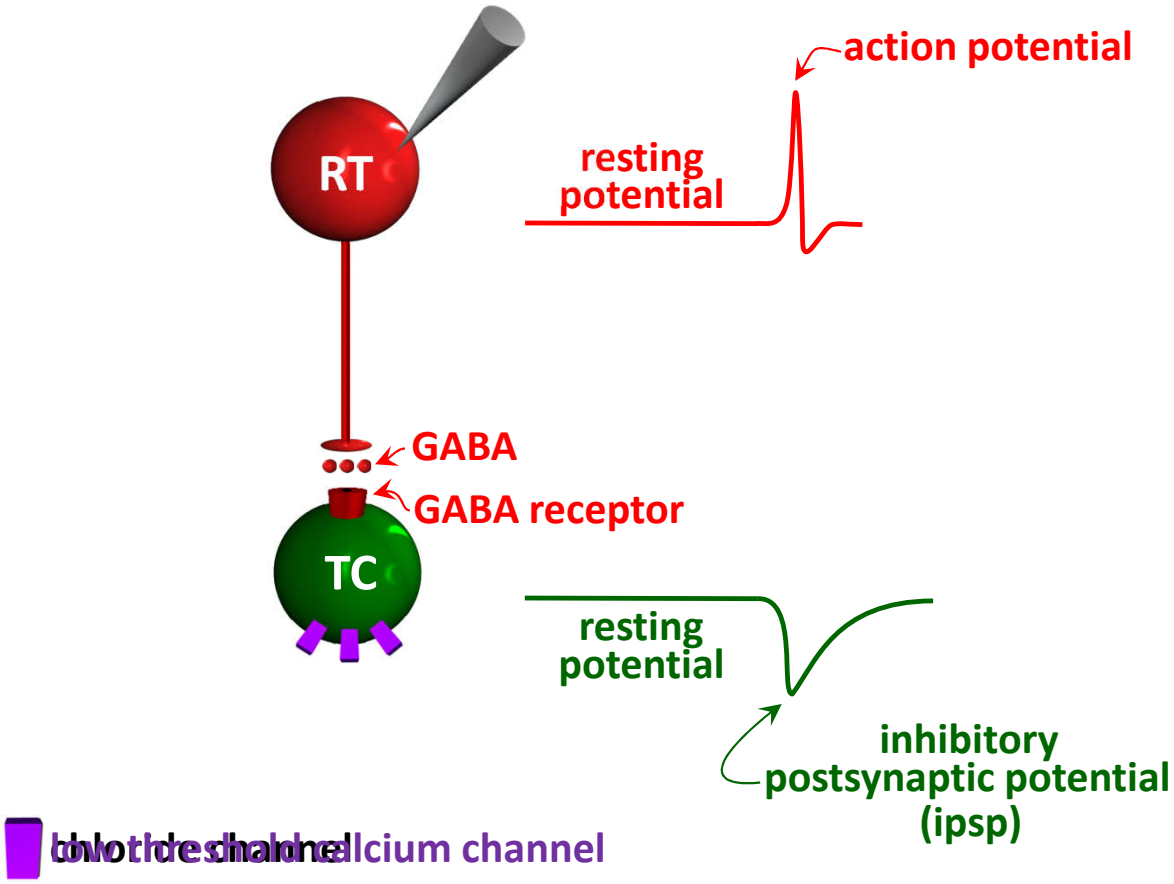
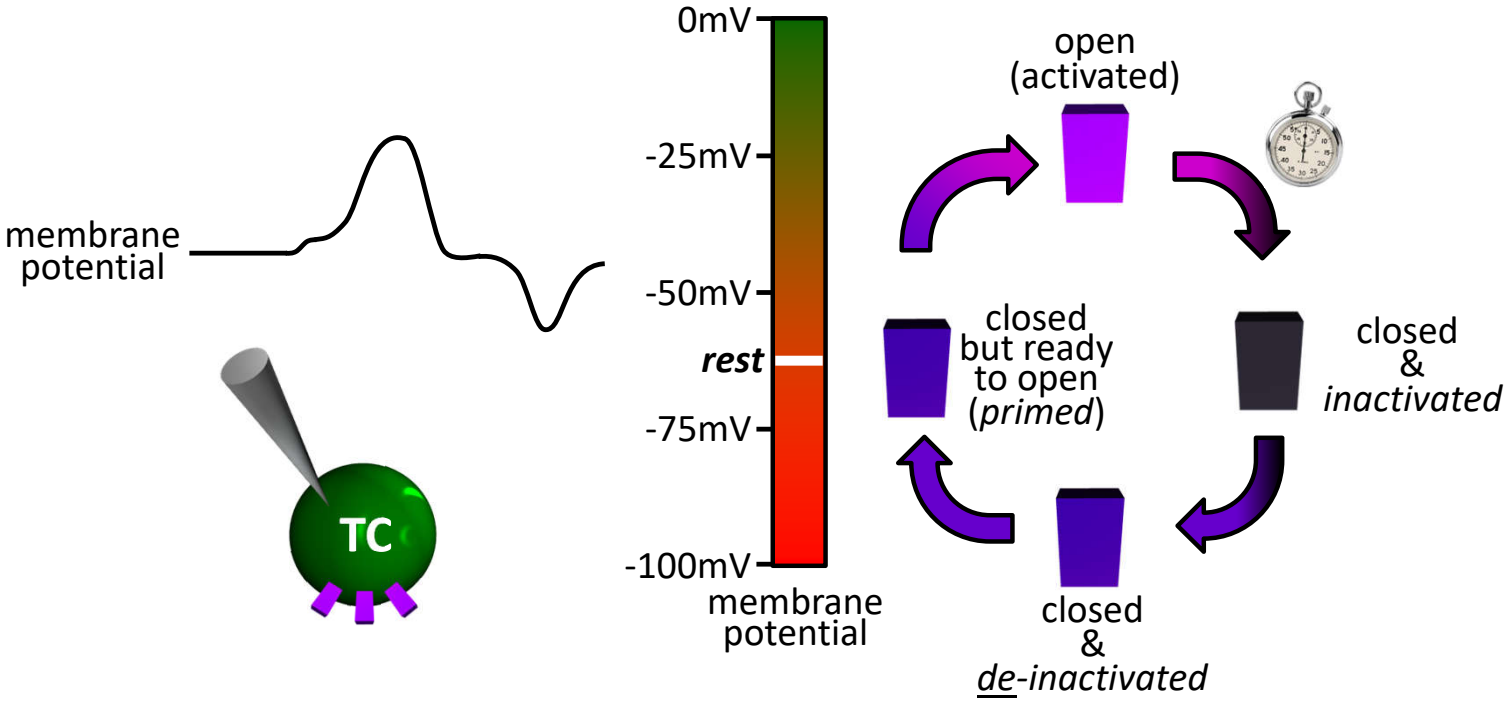


Low Threshold Calcium Channel



low threshold calcium channel

- opens with depolarization
- inactivated state *cannot* open
- de-inactivates (aka *primes*) with hyperpolarization

Low Threshold Calcium Channels are called Low Threshold because:

A. They are primarily expressed in lower vertebrates.

B. Hyperpolarization lowers their threshold for activation.

C. They are activated at relatively hyperpolarized membrane potentials.

D. They easily get angry.

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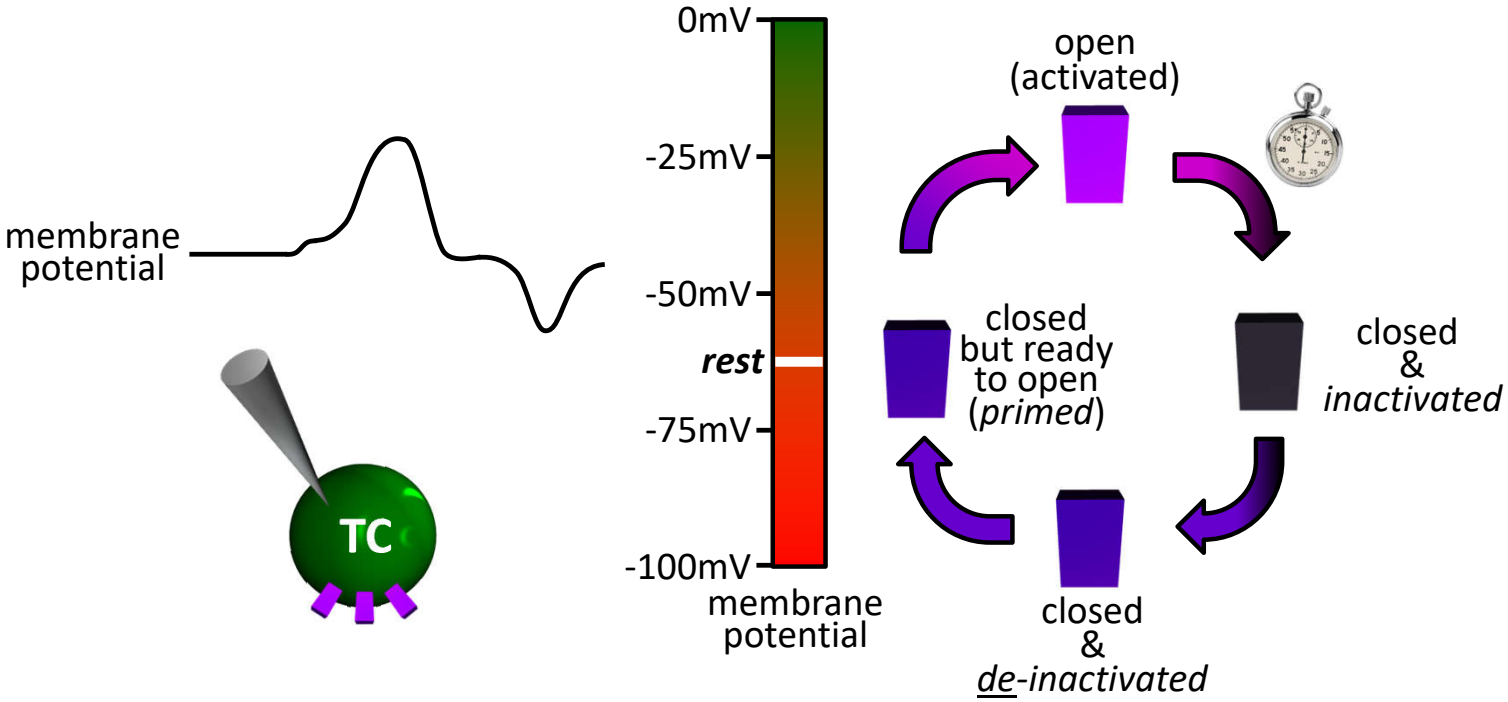

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Which Statement is True?

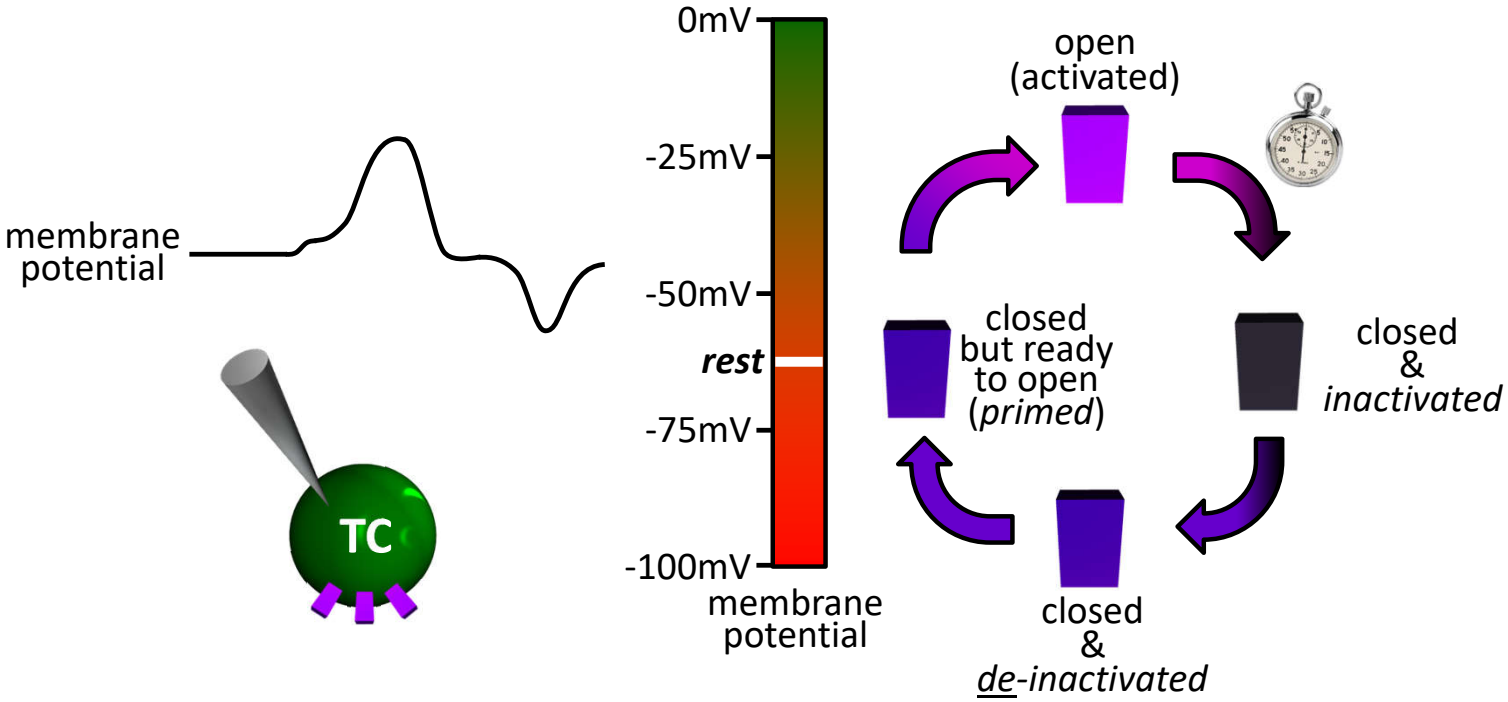
A. A de-inactivated L-T Ca^{2+} channel is open.

B. If depolarized, an inactivated L-T Ca^{2+} channel will open.

C. Hyperpolarization de-inactivates L-T Ca^{2+} channels.

D. Hyperpolarization opens L-T Ca^{2+} channels.

Low Threshold Calcium Channel



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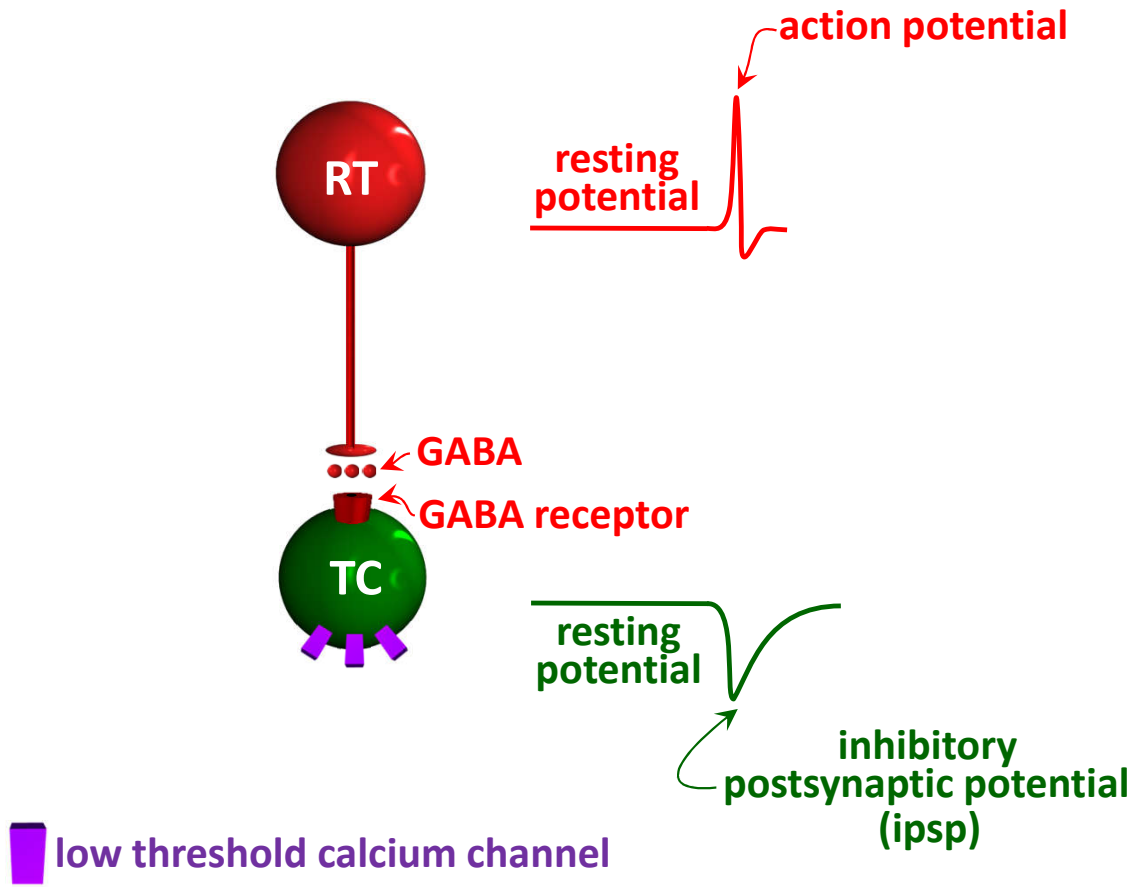

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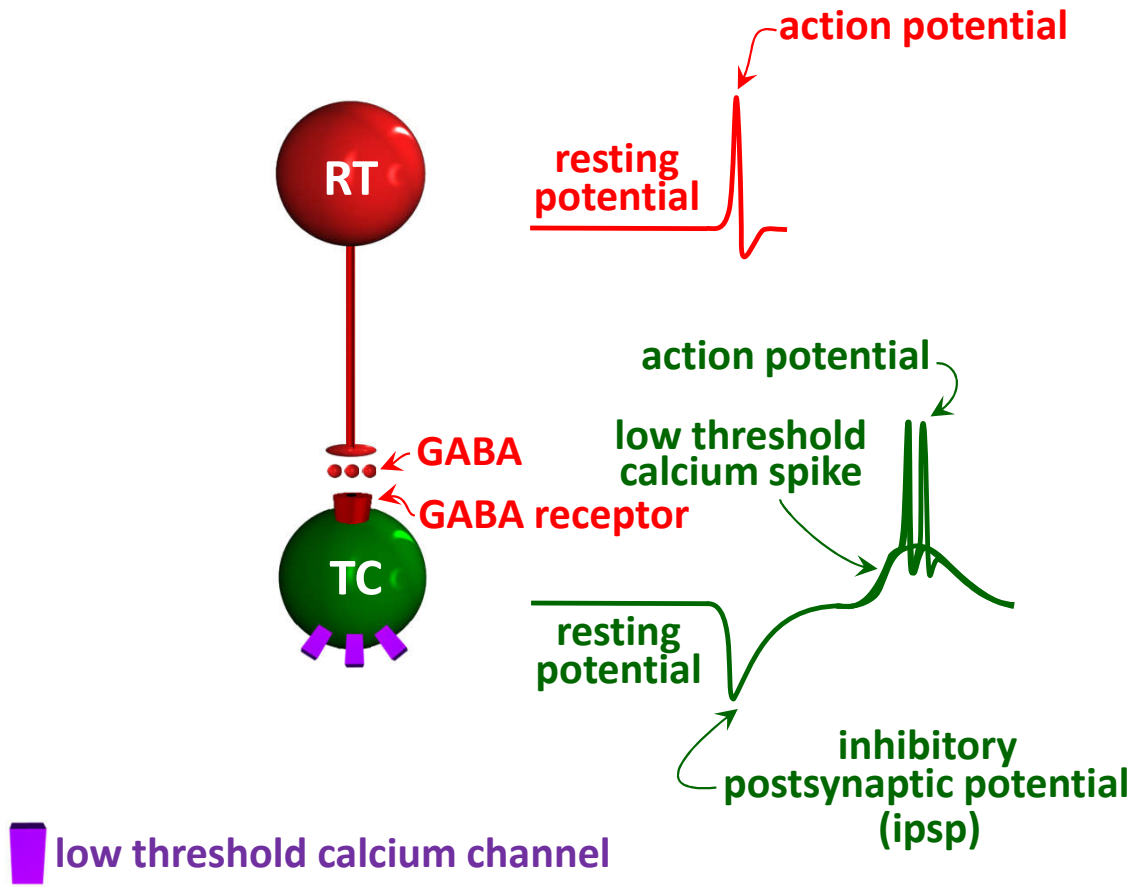

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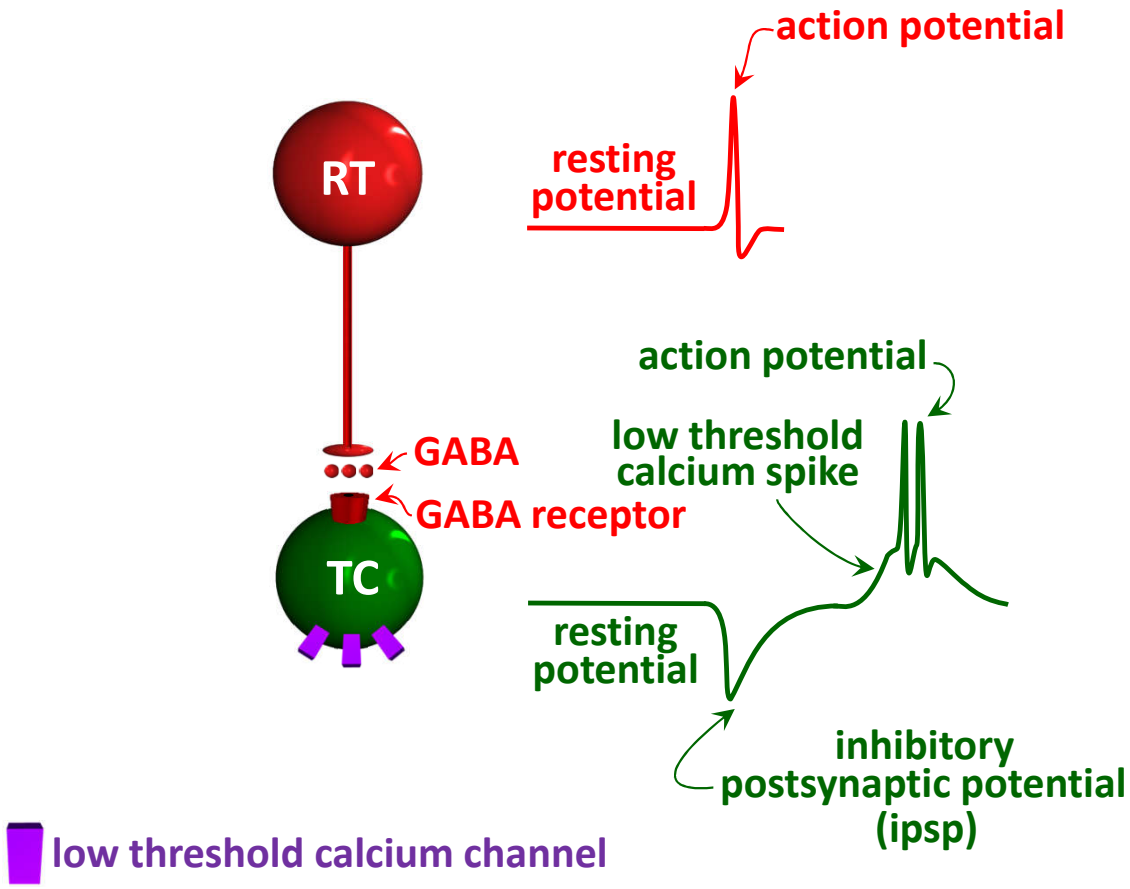

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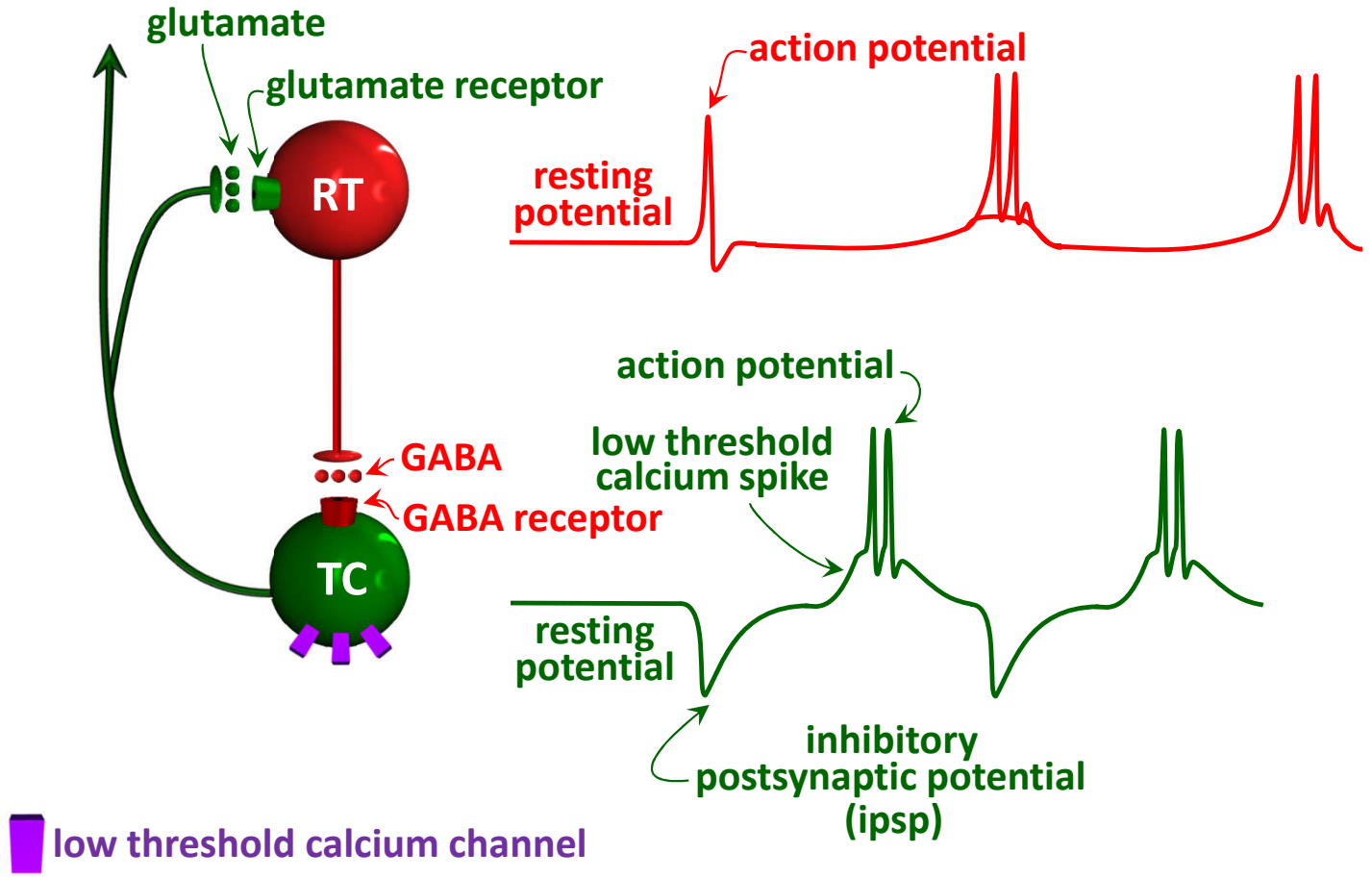

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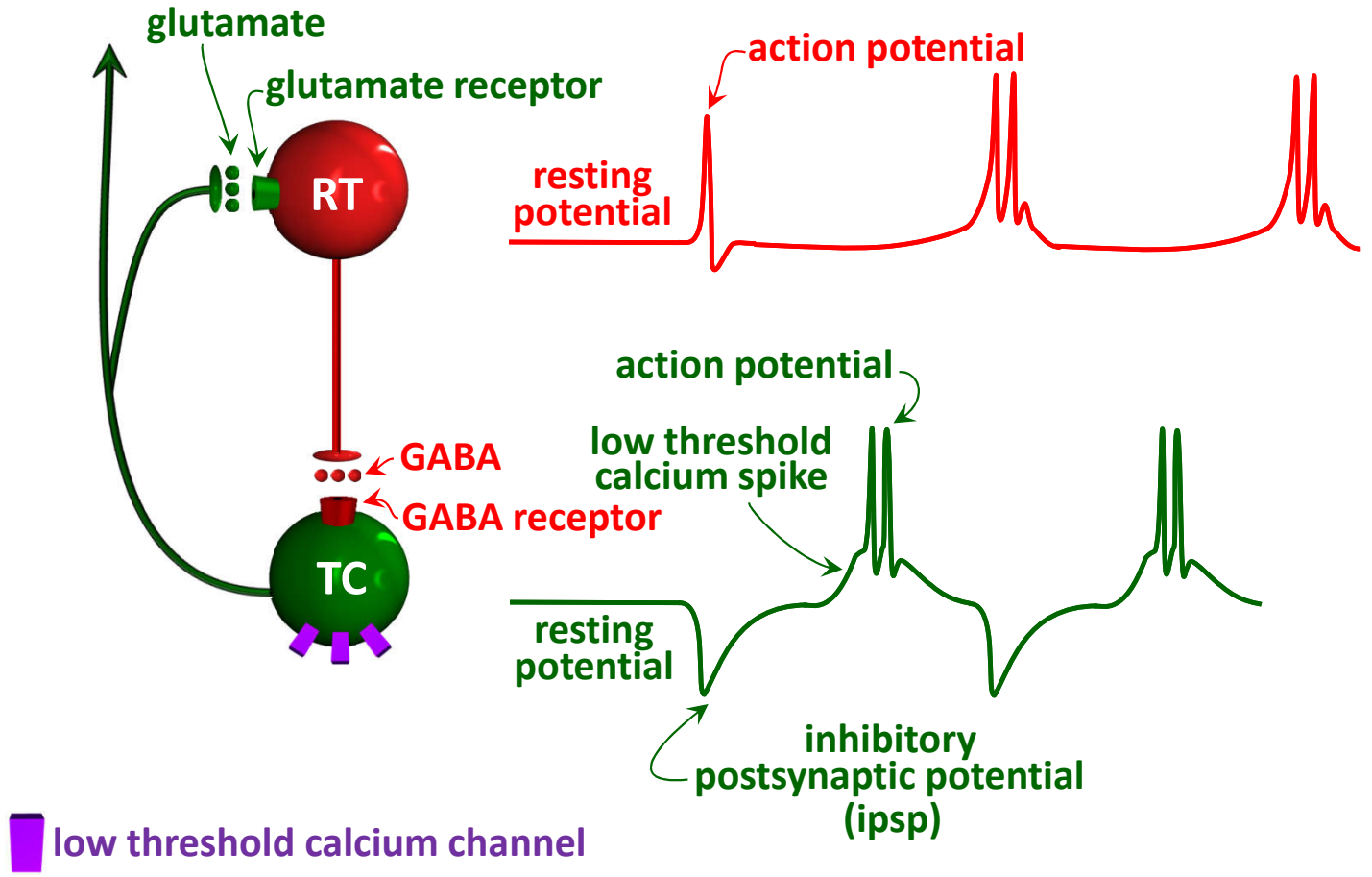


Which statement is the *most* true?:

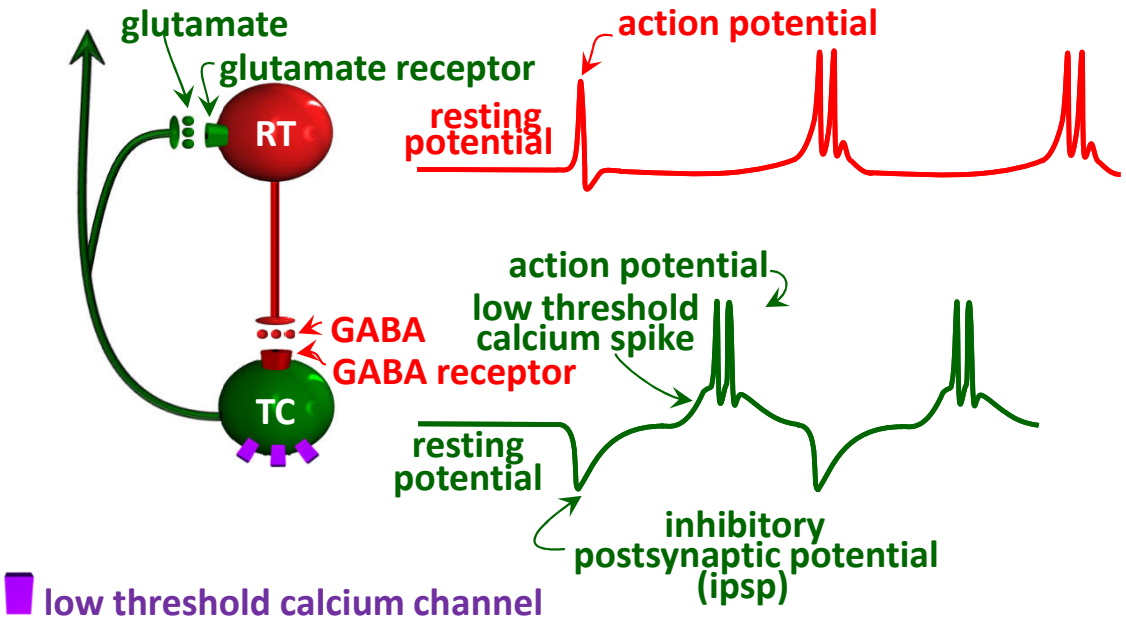
A. Neurons can turn on in response to excitation.

B. Neurons can turn on in response to inhibition.

C. Both A & B are false.

D. Both A & B are true.

Spindle Circuit



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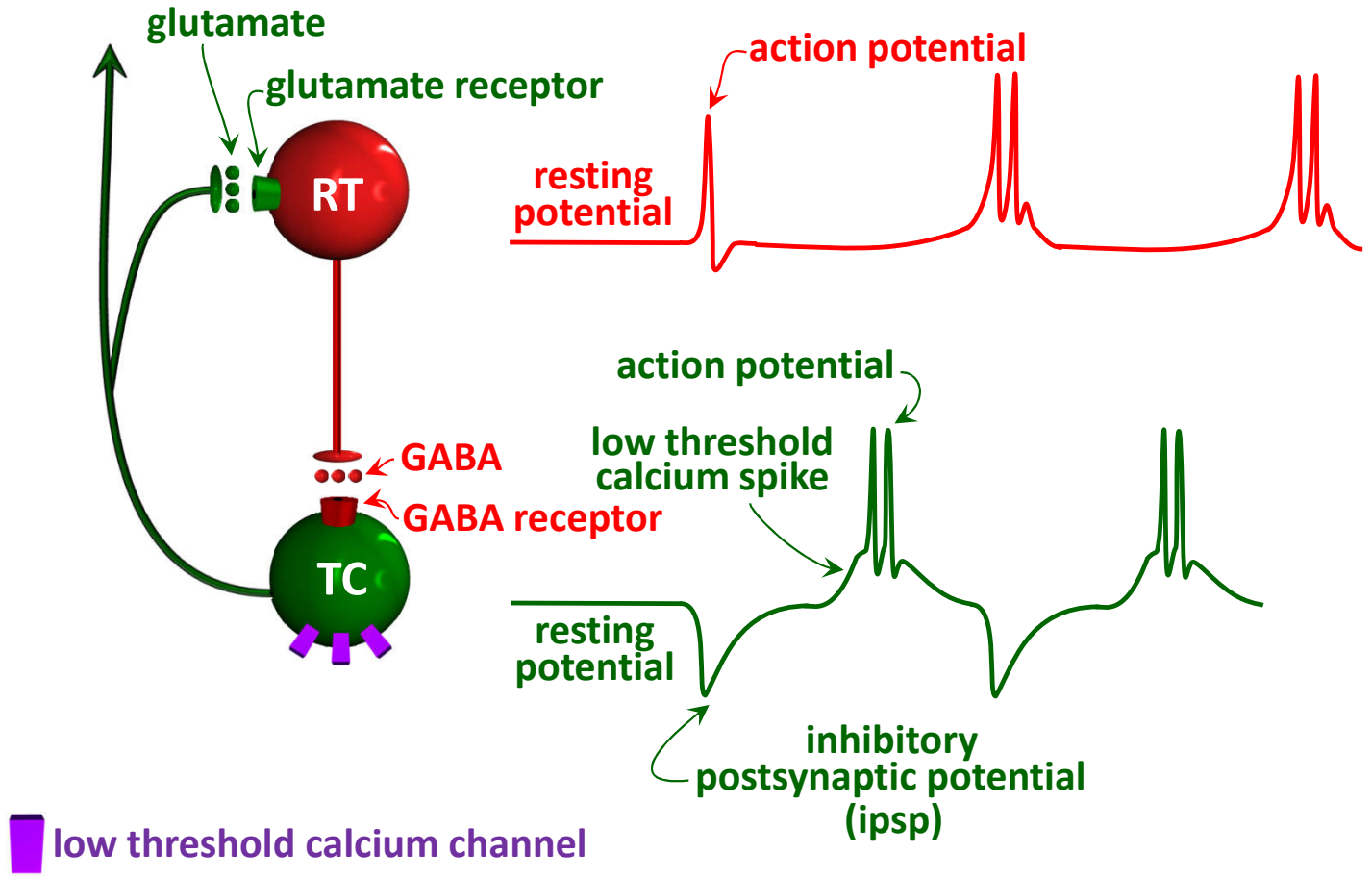

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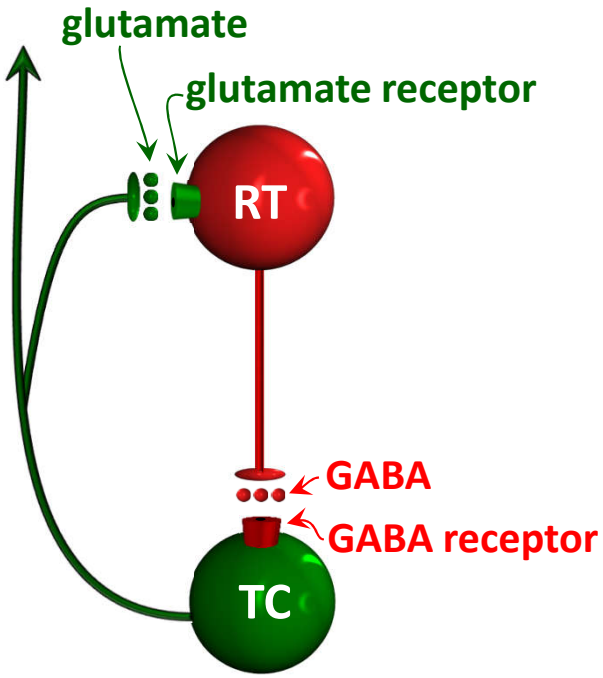
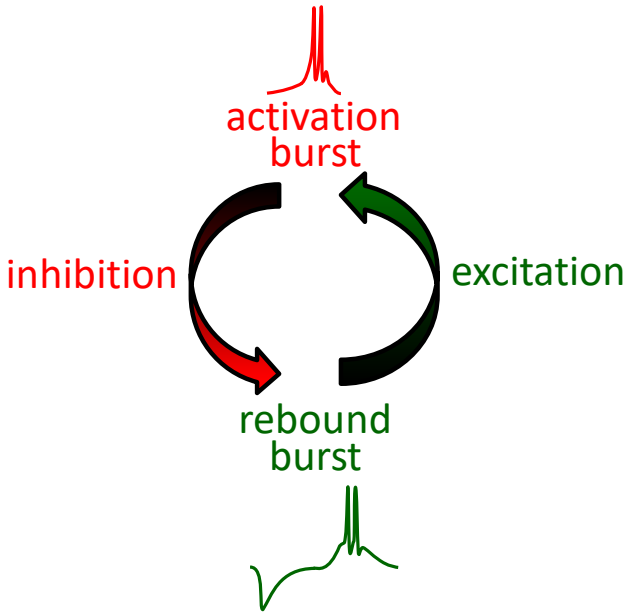
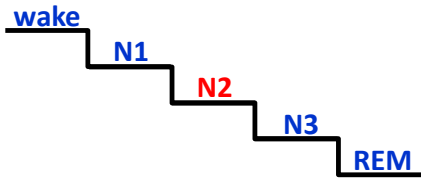




Sleep Spindle

100 millisec

Sleep



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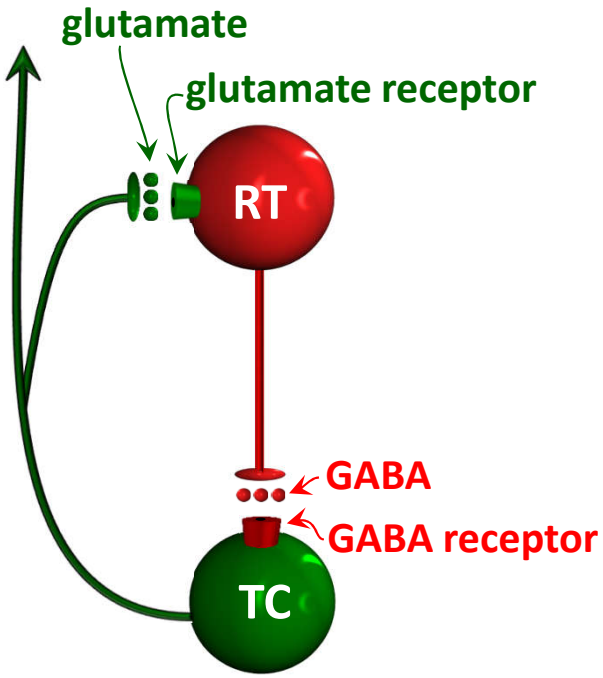

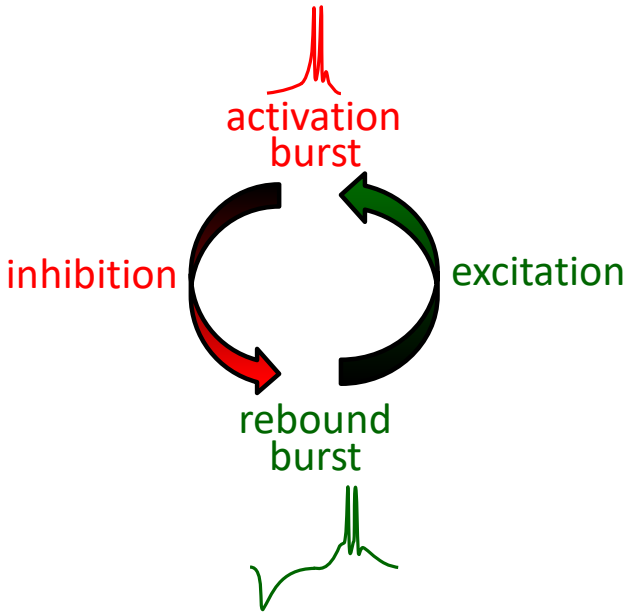

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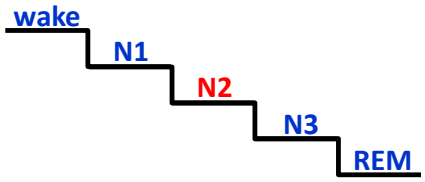

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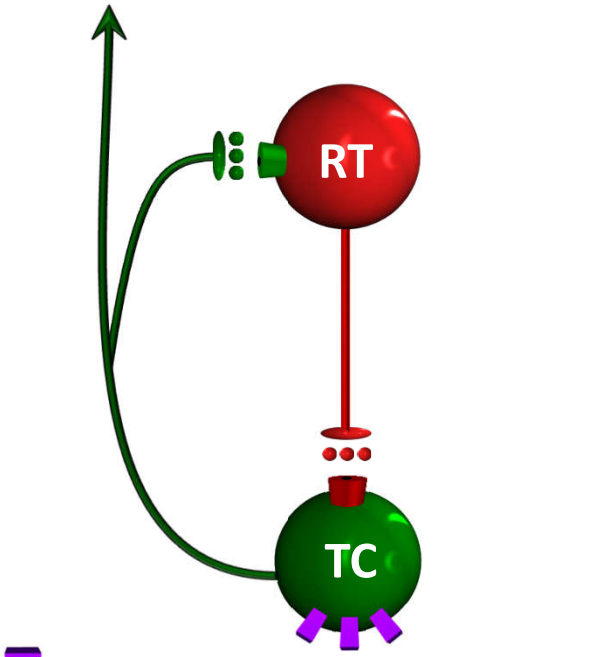

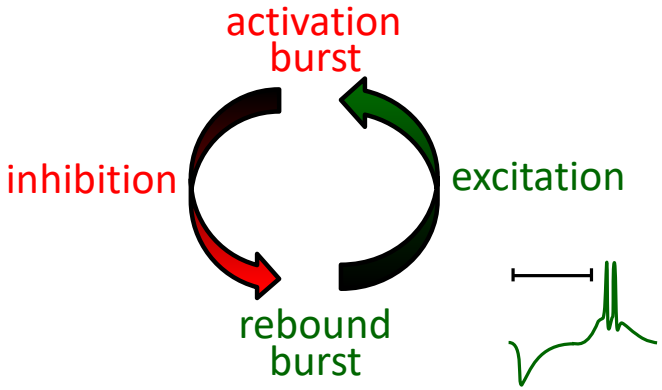

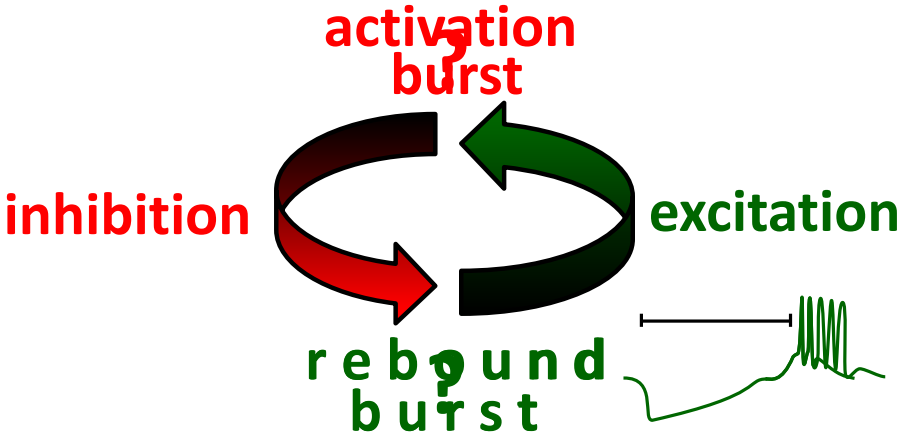

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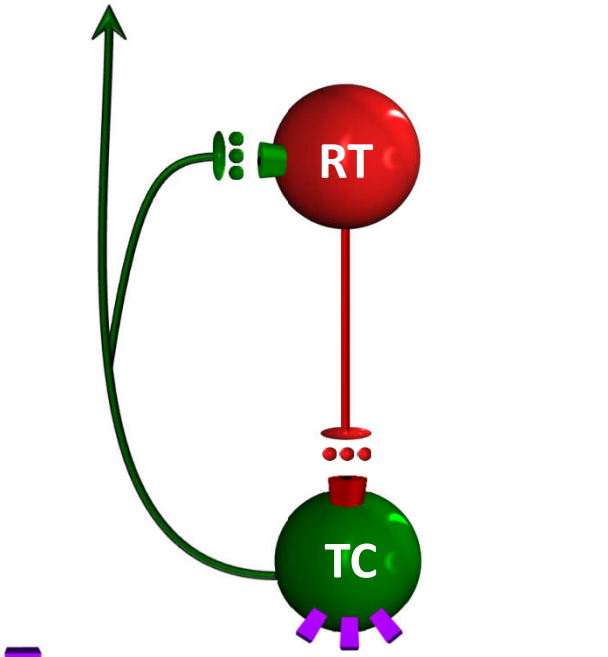
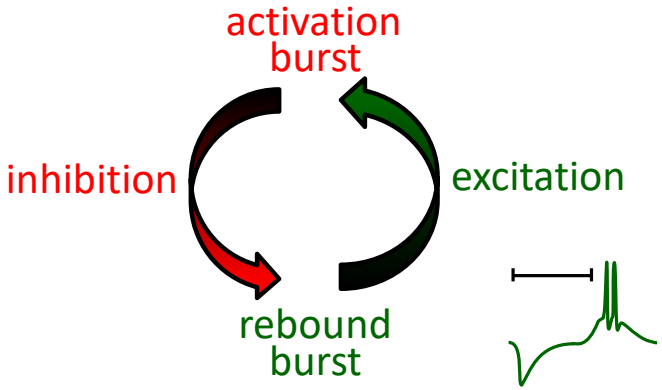
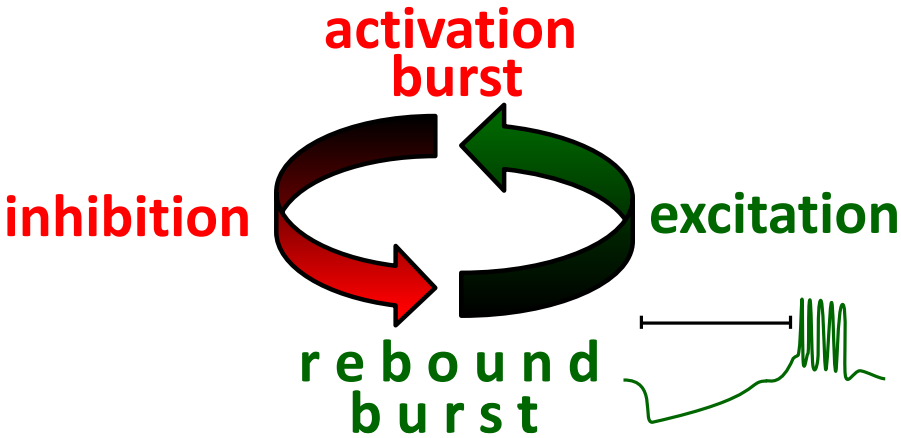






Prolonged inhibition of thalamocortical (TC) neurons will cause:

A. Weaker TC firing activity *during* the inhibition.

B. Weaker TC firing activity *after* the inhibition.

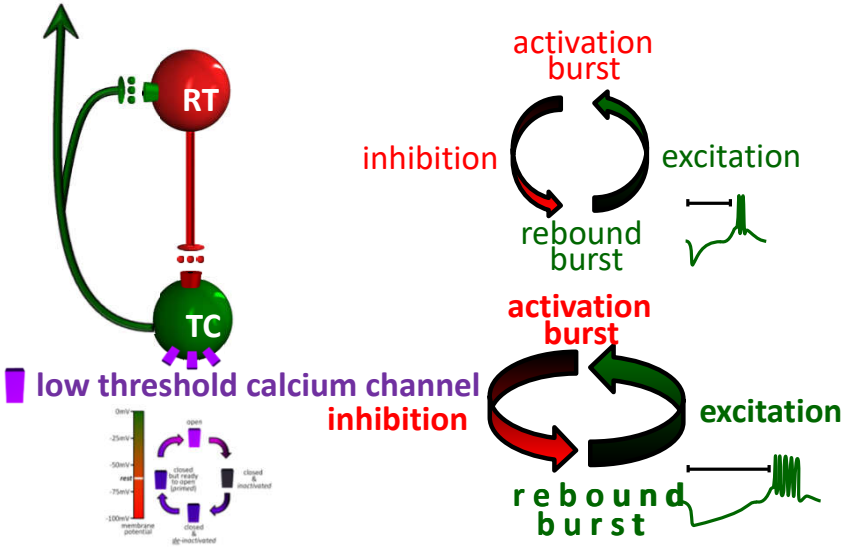
C. Stronger TC firing *during* the inhibition.

D. Stronger TC firing *after* the inhibition.

E. A & B.

F. A & D.

Spindle Circuit



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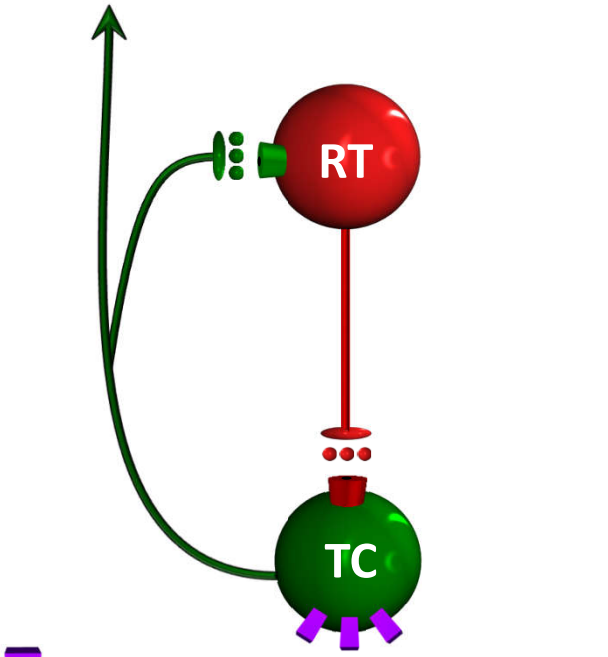
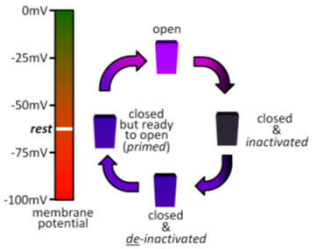
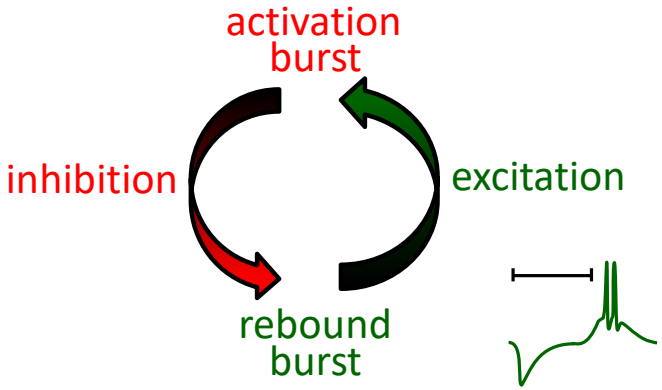
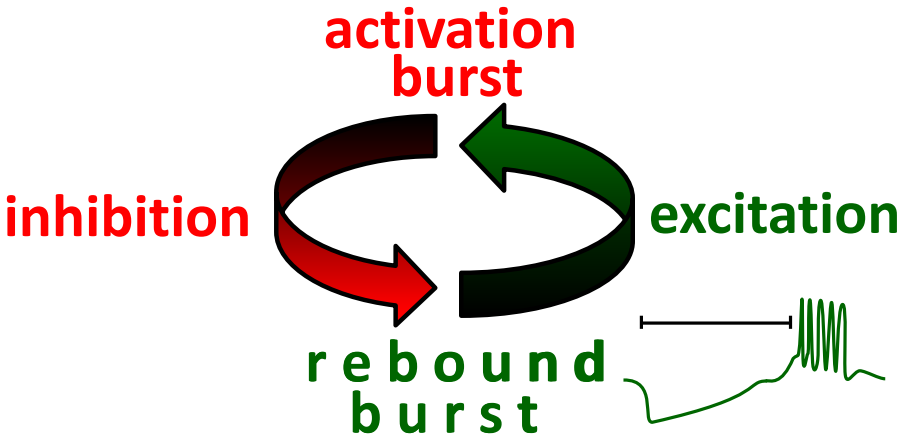


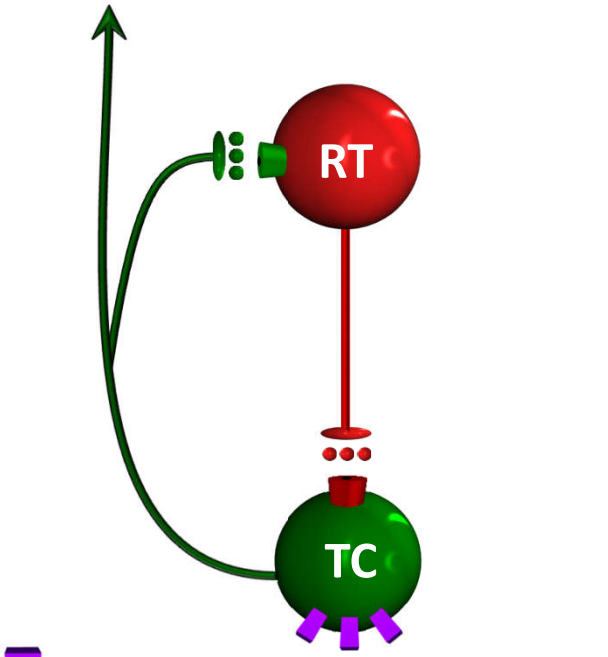
low threshold calcium channel



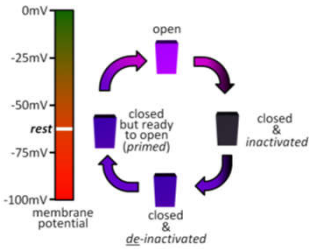


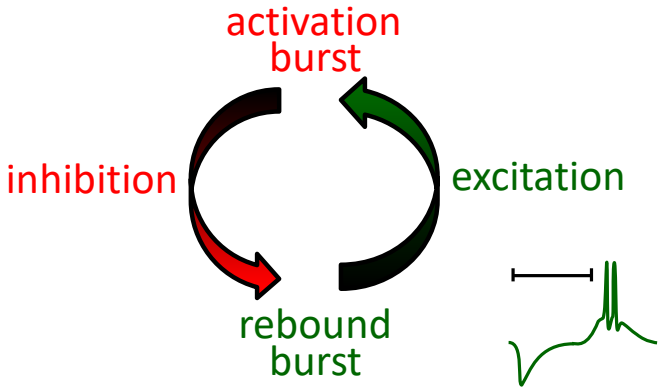


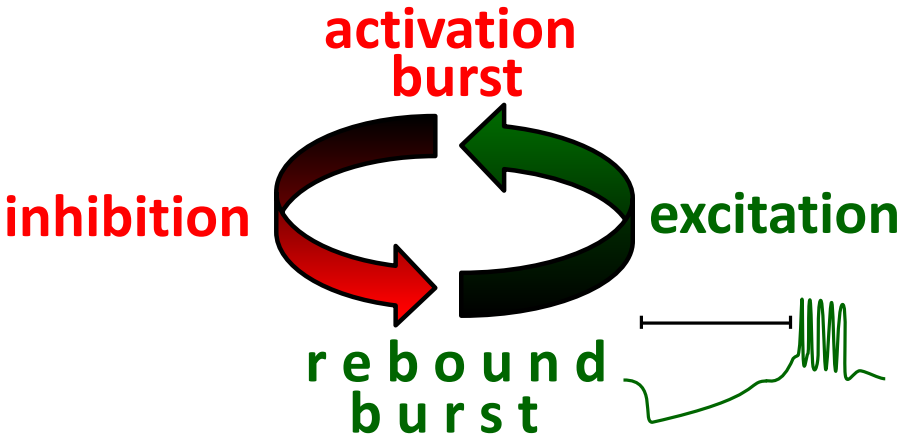
Spindle Circuit



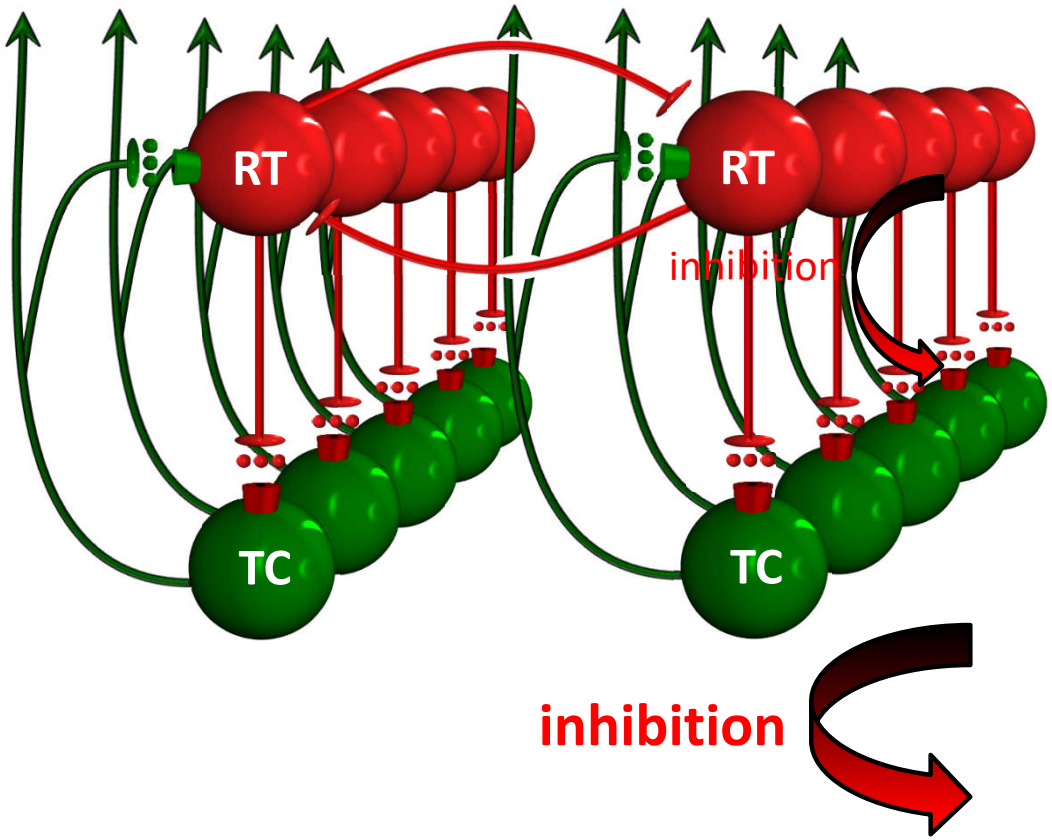
low threshold calcium channel



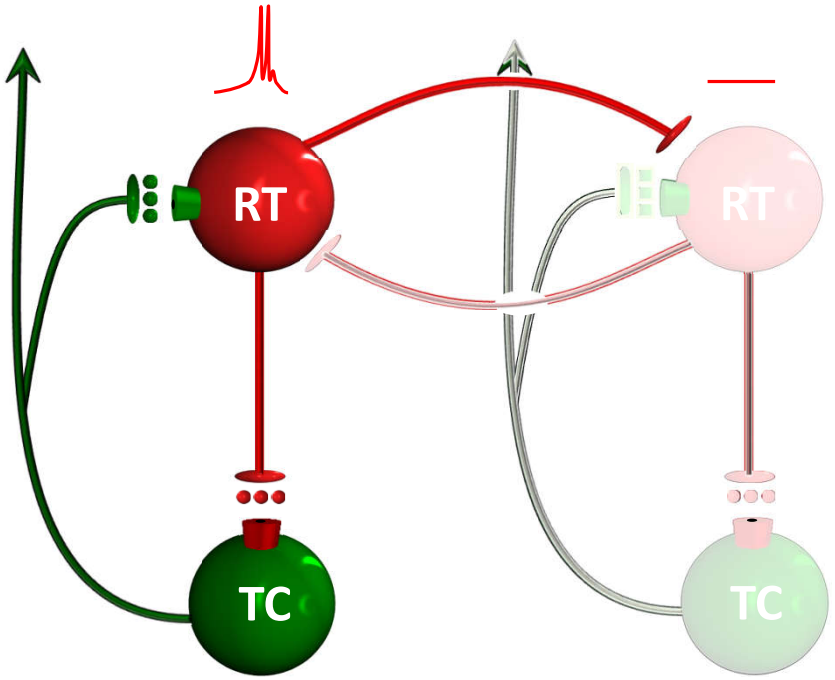




Spindle Circuit



Spindle Circuit

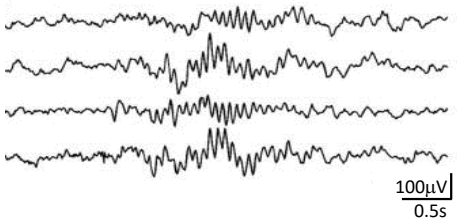


Network

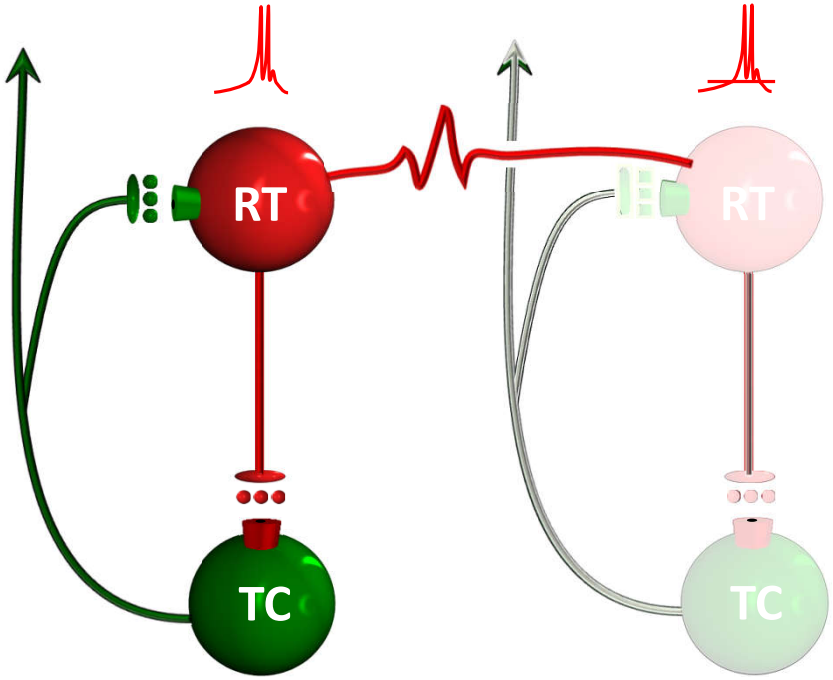
Sleep Spindle

100 millisec

Sleep Spindle



Spindle Circuit



Network

activation burst

inhibition excitation

rebound burst

activation burst

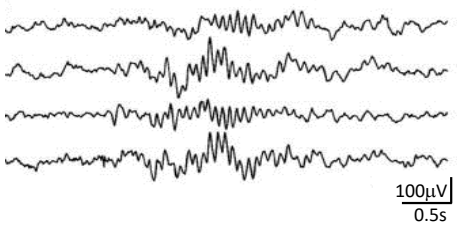
inhibition excitation

rebound burst

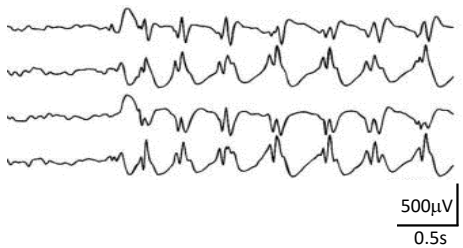
Sleep Spindle

100 millisec

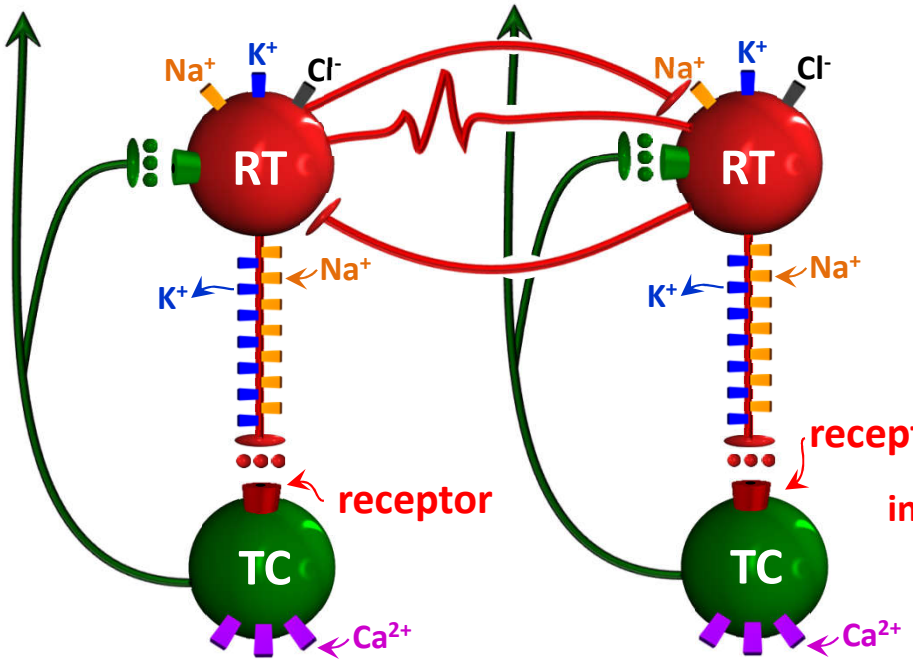
Sleep Spindle

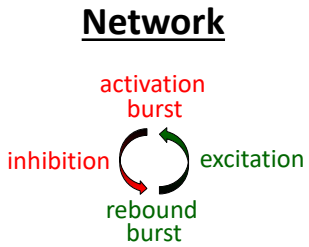


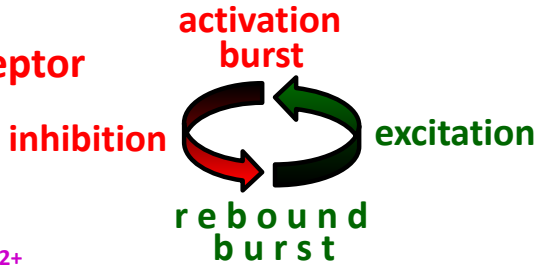
Seizure



Spindle Circuit



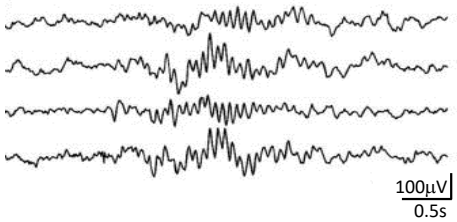




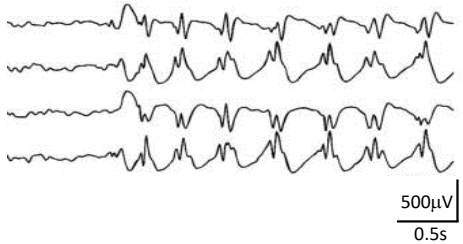
Sleep Spindle

100 millisec

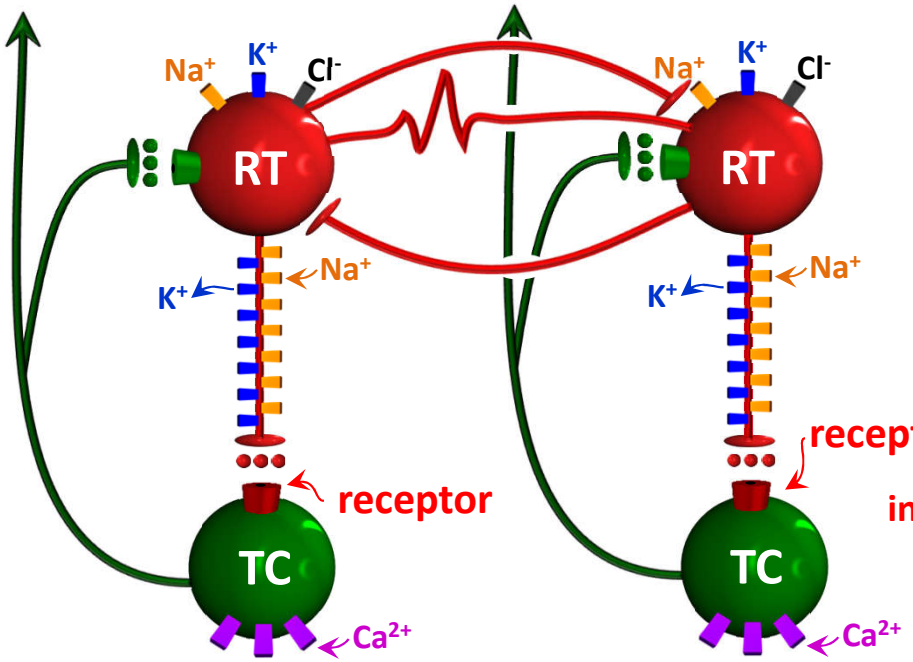
Sleep Spindle

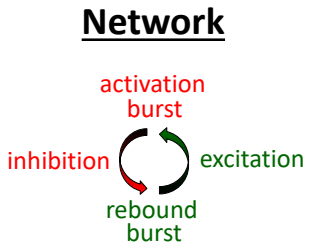


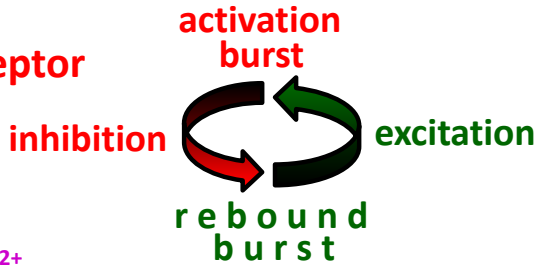
Seizure



Spindle Circuit



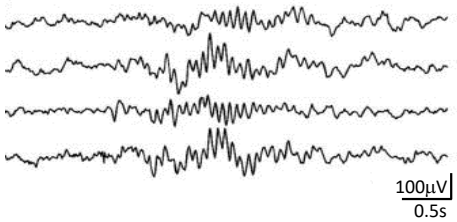




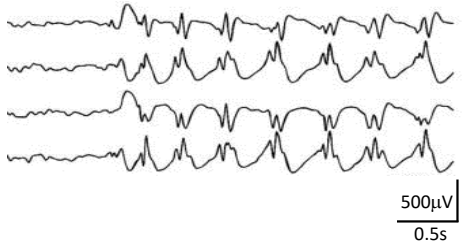
Sleep Spindle

100 millisec

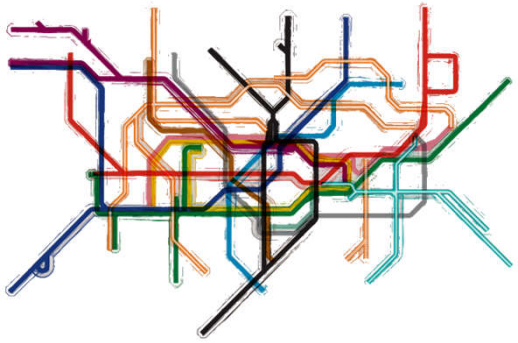
Sleep Spindle

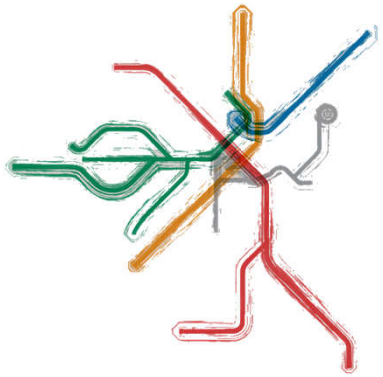


Seizure



Which one is Boston?:





Neuronal Networks: Summary