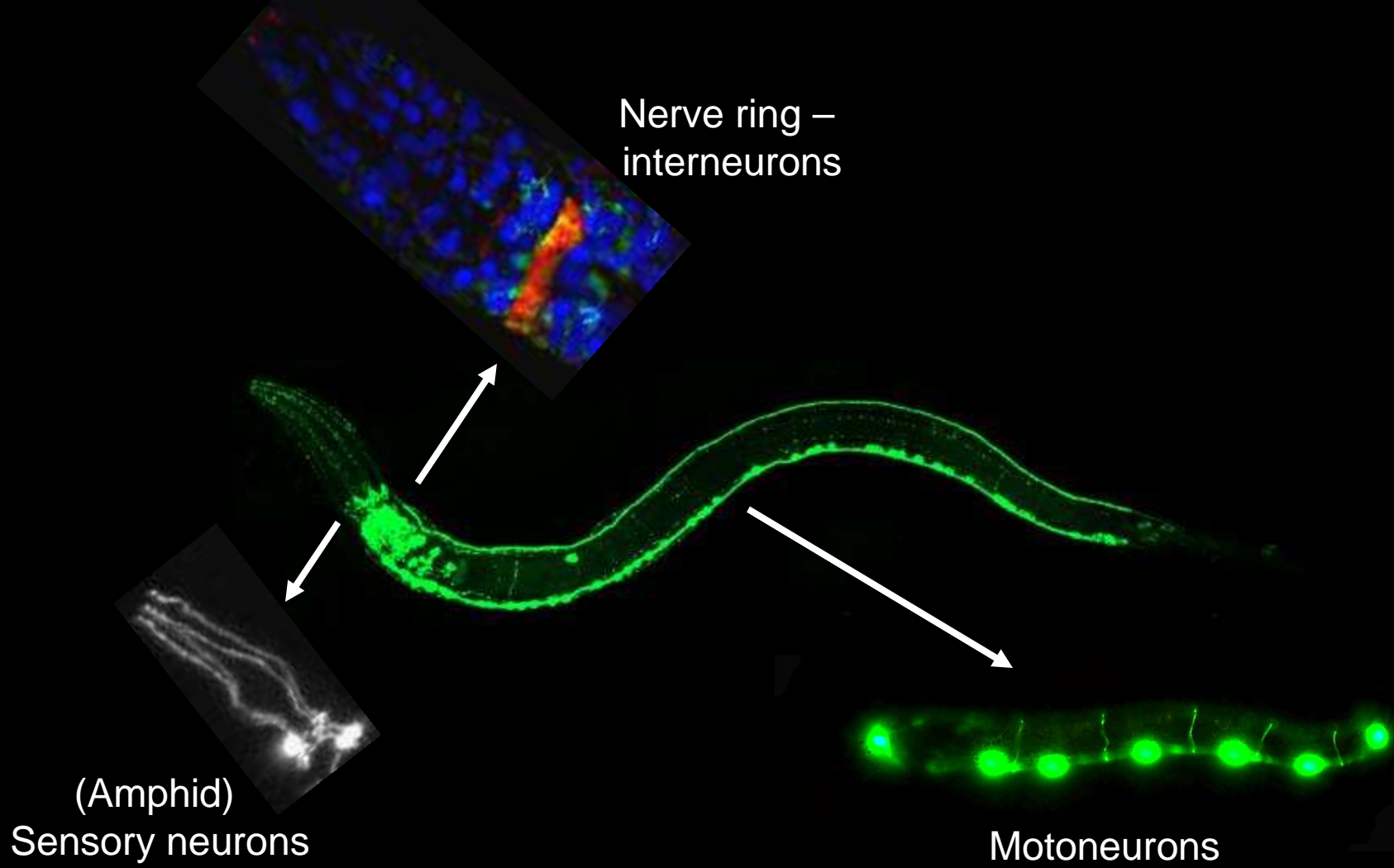


Plasticity on two different scales:  
on what scale is information  
processed?

David Biron

# *C. elegans* neurons

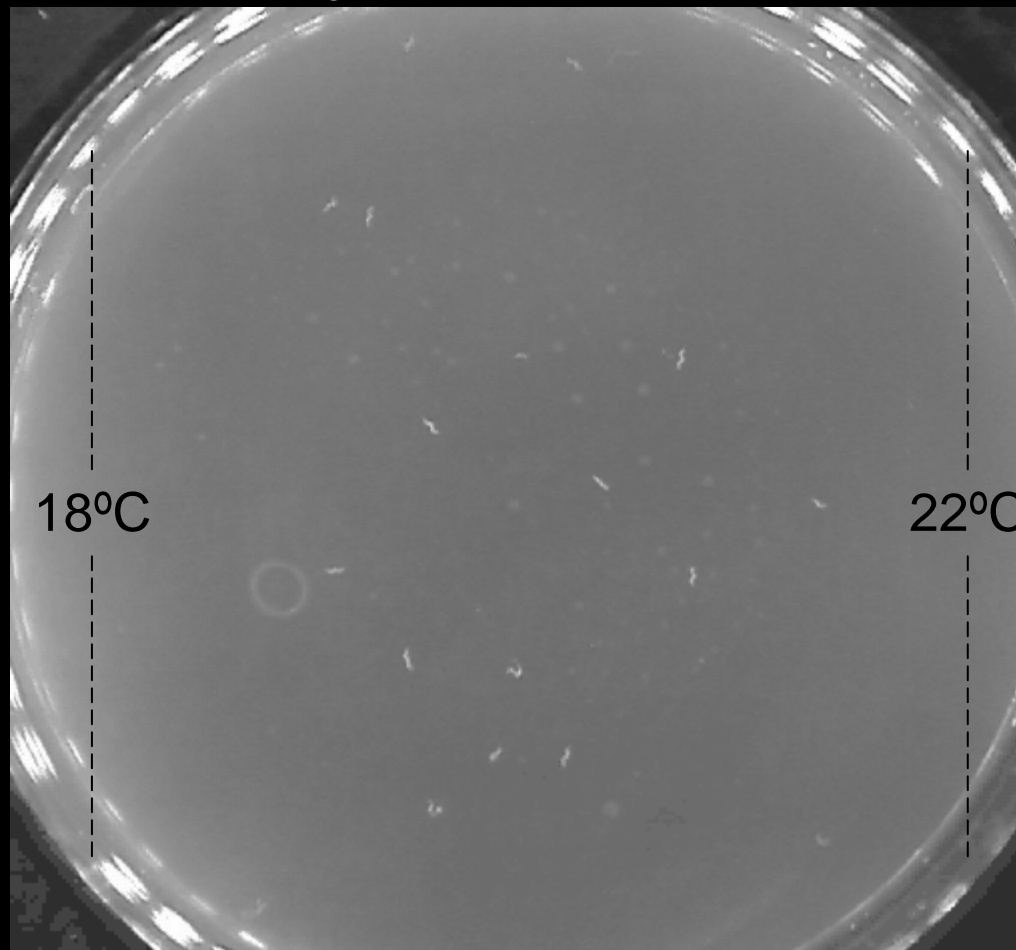


Thermotactic behavior depends on the previous cultivation temperature ( $T_s$ ) and on the ambient temperature ( $T$ )

(Hedgecock and Russell, 1975)

(Mori and Ohshima, 1995)

- $T = T_s$  : Isothermal Tracking



## Different levels of description of Thermotactic memory

- Behavior of the entire organism (1000  $\mu\text{m}$ )
- Information processing in neural circuits (10  $\mu\text{m}$ )
- Underlying molecular machinery – protein interactions (<0.01  $\mu\text{m}$ )

## *C. elegans* nomenclature

AFD

Sensory neuron



AIY

Inter-neuron



***WT dgk-3***

Enzyme (reduces DAG levels)

***dgk-3 (lof)***

A non-active *dgk-3*

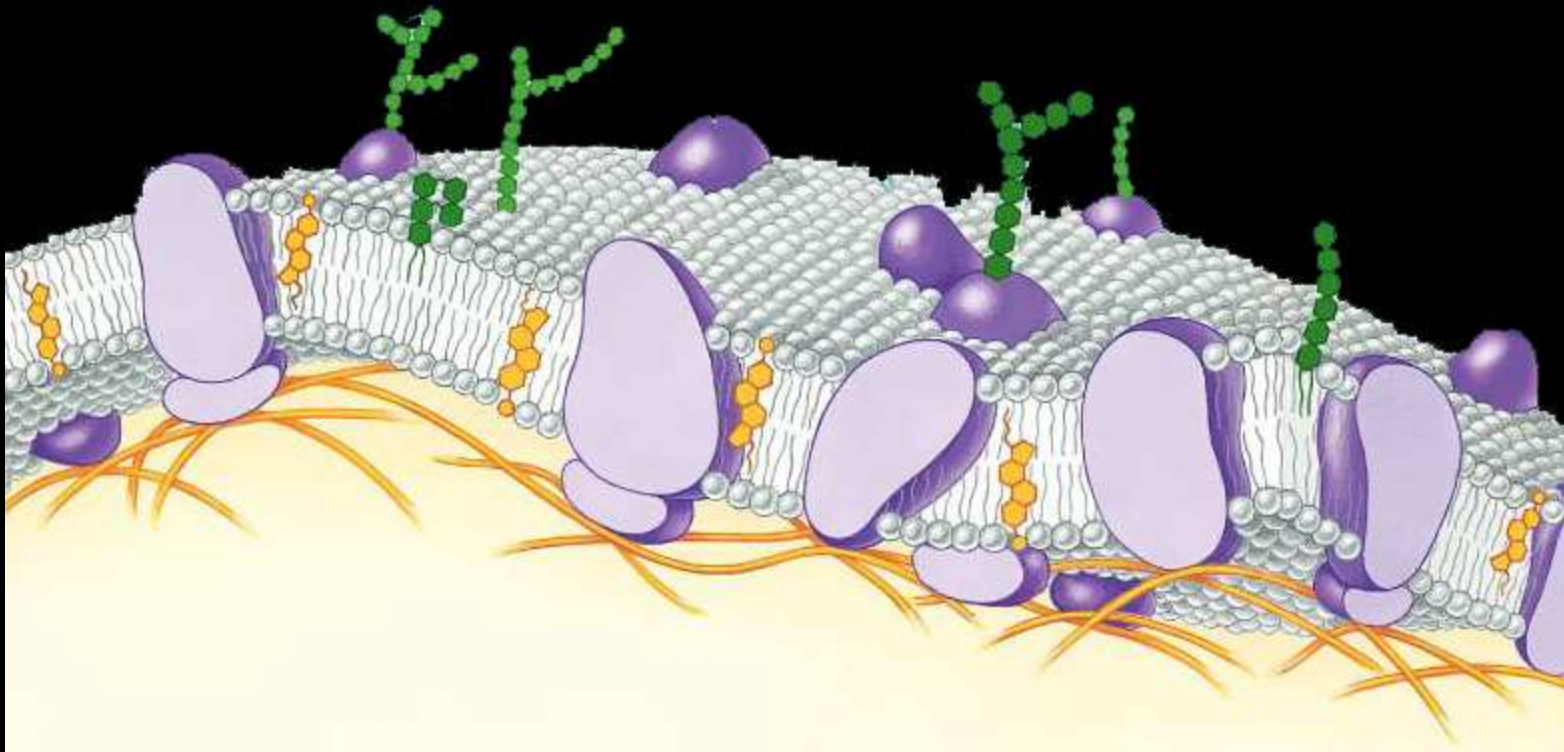


***dgk-3 gof***

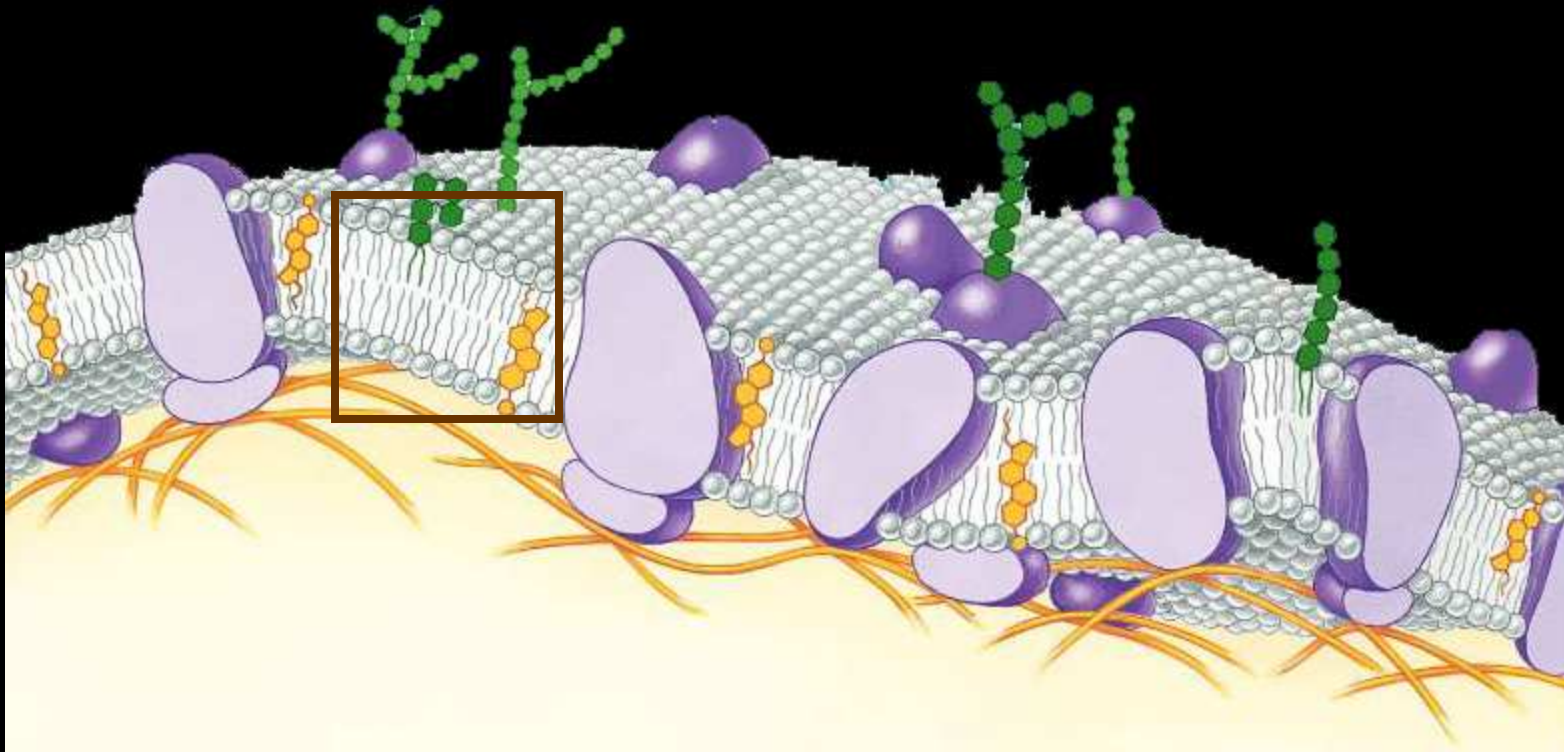
A hyper-active *dgk-3*



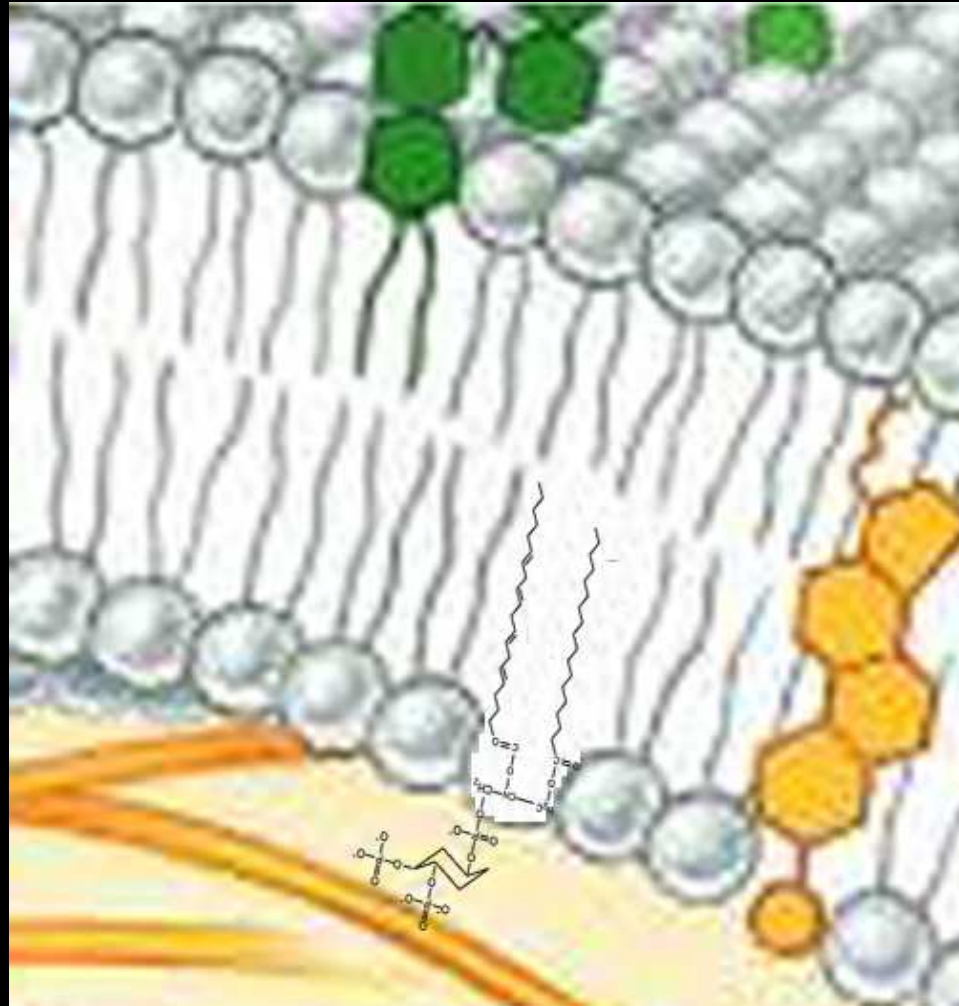
DAG is found in the plasma membrane



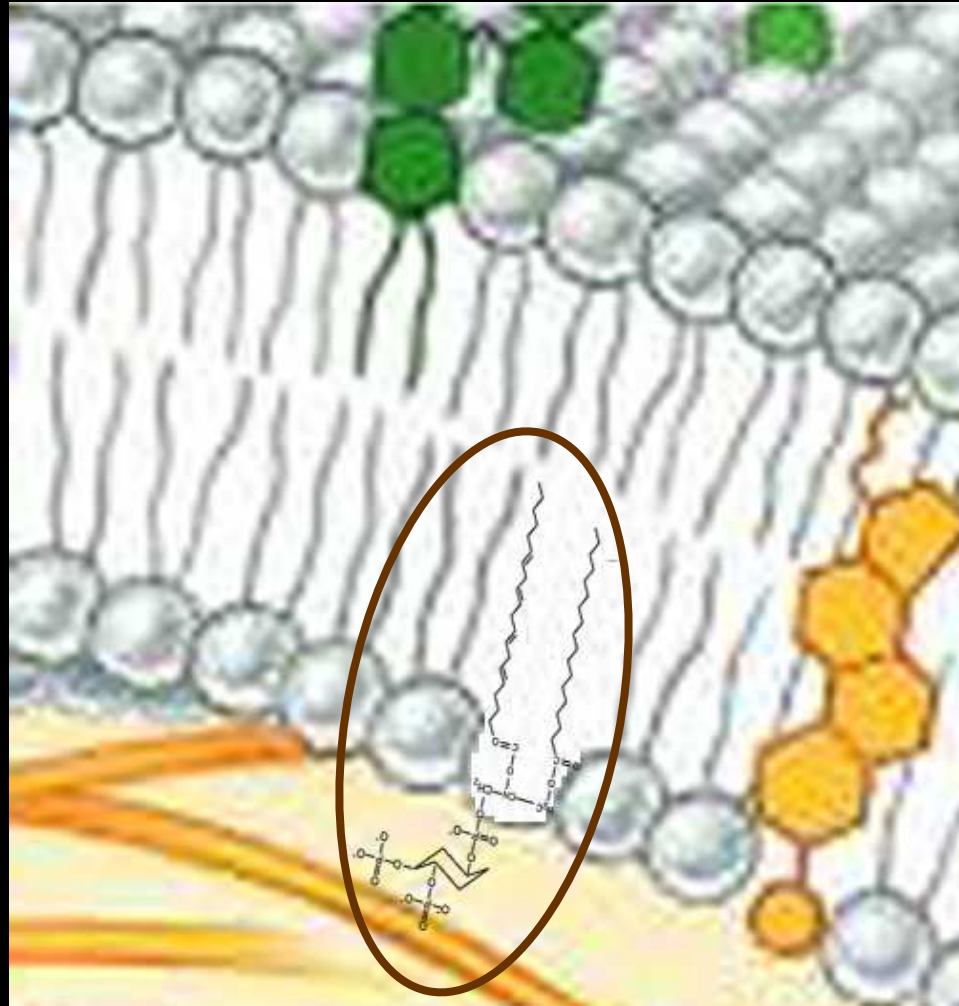
DAG is found in the plasma membrane



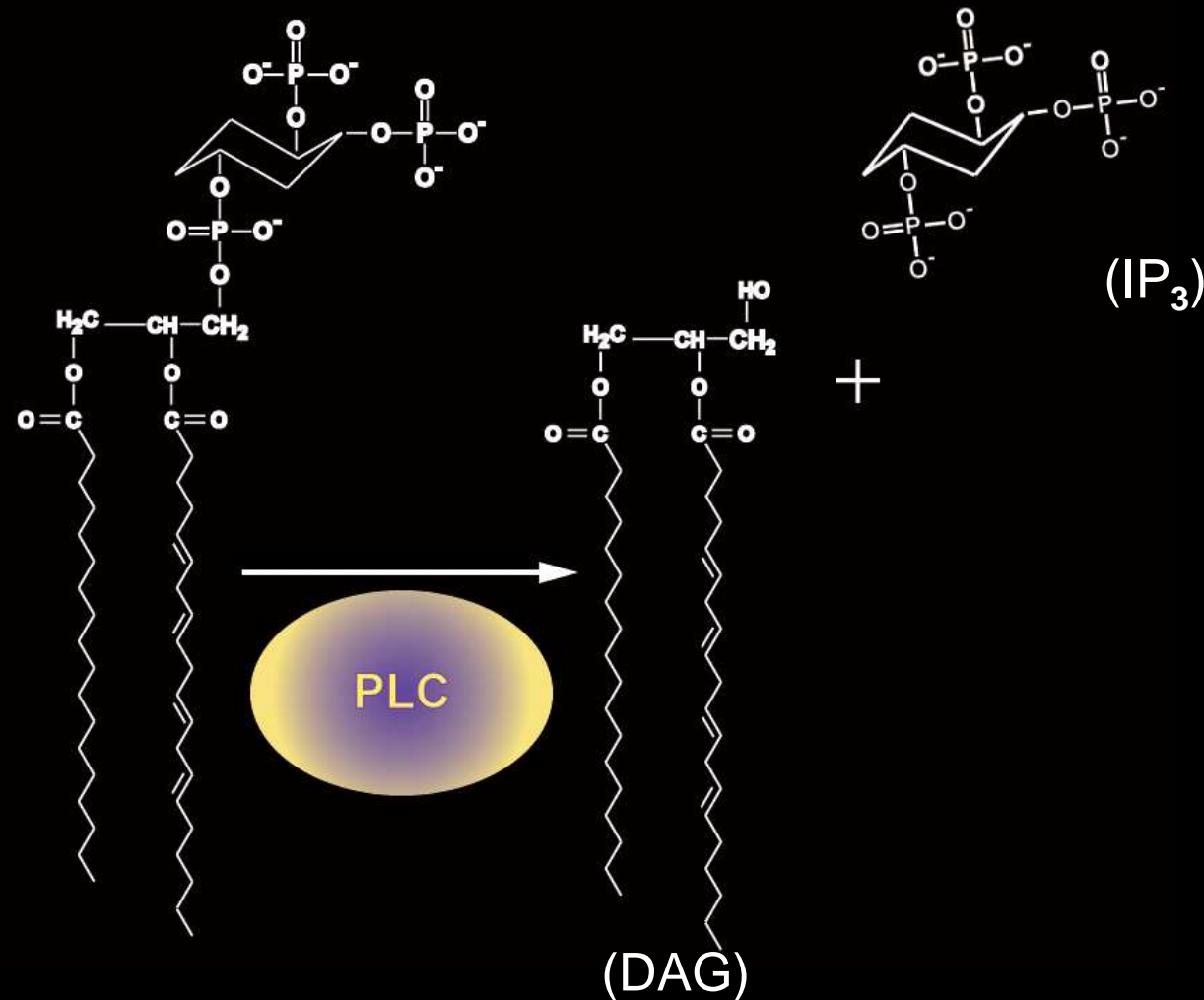
## A closer look at the plasma membrane



## A closer look at the plasma membrane



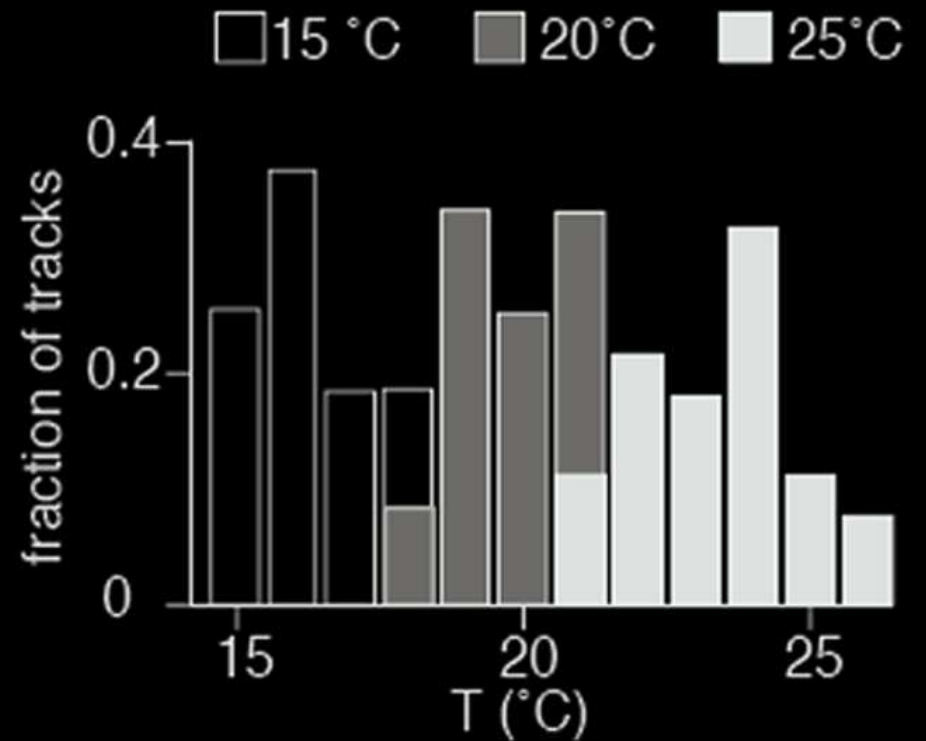
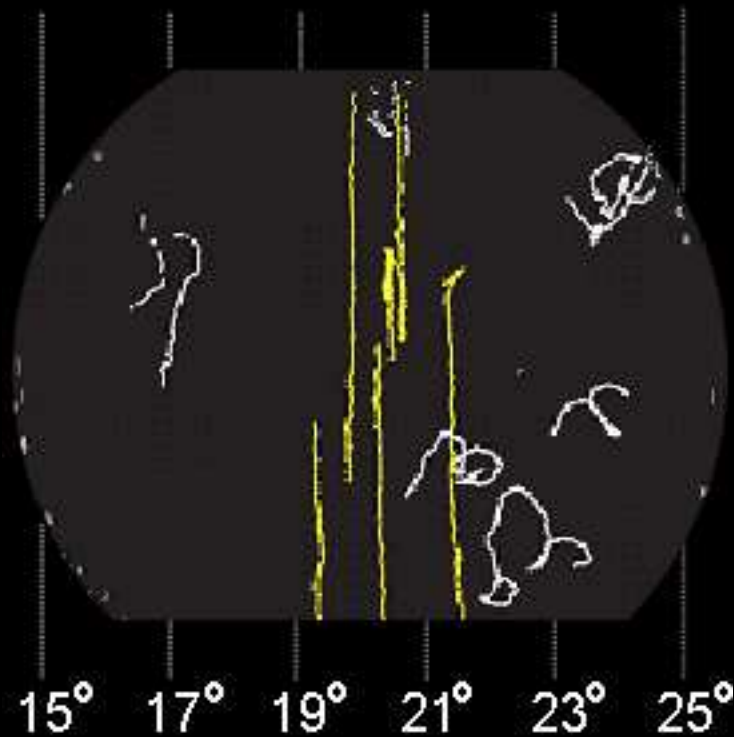
DAG and  $IP_3$  are *messengers* in the process of converting an extra-cellular signal to an electrical response  
(*sensory signal transduction*)



## *dgk-3* down-regulates DAG levels



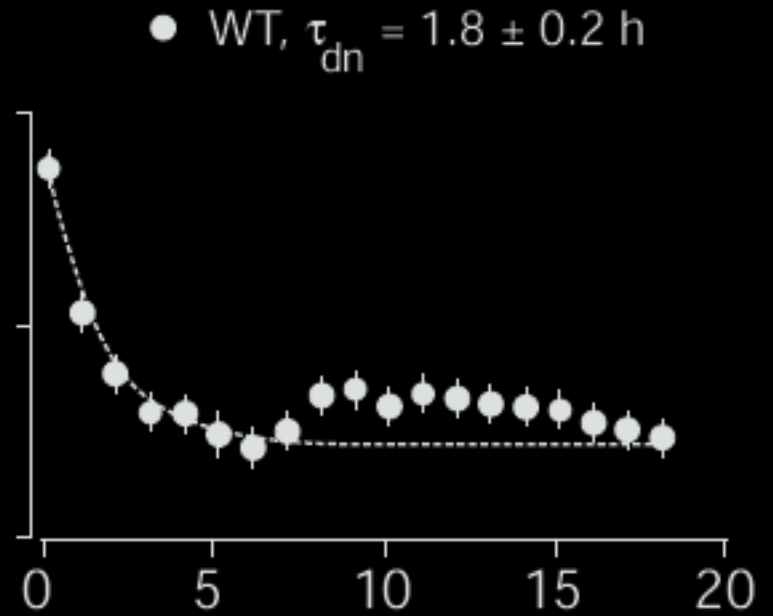
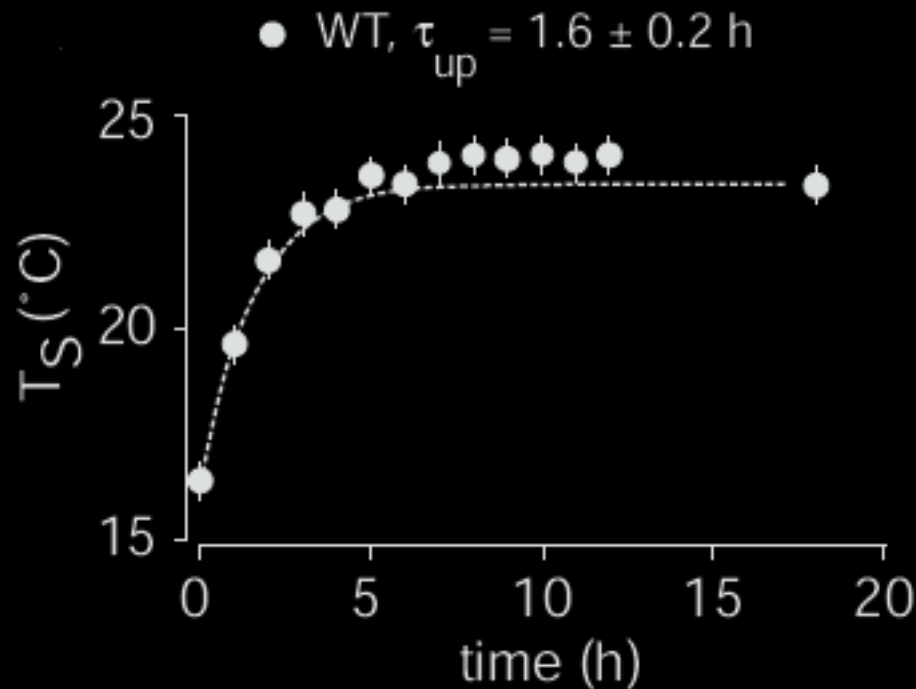
Entire organism level:  
Measuring the position of isothermal tracks  
defines the thermotactic set-point,  $T_s$



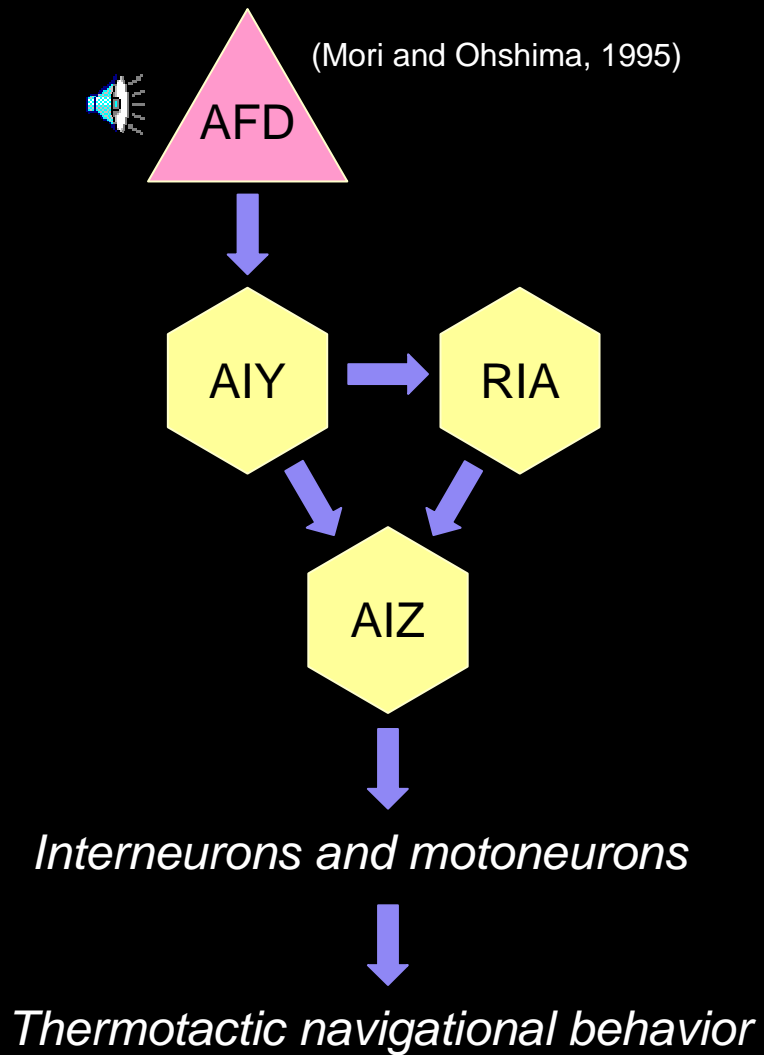
The thermotactic set-point ( $T_s$ ) of adult worms changes with continued cultivation at a new temperature



The thermotactic set-point ( $T_s$ ) of adult worms changes with continued cultivation at a new temperature

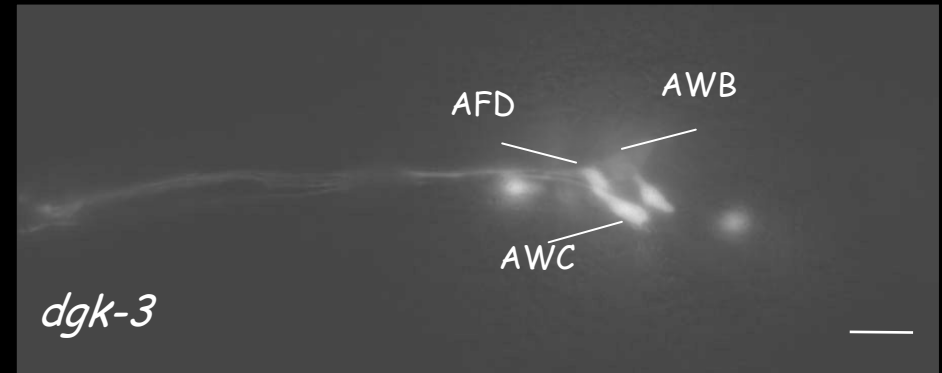
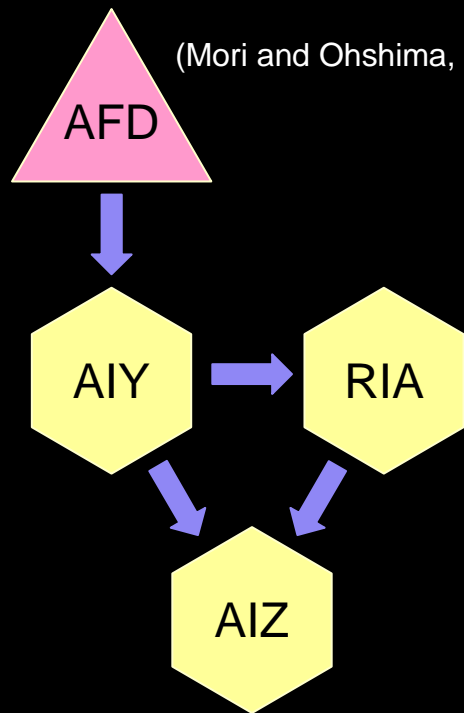


# A diacylglycerol kinase (*dgk-3*) is strongly expressed in the AFD neurons



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(Mori and Ohshima, 1995)



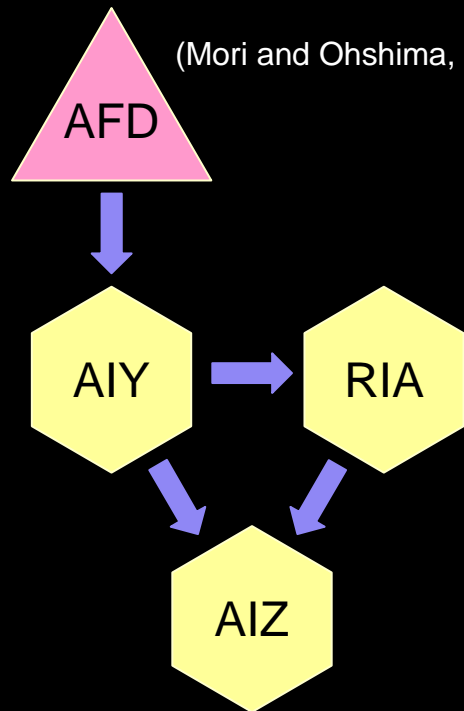
(Colosimo et al., 2004)

*Interneurons and motoneurons*

*Thermotactic navigational behavior*

# A diacylglycerol kinase (*dgk-3*) is strongly expressed in the AFD neurons

(Mori and Ohshima, 1995)

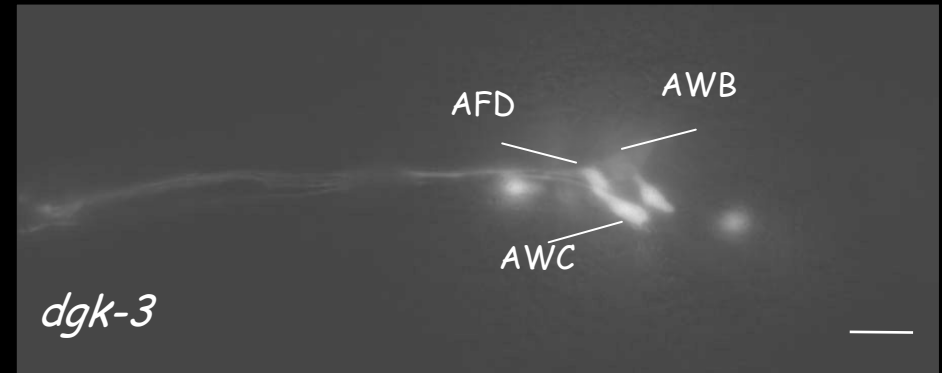


*Interneurons and motoneurons*

*Thermotactic navigational behavior*



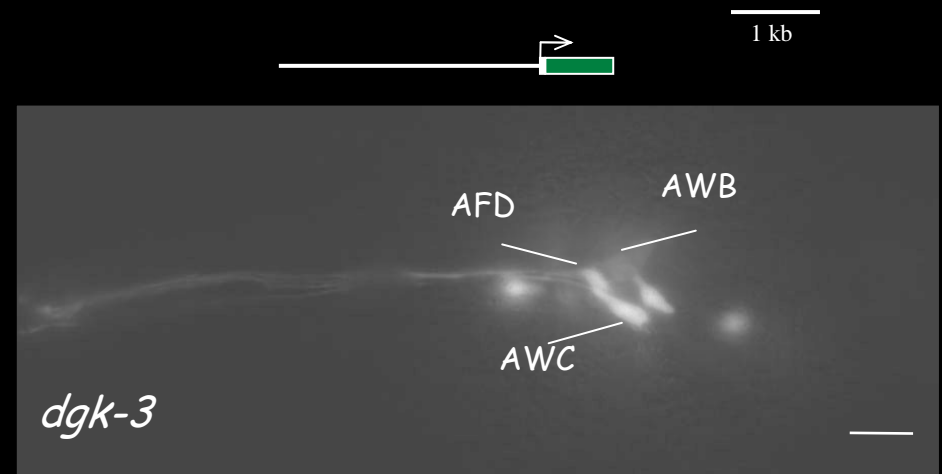
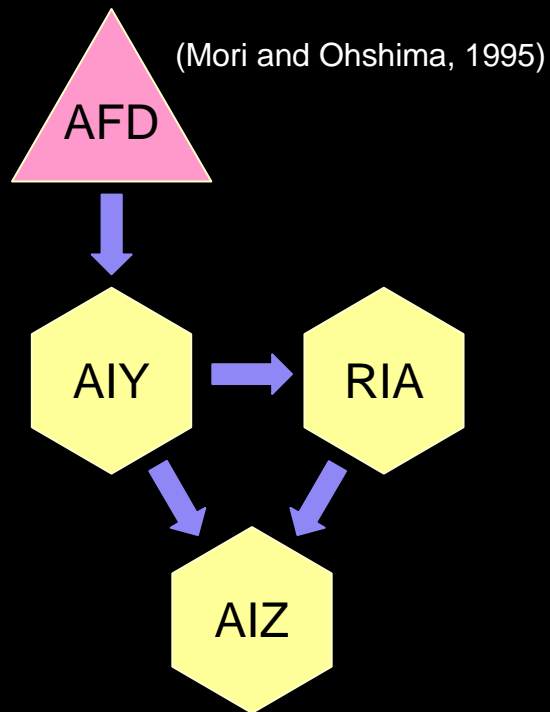
1 kb



(Colosimo et al., 2004)

	$T > T_s$	$T = T_s$
Wild-Type	Cryophilic	Track
<i>dgk-3</i>	Cryophilic	Track

So *dgk-3* is in the right neuron and has known ties to sensory signal transduction..



(Colosimo et al., 2004)

Interneurons and motoneurons  
 ↓  
 Thermotactic navigational behavior

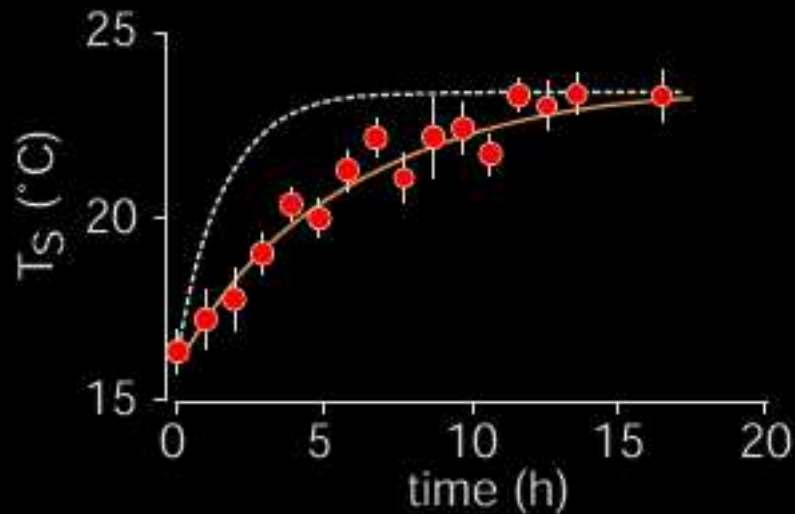
	$T > T_s$	$T = T_s$
Wild-Type	Cryophilic	Track
<i>dgk-3</i>	Cryophilic	Track

# Knocking out *dgk-3* disrupts only the worm's ability to reset $T_S$ to new warmer temperatures



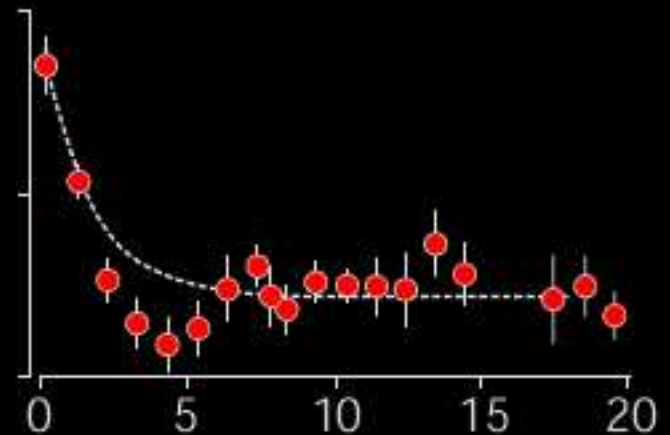
..... Reference: WT

● *dgk-3(gk110)*  $\tau_{up} = 5.8 \pm 1.0$  h \*\*

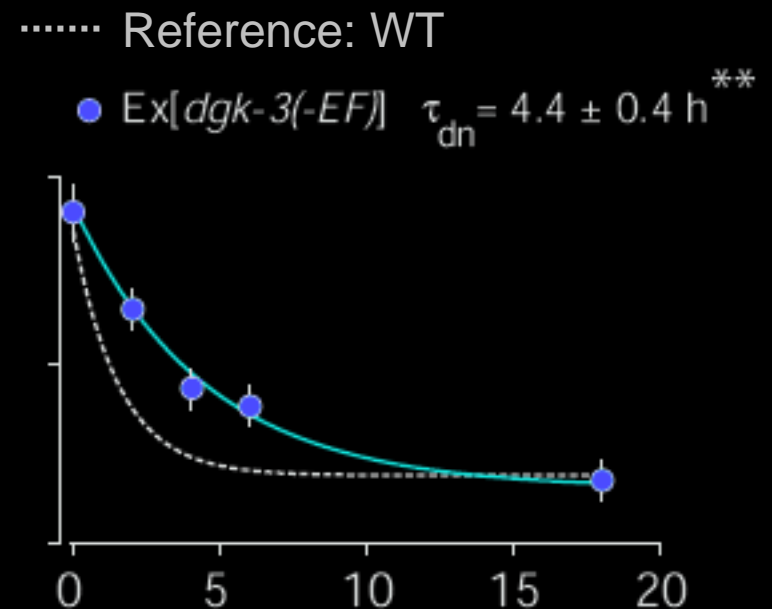
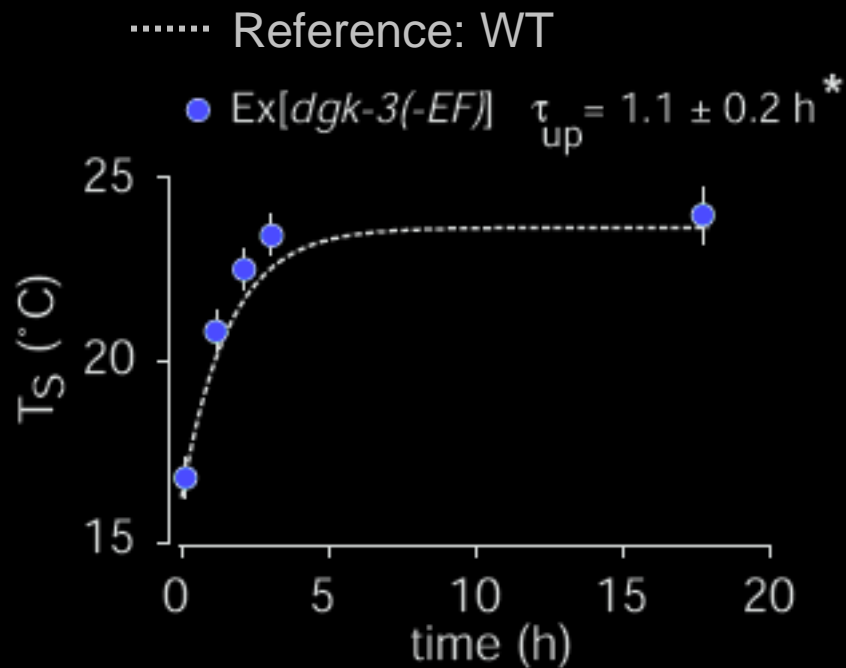


..... Reference: WT

● *dgk-3(gk110)*  $\tau_{dn} = 1.1 \pm 0.2$  h

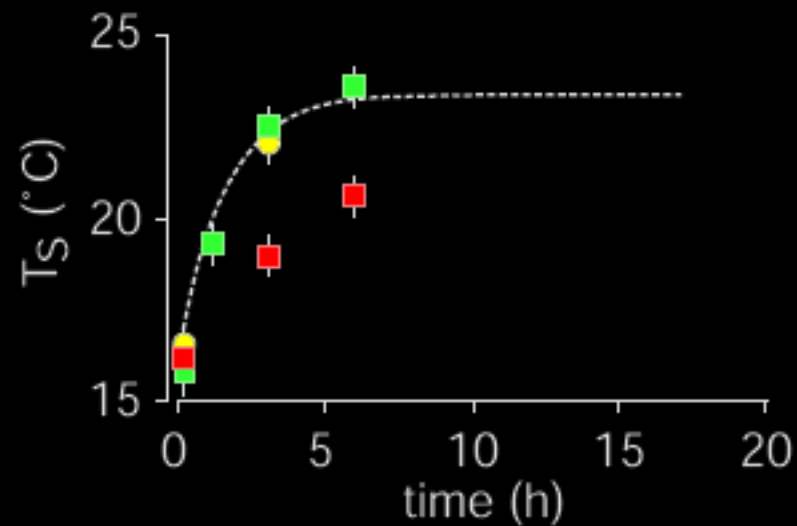


# A gain of function mutation of the *dgk-3* gene disrupts the worm's ability to reset $T_S$ to new colder temperatures



# AFD-specific expression of *dgk-3* rescues the upshift $T_S$ defect

- *dgk-3(gk110); Ex[ttx-1p::dgk-3] line1*
- *dgk-3(gk110); Ex[ttx-1p::dgk-3] line2*
- *dgk-3(gk110); Ex[ttx-1p]*



In a cycling cultivation temperature *dgk-3* mutants reset  $T_S$  to a lower value than wild-type because  $T_S$  depends on  $\tau_{up}/\tau_{dn}$

WT:  $\tau_{up}/\tau_{dn} = 1.6/1.8$

*dgk-3*:  $\tau_{up}/\tau_{dn} = 5.8/1.1$

