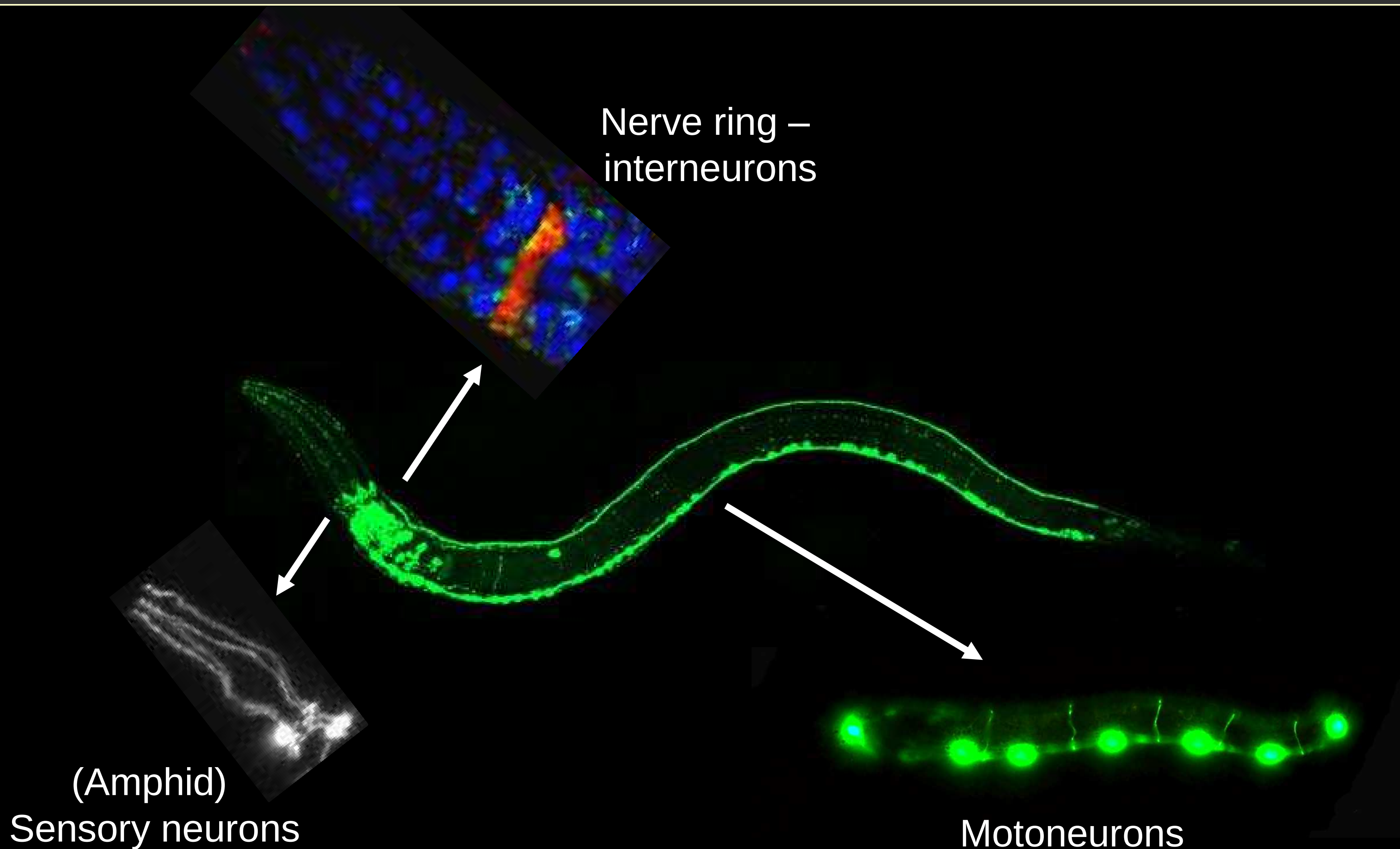
Plasticity on two different scales: on what scale is information processed?

David Biron

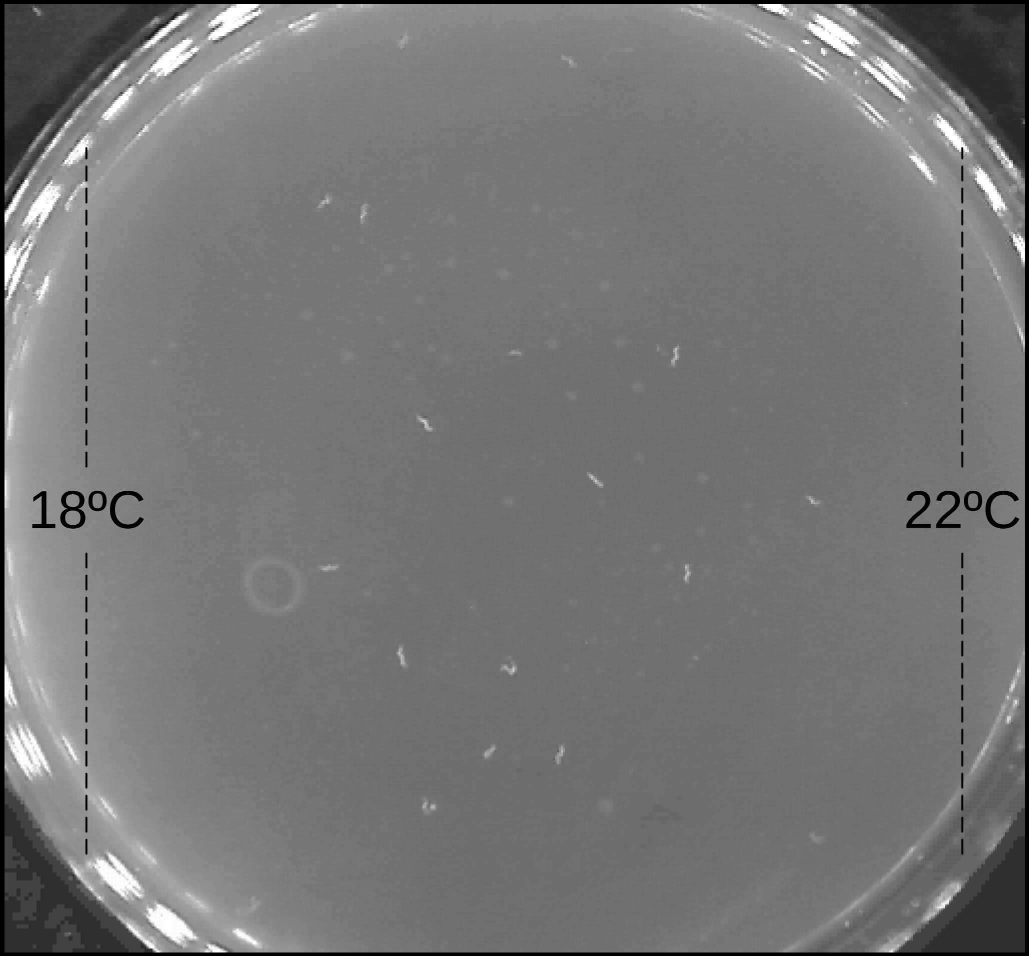
C. elegans neurons



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 μm)
- Information processing in neural circuits (10 μm)
- Underlying molecular machinery – protein interactions (<0.01 μm)

C. elegans nomenclature

AFD — Sensory neuron

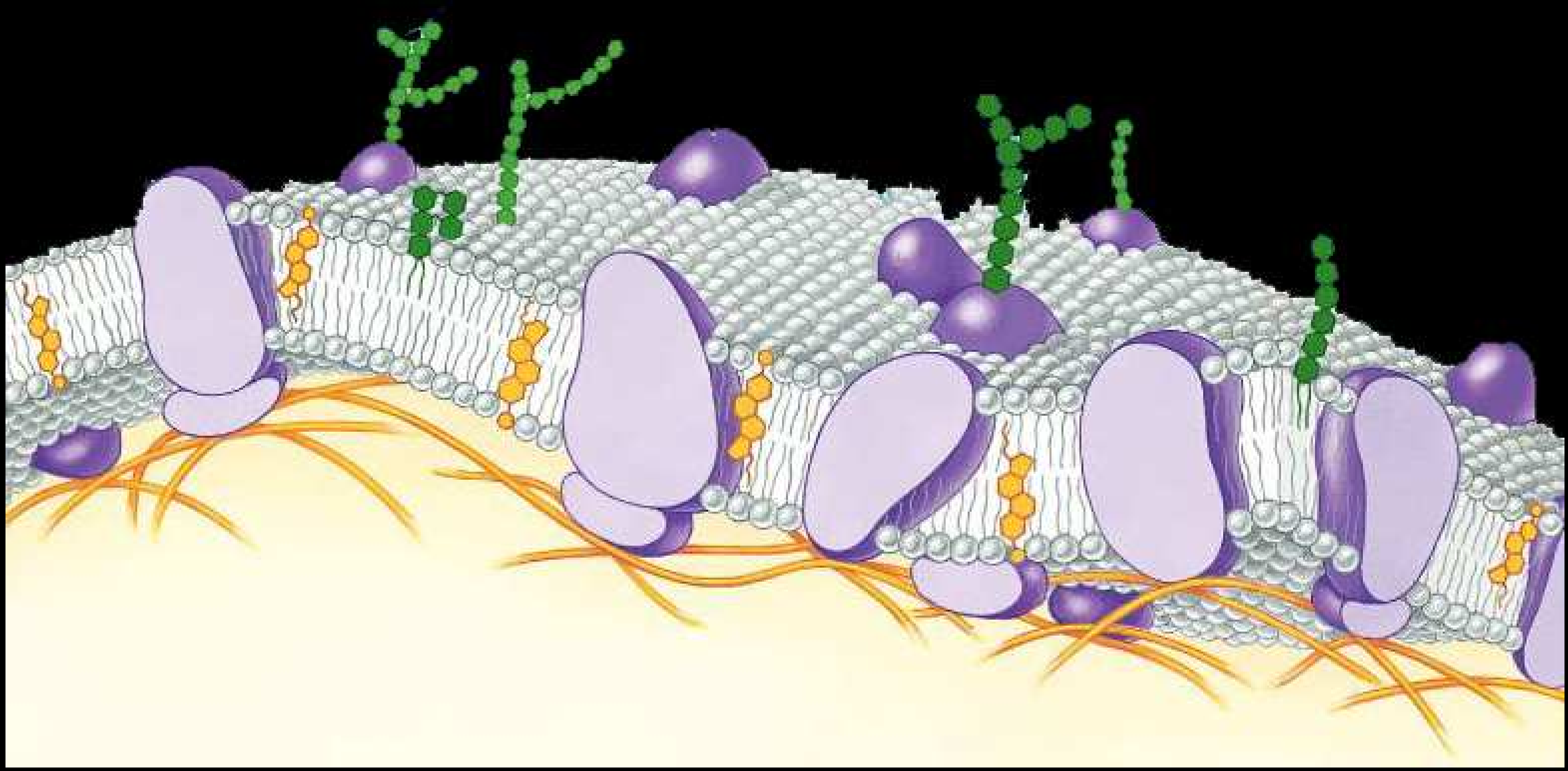
AIY — Inter-neuron

WT dgk-3 — Enzyme (reduces DAG levels)

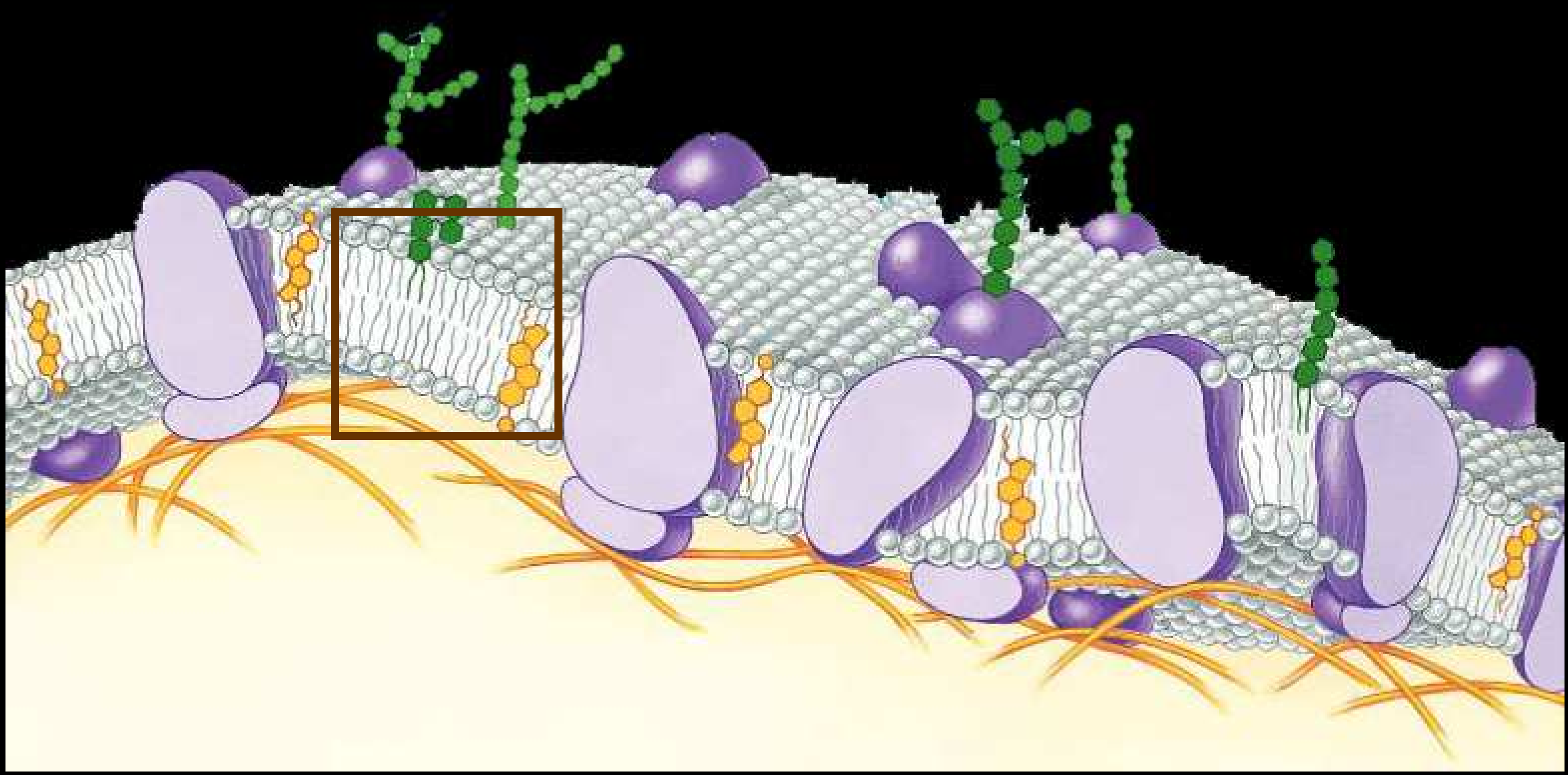
dgk-3 (lof) — A non-active *dgk-3*

dgk-3 gof — A hyper-active *dgk-3*

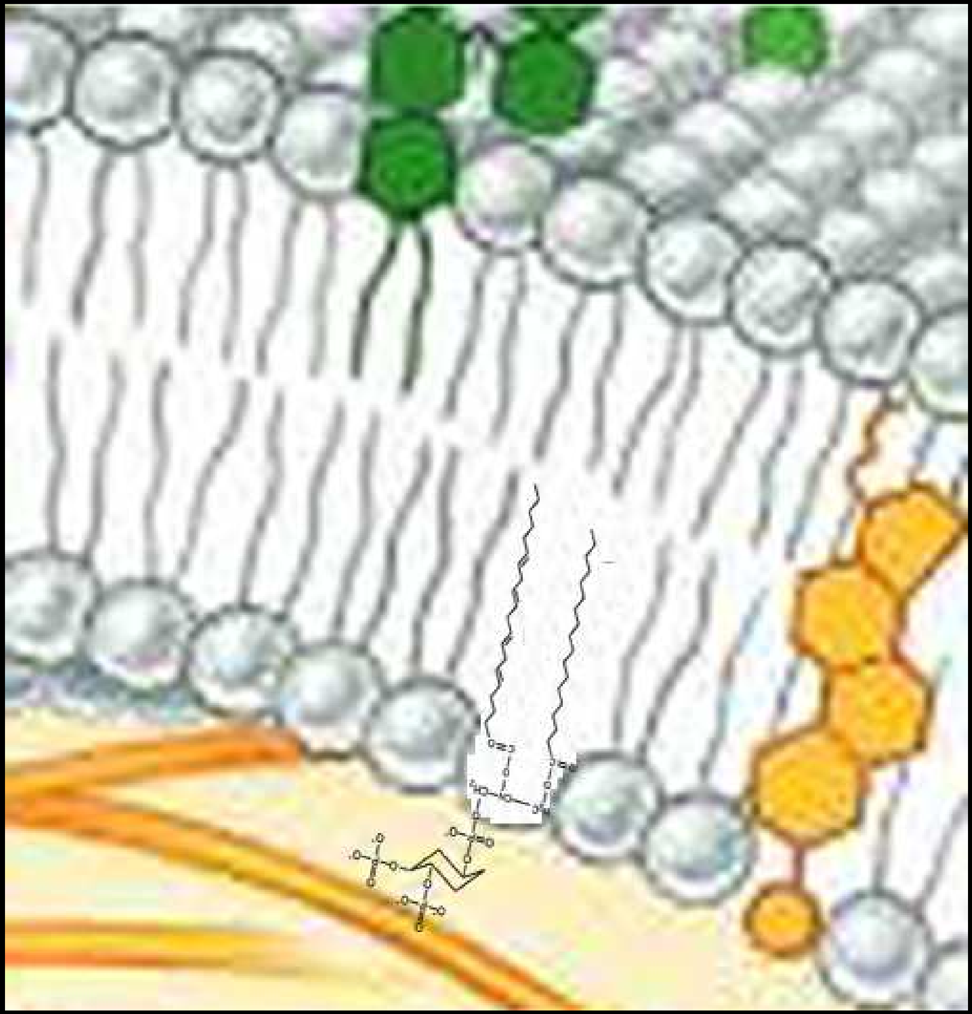
DAG is found in the plasma membrane



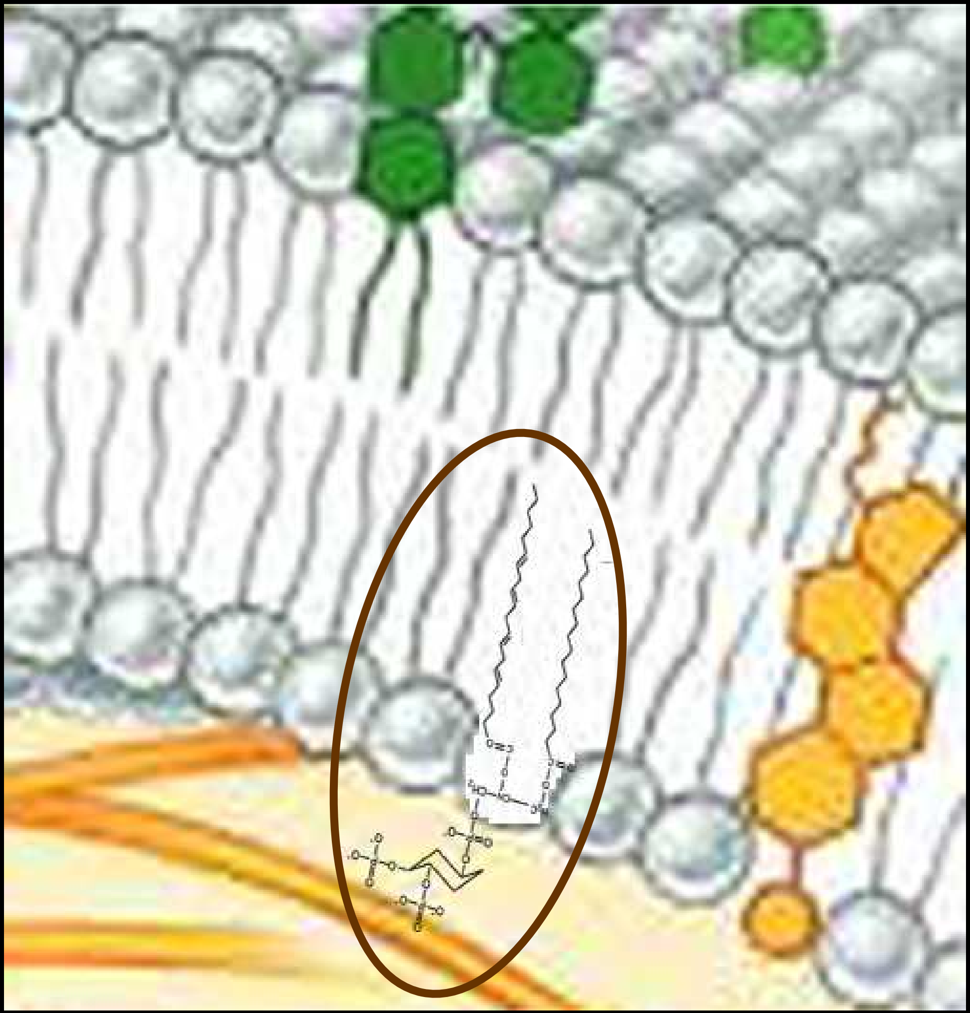
DAG is found in the plasma membrane



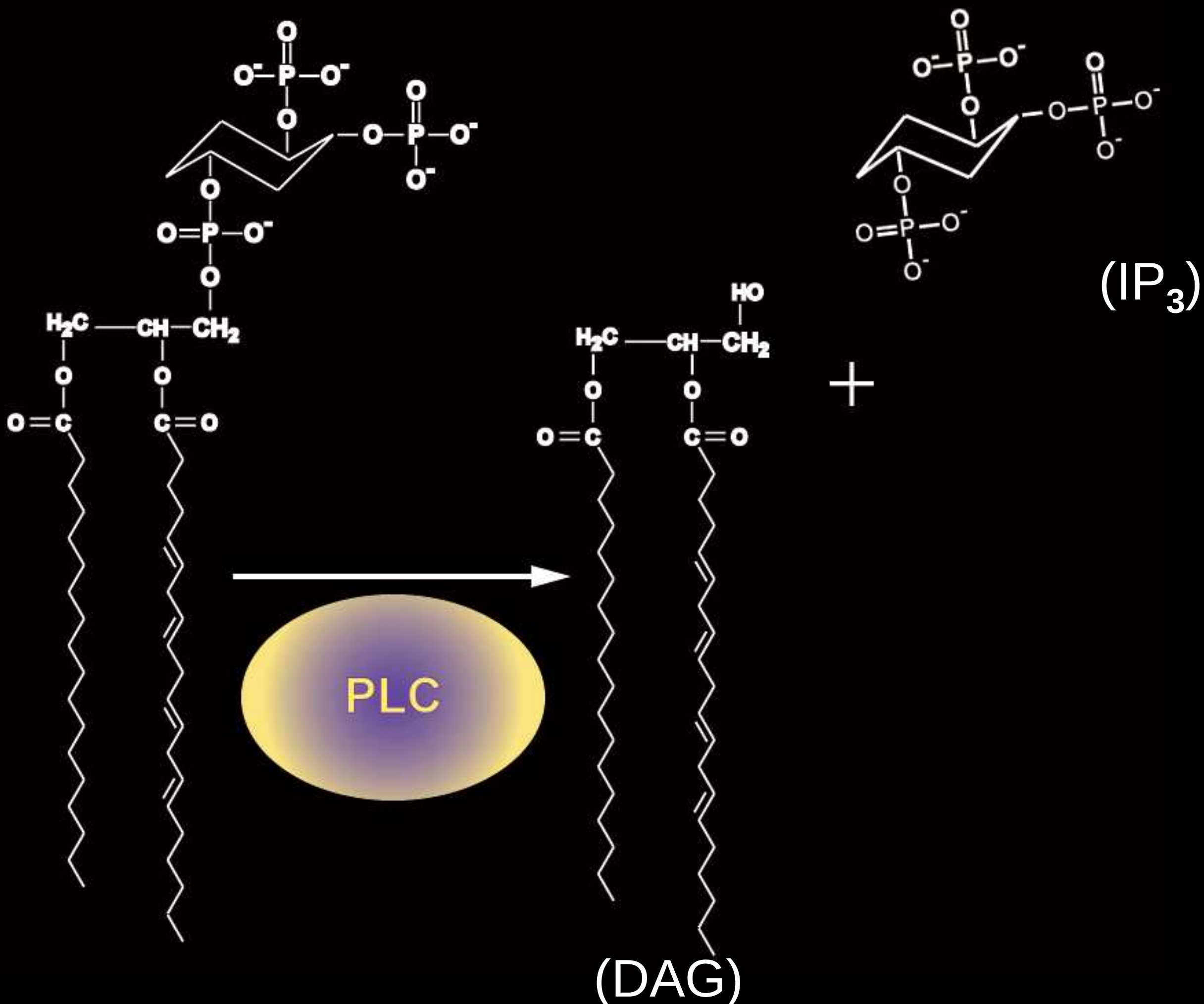
A closer look at the plasma membrane



A closer look at the plasma membrane

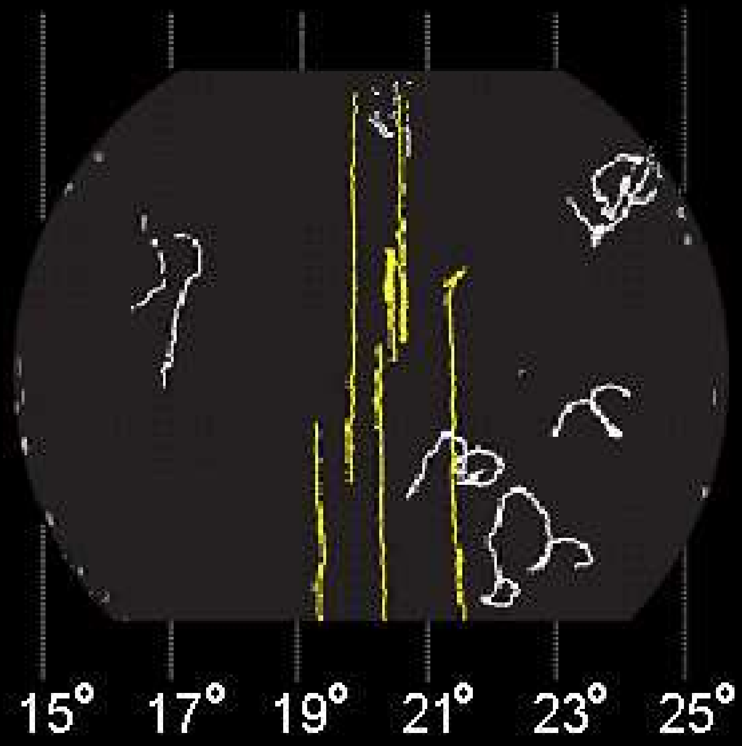


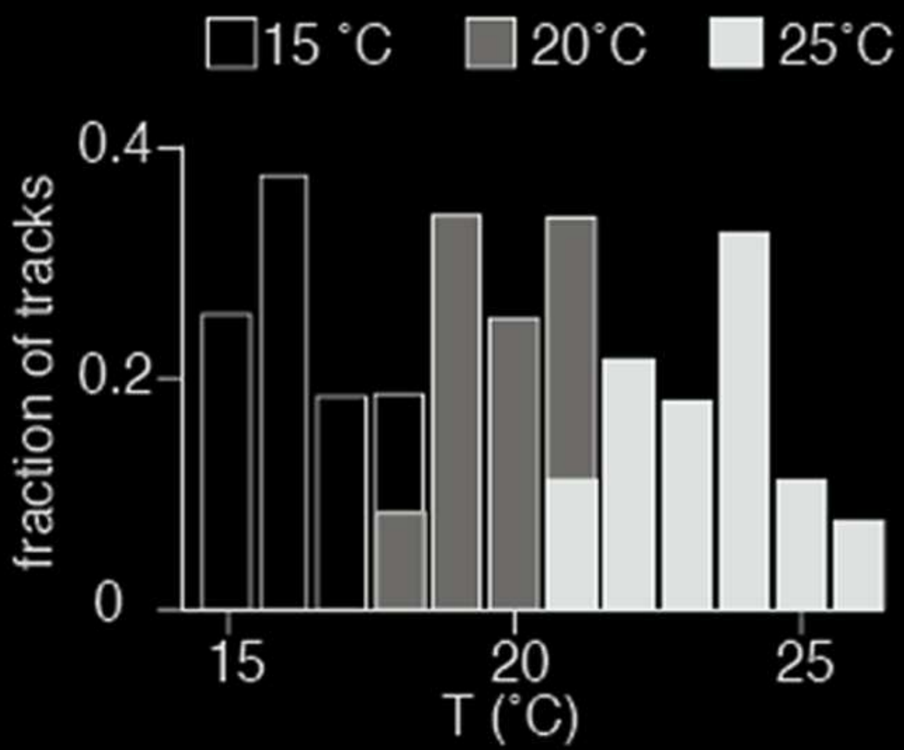
DAG and IP_3 are *messengers* in the process of converting an extra-cellular signal to an electrical response (*sensory signal transduction*)



dgk-3 down-regulates DAG levels

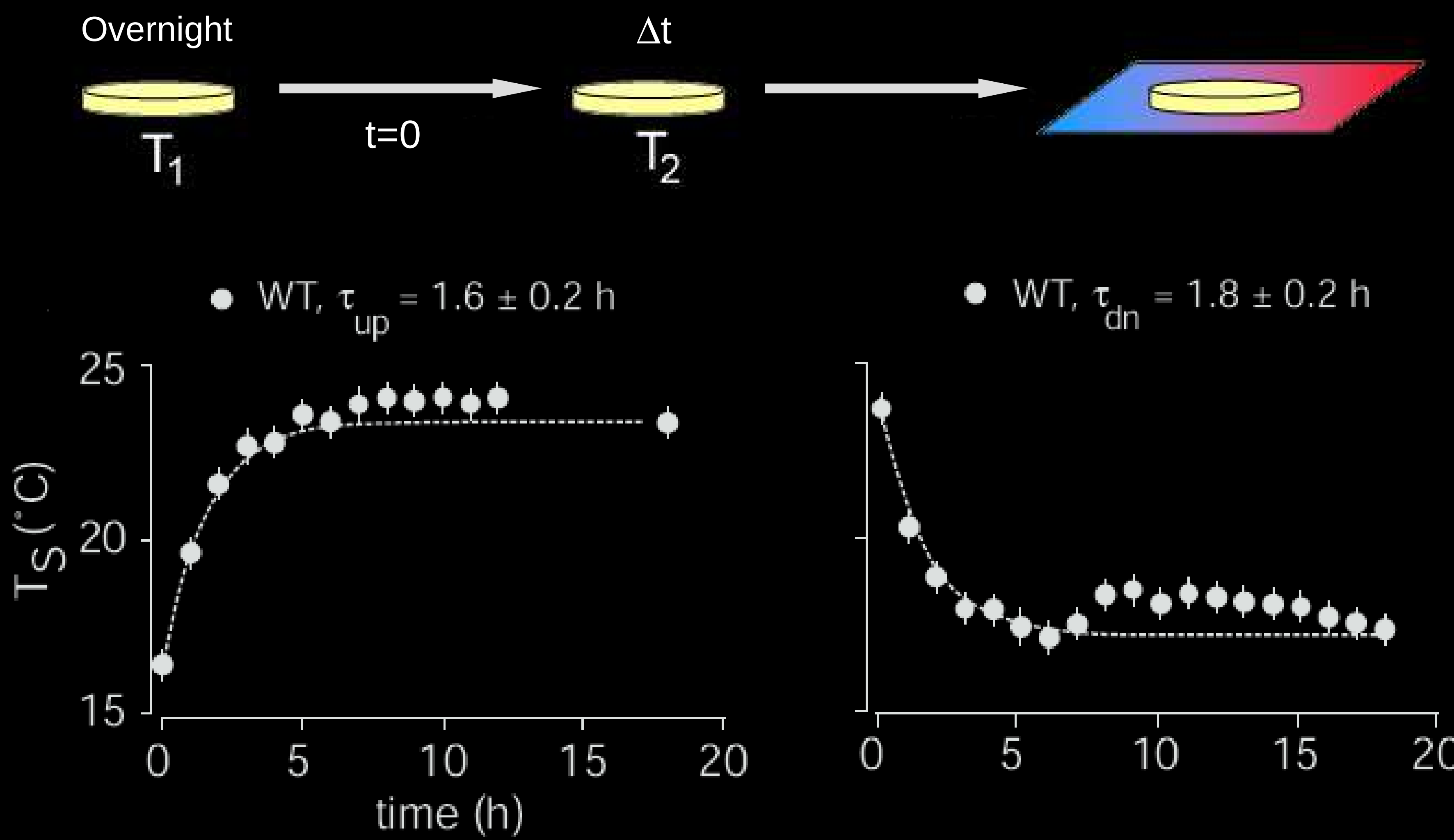
Entire organism level:
Measuring the position of isothermal tracks
defines the thermotactic set-point, T_s



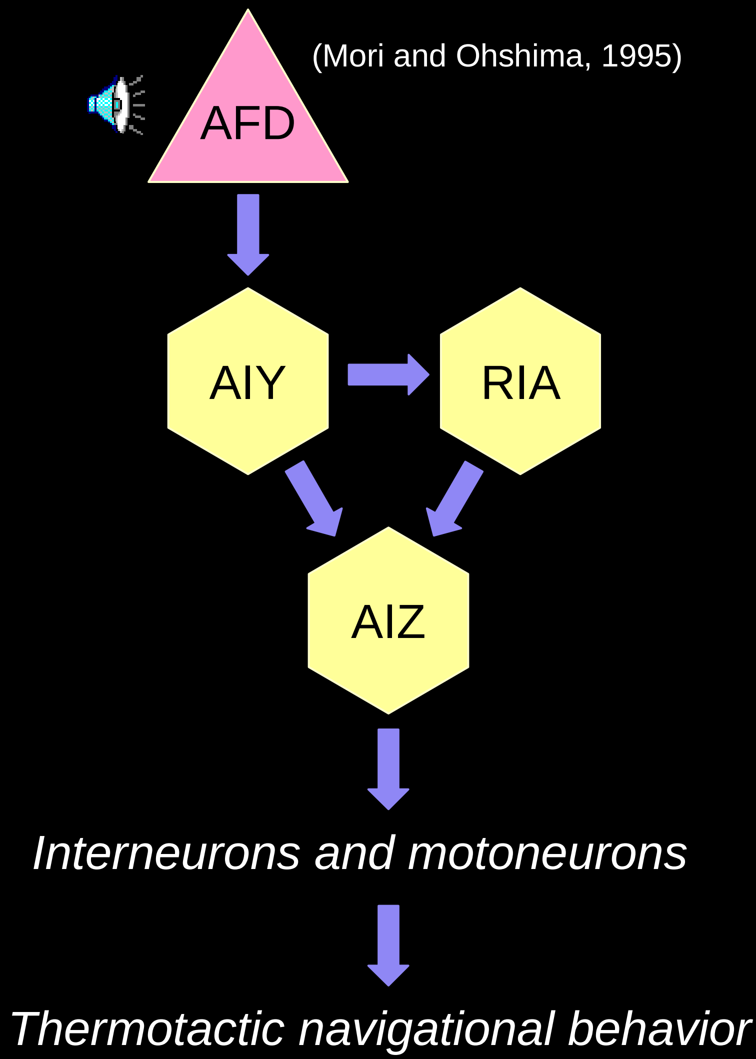


The thermotactic set-point (T_s) of adult worms changes with continued cultivation at a new temperature

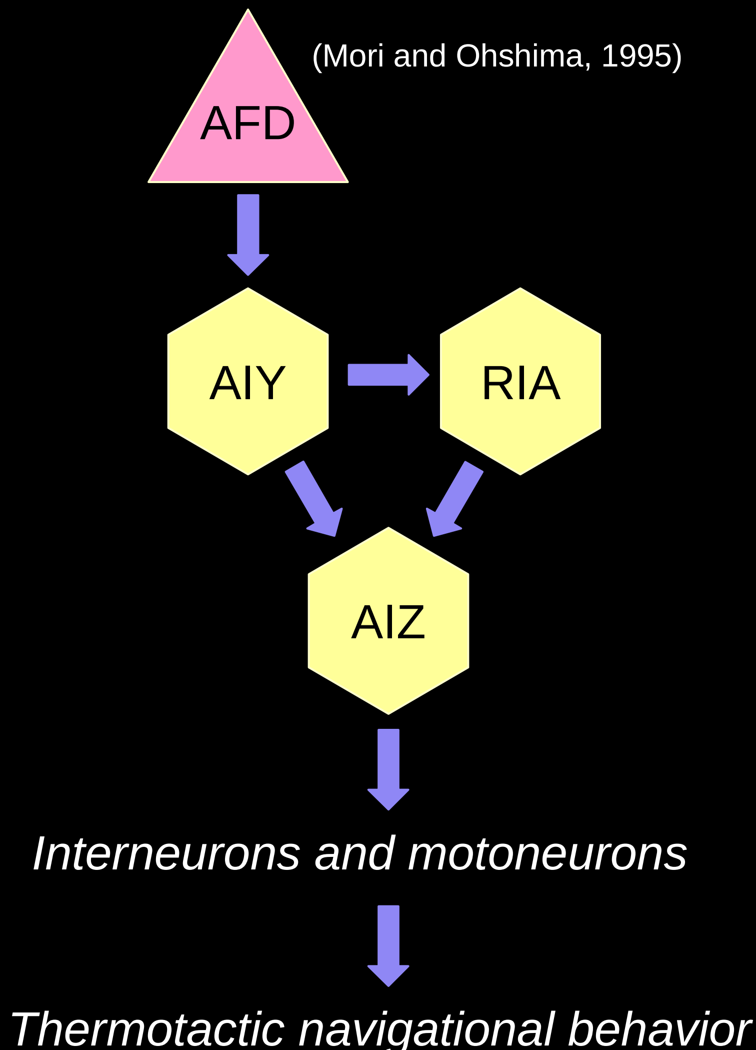
The thermotactic set-point (T_s) of adult worms changes with continued cultivation at a new temperature

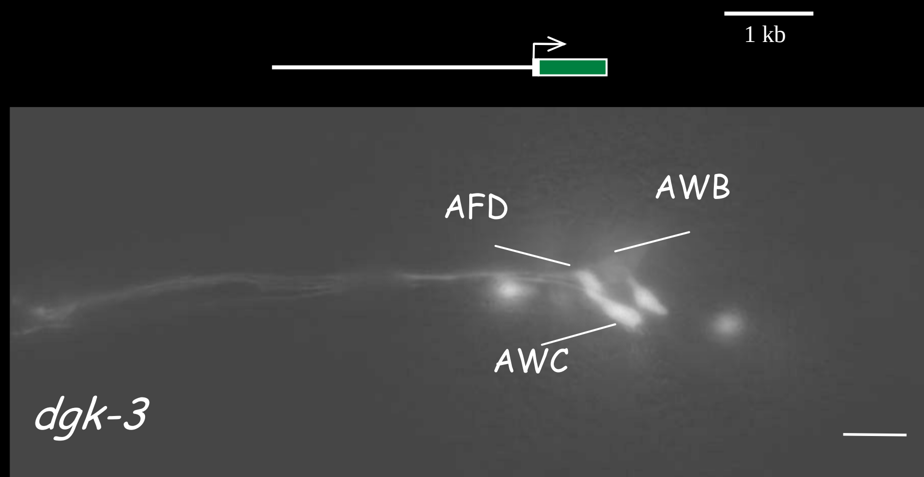


A diacylglycerol kinase (*dgk-3*) is strongly expressed in the AFD neurons



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

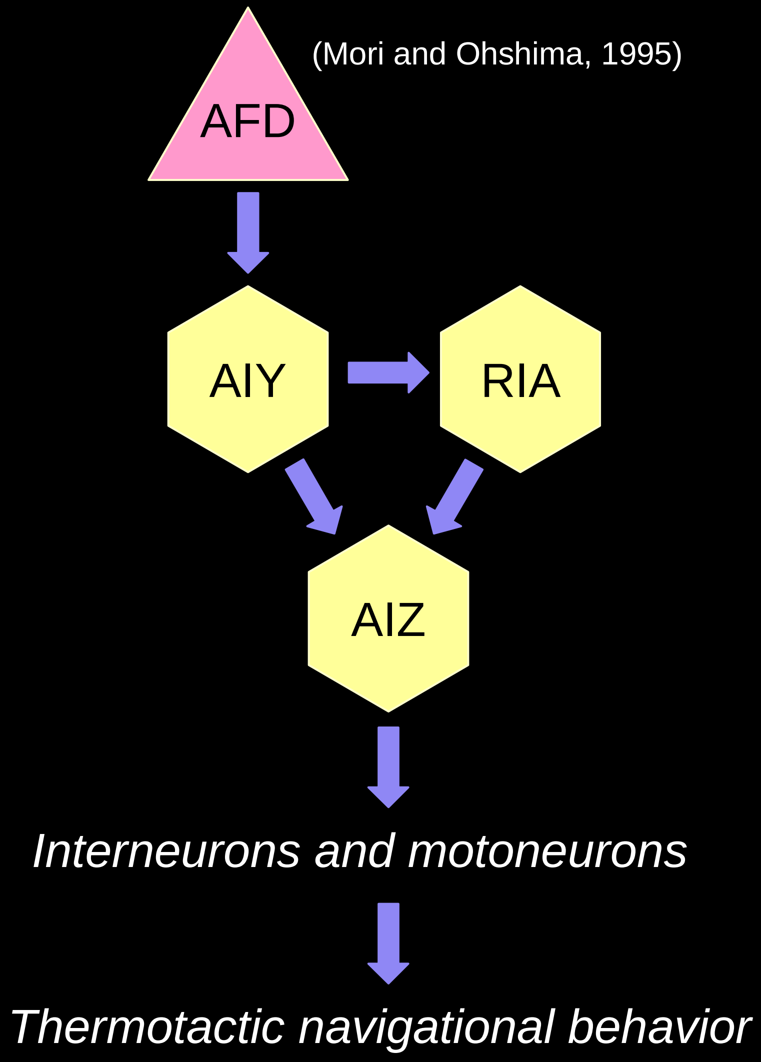


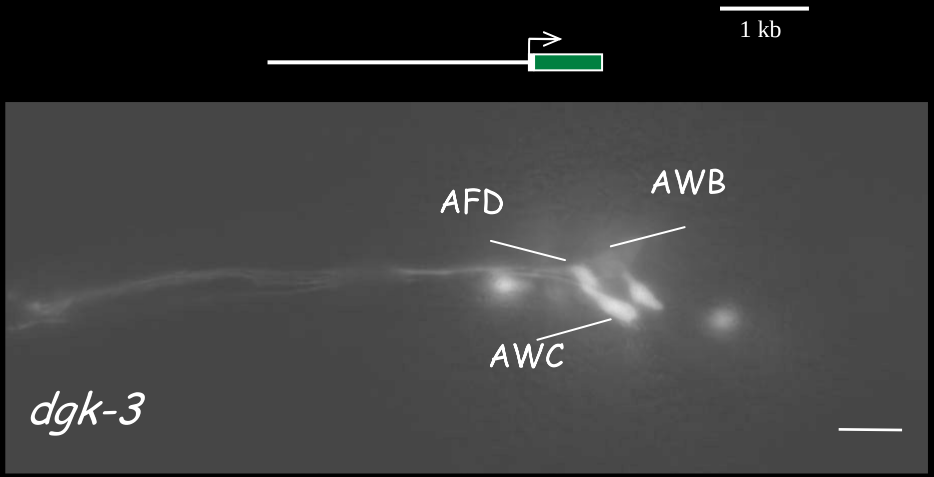


(Colosimo et al., 2004)

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

(Mori and Ohshima, 1995)

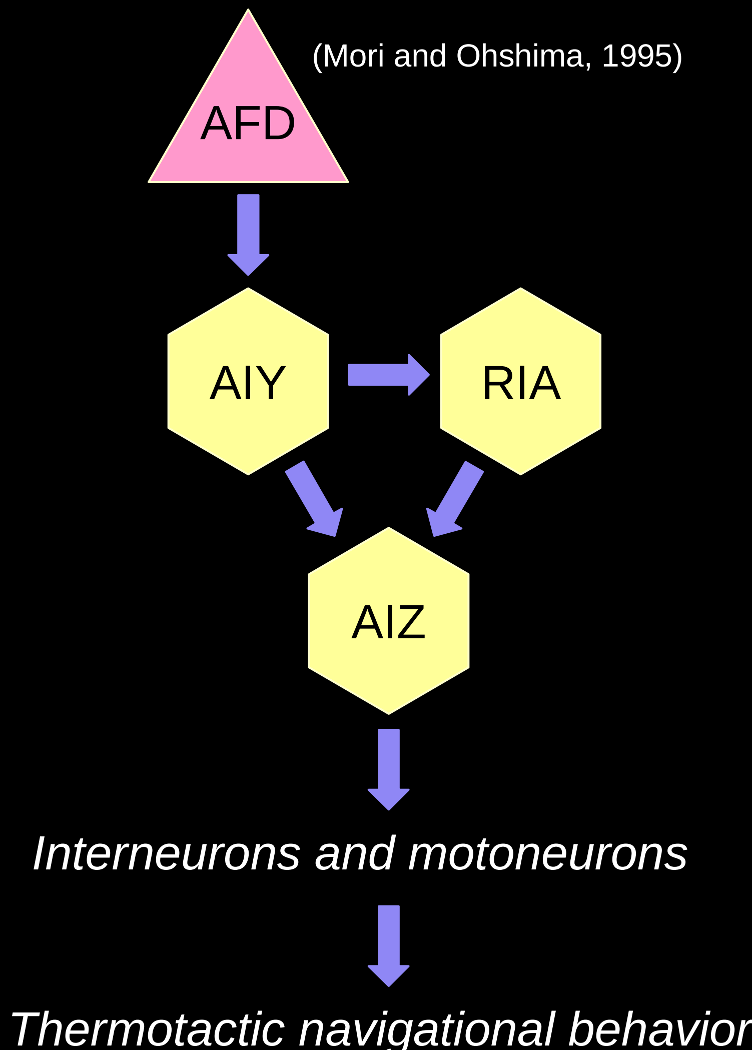




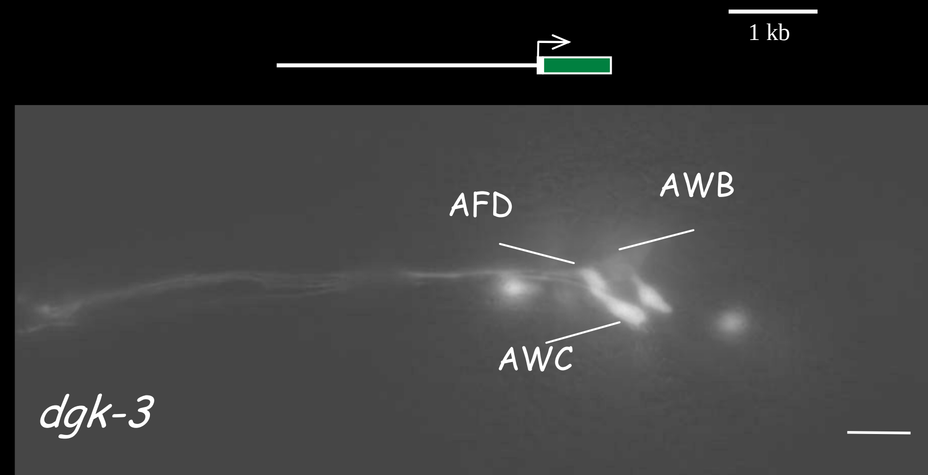
(Colosimo et al., 2004)

	$T > T_S$	$T = T_S$
Wild-Type	Cryophilic	Track
dgk-3	Cryophilic	Track

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



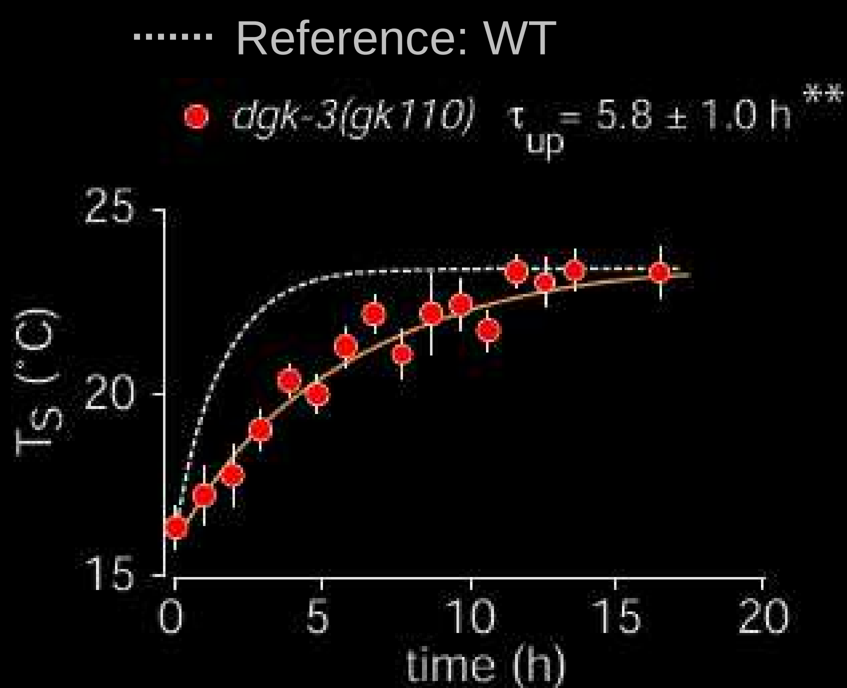
(Mori and Ohshima, 1995)

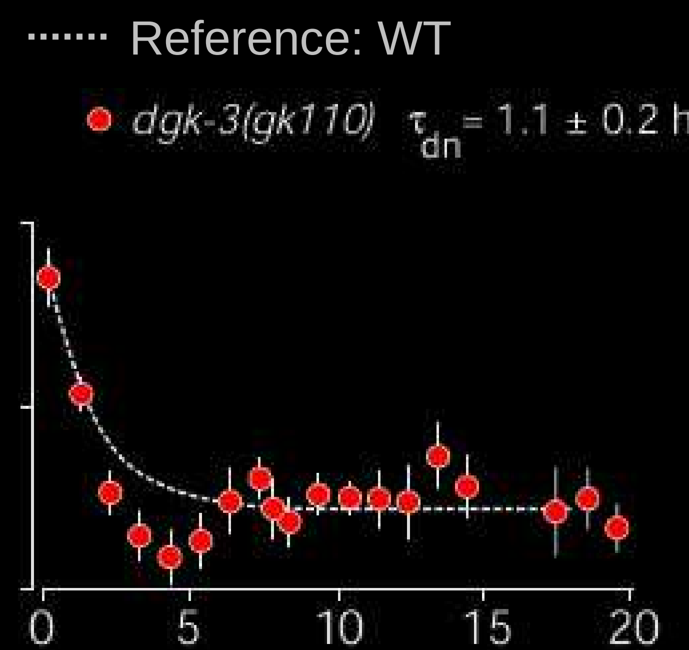


(Colosimo et al., 2004)

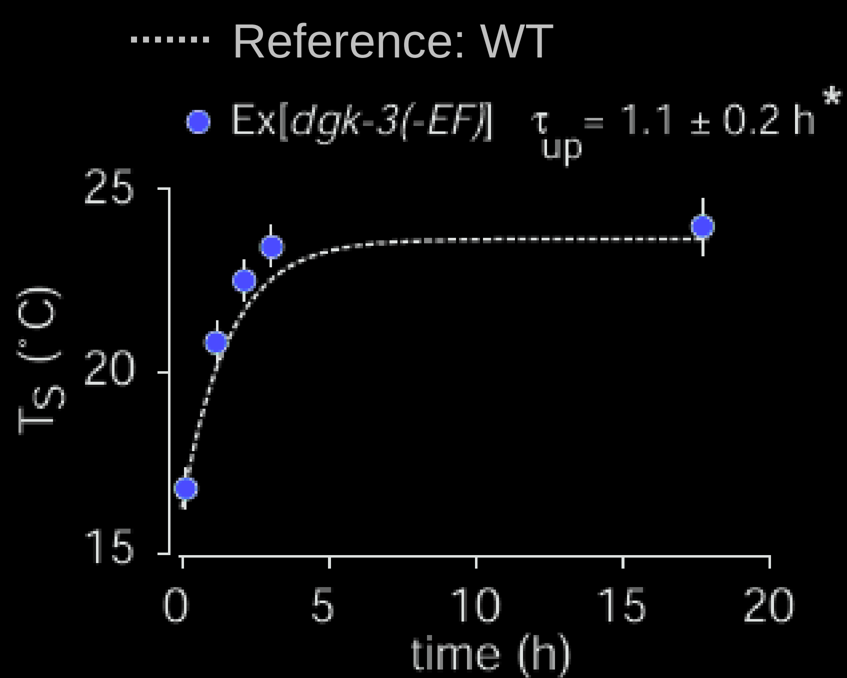
	$T > T_S$	$T = T_S$
Wild-Type	Cryophilic	Track
dgk-3	Cryophilic	Track

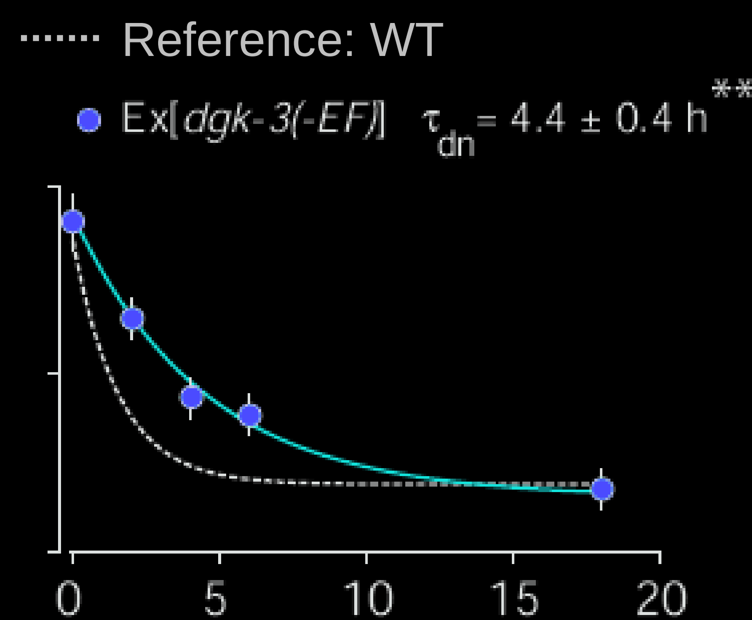
Knocking out *dgk-3* disrupts only the worm's ability to reset T_s to new warmer temperatures



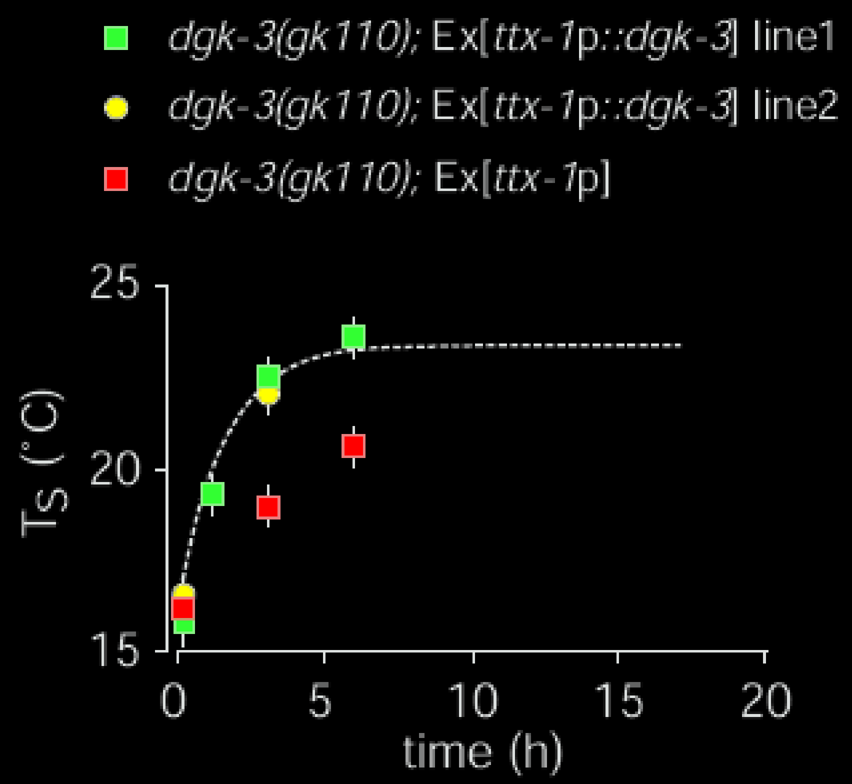


A gain of function mutation of the *dgk-3* gene disrupts the worm's ability to reset T_s to new <u>colder</u> temperatures





AFD-specific expression of *dgk-3* rescues the upshift T_s defect



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

WT: τ_{up}/τ_{dn} = 1.6/1.8

dgk-3: τ_{up}/τ_{dn} = 5.8/1.1