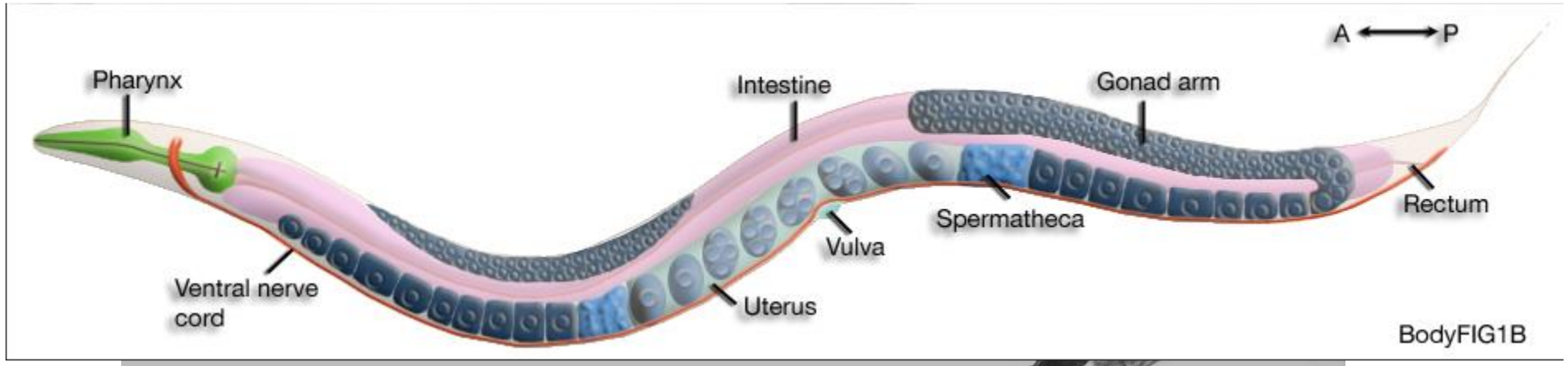
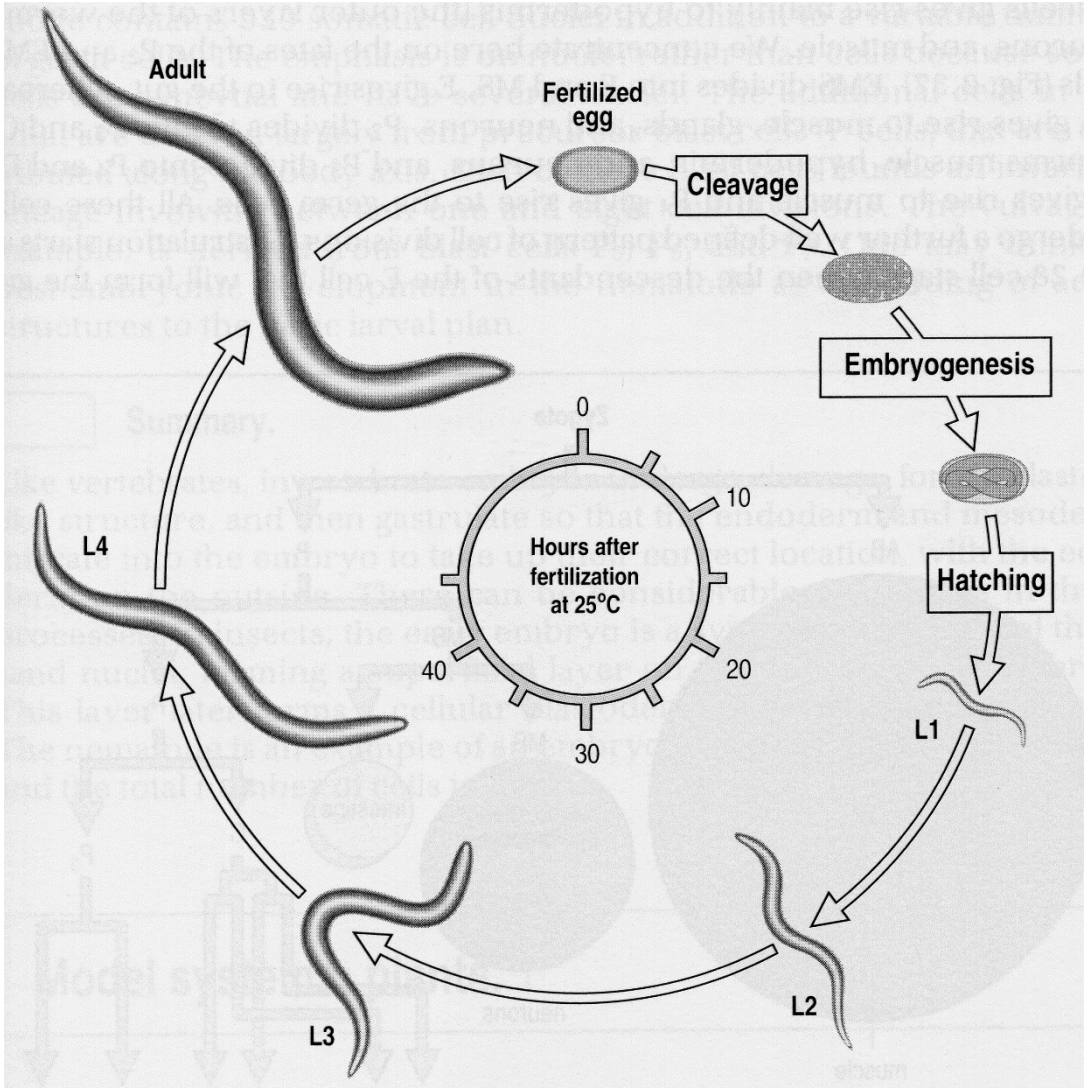
what does *Caenorhabditis elegans* look like?



The *C. elegans* life cycle



4 larvae stages

Lifespan: 18 d

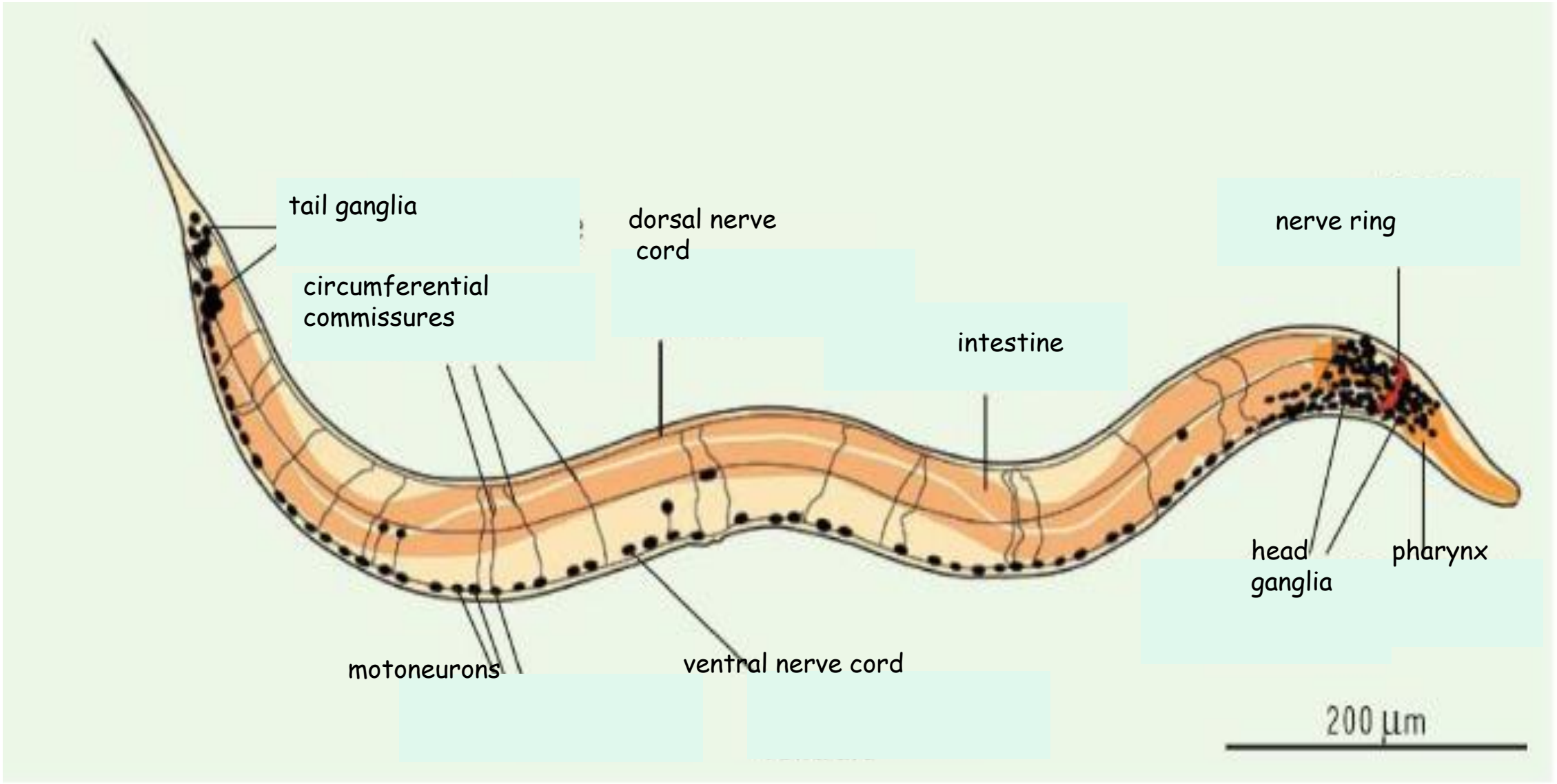
Embryonic dev^{t}: 15 h

generation time:

2.5 d @ 25° *C*
3.5 d @ 20° *C*
5.5 d @ 16° *C*

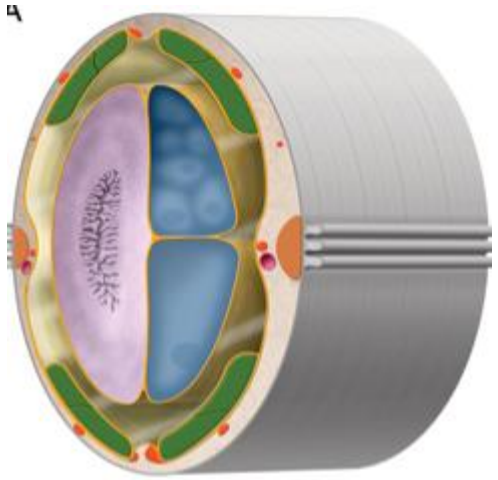
progeny number: 300

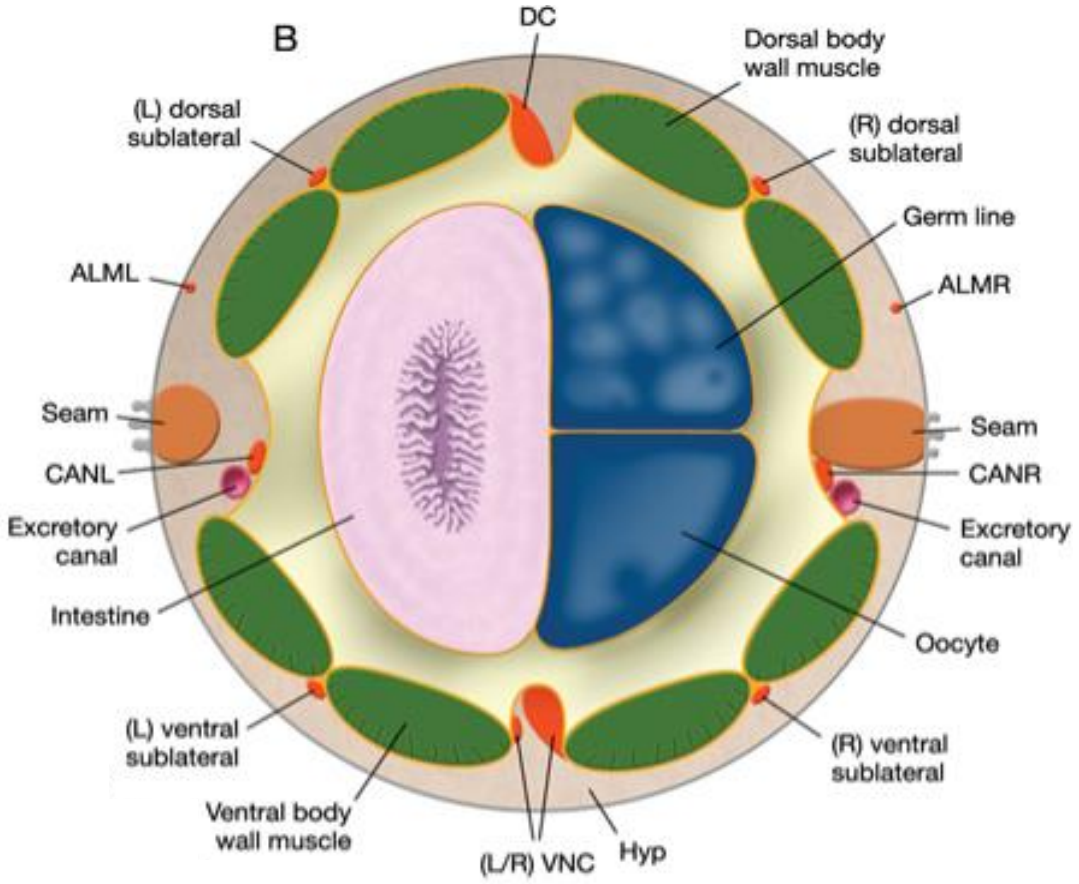
structure of *C. elegans* nervous system



C. Gally, J-L Bessereau, Médecine/Sciences 2003

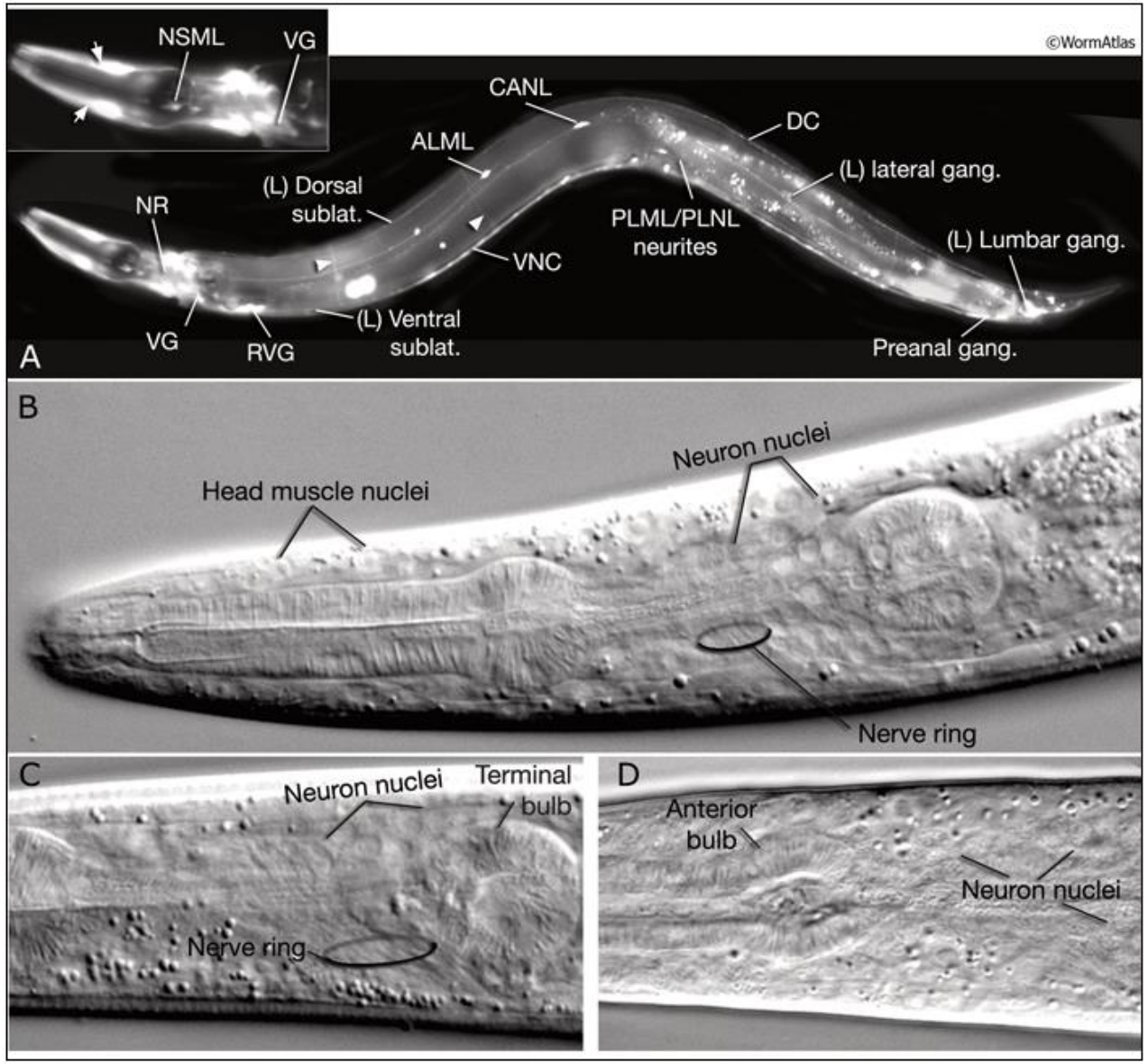
Schematic cross section through the anterior midbody of *C. elegans*





https://www.wormatlas.org

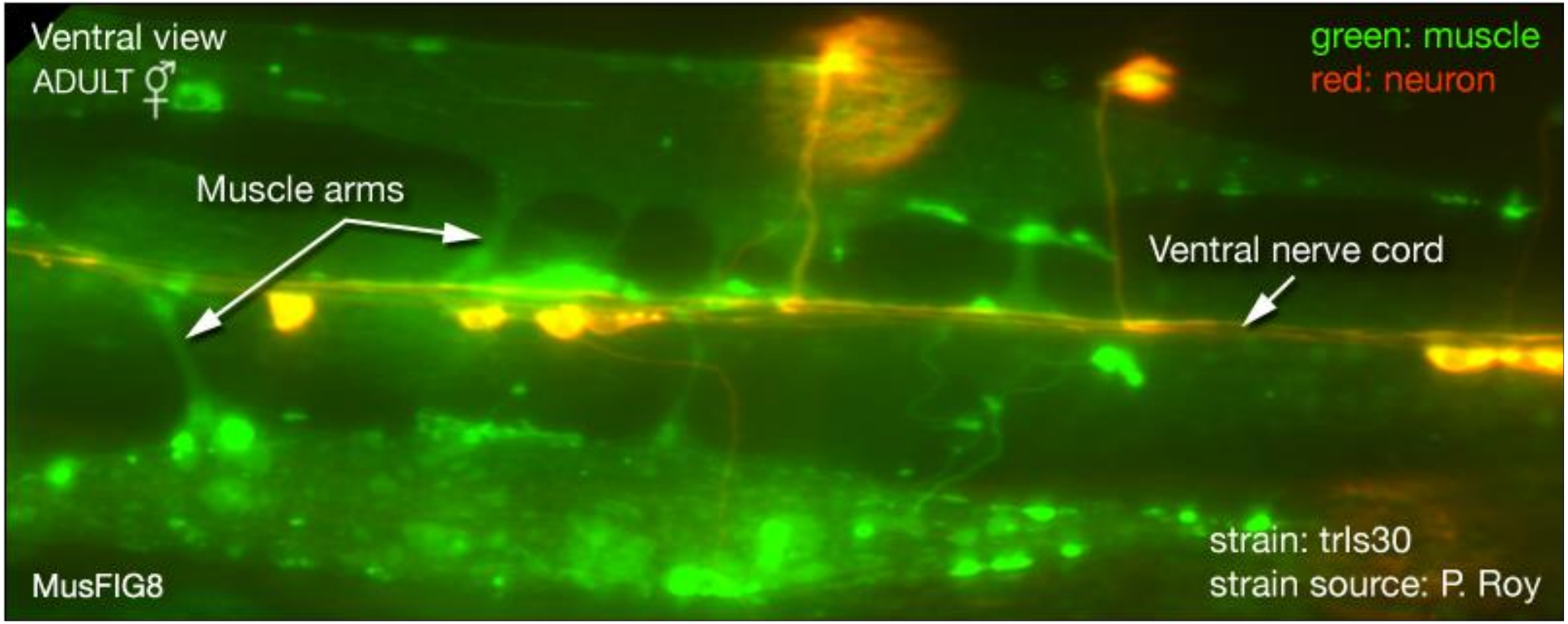
The *C. elegans* nervous system



https://www.wormatlas.org

neuromuscular junctions

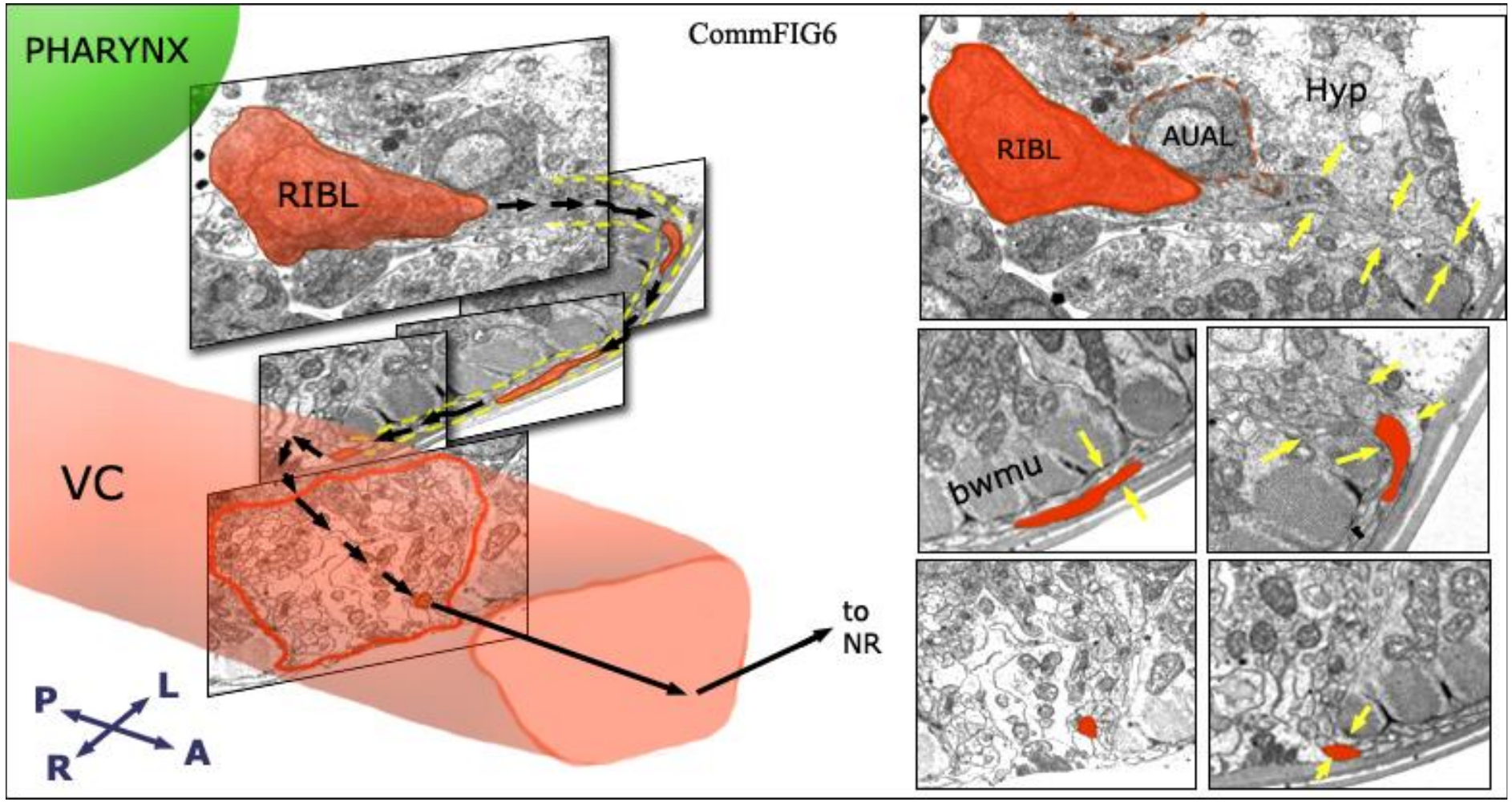
->**neuromuscular synapses “en passant”**



https://www.wormatlas.org

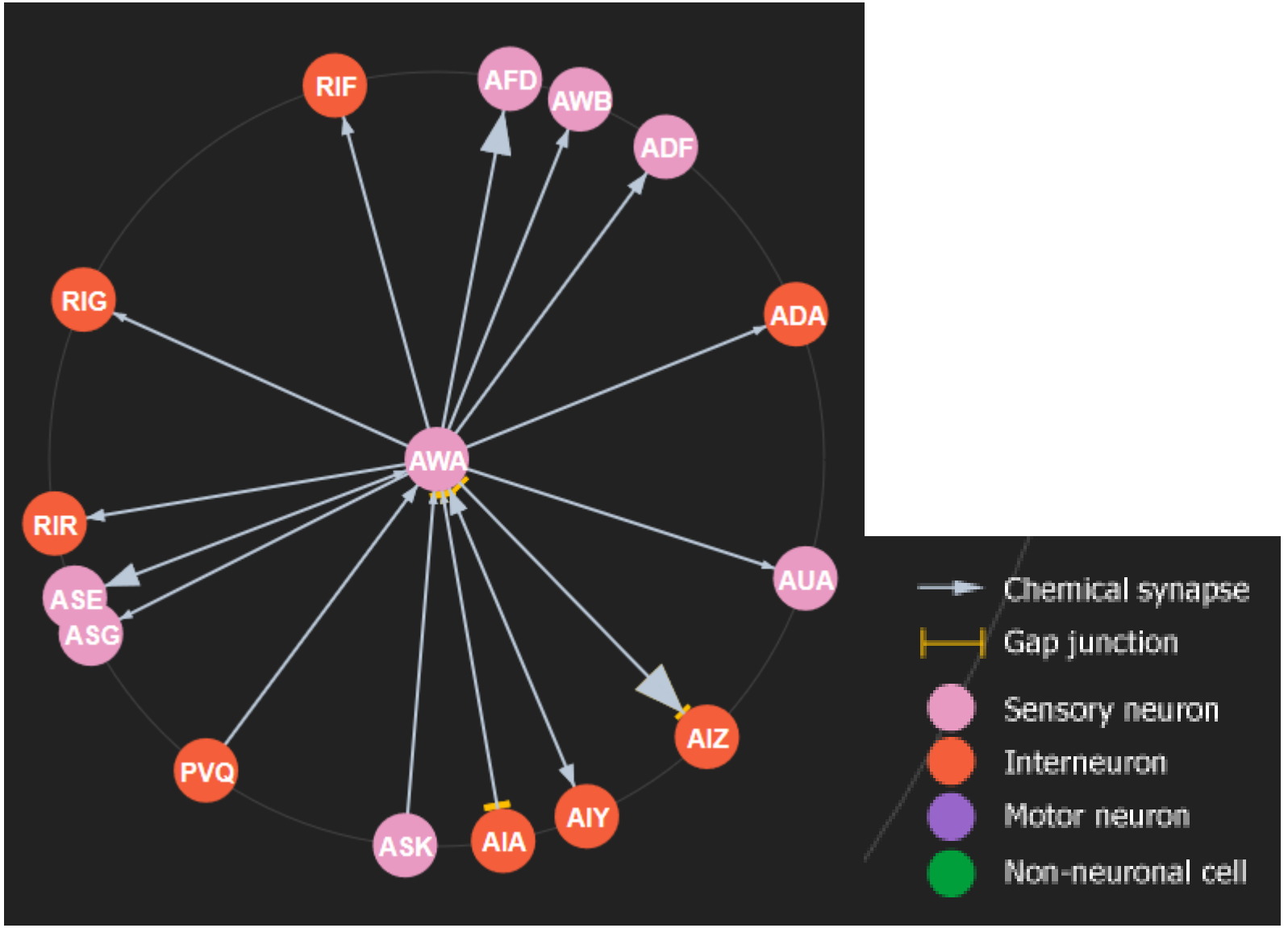
Describe the "mind" of *C. elegans*

the anatomy and connectivity of all 302 neurons of the adult hermaphrodite (Ward et al. 1975; Albertson and Thomson 1976; White et al. 1976; 1986).



The mind of the worm. John White *et al.*, 1986

AWA neural network



Some examples of mutant phenotype

-> morphology: Dumpy [Dpy], Long [Lon]

-> behaviour: Uncoordinated [Unc], Roller [Rol]

-> abnormal cell lineage: [Lin]

-> létal: [Let]

-> Masculinisation: [Tra] /Feminisation: [Fem]

->Mechanosensory abnormal: [Mec]

genetic nomenclature

-> gene name: *dpy-1, unc-5, fem-1*

3 letters, minuscul, italic, hyphen and number
generally based on one word to describe the null phenotype

-> protein name: DPY-1, UNC-5, FEM-1

3 letters, capital, hyphen and number

Key discoveries made with *C. elegans*

1983 **Discovery of apoptosis (**cell death) genes Hedgecock et al. 1983; Ellis and Horvitz 1986;

1987 Discovery of the **first axon guidance genes** Hedgecock et al. 1987, 1990; Culotti 1994

1993 Identification of genes for **conserved synaptic functions** Gengyo-Ando et al. 1993; Richmond et al. 1999; Richmond 2007

1993 Demonstration of a role for insulin pathway genes in **regulating lifespan** Friedman and Johnson 1988; Kenyon et al. 1993

1993 **First microRNA** (lin-4) and its mRNA target (lin-14) described Lee et al. 1993; Wightman et al. 1993 Vella and Sla

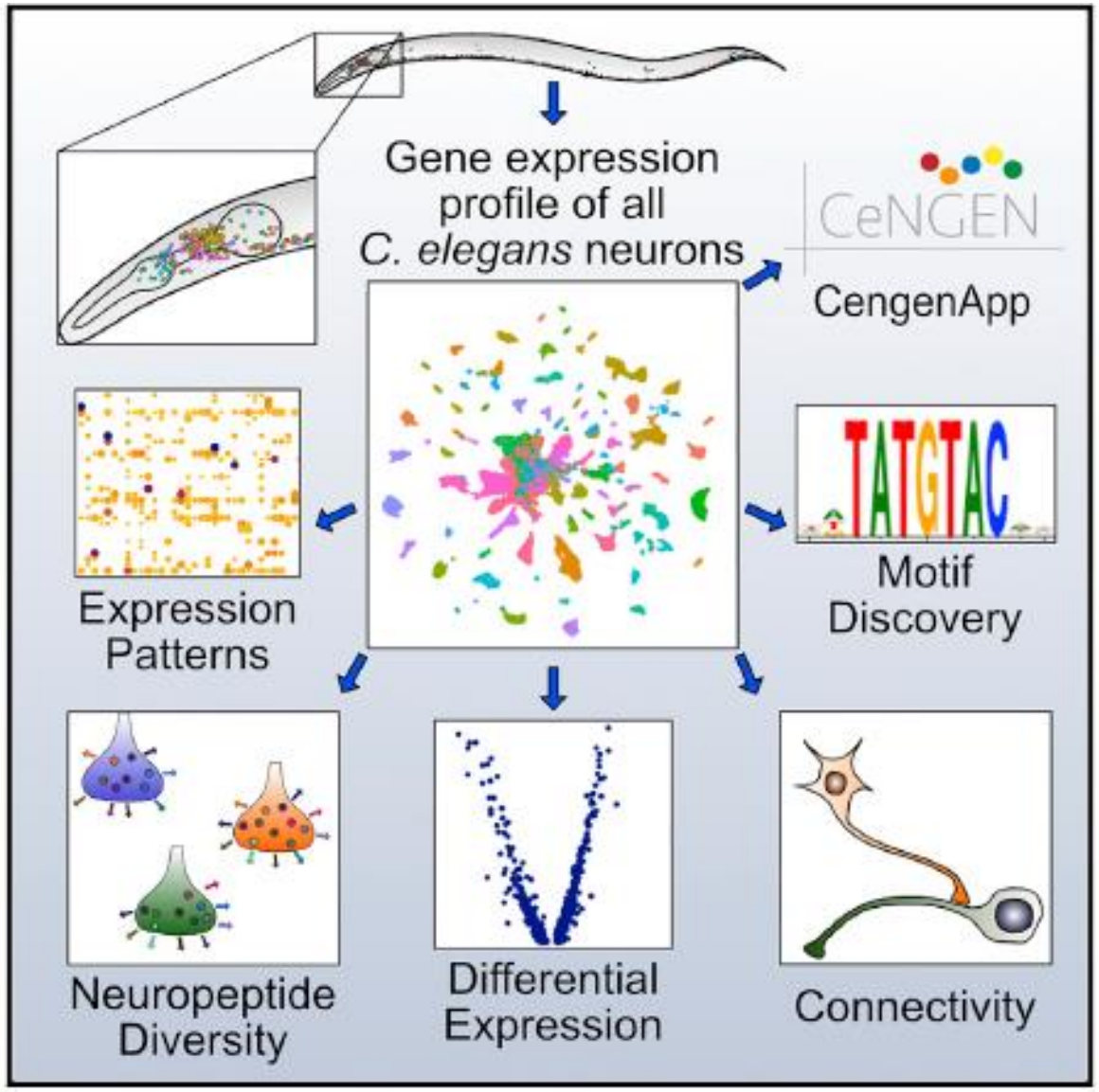
1994 **Introduction of GFP** as a biological marker Chalfie et al. 1994

1998 **First metazoan genome sequenced** C. elegans Sequencing Consortium 1998; Schwarz 2005

1998 **Discovery of RNA interference (RNAi)** Fire et al. 1998

2005 **first use** of channelrhodopsin **optogenetics** in an intact animal Nagel et al. 2005

Molecular topography of an entire nervous system



Gene expression profiles of all 118 neuron classes in the C. elegans hermaphrodite

Each neuron type expresses a distinct code of neuropeptide genes and receptors

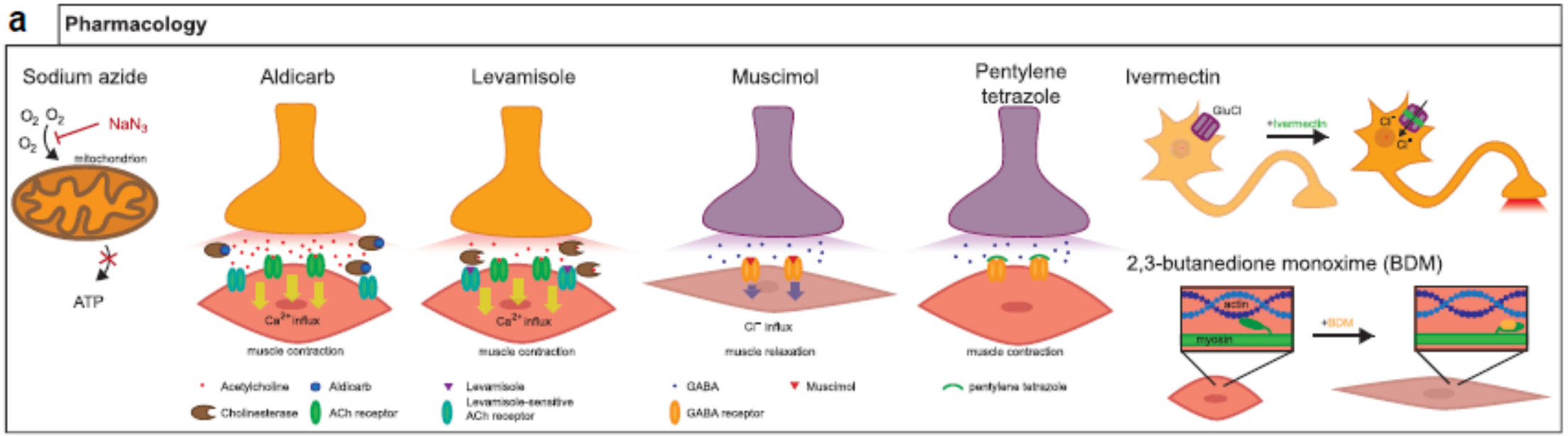
Expression profiles enable discovery of cell-type-specific cis-regulatory sequences

Cell adhesion molecules correlate with neuron-specific connectivity

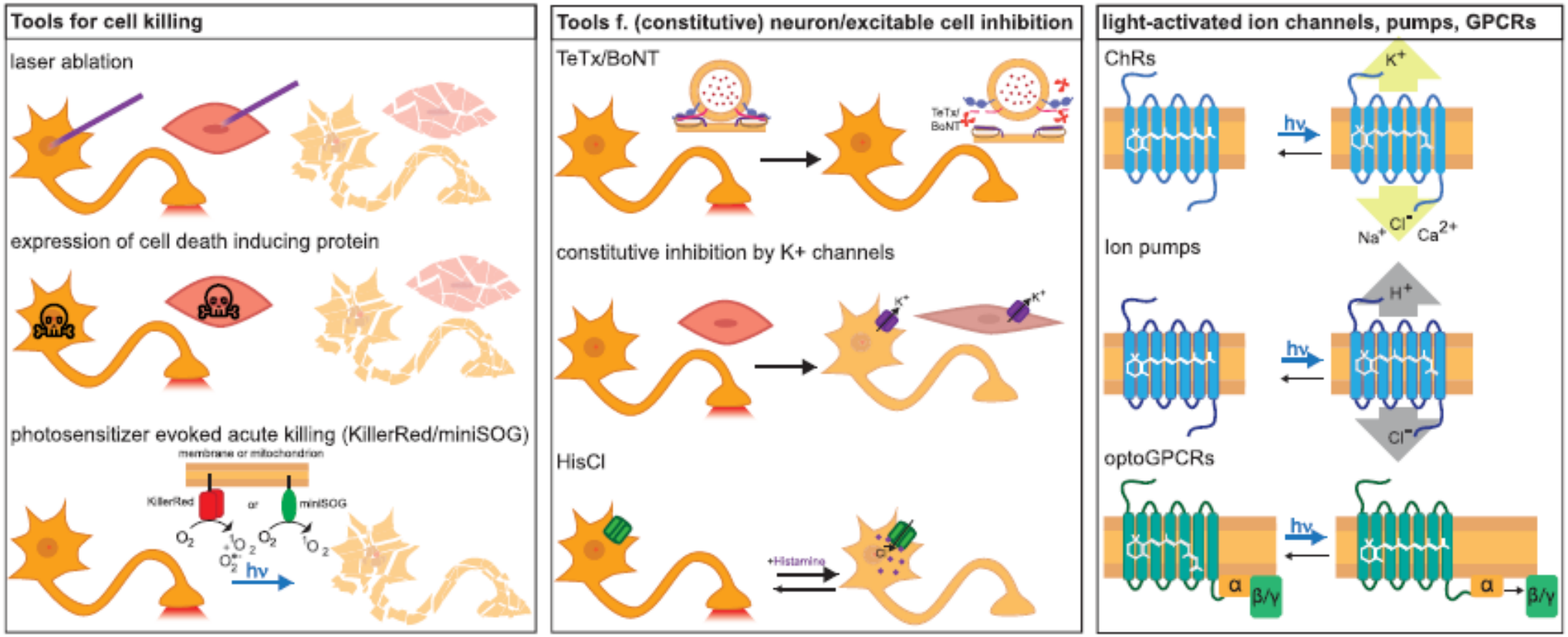
https://cengen.org

Seth R. Taylor, Cell (**2021**)

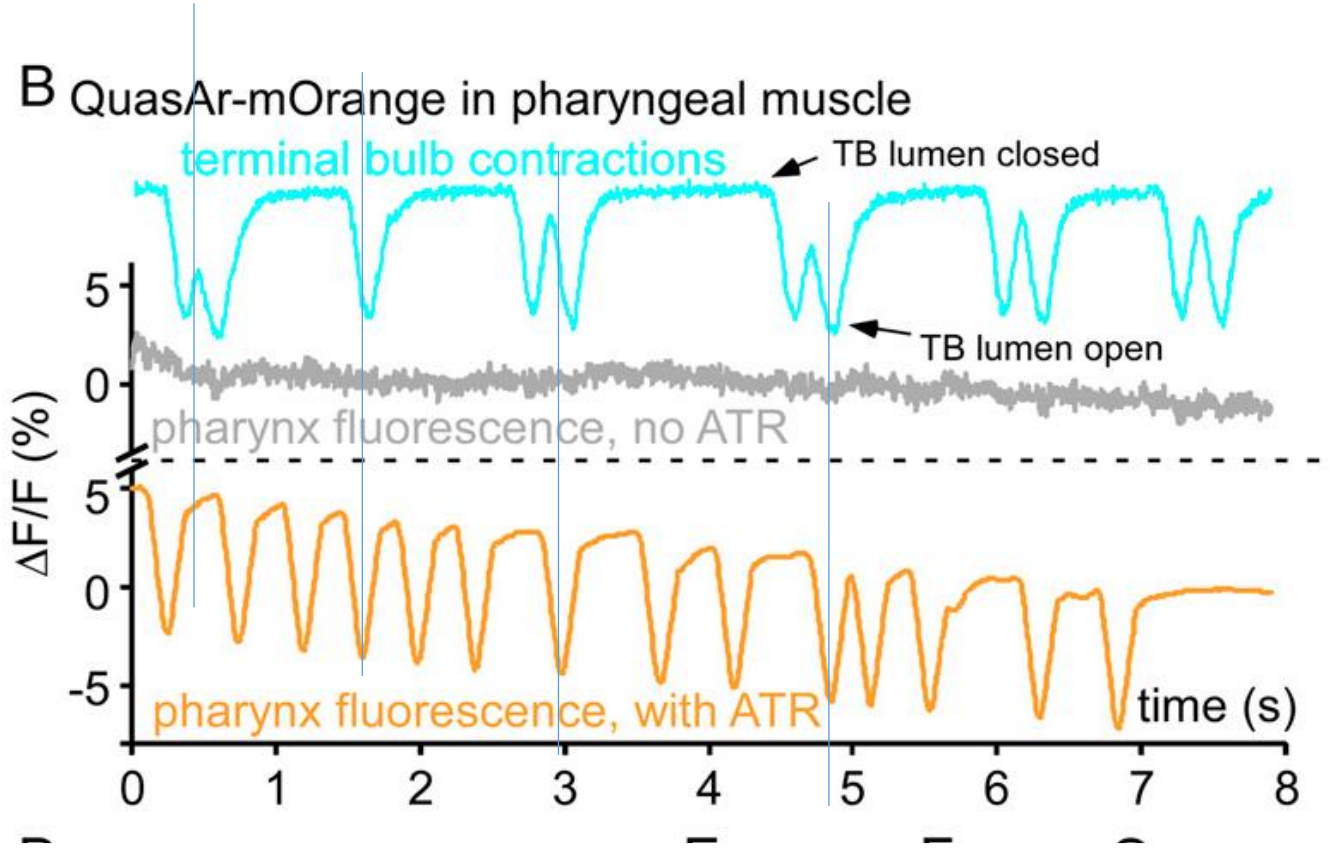
Tools and methods for cell ablation and cell inhibition in C. elegans



Tools and methods for cell ablation and cell inhibition in C. elegans



Tools to establishe all optical, noninvasive electrophysiology in live, intact C. elegans.



Non-exhaustive list of compounds that *C. elegans* can detect?

B. Chemicals detected by simple ciliated neurons

Cell	Aqueous attractants and pheromone
ASE	Na^+, Cl^-, cAMP, biotin, lysine
ADF	Pheromone; (minor) Na^+, Cl^-, biotin, cAMP
ASI, ASG	Pheromone; (minor) Na^+, Cl^-, biotin, cAMP, lysine
ASK	Lysine
ASJ	Pheromone

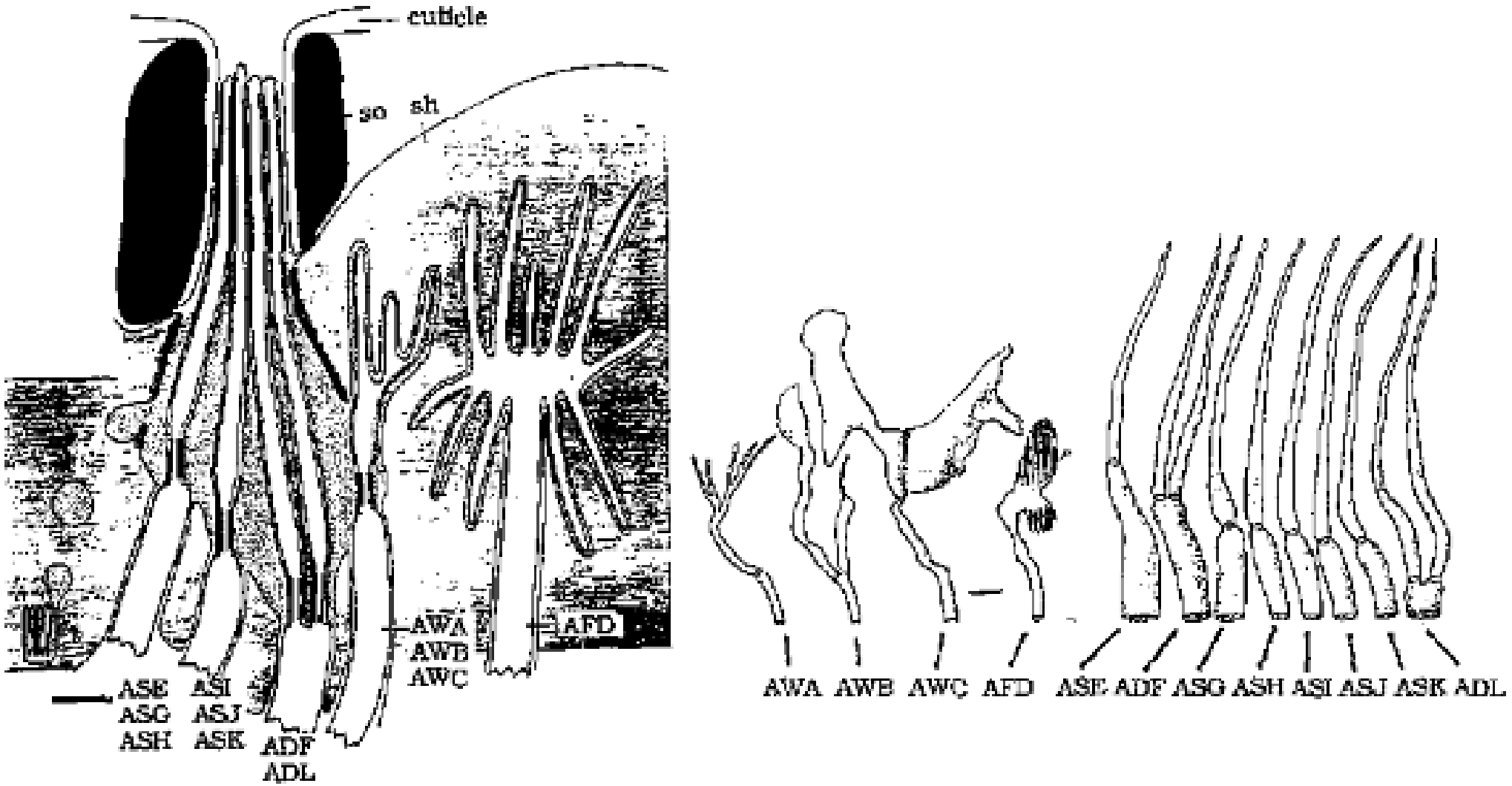
Cell	Aqueous and volatile repellents
ADL	Octanol
ASH	High osmolarity, benzaldehyde (high conc.), octanol

C. Chemicals detected by wing-like ciliated neurons

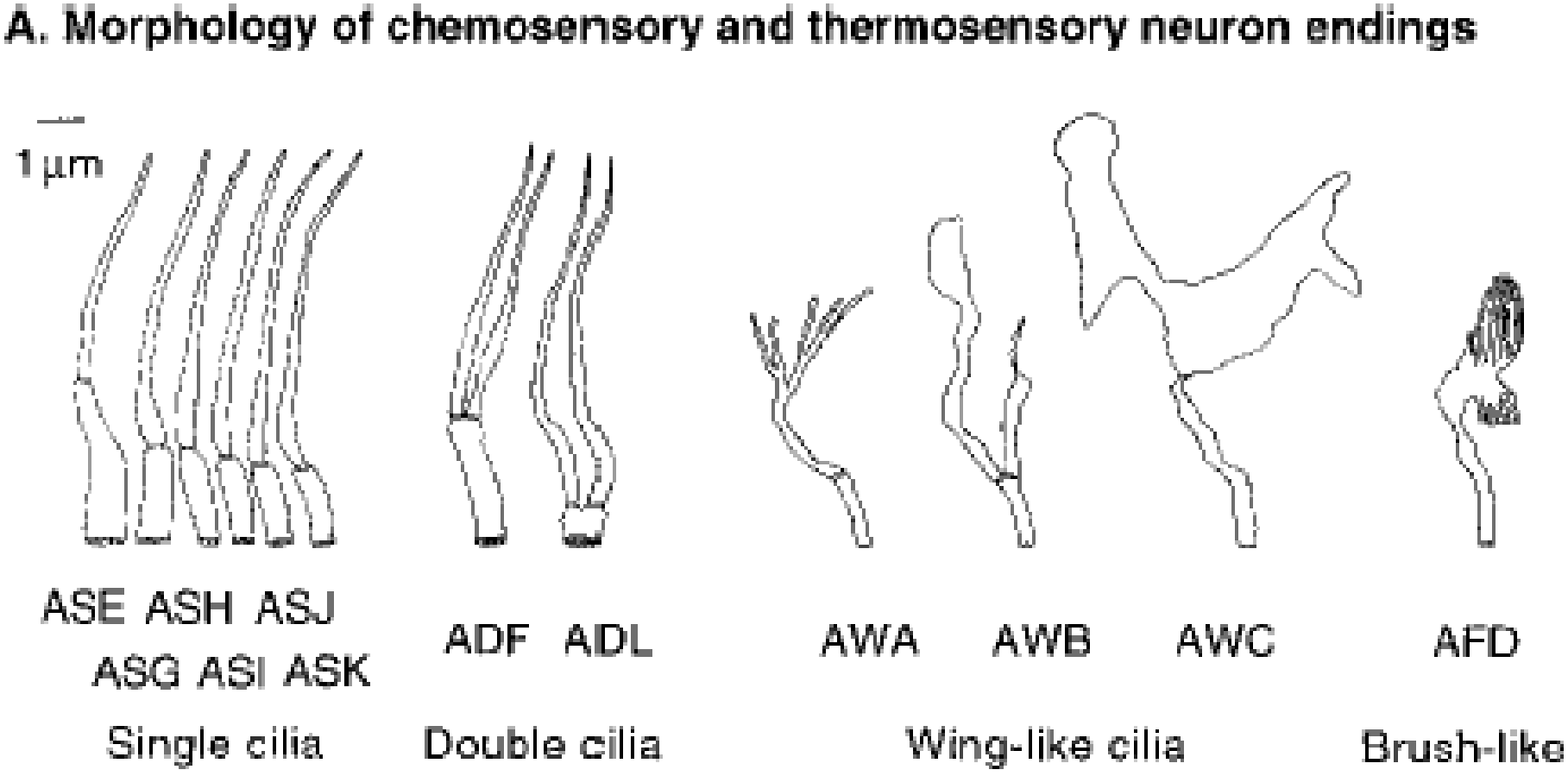
Cell	Volatile attractants
AWA	Diacetyl, pyrazine, 2,4,5 trimethyl thiazole
AWC	Benzaldehyde (low conc.), isoamyl alcohol, butanone, trimethyl thiazole

Cell	Volatile repellents
AWB	2-nonanone

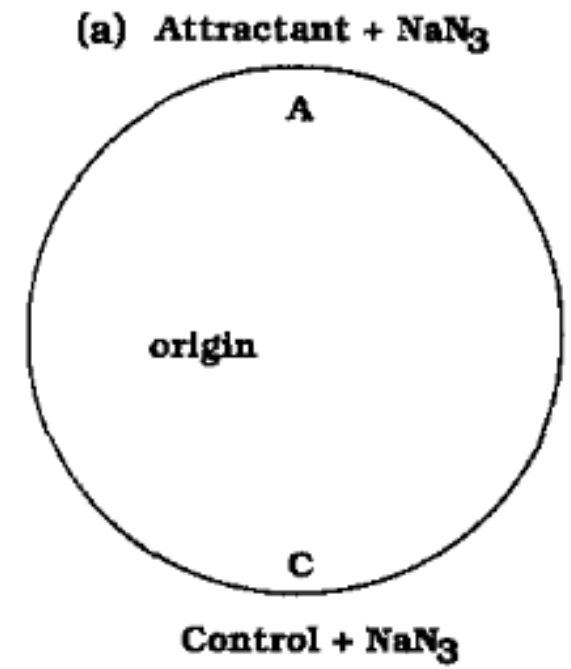
Structure of the amphid and of the 12 amphid sensory neurons



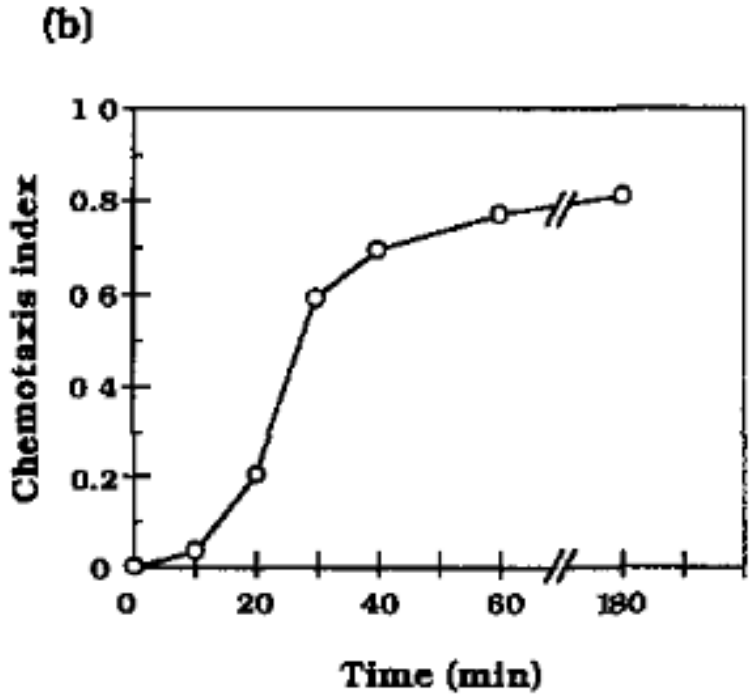
C. elegans cells involved in chemosensory



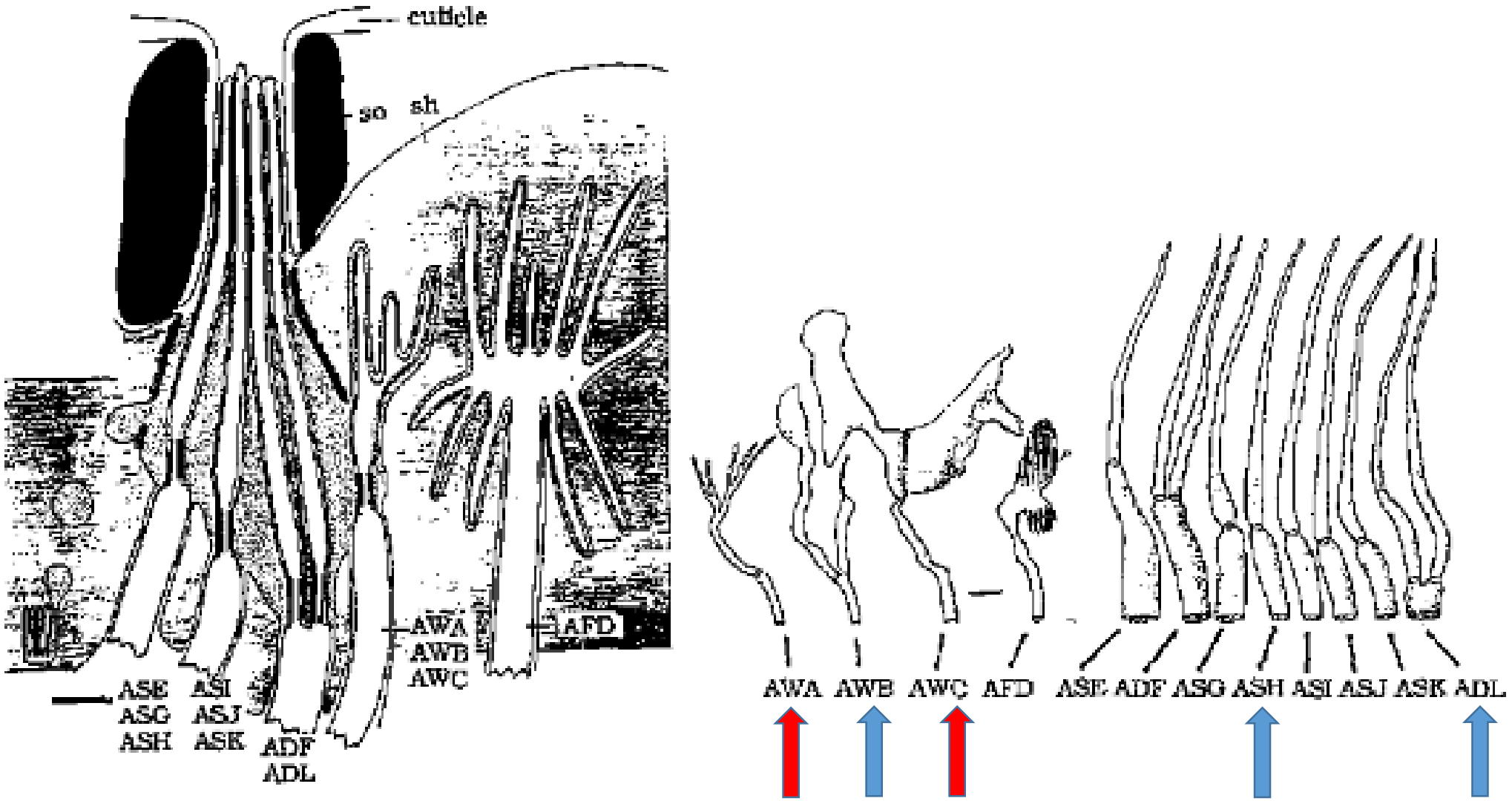
Chemotaxis assay/The Bargmann test



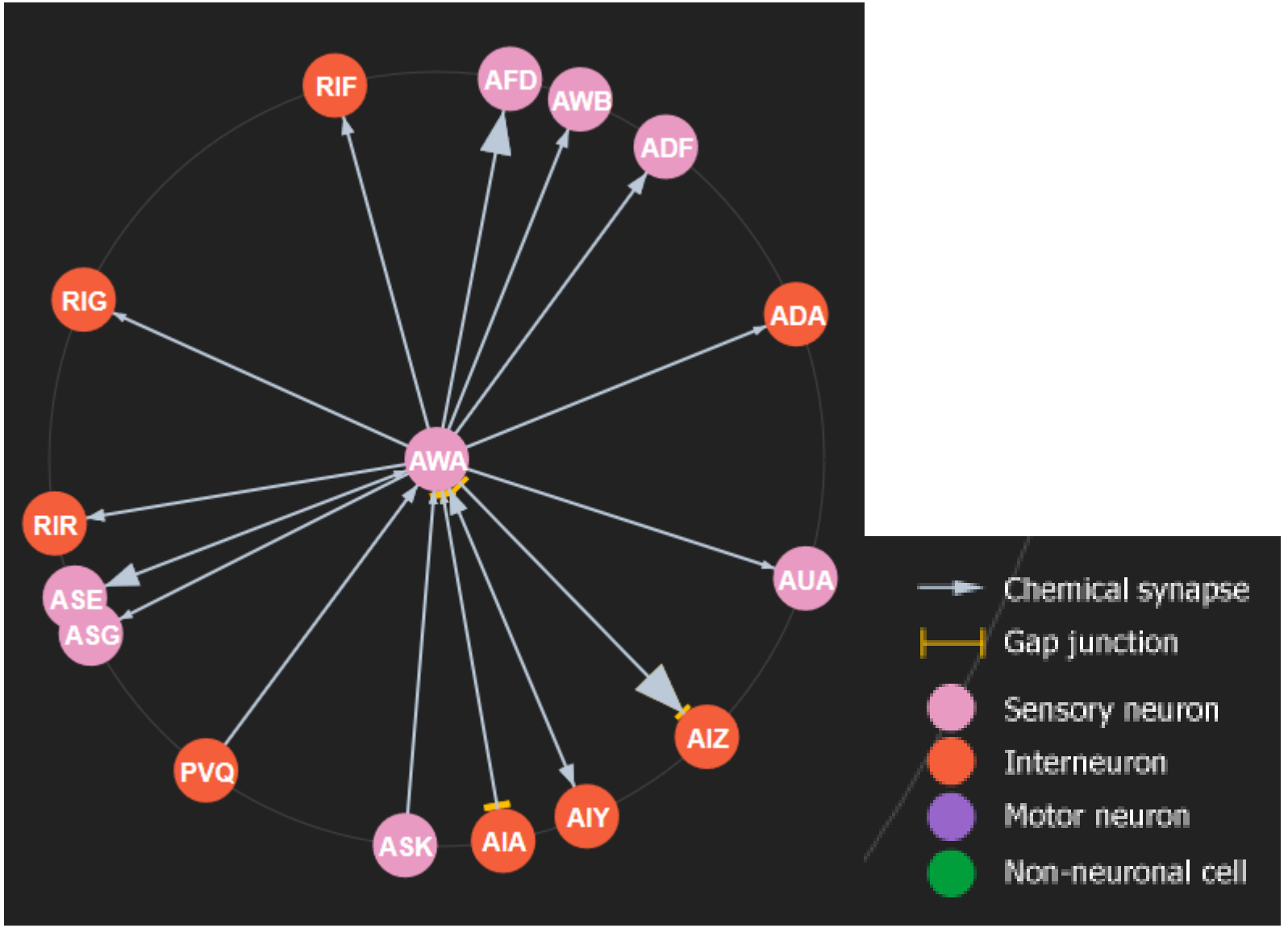
$$\text{Chemotaxis index} = \frac{\#A - \#C}{\#\ \text{total}}$$



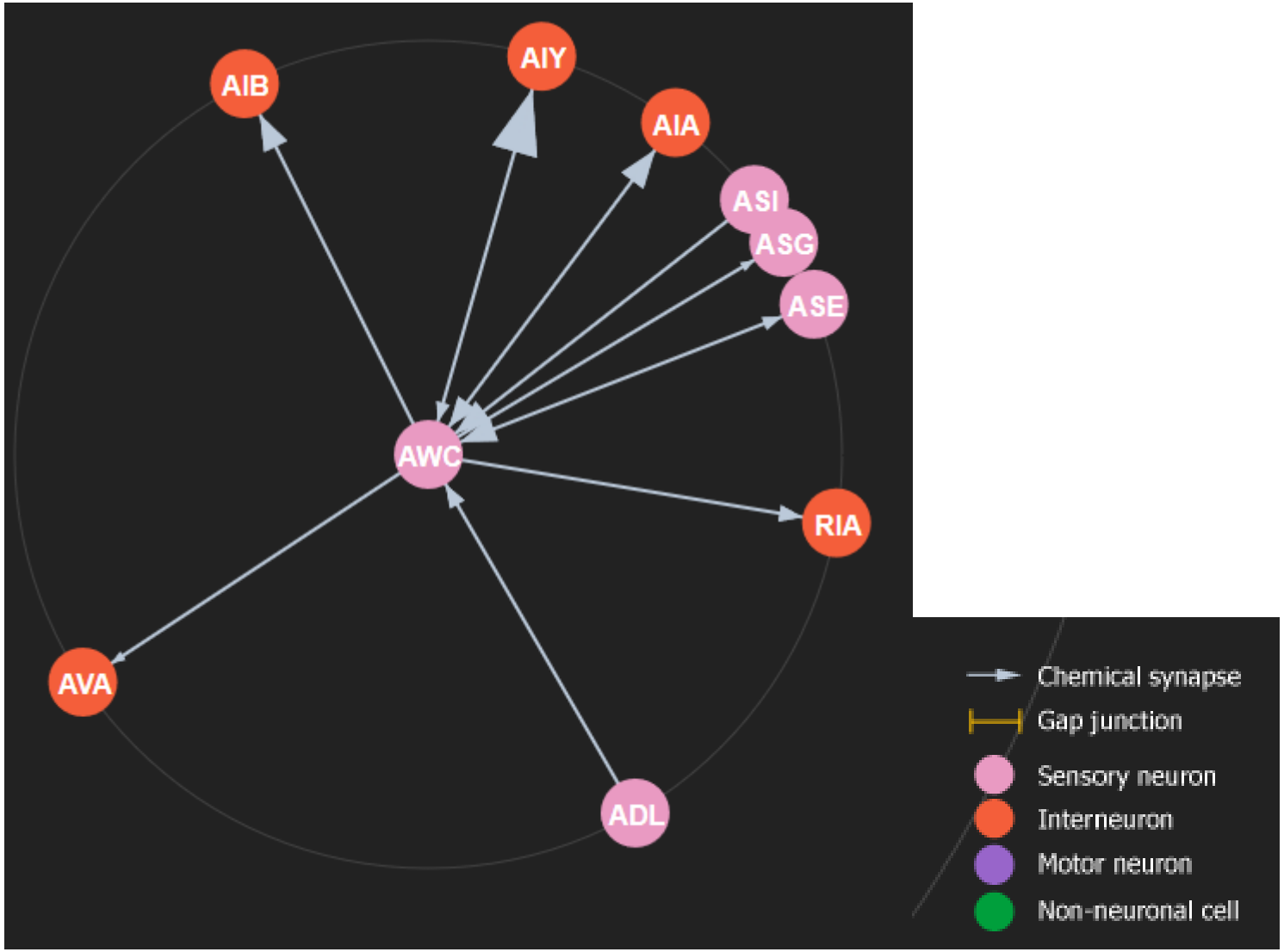
Structure of the amphid and of the 12 amphid sensory neurons



AWA neural network



AWC neural network



Odorants that are detected by the *C. elegans* olfactory system

Pyrazine	AWA	V	(Bargmann *et al.* 1993)
Diacetyl (low)	AWA	V	(Bargmann *et al.* 1993)
Diacetyl (intermediate)[a]	AWA, AWC	V	(Chou *et al.* 2001)
2,4,5-Trimethylthiazole (low)	AWA, AWC	V	(Bargmann *et al.* 1993)
Butyric acid[b]	AWA (AWC ?)	V	(Choi *et al.* 2018)
Isobutyric acid	AWA (AWC ?)	V	(Choi *et al.* 2018)
Benzyl proprionate	AWA, AWC	V	(Choi *et al.* 2018)
Benzaldehyde (low)	AWC (AWA)	V	(Bargmann *et al.* 1993) (Leinwand *et al.* 2015)
Isoamyl alcohol (low)	AWC (AWA)	V	(Bargmann *et al.* 1993)
2-Butanone	AWC^{ON}	V	(Bargmann *et al.* 1993) (Wes and Bargmann 2001)
Acetone	AWC^{ON}	V	(Bargmann *et al.* 1993) (Worthy *et al.* 2018)
Dimethylthiazole	AWC	V	(Bargmann *et al.* 1993) (Choi *et al.* 2018)
1-Methylpyrrole	AWC	V	(Choi *et al.* 2018)
1-Pentanol	AWC	V	(Bargmann *et al.* 1993) (Choi *et al.* 2018)
2-Cyclohexylethanol	AWC	V	(Choi *et al.* 2018)
2-Ethoxythiazole	AWC	V	(Bargmann *et al.* 1993) (Choi *et al.* 2018)
2-Isobutylthiazole	AWC (AWA ?)	V	(Bargmann *et al.* 1993) (Choi *et al.* 2018)
2-Methylpyrazine	AWC (AWA ?)	V	(Choi *et al.* 2018)
4-Chlorobenzyl mercaptan	AWC (AWA ?)	V	(Choi *et al.* 2018)
Benzyl mercaptan	AWC (AWA ?)	V	(Choi *et al.* 2018)
2-Heptanone	AWC^{ON}	V	(Bargmann *et al.* 1993) (Zhang *et al.* 2016)
2,3-Pentanedione (low)	AWC^{OFF}	V	(Chou *et al.* 2001) (Wes and Bargmann 2001)
2,3-Pentanedione (intermediate)[c]	AWA, AWC	V	(Chou *et al.* 2001)
Diacetyl (high)	ASH	V	(Yoshida *et al.* 2012) (Taniguchi *et al.* 2014)
2,4,5-Trimethylthiazole (high)		V	(Bargmann *et al.* 1993) (Yoshida *et al.* 2012)
Benzaldehyde (high)	ASH (AWB)	V	(Bargmann *et al.* 1993)
Isoamyl alcohol (high)	ASH (ADL, AWB)	V	(Luo *et al.* 2008) (Yoshida *et al.* 2012)
Alcohols 1-Octanol (100%) 1-Octanol (30%)	ASH (ADL, AWB—off food) ASH	V	(Bargmann *et al.* 1993) (Troemel *et al.* 1995) (Troemel *et al.* 1997) (Chao *et al.* 2004)
Ketones 2-Nonanone	AWB (ASH)	V	(Bargmann *et al.* 1993) (Troemel *et al.* 1997) (Tanimoto *et al.* 2017)

What hypothesis does this experiment test?

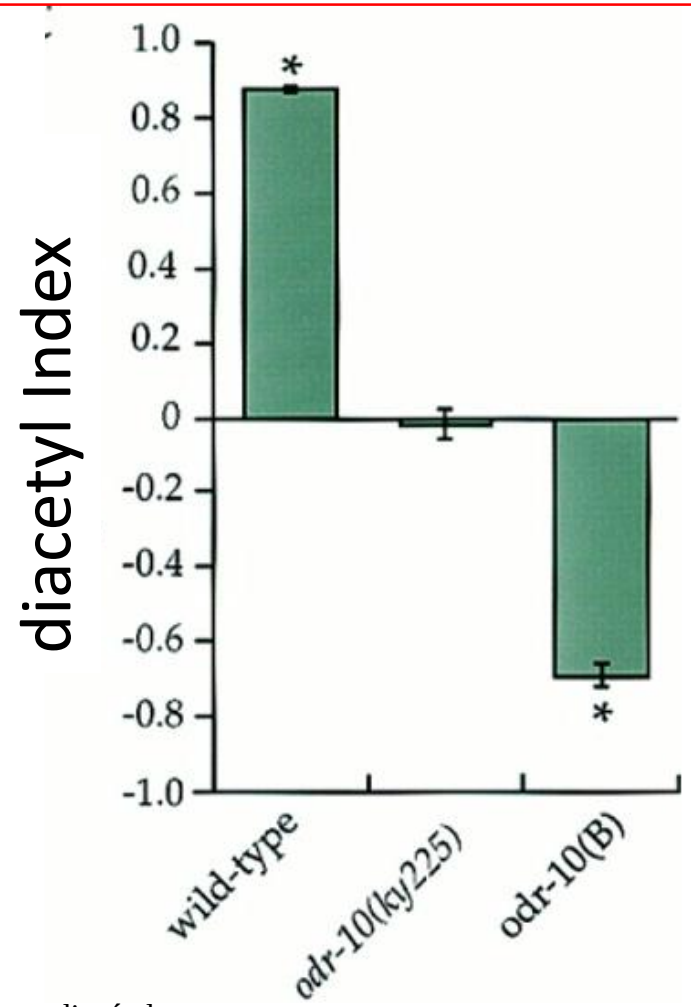


Figure 1. indice de réponse olfactive de trois souches de nématodes au diacétyl.

wild-type = souche sauvage N2
odr-10(ky225) = souche mutante odr-10 (allèle ky225)
odr-10 (B) = souche mutante *odr-10* exprimant l'ADNc du gène sauvage *odr-10* sous le contrôle du promoteur du gène *str-1*.

Question réalisée à partir de l'article : Troemel *et al*.(1997), Cell, 91, 161-169.

Overview of the protocole used for conditionning C. elegans

https://www.jove.com/fr/v/2490/c-elegans-positive-butanone-learning-short-term-long-term-associative