Neurons on wifi: Wireless spiking neural P systems

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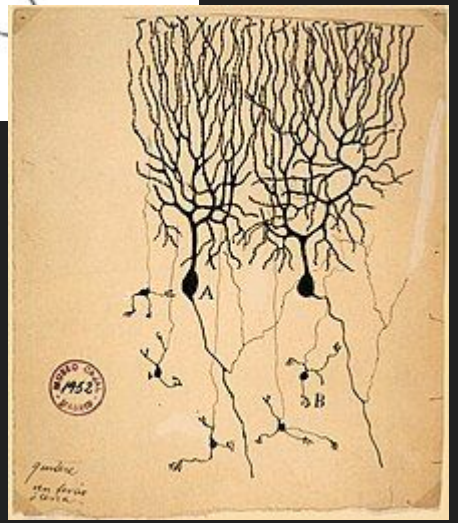
``wires'' of neurons: ***synapses***

Synapses: **not** the only way neurons ``talk'' to each other.

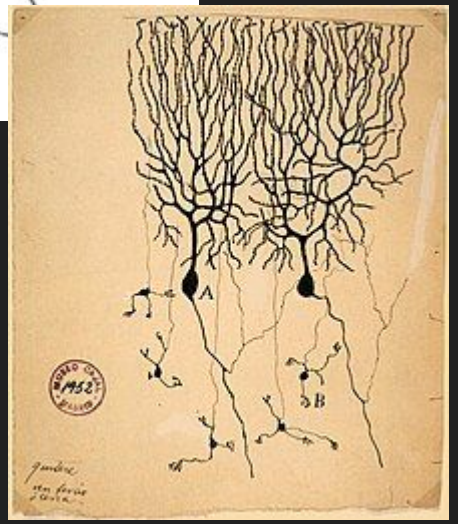


Santiago Ramón y Cajal, https://en.wikipedia.org/wiki/Neuron

``wires'' of neurons: ***synapses***

Synapses: **not** the only way neurons ``talk'' to each other.

Extrasynaptic communication of neurons: ``*wireless*'' communication with **<u>neuropeptides,</u>** or molecular signals.



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By Claudia López Lloreda

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The neuropeptidergic connectome of *C. elegans*

Lidia Ripoll-Sánchez • Jan Watteyne • HaoSheng Sun • ... Isabel Beets [9] • Petra E. Vértes [9] • William R. Schafer [9, 10] • Show all authors • Show footnotes

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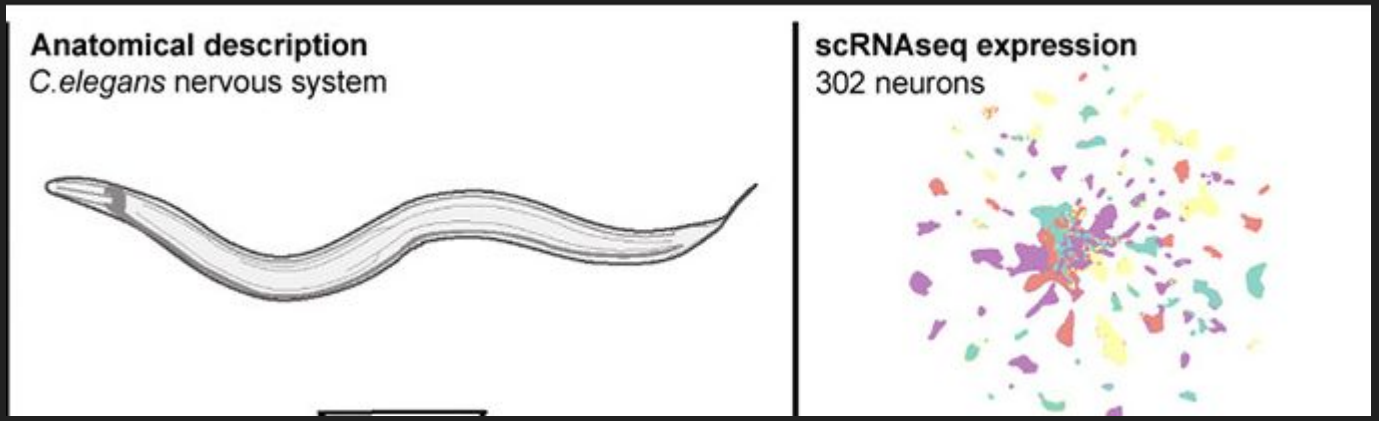
Extrasynaptic network in model organism: *C. elegans*



The neuropeptidergic connectome of C. elegans https://doi.org/10.1016/j.neuron.2023.09.043

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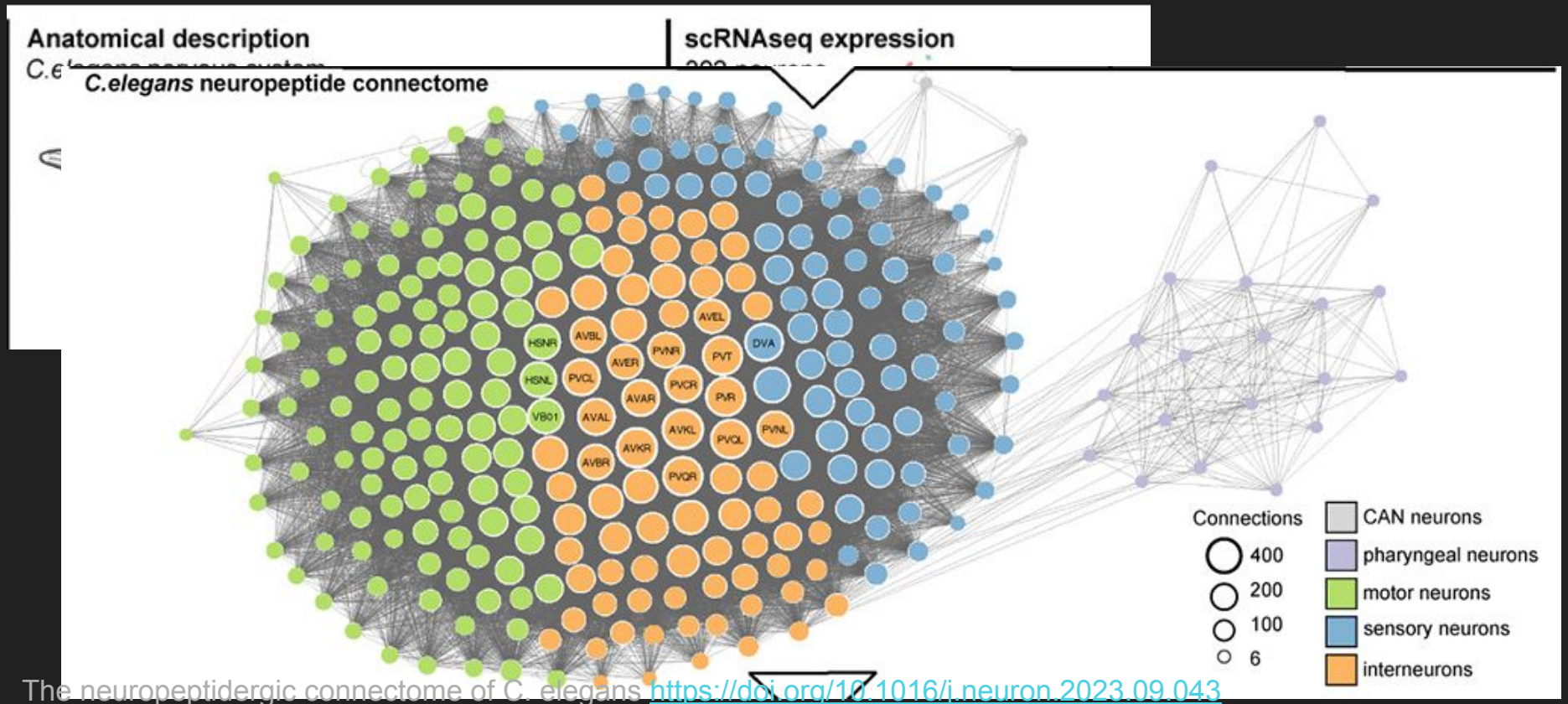

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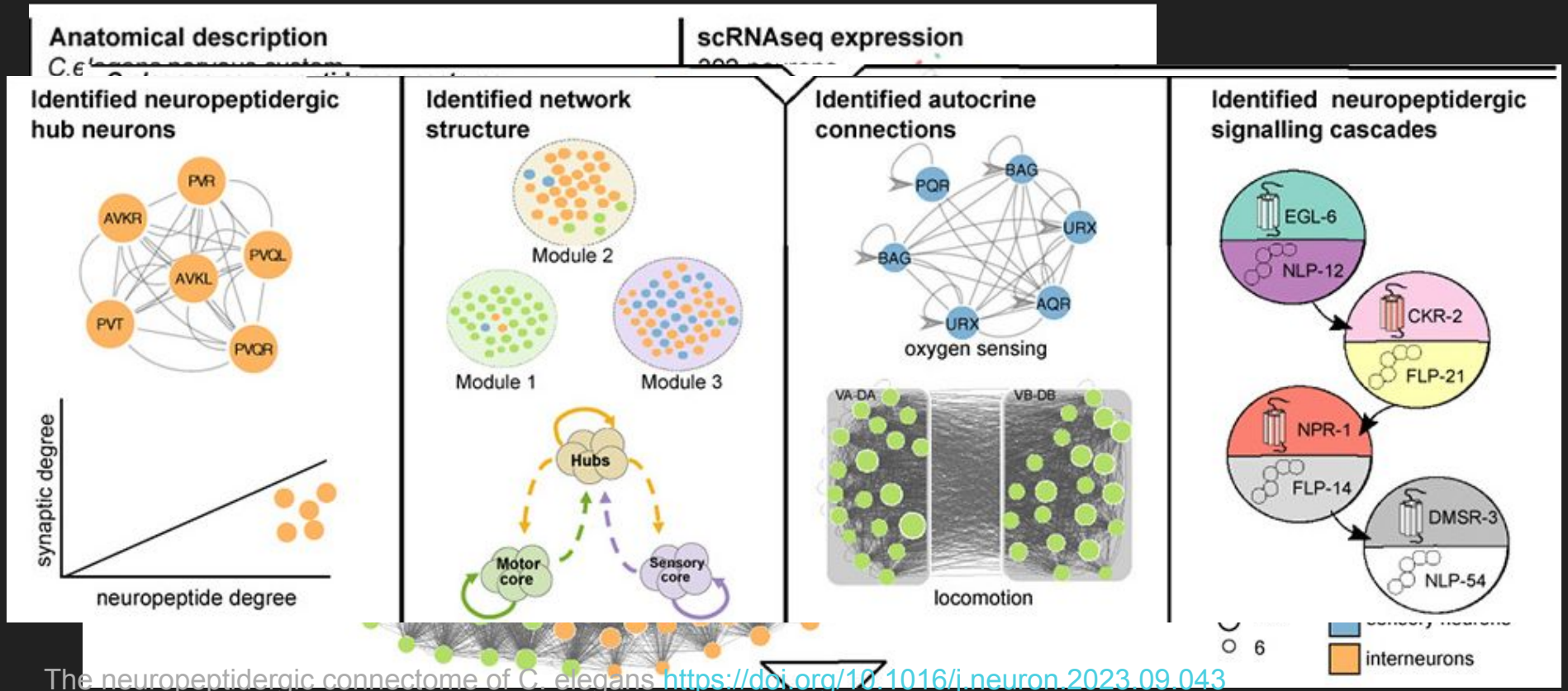
Extrasynaptic network in model organism: *C. elegans*

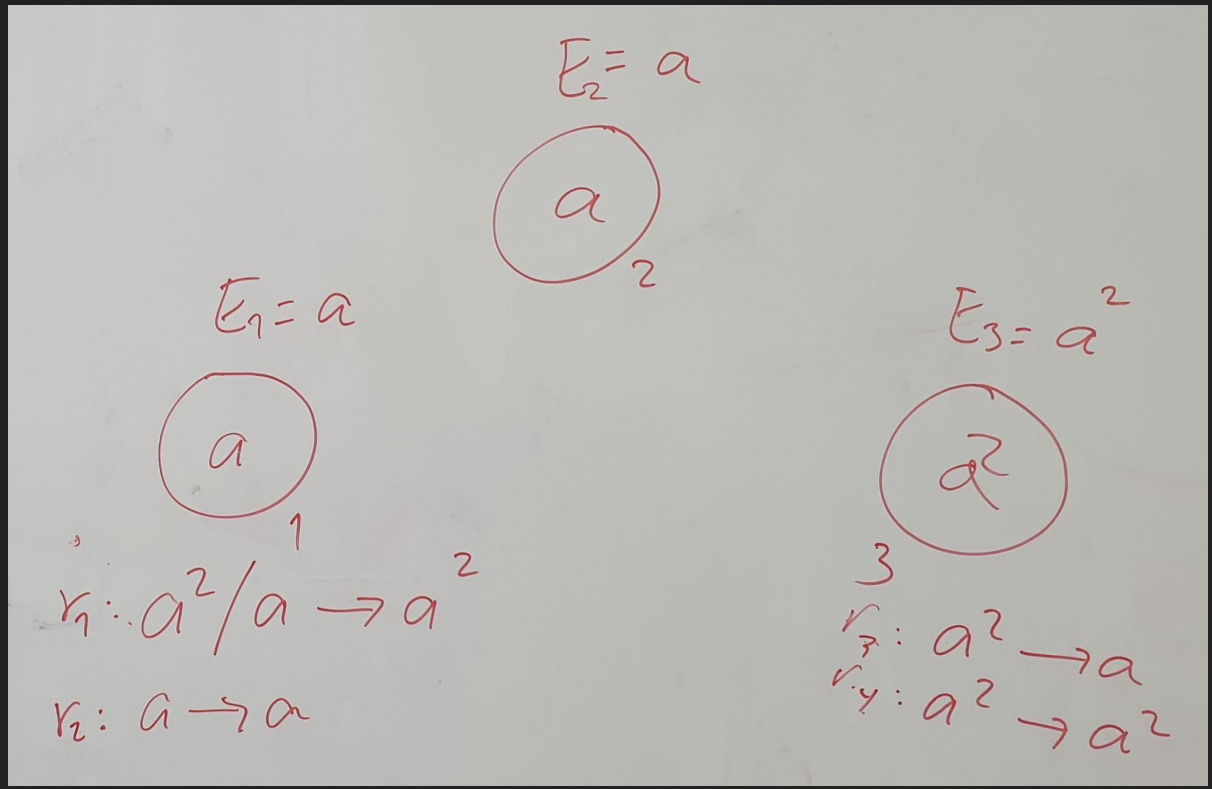


The neuropeptidergic connectome of C. elegans https://doi.org/10.1016/j.neuron.2023.09.043

Extrasynaptic (peptidergic) network: recent results

- **Neuropeptides:** *ancient* and *conserved* signaling molecules in brains of *all organisms*.
- **Wireless network**: release + receive of neurotransmitters => *not random chemicals floating between neurons*.
- **Neuropeptides**: affects system over larger scales (time + space), unlike synaptic signals (restricted only to pre- and post-synapse).
- **Self-loops** or *autocrine* connections: similar to autapses (self-synapse).
- Interesting properties (compared to wired/synaptic network): *more flat, many high-degree nodes, higher clustering and reciprocity (decentralisation), rich-club property*.
- Better understanding of *neuron behaviour*: **synaptic + (neuro)peptidergic networks**.

An early attempt



Fin! ¡Gracias por tu atención! Questions? Collaborations?

Monumento a Santiago Ramón y Cajal, parque del Retiro, Madrid

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Spiking neural P systems (SN P systems)

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Spiking Neural P Systems

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Specifically, we consider a *spiking neural P system* (in short, an SN P system), of degree $m \geq 1$, in the form

$$\Pi = (O, \sigma_1, \ldots, \sigma_m, syn, i_0),$$

where:

1. $O = \{a\}$ is the singleton alphabet (a is called *spike*);
2. $\sigma_1, \ldots, \sigma_m$ are *neurons*, of the form

$$\sigma_i = (n_i, R_i), 1 \leq i \leq m,$$

where:

a) $n_i \geq 0$ is the *initial number of spikes* contained by the neuron;
b) R_i is a finite set of *rules* of the following two forms:
   (1) $E/a^r \rightarrow a; t$, where E is a regular expression over O, $r \geq 1$, and $t \geq 0$;
   (2) $a^s \rightarrow \lambda$, for some $s \geq 1$, with the restriction that $a^s \notin L(E)$ for any rule $E/a^r \rightarrow a; t$ of type (1) from R_i;

3. $syn \subseteq \{1, 2, \ldots, m\} \times \{1, 2, \ldots, m\}$ with $(i, i) \notin syn$ for $1 \leq i \leq m$ (*synapses* among neurons);
4. $i_0 \in \{1, 2, \ldots, m\}$ indicates the *output neuron*.

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YAVSN P system: Yet another variant of SN P system