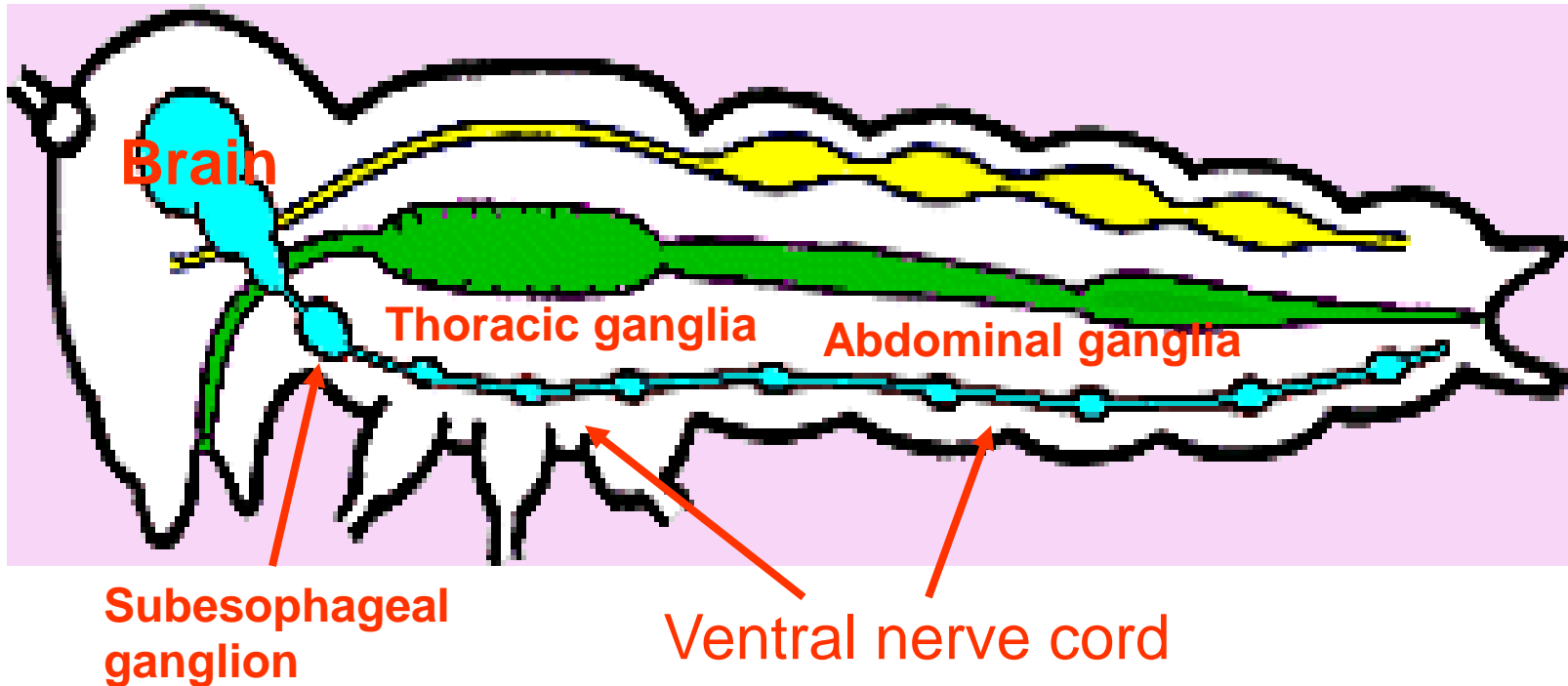


Lecture 13: Insect nerve system (NS)



Signal transducer, transmitter, processor (integrator)

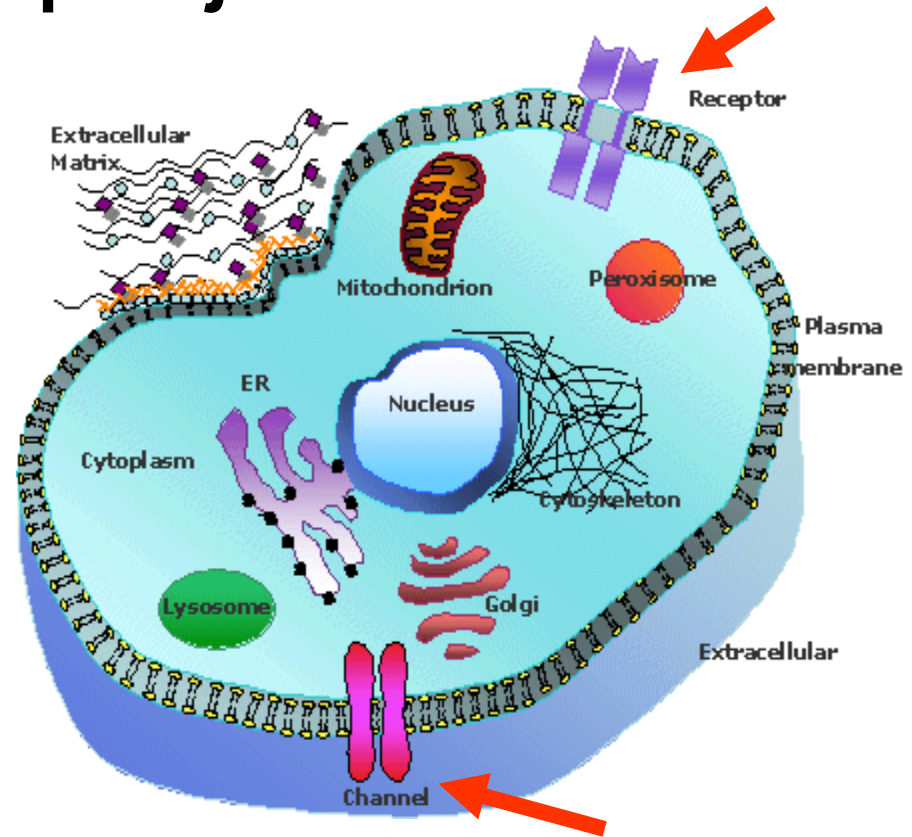
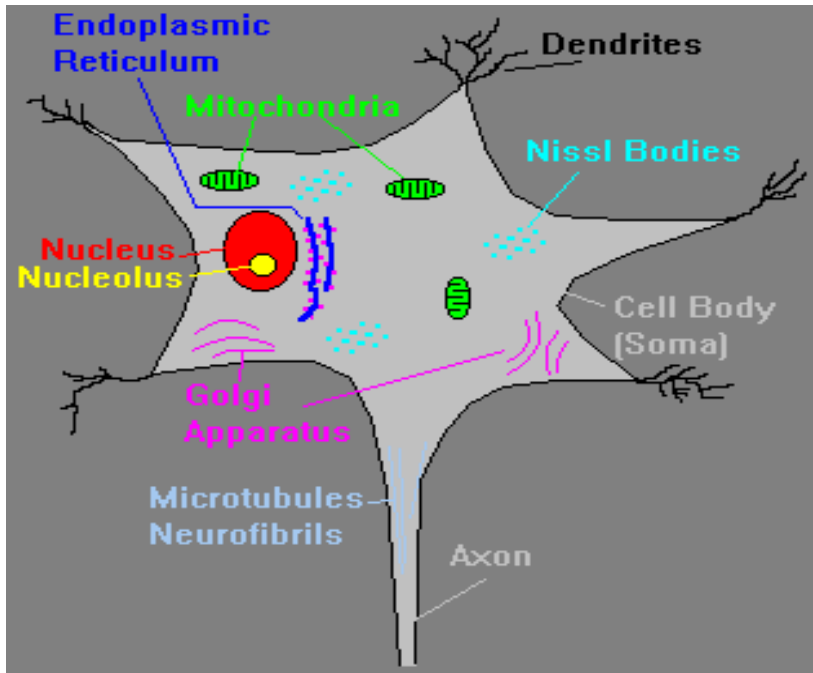
Overview

- Structures (Anatomy)
 - Cells
 - Anatomy
- Functions
 - Signal transduction
 - Signal transmission

Cells in the nerve system

1. **Nerve cells (=Neurons):** Conducting cells that transduce, transmit or process nerve impulses.
2. **Glial cells:** Non-conducting supporting cells that surround neurons and help to protect neurons and maintain stable ionic environment

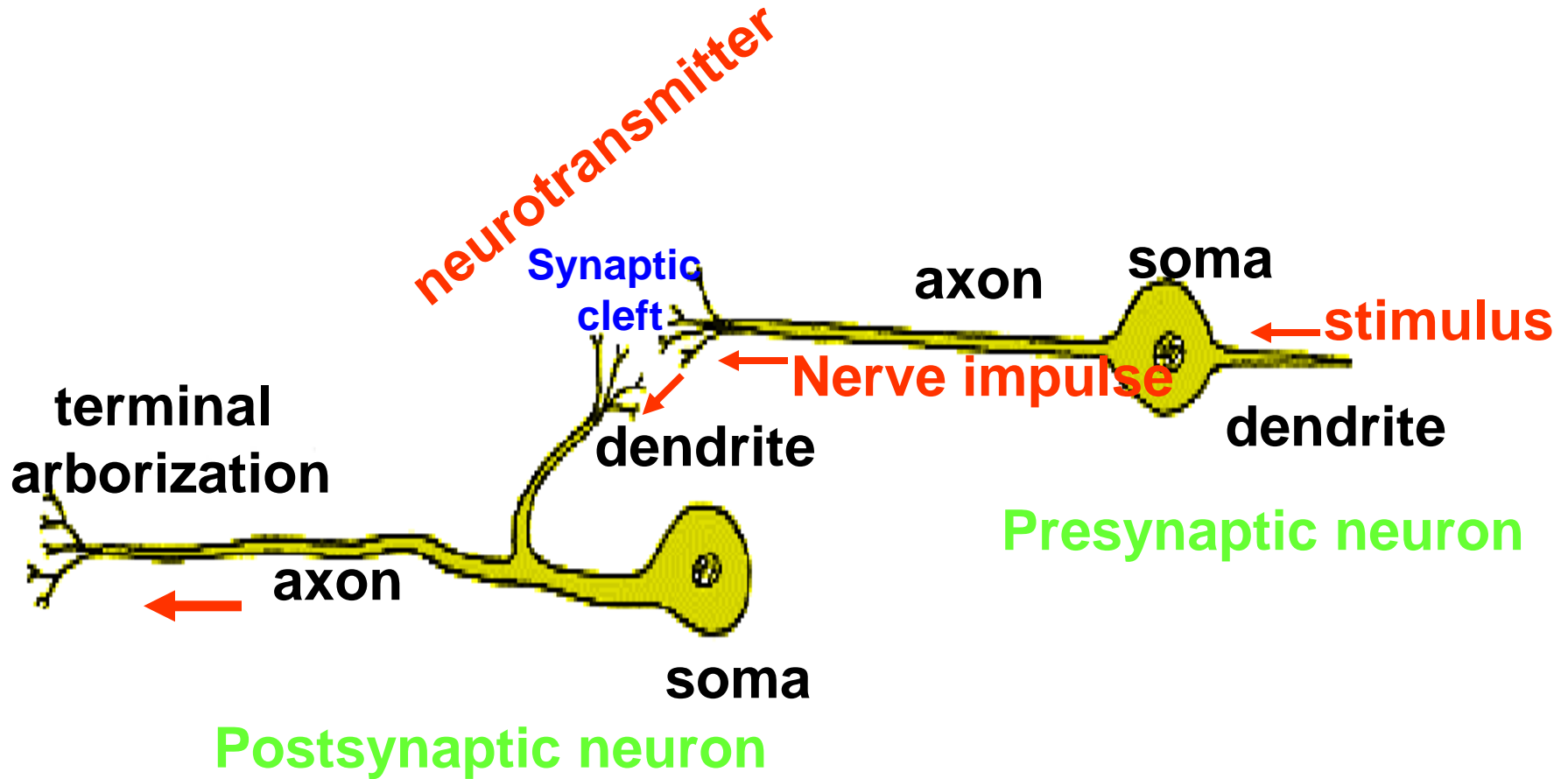
Neuron has projections



Neurons similar to other cells, but:

1. have specialized extensions called **dendrites** and **axons**. Dendrites bring information to the soma and axons take information away from the soma.
2. Neurons communicate with each other through specialized structures called synapses and chemicals (e.g. neurotransmitters).

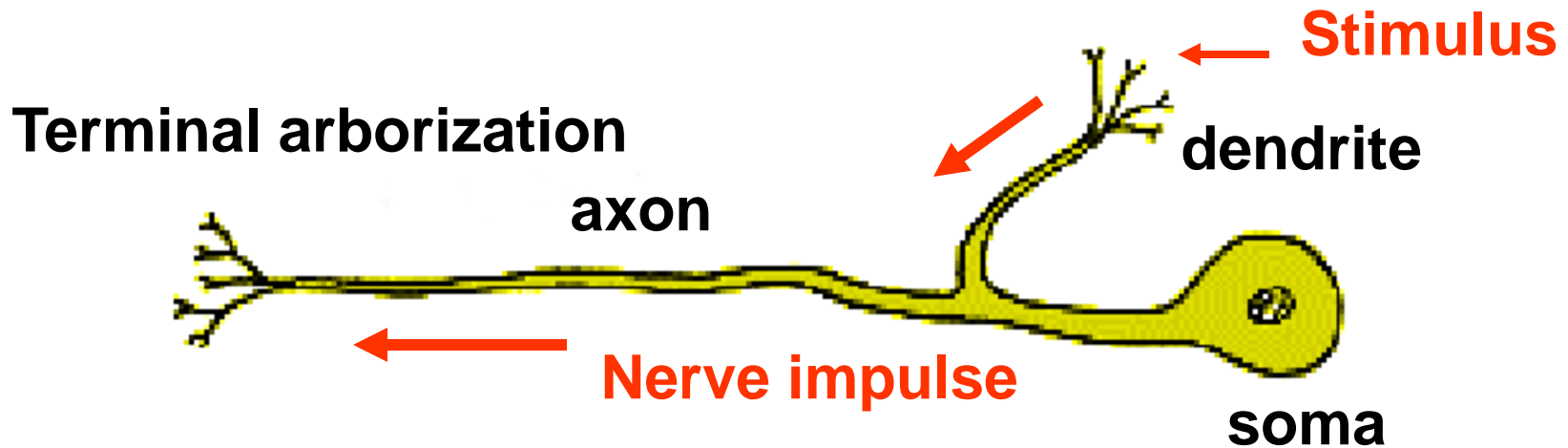
Neuron-neuron junction: synapse



Remember: electric synapse

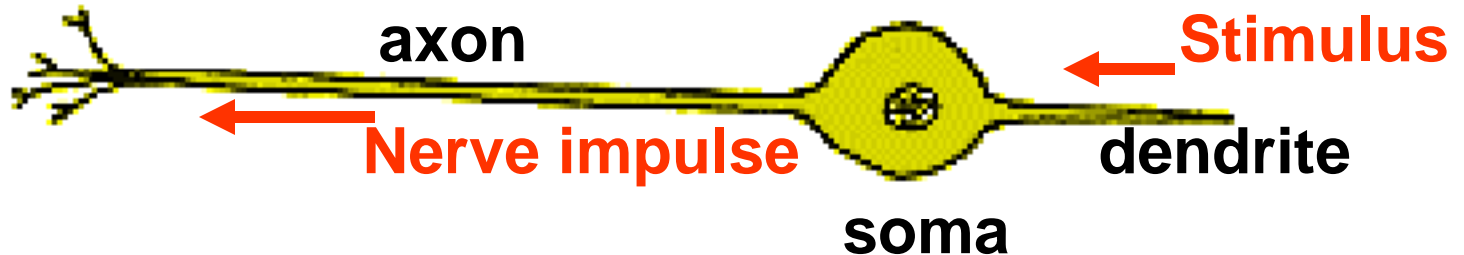
Types of neuron: unipolar

one projection extending from the soma



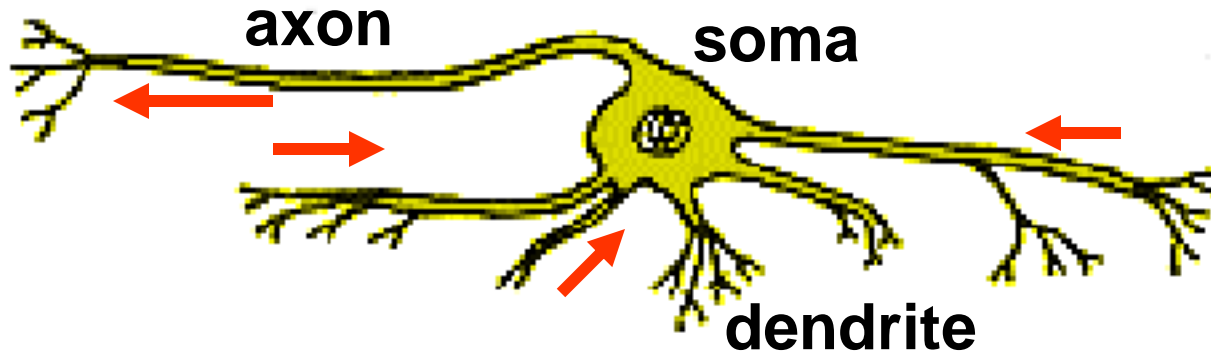
Types of neuron: bipolar

Terminal arborization



- Two projections extending from the cell body
- Typical of sensory neuron

Types of neuron: multipolar



**Many projections extending from the soma
But only one axon**

Types of neuron: two ways of classification

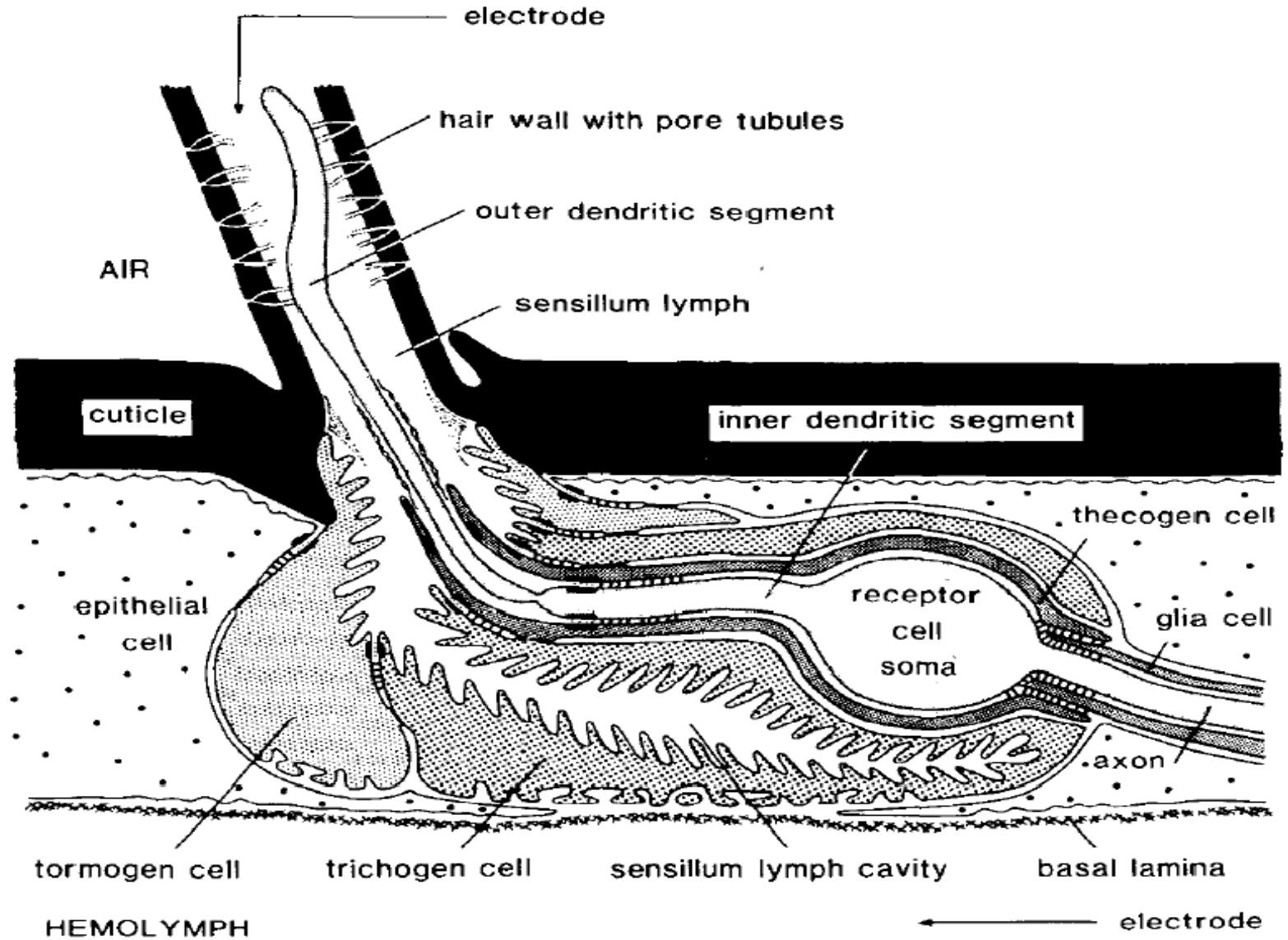
By the number of extensions

- **unipolar neurons** have one projection extending from the soma.
- **Bipolar neurons** have two projection extending from the soma
- **Multipolar neurons** have many projections extending from the soma. However, each has only one axon

By the direction of information that they send (function)

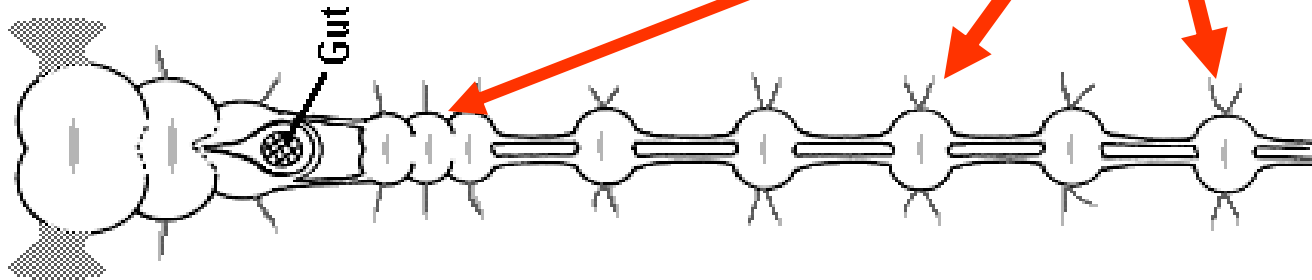
- **Afferent (sensory) neurons** --bipolar or multipolar cells have dendrites that are associated with sense organs. They carry information **TOWARD** the central nervous system (CNS).
- **Efferent (motor) neurons** -- unipolar cells that conduct signals **AWAY** from CNS and stimulate responses in muscles and glands.
- **Interneuron (association neuron)** -- unipolar cells that form connections between afferent and efferent neurons and conduct signals **WITHIN** CNS.

Sensory neuron



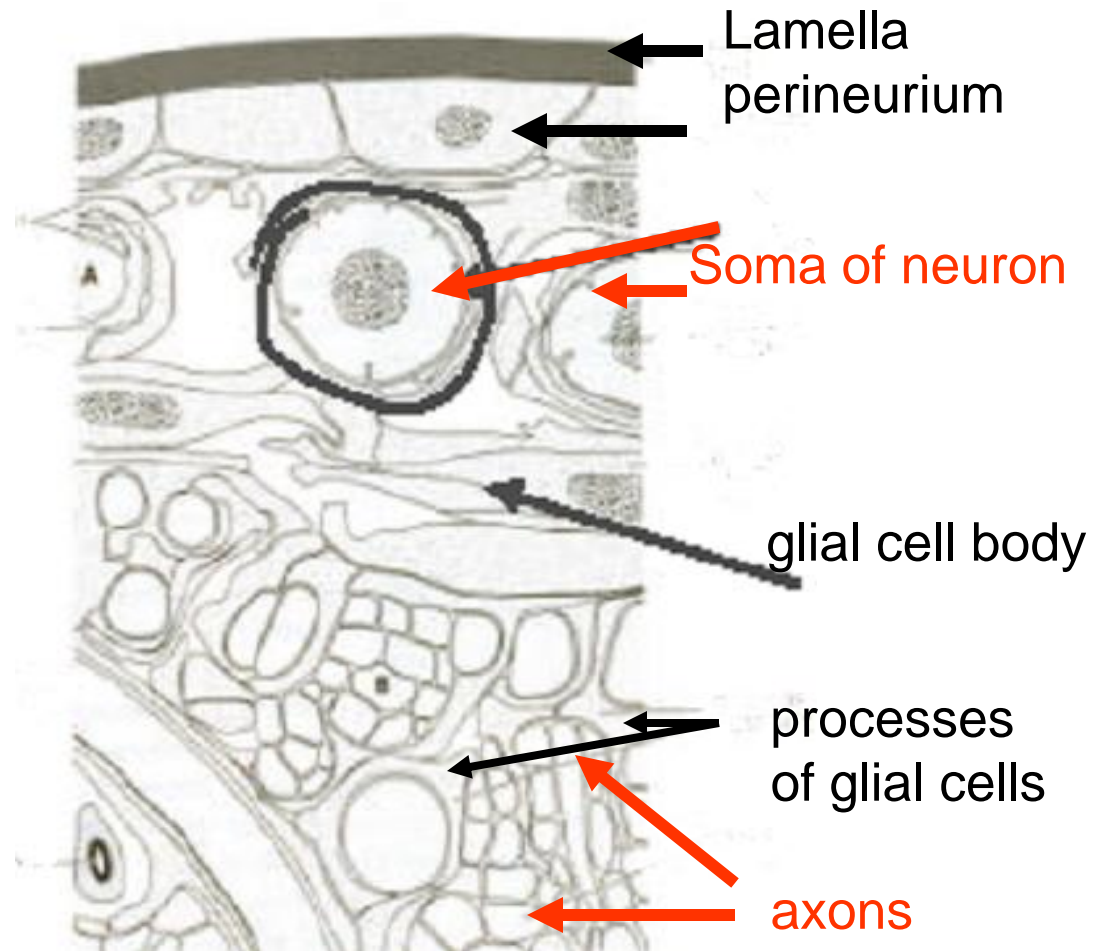
Where are motor neurons and interneurons?

Aggregate in **Ganglion**



Inside ganglion

- Cell bodies cluster on outside ring
- Center region: axons and dendrites of interneurons and motor neurons AND axon arborizations of sensory neurons
- Center region = **NEUROPIIL**



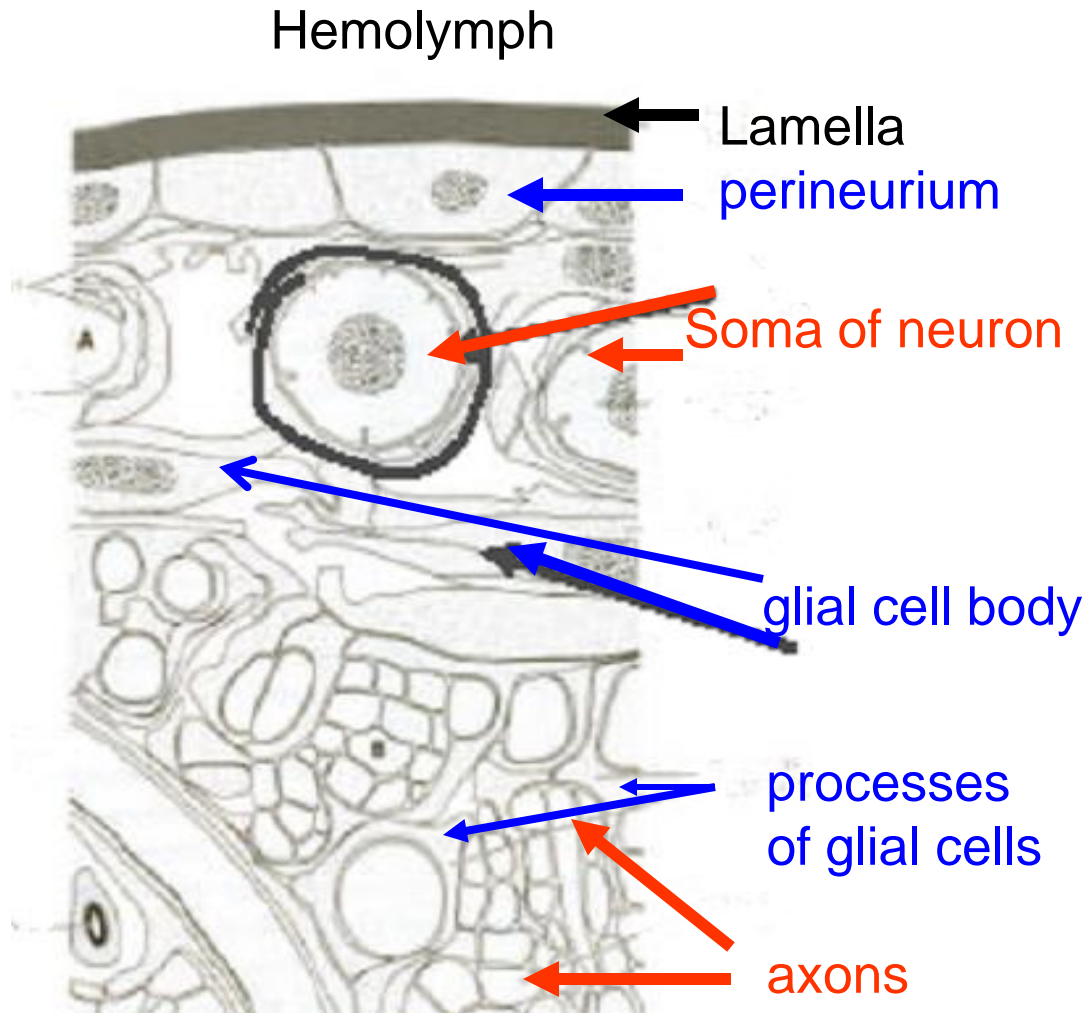
Inside ganglion: glial cells

Surround ganglion

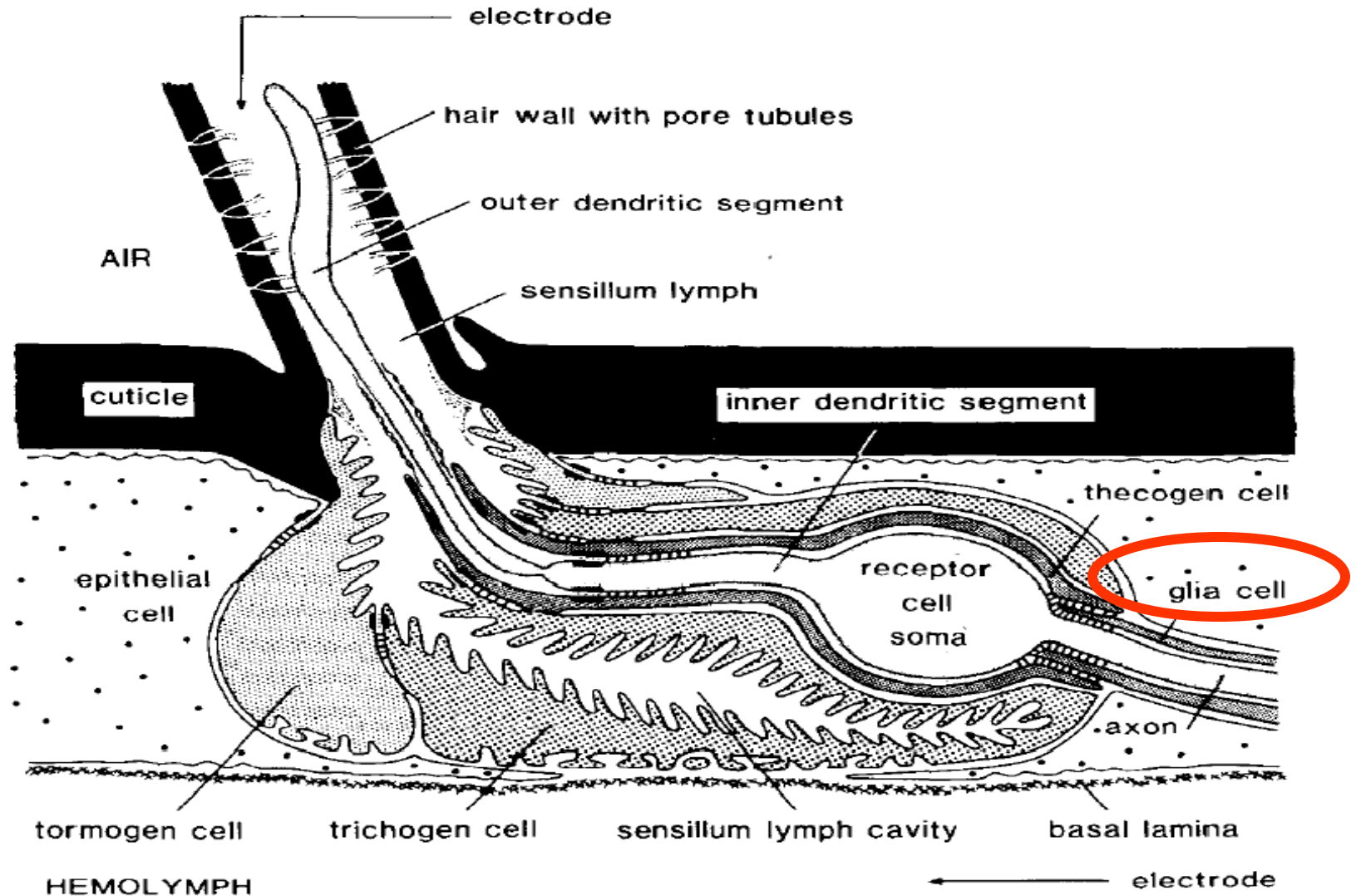
- **Neural lamella**: mechanical support for NS, secreted by perineurium
- **Perineurium=brain-blood barrier**: a layer of glial cells that maintain stable ionic environment
- **Nerve sheath**= lamella + perineurium

Surround individual nerve (axon)

- Protect, insulate and repair neuron
- Pass nutrients to nerve and control ionic environment
- More glial cells than neurons



Glial cells: go with sensory neurons

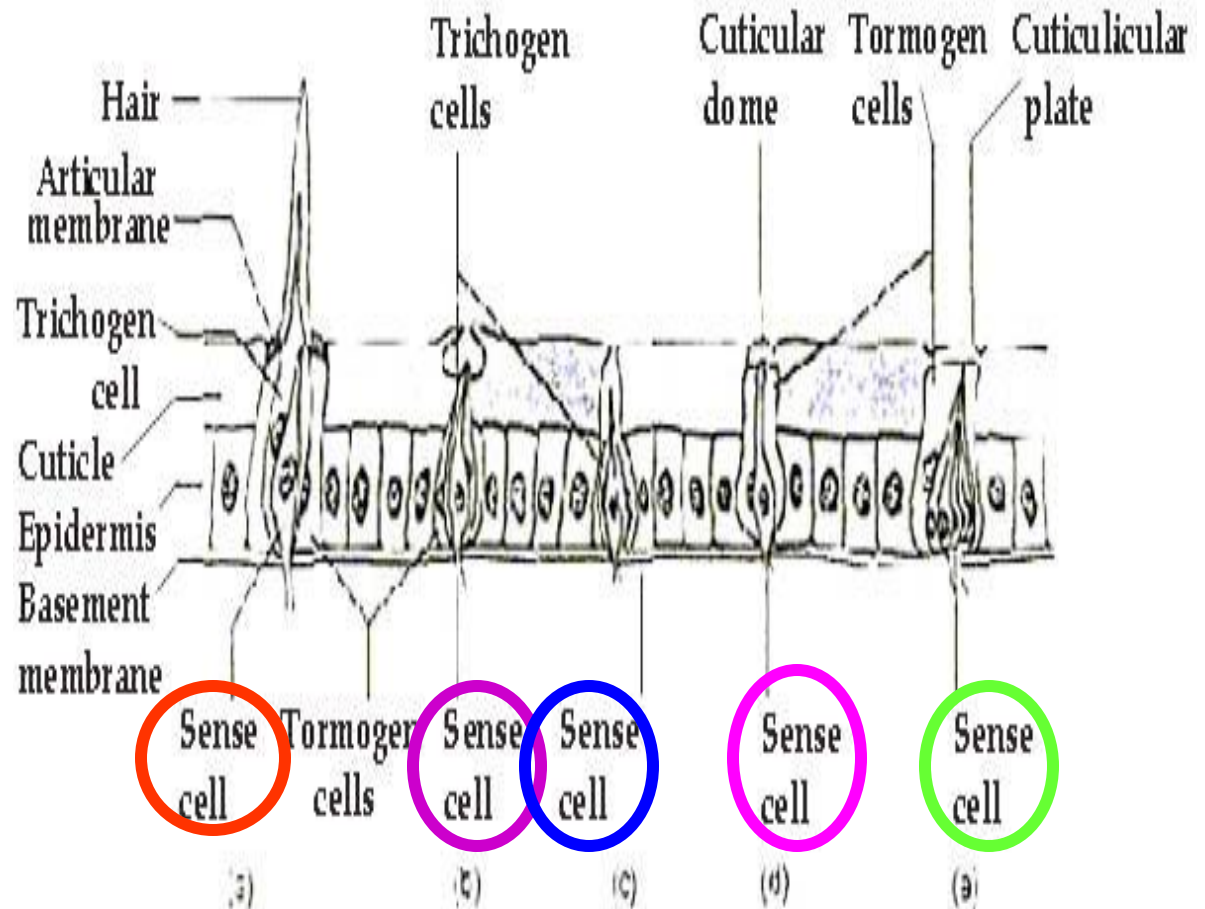


Insect Nerve system: anatomy

- **Central nerve system (CNS)** - most ganglia included: brain+ventral nerve cord
- **Stomatogastric nerve system (SNS)** - Frontal ganalion + hypocerebral ganglion + ventricular ganglion; innervate muscles of the mouth cavity, foregut, midgut; and regulate food uptake and food transport
- **Peripheral Nerve system (PNS)**- all sensory neurons; not bundled in ganglia; located in integument

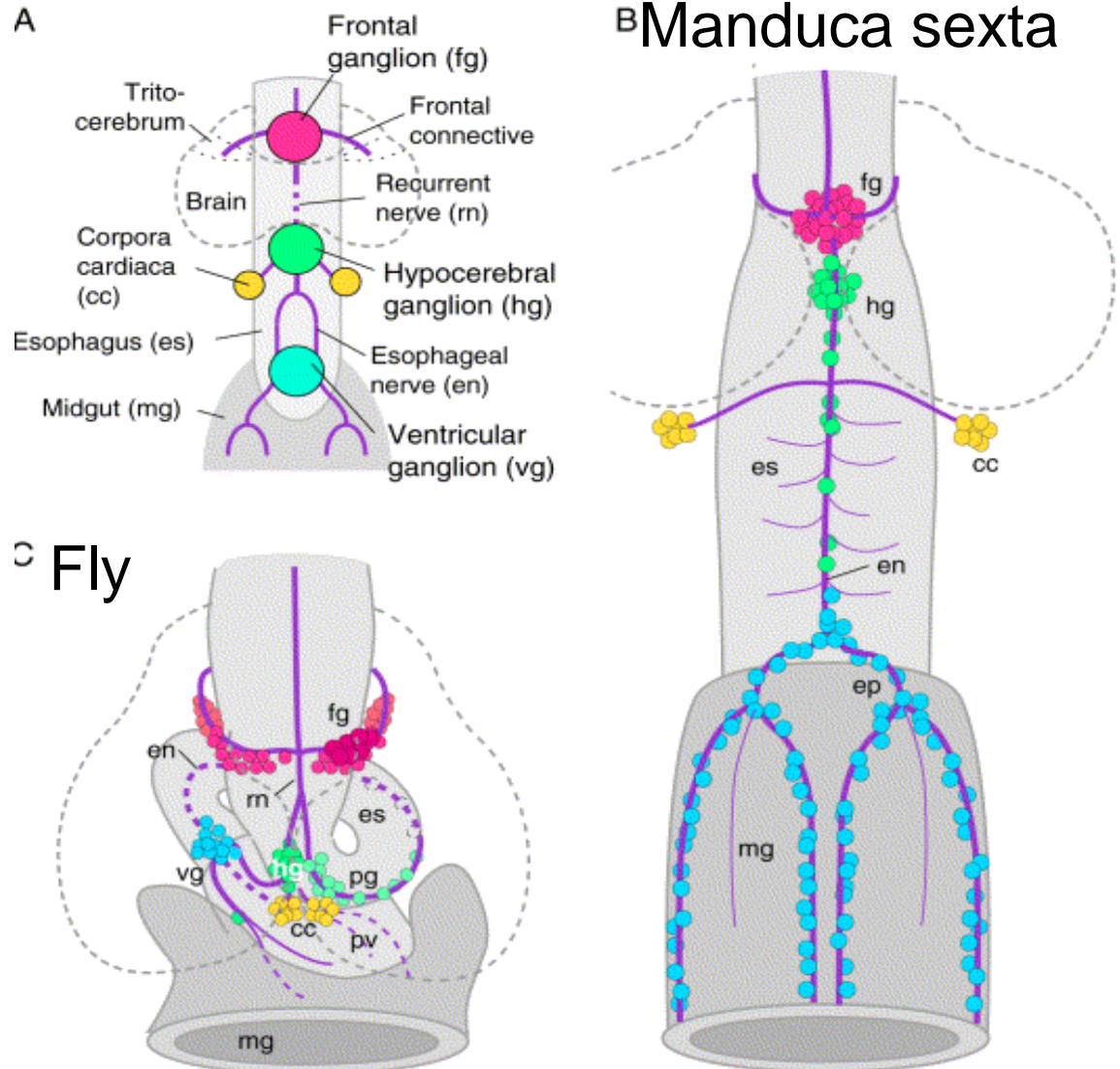
PNS: all sensory neurons

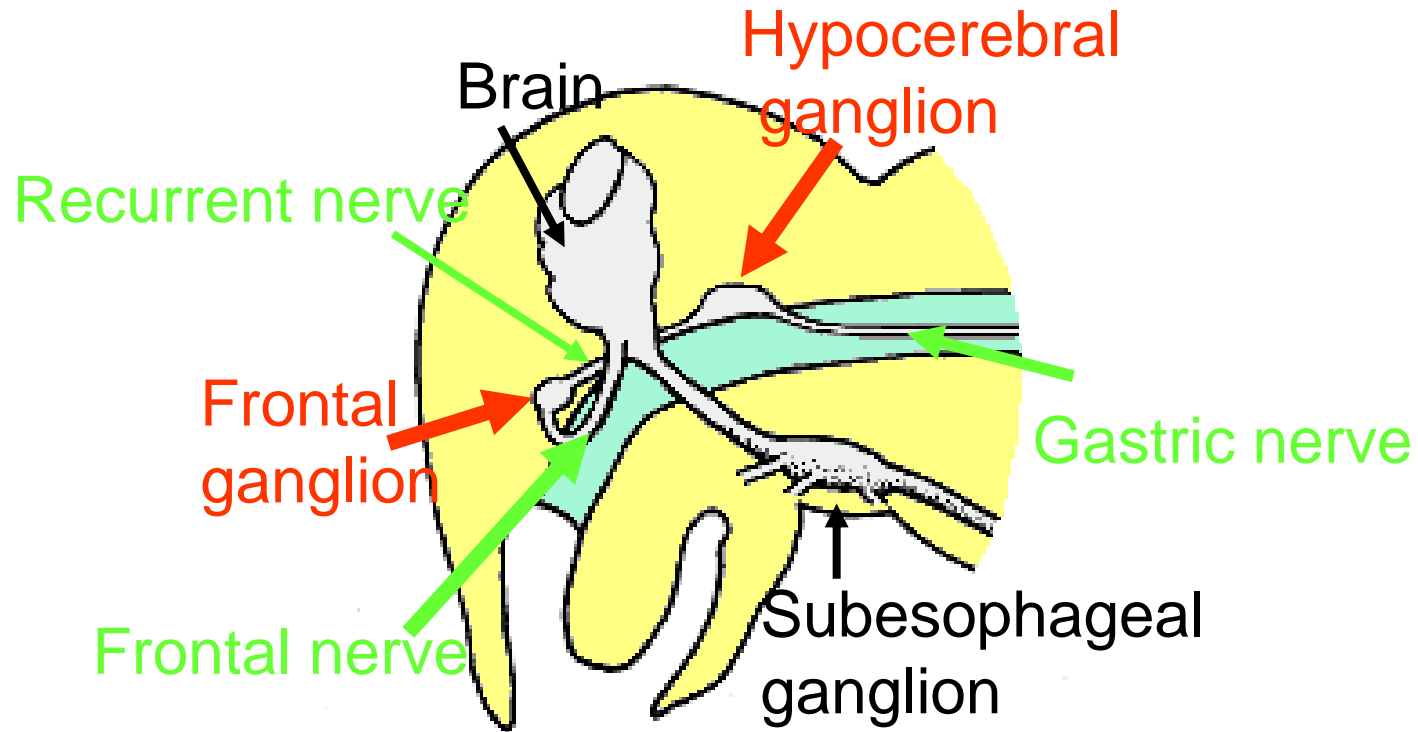
- In epidermis
- Sensory neurons
- Outside ganglion



SNS: FG, HG and VG

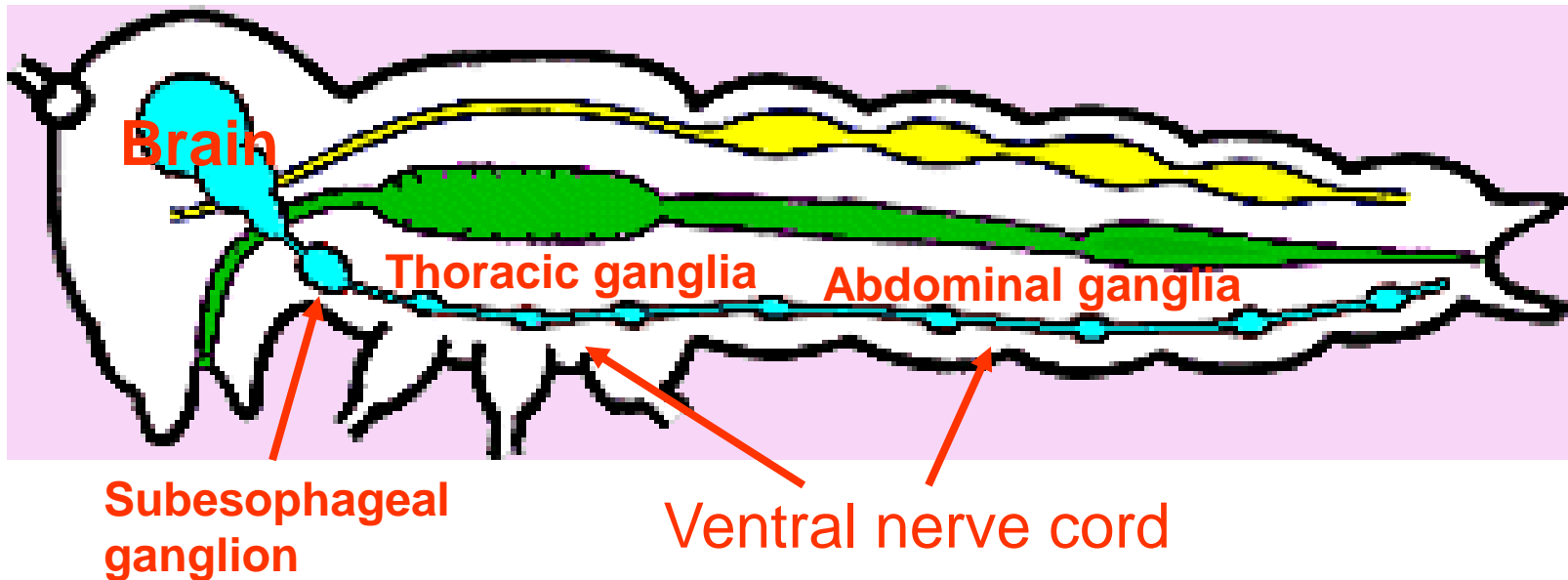
- FG: Frontal ganglion
- HG: Hypocerebral ganglion
- VG: Ventricular ganglion or cluster of neurons





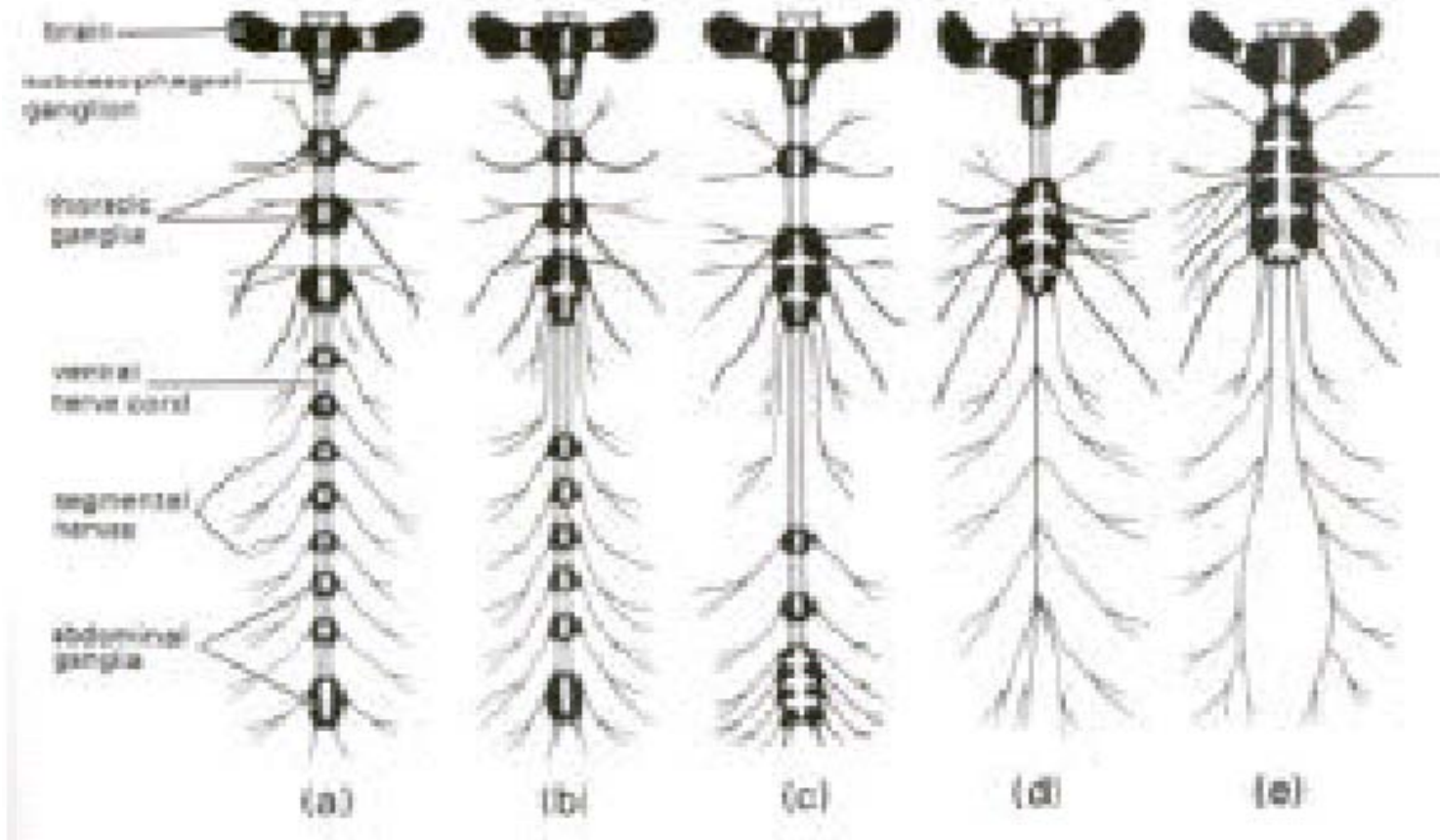
- **FG:** connect with tritocerebrum and HG, send axons to pharynx and esophagus. control of food passage through the gut and crop emptying
- **HG:** sends axons to CC and VG
- **VG:** associate with foregut and midgut

CNS: brain + ventral nerve cord



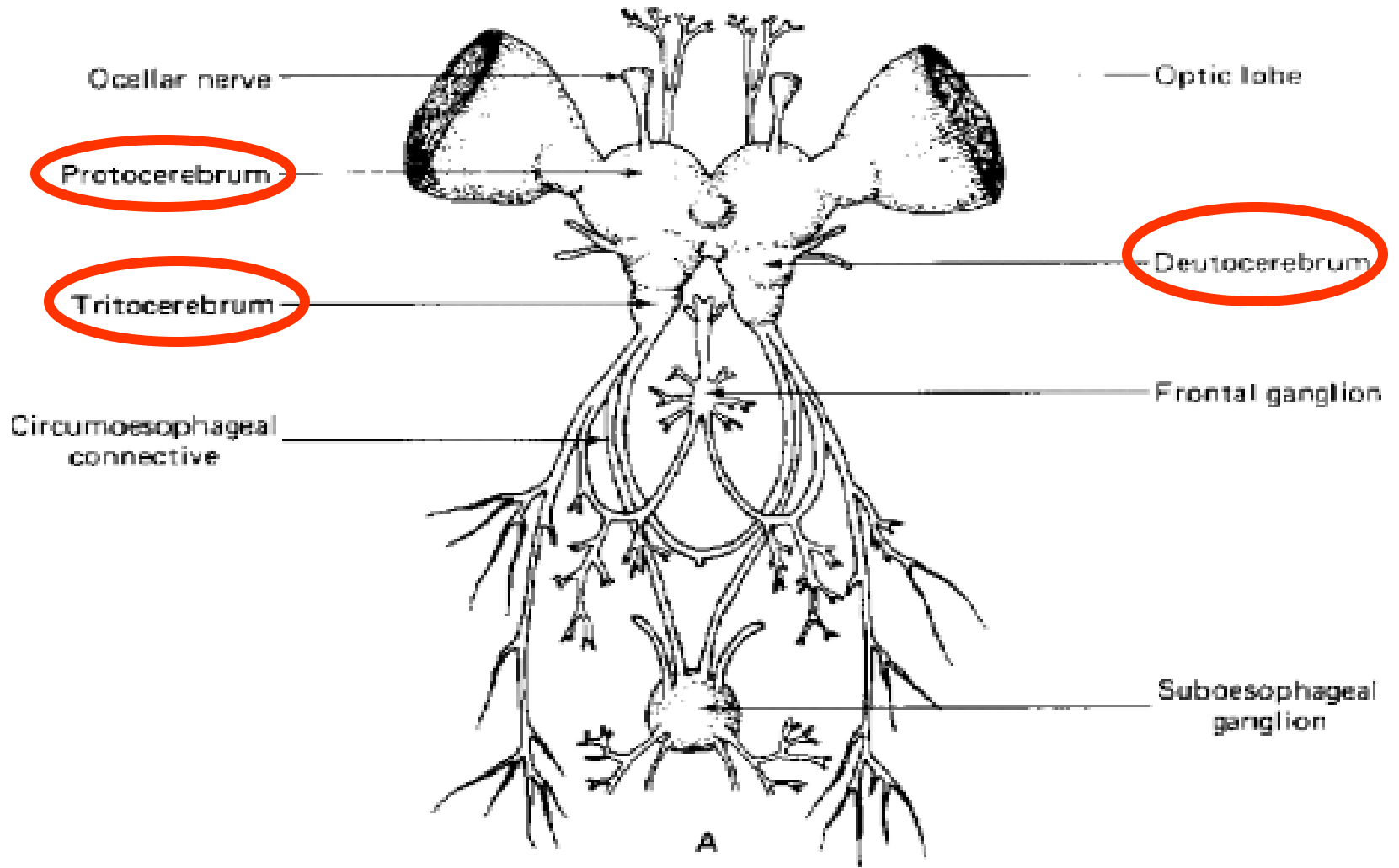
- **Brain:** a compound ganglion, major association center
- **Ventral nerve cord:** SG + TG + AG: local association center
- **SG:** a compound ganglion (mandible maxillae, and labium)

Ventral nerve cord: trend towards ganglia (fusing) condensing

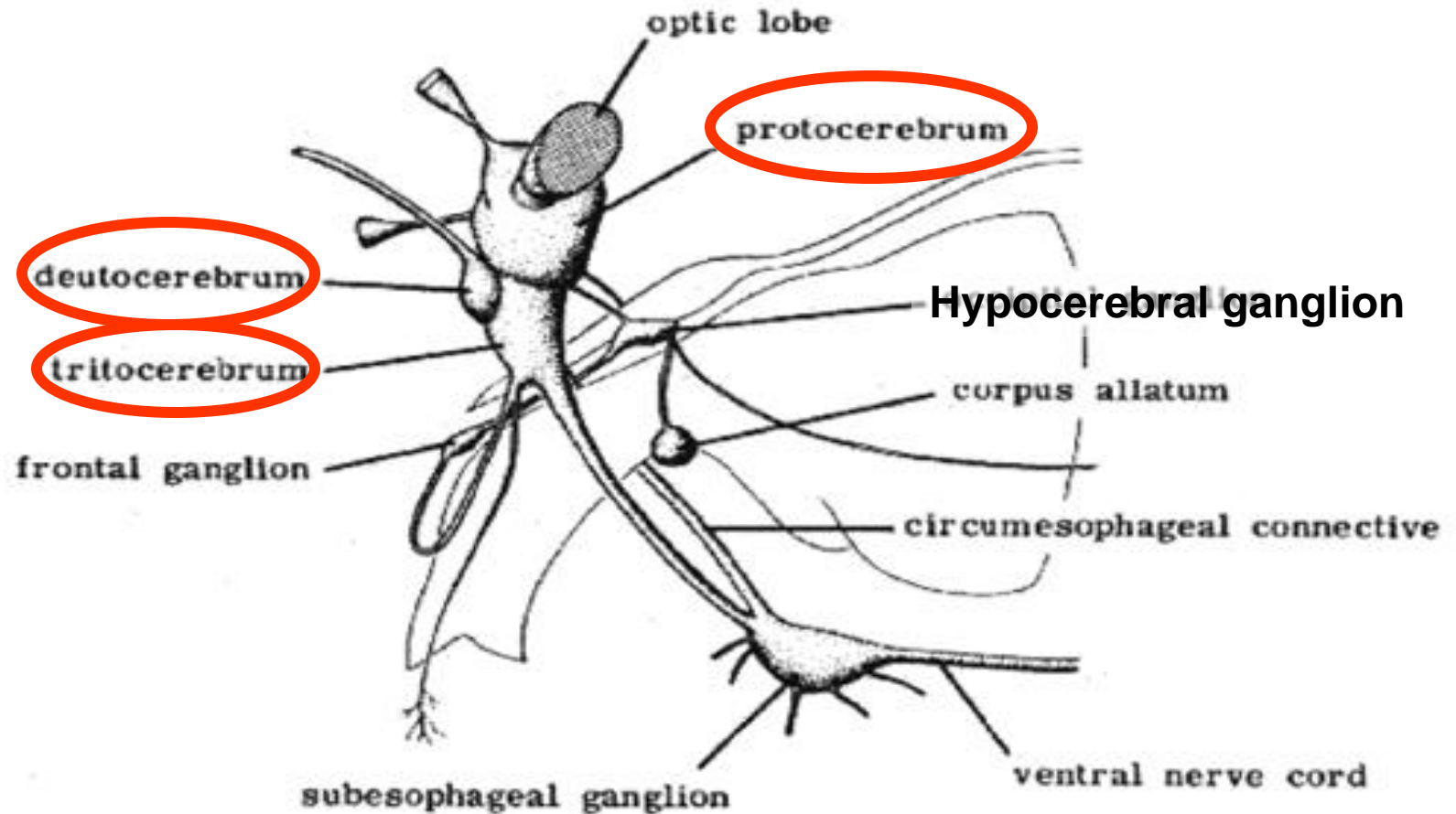


More ventral ganglia in primitive species than in advanced ones
More in larvae than in adult

Brain: proto-, deuto- and tritocerebrum

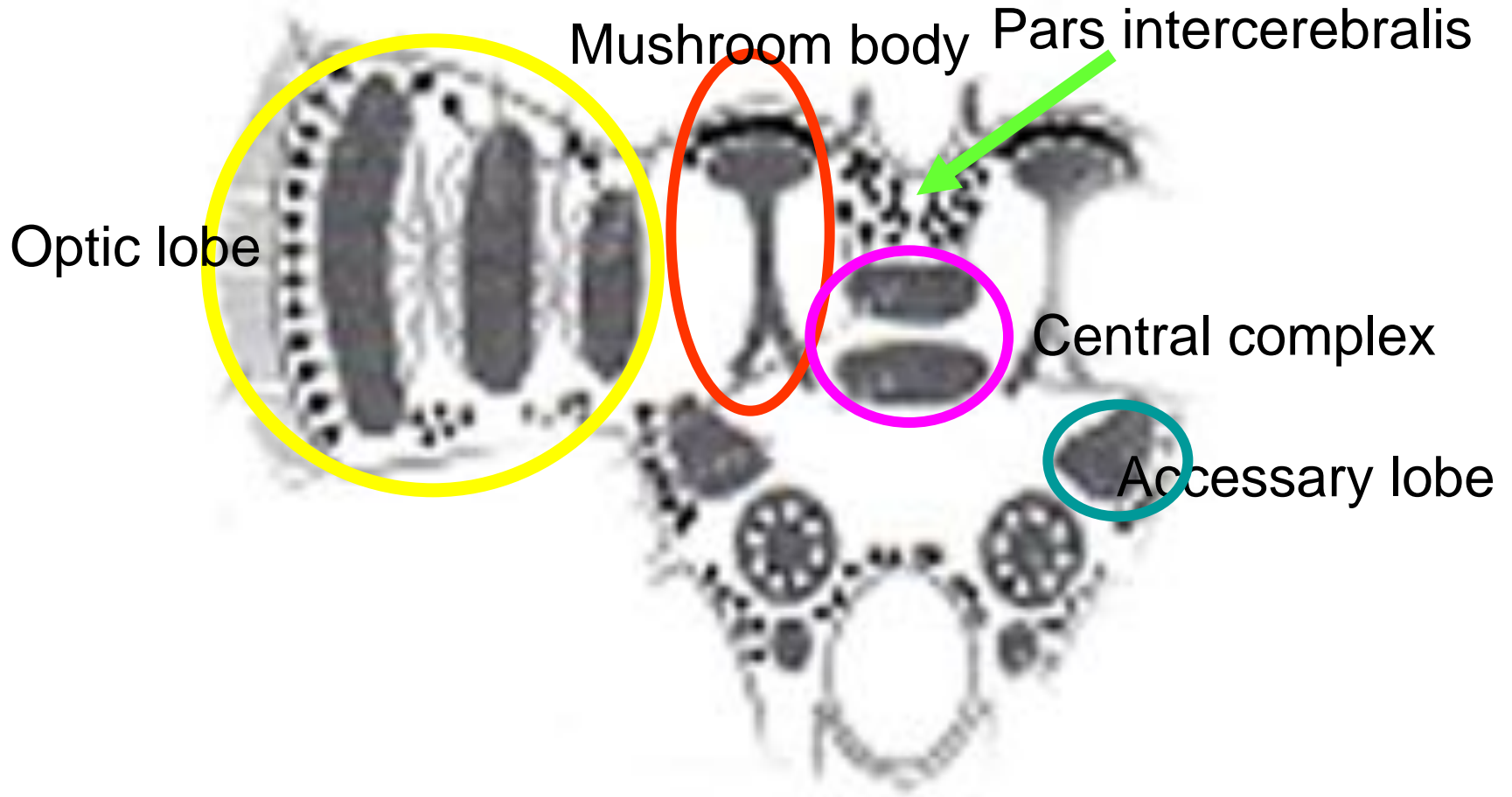


Brain: another perspective

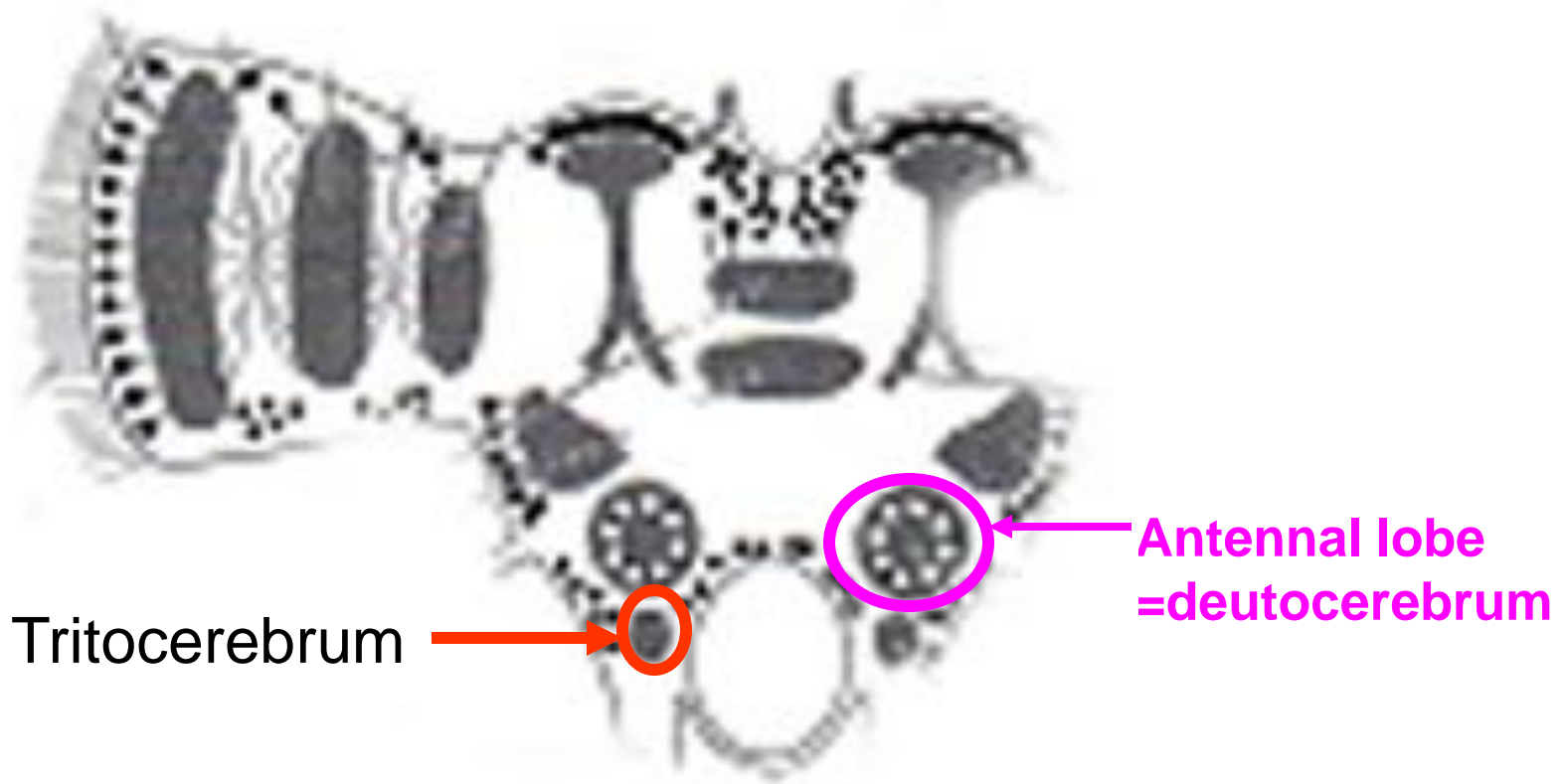


Components of the insect brain.

Protocerebrum

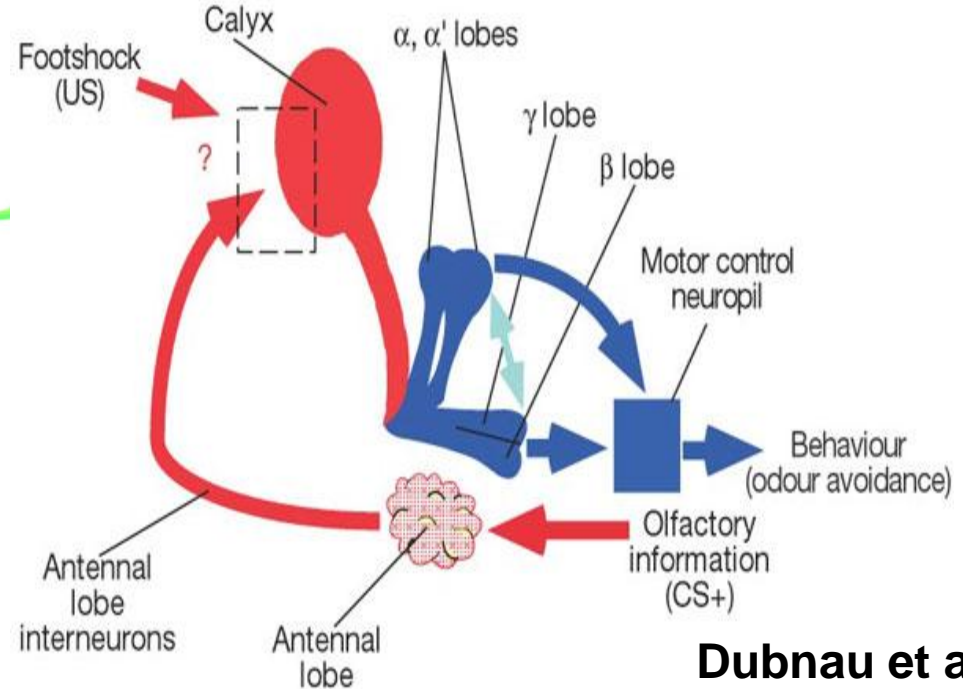
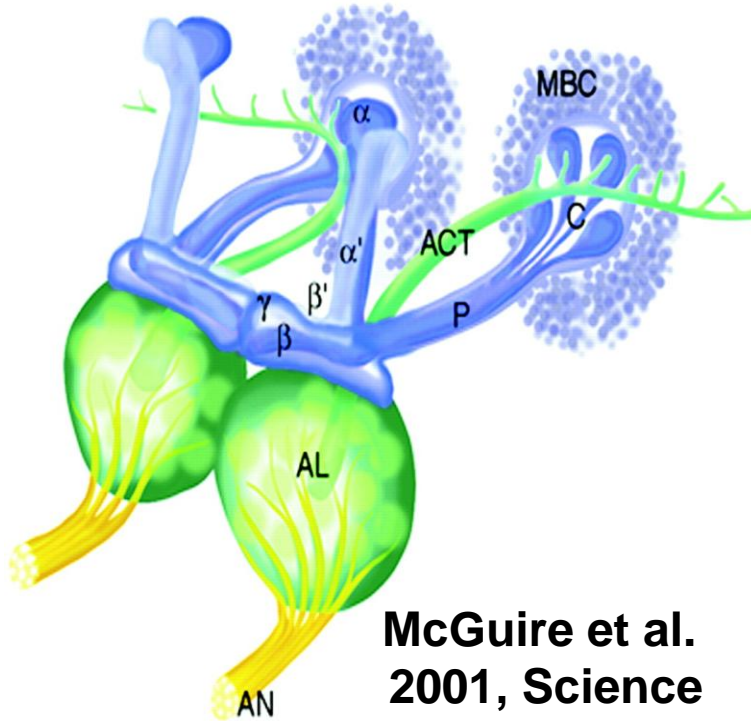


Deuto- and tritocerebrum



- **Antennal lobe:** the centers that receive the antennal nerves
- **Tritocerebrum:** the origin of the labral nerves that run to the upper lip

Mushroom body: center for higher-order sensory integration and learning



- Receive information mainly from olfactory (antennal lobe). Hymenoptera also from optic lobe
- Olfactory learning and memory, place memory, associative memory, and roles in motor control

Roles of central complex

- control of locomotor activity, particularly flight and walking
- center for direction perception and spatial navigation
- coordinates L and R brain?

