

How vEM can help map neuronal circuits



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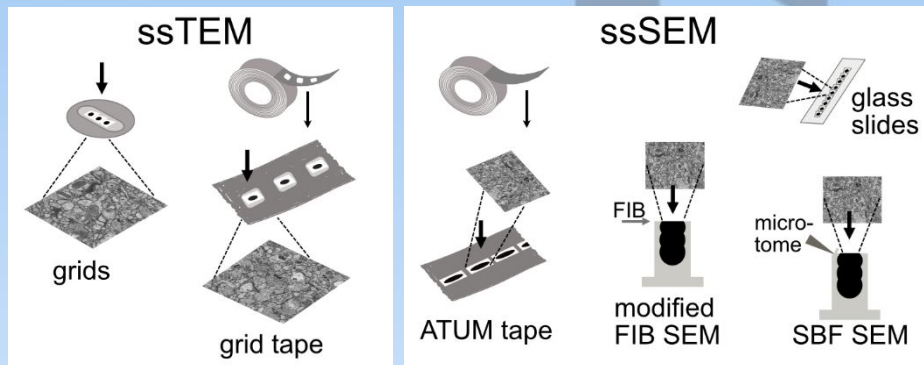
Challenge

The nervous system processes sensory information and generates different behavioural outputs accordingly. Synaptic resolution wiring diagrams form a basis for our understanding of how the brain works. Such a connectome provides the synaptic connectivity between all neurons and allows to identify all potential neuronal pathways which mediate different behaviours. This “road map” can then be combined with cell-specific molecular information, neuronal dynamics, targeted manipulation and behavioural experiments.

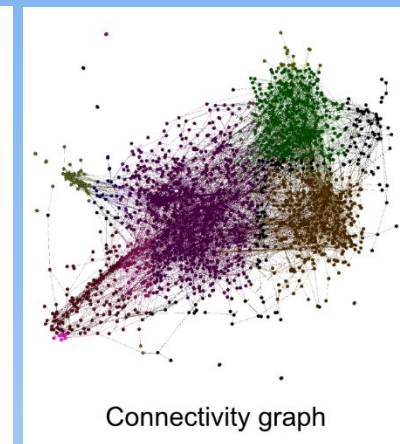
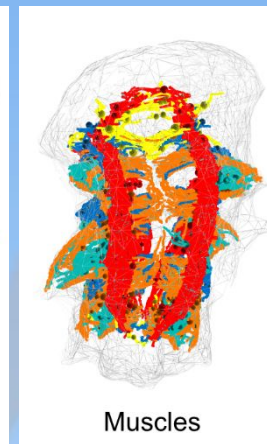
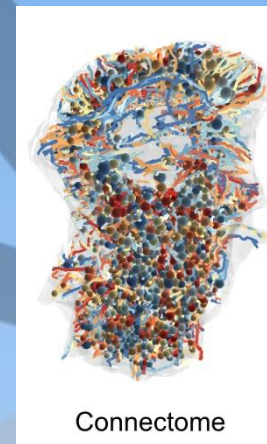
A main challenge is the acquisition of large, continuous EM volumes with sufficient resolution. Several volume EM (vEM) techniques can be applied to generate these volumes, which form the basis for whole nervous system wiring diagrams; only such diagrams will allow comprehensive exploration and understanding of sensory computation and the evoked behavioural outputs.

Technique: serial section TEM/SEM

Large, continuous EM volumes with synaptic resolution can be acquired using ssTEM on grids or ssSEM on glass slides¹. Both methods are also compatible with serial sections mounted on grid and ATUM tape^{2,3}. Furthermore, serial blockface (SBF) SEM⁴ and modified focused ion beam (FIB) SEM⁵ can be used to image samples *en bloc*.



Research



Currently, the largest existing whole animal connectome has been generated in *Platynereis*⁶. Using vEM, all cells and connections of the entire sensory-motor pathways have been mapped^{7,8}. The researchers used the connectome to identify how information is transmitted from the brain to global or local segment-specific areas in the ventral nerve cord, and vice versa. They also could link specific neuronal circuits with different behaviors: For example, they discovered how the nervous system coordinates whole-body ciliary activity for locomotion, visual phototaxis and predator escape response⁹⁻¹¹.

Impact

- Systems Biology approach for understanding the function and evolution of nervous systems
- Identification of individual neurons and all possible neuronal pathways
- Combining molecular and functional properties with neuronal circuit elements
- Mechanistic understanding of behaviour