THE STRUCTURE AND FUNCTION OF THE RAT RETINA WITH
PARTICULAR REFERENCE TO THE ACETYLCHOLINESTERASE
SYSTEM IN THE INNER PLEXIFORM LAYER.
VOLUME I.

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Summary

The ultrastructure of the rat retina, with particular reference to the inner plexiform layer (IPL), was studied with osmium and aldehyde-osmium fixation, and with methods for cytochemical localisation of acetylcholinesterase. Investigations were undertaken on effects of chronic administration of the anti-cholinesterase diisopropylfluorophosphate (DFP), and chronic occlusion of the eye on retinal ultrastructure.

The IPL contains neural processes of amacrine, bipolar, and ganglion cells, and glial (Müller) processes. Processes were traced to somata in fortuitous montage sections.

Type 1 amacrine processes were up to 3μ in diameter, and resembled structurally amacrine perikarya. Type 2 amacrine processes were 0.3 - 0.7μ in diameter, radially oriented, forming synaptic expansions en passant, giving origin to collaterals, also with expansions. Type 2 amacrines formed conventional synapses onto bipolar, ganglionic and other amacrine processes, onto amacrine and ganglion somata, and formed spine and serial synapses.

Bipolar processes traversed the IPL, forming terminal expansions 1 - 5μ in diameter near the ganglion somata.
which they occasionally contacted. These contacts were characterised by tight-like junctions without synaptic vesicle clustering. Bipolar processes formed synapses chiefly at synaptic ribbons onto pairs of postsynaptic processes called dyads. In 73% of dyads, both processes were vesiculated. One process of the dyad pair could be identified as an amacrine by its reciprocal synapse back onto the presynaptic bipolar process. The other dyad process, when vesiculated, contained vesicles which were significantly larger and less concentrated than in the adjacent amacrine, and was presumably a ganglion cell dendrite. Occasionally "classical" dyads were also seen. The incidence of amacrine and bipolar synapses in the IPL was $0.062 - 0.114/\mu^2$ and $0.008 - 0.015/\mu^2$, respectively. A subdivision of the IPL into thirds showed a significantly higher incidence of amacrine synapses in the middle third than in either outer or inner thirds. However, incidence of amacrine-bipolar synapses was highest in the inner third. Results are discussed in terms of comparative ultrastructure and retinal lateral interaction.

Chronic DFP administration caused significant increases in the incidence of amacrine synapses in the IPL, and in the vesicle concentrations of amacrine,
bipolar, and receptor processes. Evidence suggests effects were dependent on dosage rather than duration of DFP treatment. Findings are discussed in terms of the cholinergic vesicle hypothesis.

Chronic occlusion resulted in a significant increase in incidence of amacrine synapses and in vesicular diameters of processes in the IPL.

Acetylcholinesterase enzyme product was highly concentrated in intercellular spaces of the IPL. Intracellular enzyme product was seen in the nuclear envelope and endoplasmic reticulum of ganglion, amacrine, and bipolar somata, and in neural processes of the IPL. Small amounts of product were seen in the outer plexiform layer, presumably associated with the dendrites of bipolar cells. These findings confirm and extend previous light histochemical studies. The rationale underlying recent techniques for localising acetylcholinesterase activity with the electron microscope was evaluated.