B0010

Comparative anatomy and connectivity of the Aii amacrine cell in mouse and rabbit retina

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Purpose

Mouse retina structurally differs from rabbit retina, as it is thicker and vascularized, while the rabbit retina is thinner and avascular. The implications of these differences on neuronal morphology and connectivity is not known. This project compares the morphology and connectivity of the Aii amacrine cell (AC) with ultrastructural precision in connectomes of rabbit (RC1) and mouse (RC2) retina. The Aii amacrine cell is a crucial cell class involved in the switching of light information from bright to dark environments and visa versa.

Methods

RC1 and RC2 are retinal connectomes built by automated transmission electron microscopy at ultrastructural (2 nm/pixel) resolution. RC1 and RC2 are 0.25mm diameter volumes of retina. RC1 is from a 13 month old, female Dutch Belted rabbit. RC2 is from a 5 month old female C57BL/6J mouse. The Viking application was used to annotate Aii ACs in both connectomes.

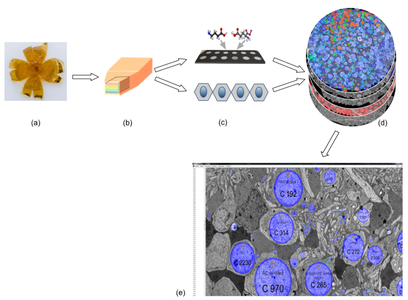

Figure 1. Construction of connectomes.
(a) Isolated retina is fixed and flat mounted. (b) A small punch is embedded in resin. (c) Serial sections (70 nm) are placed on slides for immunocytochemistry for small molecules used for metabolic labeling and cell classification or formvar grids for TEM imaging. (d) A registered volume is built by computational assembly from the TEM and light microscopy images. (e) All structural features including cells their chemical and electrical synapses are annotated section by section using the Viking application.

Conclusion

Lateral expansion of rabbit Aii ACs may be attributable to eccentricity. However, morphological differences appear to mediate greater output to the OFF versus ON pathways in mouse. Synaptic partners are currently being analyzed. Comparative anatomy connectomics is essential for understanding possible implications of retinal structure on neuronal morphology and connectivity that may underlie network differences between the mouse and rabbit retina.

Support

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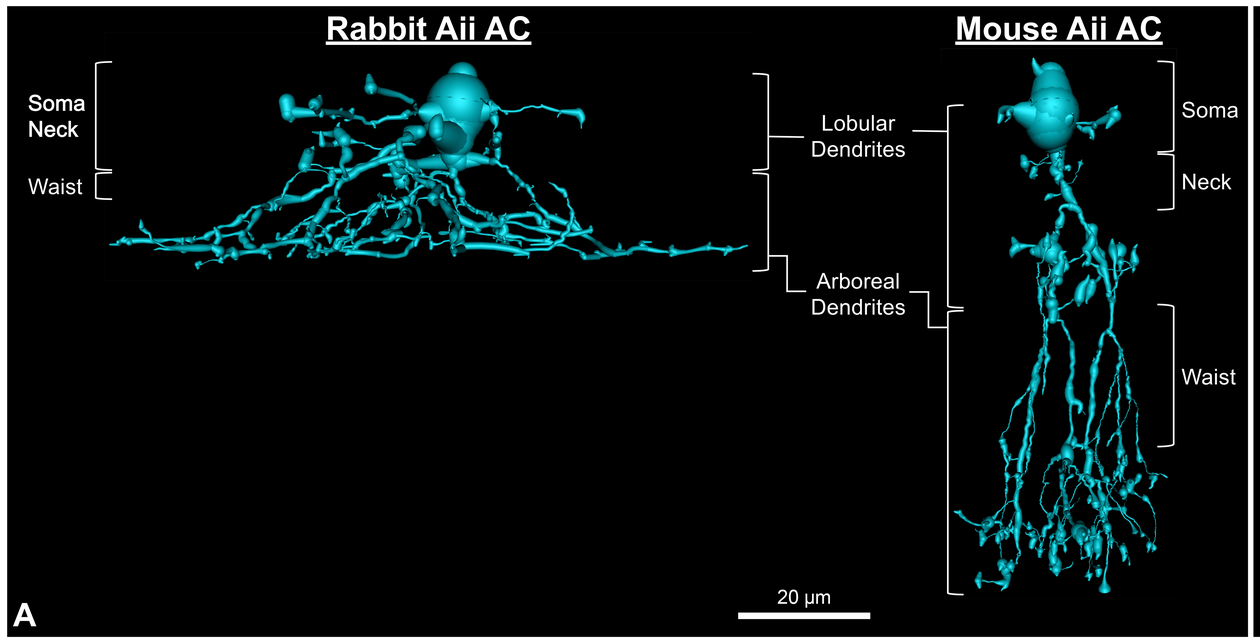
Commercial Relationship Disclosures

SW,CLS,JRA,DPE,CNR,JD,RLP,KDR,JY,CBW,BWJ: None. REM: Signature Immunologics, Inc. (Personal Financial Interest).



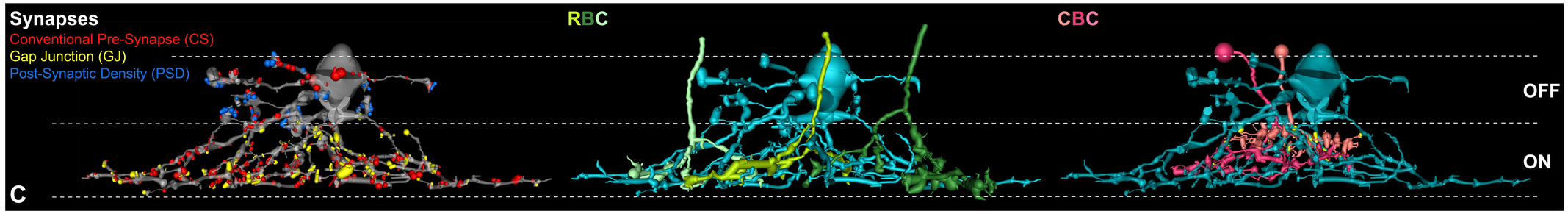
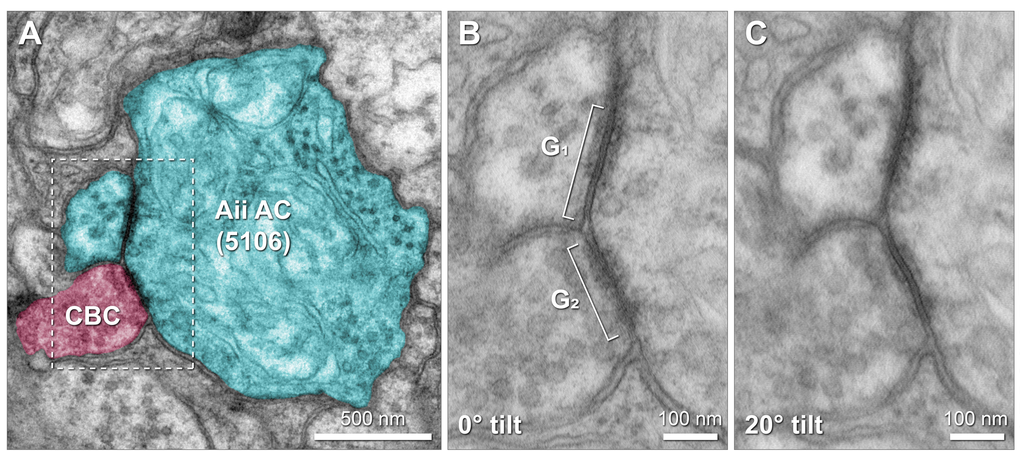


Figure 2. Comparison of morphology and synaptology of Aii amacrine cells between mouse and rabbit.
(A) Mouse Aii ACs are noticeably elongated to span the thicker inner plexiform layer and have prominent neck and waist regions. Rabbit Aii ACs are more compact, lacking distinct neck and waist regions. The arboreal dendrites of rabbit Aii ACs travel obliquely through the ON sublamina, while those of mouse Aii ACs travel more vertically with limited lateral expansion until they reach the terminals of rod bipolar cells (RBCs). (B) Mouse Aii ACs exhibit distinct synaptic compartments, corresponding with the stratification of their principle synaptic partners. Lobular dendrites in the OFF sublamina are dominated by conventional pre-synapses (blue) with OFF cone bipolar cells and post-synaptic densities (red) to their reciprocal ribbon pre-synapses. Gap junctions (yellow) dominate the arboreal dendrites in the waist region while post-synaptic densities (red) to RBC ribbon synapses dominate deeper. Uniquely, mouse Aii ACs form gap junctions (yellow) with the descending axons of ON cone bipolar cells as they pass the soma and lobular dendrites (arrows, and Figure 3). View is rotated for visualization of stratification with RBC terminals and gap junctions with CBCs. (C) In rabbit, conventional pre-synapses (blue) and gap junctions (yellow) occupy distinct compartments. Abbreviations: CBC, cone bipolar cell, RBC, rod bipolar cell.



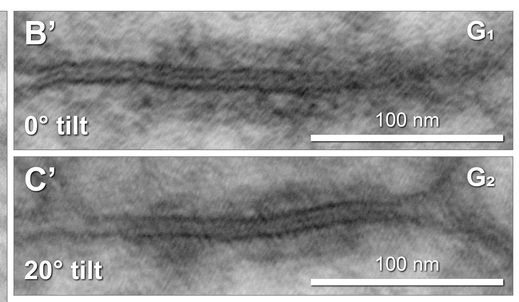


Figure 3. Recapture of gap junctions for validation.
(A) Mouse Aii AC 5106 forms neighboring gap junctions with another branch of itself (top, G_1) and an ON cone bipolar cell (bottom, G_2). Recapture at 30,000 X magnification (0.36 nm/pixel) with goniometric tilts of 0° (B) and 20° (C) can be used to confirm gap junction identity. (B',C') enlarged to view pentalaminar structure characteristic of gap junctions.

Table 1: Comparisons of connectivity across species

Feature	Rabbit (Mean ± SD)	Mouse (Aii AC 5106)
Total conventional pre-synapses	55.4 ± 15	124
Total gap junctions	104.8 ± 13.7	148
Total post-synaptic densities	272.4 ± 39.1	442
Input : Output	2.3 : 1	2.2 : 1
Output to OFF vs ON	0.53 : 1	0.83 : 1

Poster Link:

http://marclab.org/blog/2019/04/28/comparative-anatomy-and-connectivity-of-the-aii-amacrine-cell-in-mouse-and-rabbit-retina/

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