SUPPLEMENTAL INFORMATION

Figure S1. PCR and immunohistochemical characterizations of C*hx10^{Cre};Bmal1$^{fl/fl}$* mice.

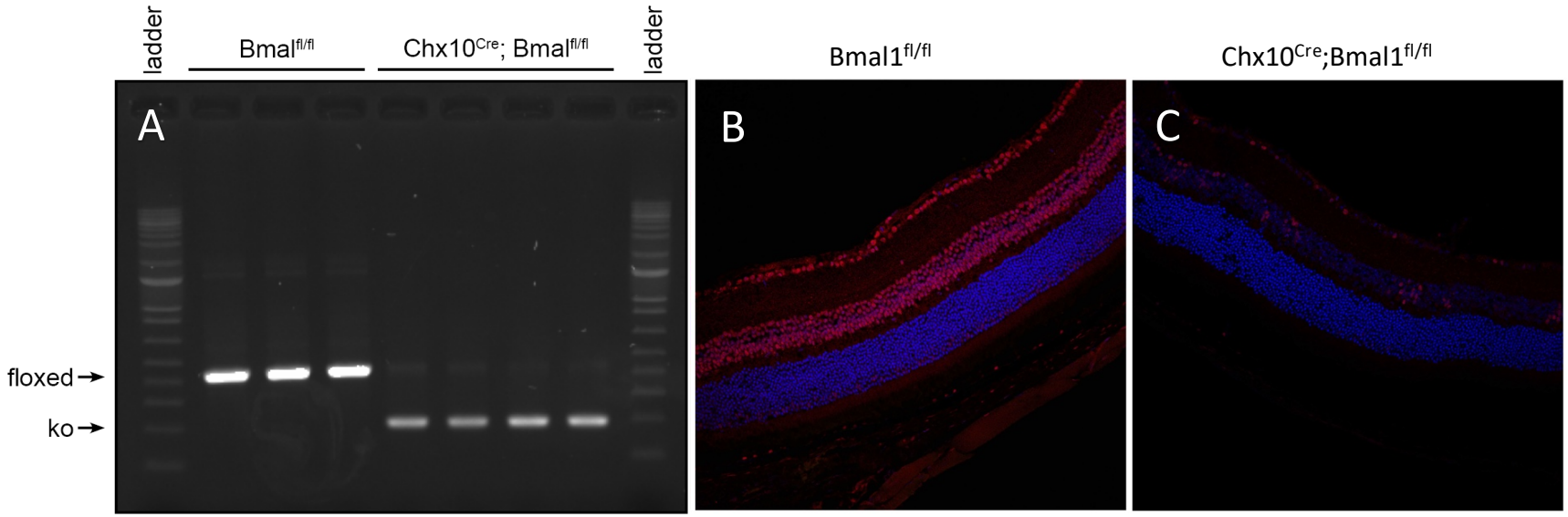

Figure S1. Retinas were collected 6 hours after light onset of the light/dark cycle. A. PCR analysis of genomic DNA. PCR was used to confirm knockout of the *Bmal* floxed allele in retina. Retinas were collected from *Chx10^{Cre}; Bmal$^{fl/fl}$* and *Bmal$^{fl/fl}$* mice. DNA was extracted from the retinas using QuickExtract DNA Extraction Solution (Lucigen Corporation, Middleton, WI) as per manufacturer's protocol. PCR was performed using HotStarTaq Plus Master Mix kit with primers ARNTL-5'lox F – 5'-TCCTGGTTGGTCCAAGAATATG-3', oIMR7525 5'-ACTGGAAGTAACTTTATCAAACTG-3', and oIMR7526 5'-CTGACCAACTTGCTAACAATTA-3'. Bands of 731 bp (floxed allele), and 210 bp (knockout allel) are expected using these primers. PCR products were separated by electrophoresis on a 1% agarose gel and imaged (Figure S1A). Retinal BMAL1 immunostaining (red) in (B) *Bmal1$^{fl/fl}$* and (C) *Chx10^{Cre}; Bmal1$^{fl/fl}$* mice. Nuclei are stained with DAPI (blue).

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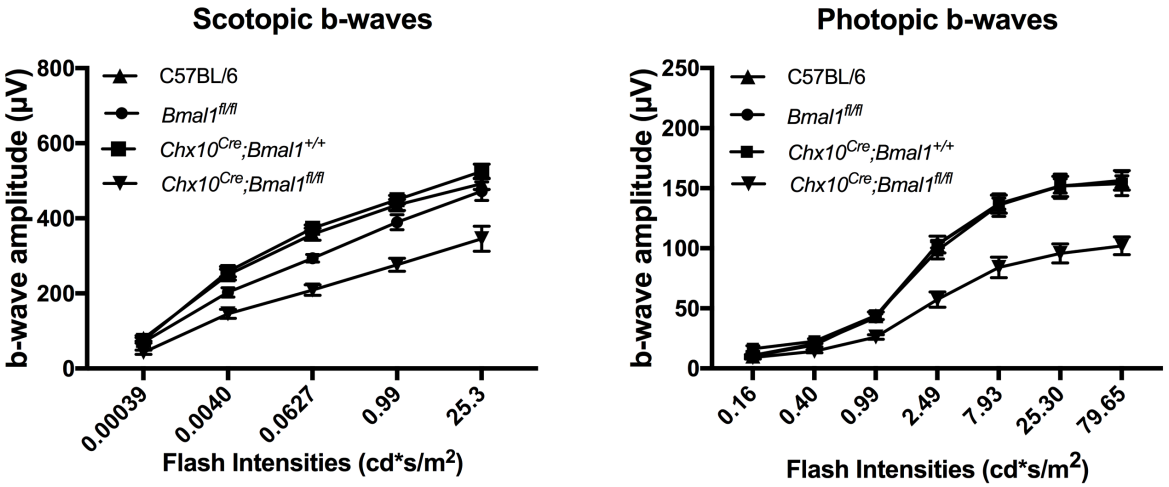
Figure S2. Genotype controls for ERG recordings



Scotopic and photic b-wave amplitudes were measured in 3 month-old C57BL/6 (n=7), *Bmal1*$^{fl/fl}$ (n=4), *Chx10*^{Cre}*; Bmal1*$^{+/+}$ (n=5) and *Chx10*^{Cre}*; Bmal1*$^{fl/fl}$ (n=3) mice. Amplitudes of the *Chx10*^{Cre}*; Bmal1*$^{fl/fl}$ mice were significantly lower than all other genotypes (scotopic $p<0.01$; photopic $p<0.001$).

Figure S3. Morphological evaluation of retinas from *Chx10^{Cre};Bmal1$^{fl/fl}$* mice and *Bmal1$^{fl/fl}$* control mice at three different ages.

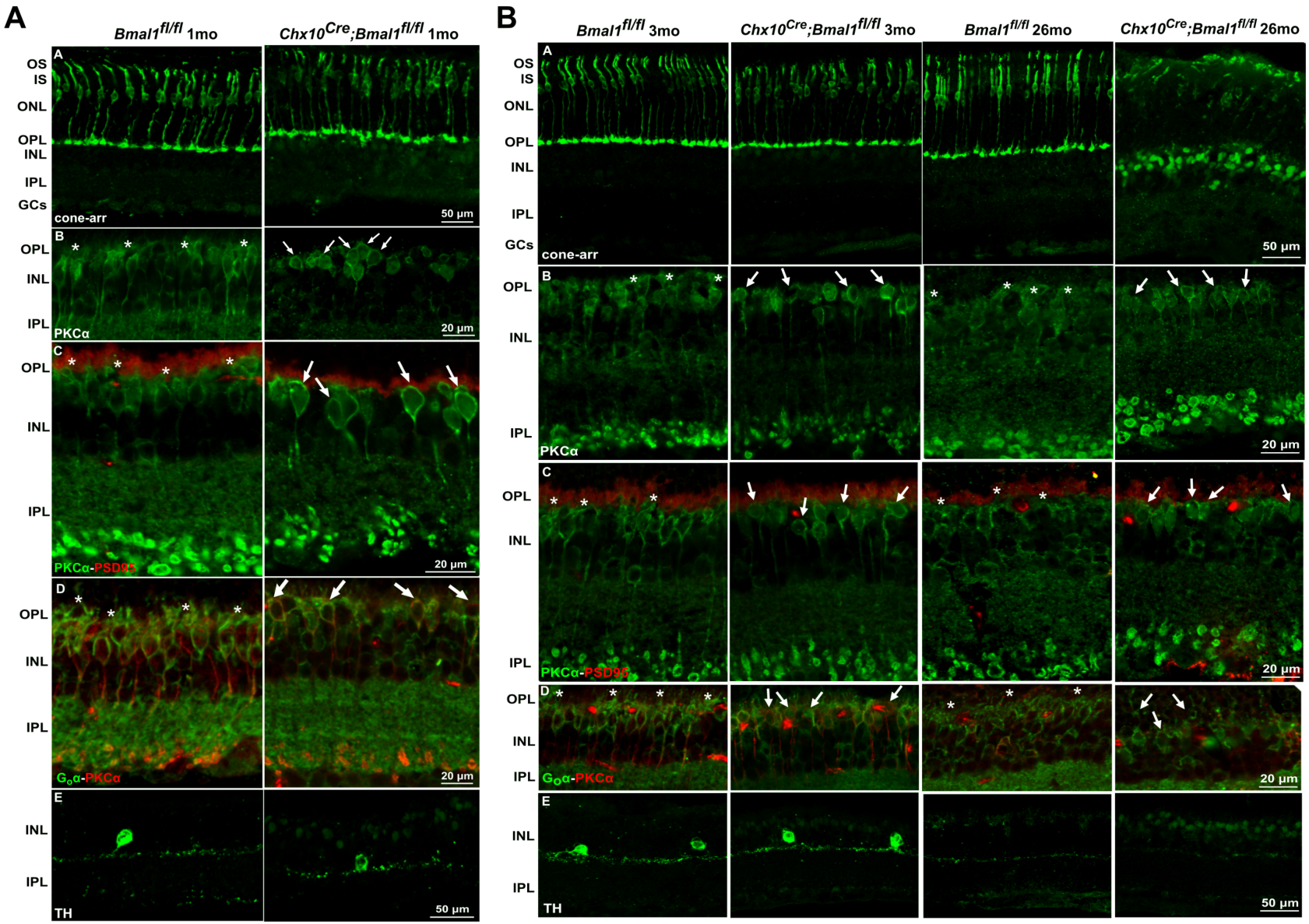
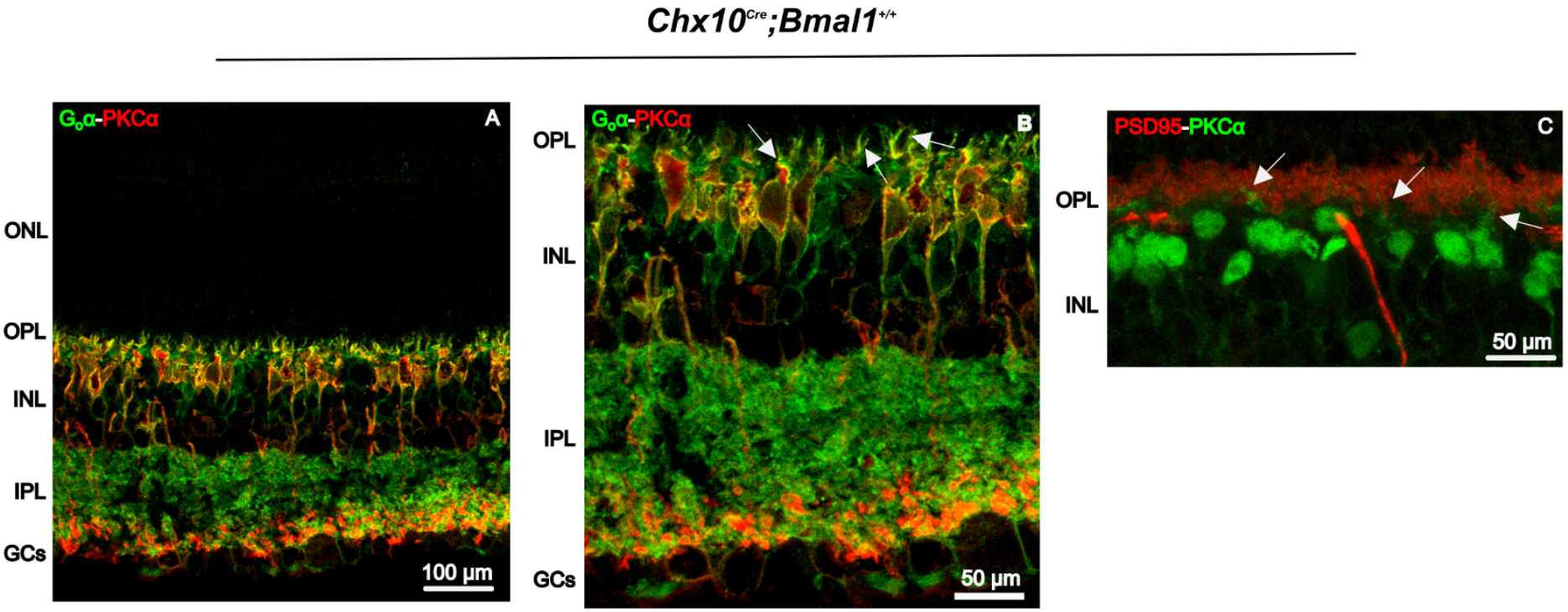


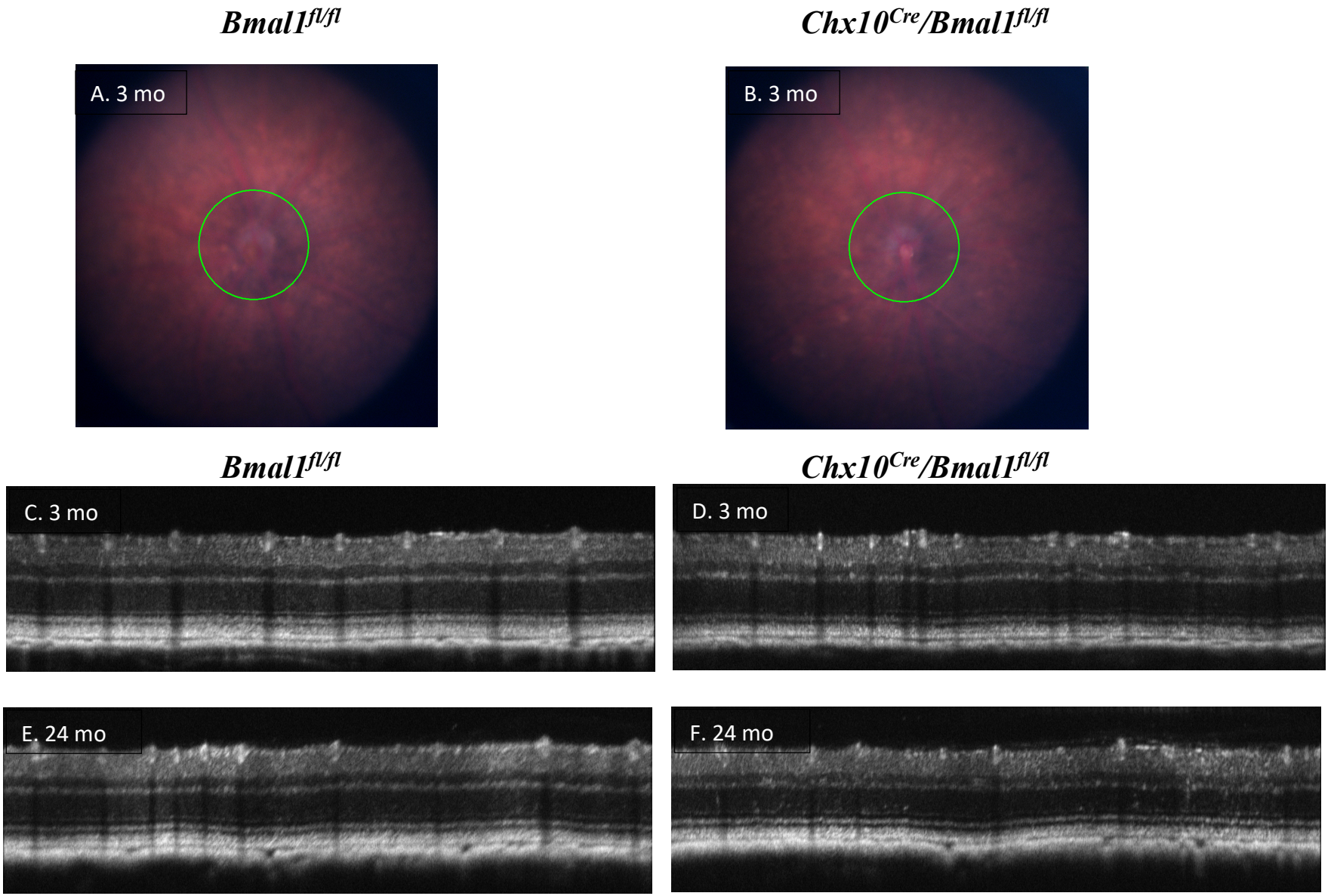
Figure S3. Morphological evaluation of retinas from *Chx10^{Cre};Bmal1$^{fl/fl}$* mice and *Bmal1$^{fl/fl}$* control mice at three different ages. (A) Retinal circuitry in the retina of 1 month old mice; B) Retinal circuitry in the retina of 3 and 26 months old mice. Cone arrestin staining (cone-arr. green) shows the difference in the cone photoreceptor structure between age 26 month old *Chx10^{Cre};Bmal1$^{fl/fl}$* and *Bmal1$^{fl/fl}$*. B,C,D. PKCα staining (green) shows that in *Chx10^{Cre};Bmal1$^{fl/f}$* the dendritic arbors are stunted at all the 3 ages investigated; asterisks show the presence of dendrites and arrows indicate cell bodies of rod bipolar cells without dendrites. C. PKCα staining (green) associated with cone photoreceptor synaptic terminals labeled with PSD95 (red). D. Co-localization of PKCα (red) and Goα (green) shows that only the rod bipolar cells (merge, yellow) are without dendrites in *Chx10^{Cre};Bmal1$^{fl/fl}$* retinas. E. TH positive amacrine cells (green); note that in both *Bmal1$^{fl/fl}$* and *Chx10^{Cre};Bmal1$^{fl/fl}$* mice there is a reduction in cell bodies labeled with TH antibody at 26 months of age.

Figure S4. Normal dendritic arbors of rod bipolar cells in *Chx10^{Cre}; Bmal1$^{+/+}$* control mice.



A) Low magnification retinal image shows apparently normal rod bipolar cell dendrites and overall inner retinal morphology in *Chx10^{Cre}/Bmal1$^{+/+}$* retinas; **(B)** High magnification of double staining for PKCα (red) and Goα (green), the arrows show that in *Chx10^{Cre}/Bmal1$^{+/+}$* retinas the dendritic arborization is normally developed; C) Image shows that connections between photoreceptor cells (PSD95, red) and rod-bipolar cells **(**PKCα, green) in *Chx10^{Cre}/Bmal1$^{+/+}$* appear normal (arrows indicate the dendrites of rod bipolar cells associated with the synaptic terminals of photoreceptors).

Figure S5. Representative fundus and SD-OCT images of *Chx10^{Cre}/Bmal1$^{fl/fl}$* and *Bmal1$^{fl/fl}$* mice.



A,B. Representative fundus photographs showing the circle around the optic nerve head for SD-OCT images. C,E. SD-OCT images from 3 and 24 month old *Bmal1$^{fl/fl}$* mice. D,F. SD-OCT images from 3 and 24 month old *Chx10^{Cre}; Bmal1$^{fl/fl}$* mice.

Figure S6. SD-OCT measurements of retinal thickness: *Chx10^{Cre}/Bmal1$^{fl/fl}$ vs Chx10Cre/Bmal1$^{+/+}$* controls

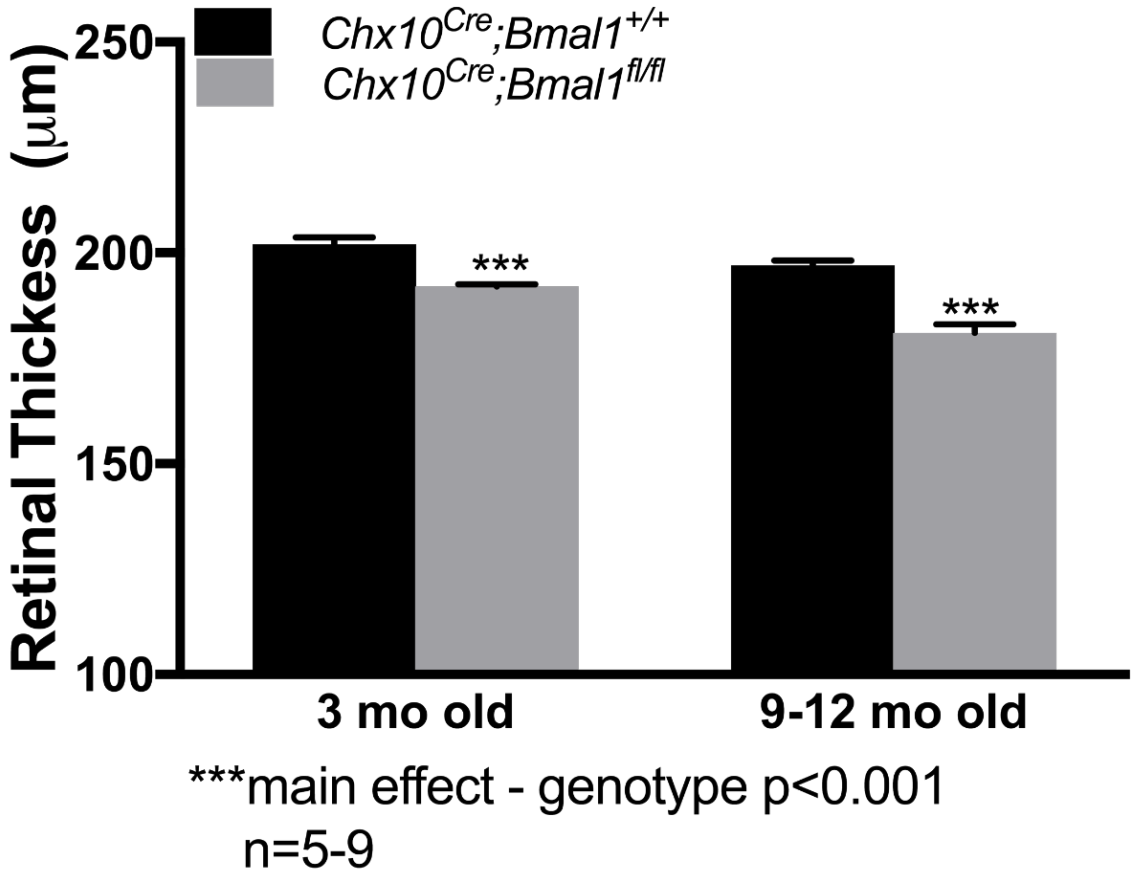
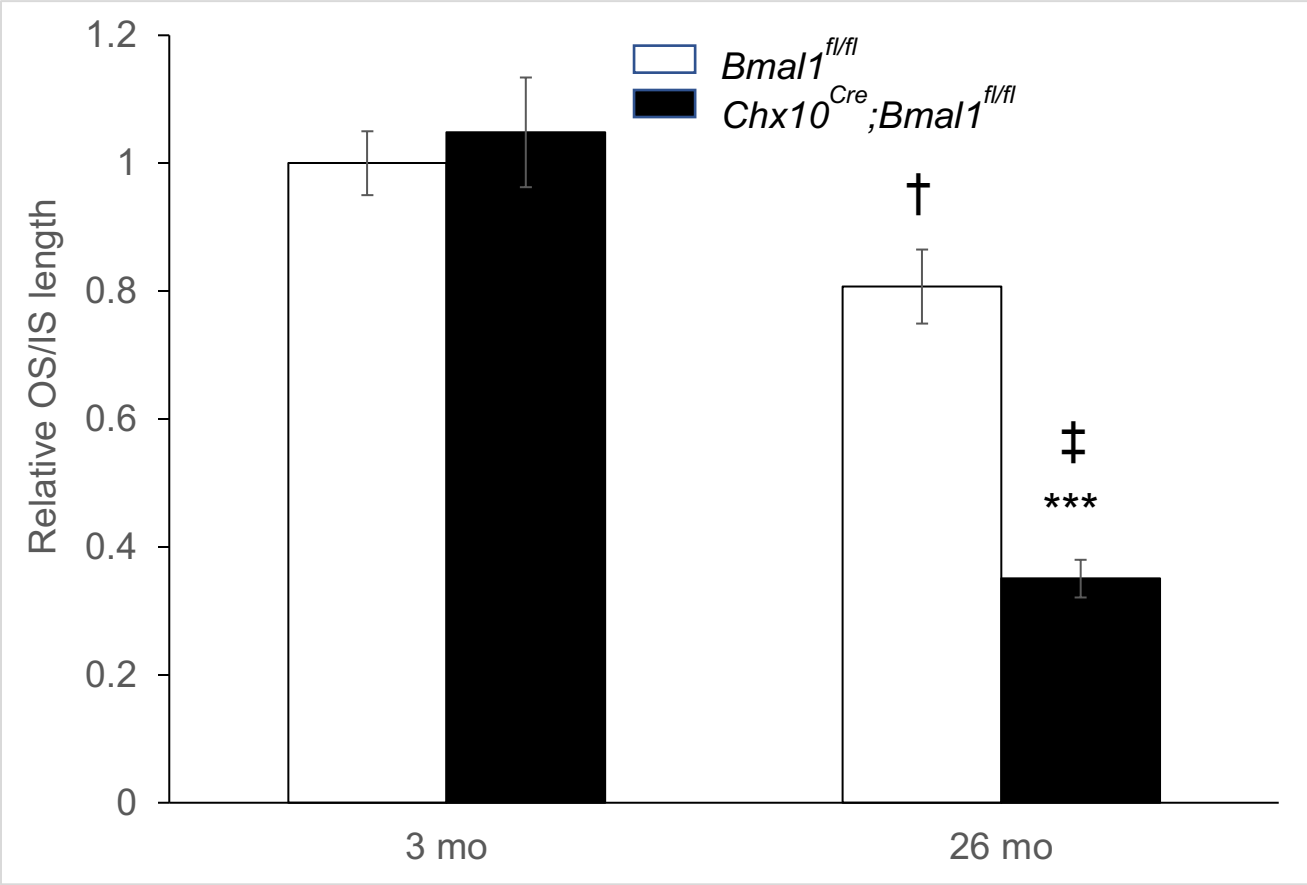
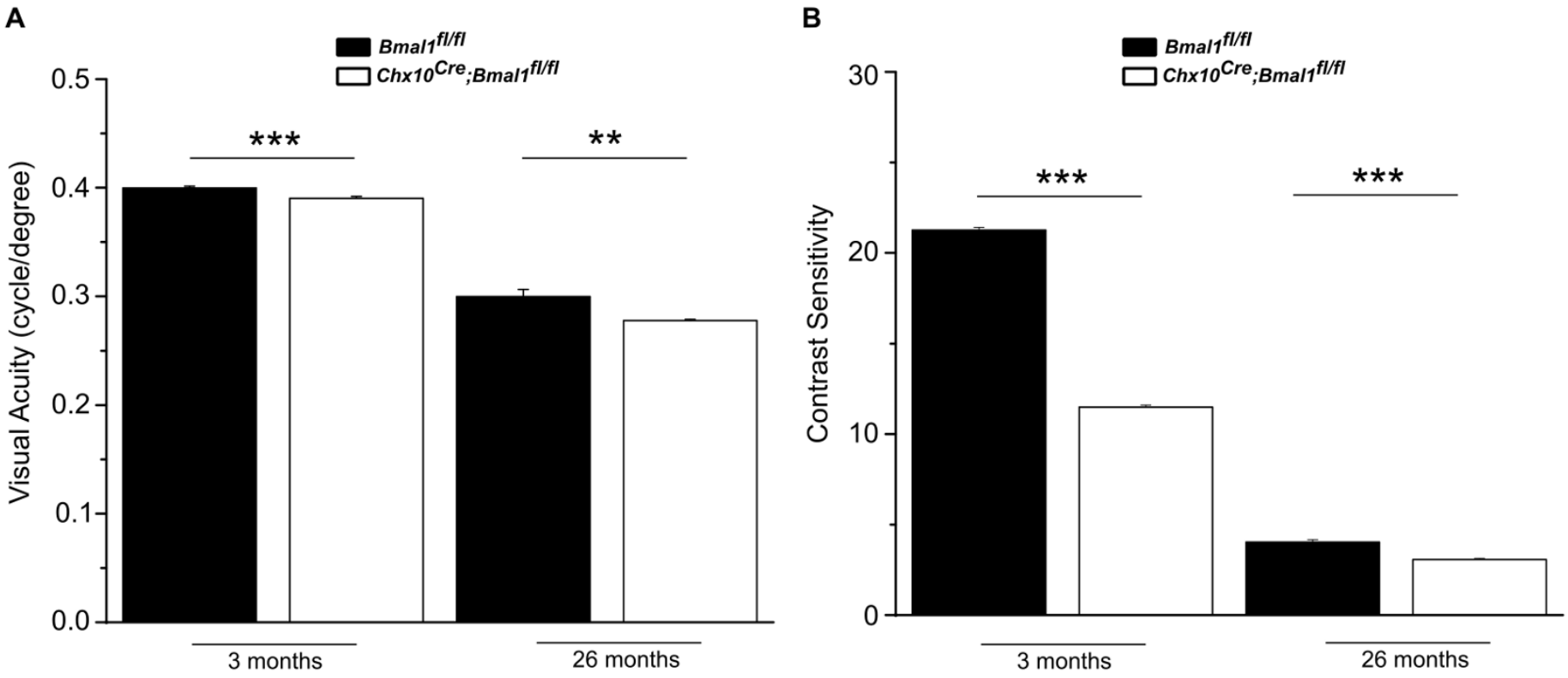


Figure S7. Relative cone outer segment / inner segment length in young and old *Chx10^{Cre};Bmal1$^{fl/fl}$* and *Bmal1$^{fl/fl}$* mice



The combined length of the inner and outer segments (OS/IS length) of cone cells was measured from PNA stained micrographs using Image J. Values are expressed relative to the 3 month old *Bmal1$^{fl/fl}$* control mice. Approximately 70 % decrease was observed in The OS/IS length of the old *Chx10^{Cre};Bmal1$^{fl/fl}$* mice was approximately 70% shorter relative to the length of the young mice ($p<0.001$). The OS/IS length of the old *Bmal1$^{fl/fl}$* mice was only reduced approximately 20% compared to the young mice ($p<0.05$). n=4-6, † $p<0.05$, ‡ $p<0.001$ vs. 3 mo, ***$p<0.001$ vs. 26 mo old *Bmal1$^{fl/fl}$* mice.

Figure S8. Visual acuity and contrast sensitivity in *Bmal1*$^{fl/fl}$ and *Chx10*^{Cre}*;Bmal1*$^{fl/fl}$



A) Spatial frequency threshold (visual acuity) is slightly but significantly reduced in *Chx10*^{Cre}*;Bmal1*$^{fl/fl}$ mice with respect to the values observed in *Bmal1*$^{fl/fl}$ in young (**p<0.01, n=5/group) and old mice (***p<0.001, n=6-8/group). B) Contrast sensitivity is greatly reduced in young *Chx10*^{Cre}*;Bmal1*$^{fl/fl}$ mice with respect to *Bmal1*$^{fl/fl}$ (***p<0.001, n=5/group). A dramatic decrease in contrast sensitivity was observed in both genotypes during aging, but the genotype differences persisted (n=6-8/group).

Table S1. SD-OCT segmentation analysis of retinal layers of *Chx10^{Cre}; Bmal1$^{fl/fl}$* and *Bmal1$^{fl/fl}$* mice

AGE		ONL	OPL	INL	IPL	GC/NFL
3mo	***Bmal1$^{fl/fl}$***	75.2 ± 0.6	12.9 ± 0.3	24.7 ± 0.7	49.1 ± 0.8	14.6 ± 0.4
	Chx10^{Cre}; Bmal1$^{fl/fl}$	73.4 ± 0.4	11.4 ± 0.1	20.1 ± 0.2	44.3 ± 0.7	13.9 ± 0.2
	p=	0.051 NS	0.003	0.0005	0.0003	0.200 NS
12mo	***Bmal1$^{fl/fl}$***	65.7 ± 0.7	13.3 ± 0.3	20.6 ± 0.5	48.2 ± 0.5	14.3 ± 0.3
	Chx10^{Cre}; Bmal1$^{fl/fl}$	60.4 ± 0.8	12.6 ± 0.4	14.6 ± 0.7	41.7 ± 0.6	13.9 ± 0.2
	p=	0.00008	0.203 NS	0.000001	0.000004	0.356 NS
18mo	***Bmal1$^{fl/fl}$***	63.1 ± 0.6	12.1 ± 0.3	15.7 ± 0.4	44.6 ± 0.8	14.5 ± 0.3
	Chx10^{Cre}; Bmal1$^{fl/fl}$	58.7 ± 0.8	10.9 ± 0.5	13.7 ± 0.5	37.0 ± 0.6	13.2 ± 0.5
	p=	0.0005	0.047	0.007	0.000006	0.03
24mo	***Bmal1$^{fl/fl}$***	60.9 ± 0.9	11.5 ± 0.4	15.7 ± 0.2	42.4 ± 0.9	12.6 ± 0.4
	Chx10^{Cre}; Bmal1$^{fl/fl}$	55.6 ± 1.6	9.5 ± 0.4	10.1 ± 0.5	37.5 ± 0.2	11.2 ± 0.4
	p=	0.0124	0.004	0.000003	0.00036	0.0313

Table S2. List of antibodies

Antibody	Host	Dilution	Supplier	Application
Protein Kinase C α	mouse	1:100	Sigma Aldrich	IF
Protein Kinase C α	rabbit	1:100	Sigma Aldrich	IF
PSD95	mouse	1:1000	Millipore	IF
Cone-Arrestin	rabbit	1:5000	Millipore	IF
Go-alpha	rabbit	1:100	AbCam	IF
BMAL1	rabbit	1:1000	Novus	IF
TH	rabbit	1:500	AbCam	IF

IF: Immunofluorescence