



**XX CONGRESSO SOC**  
**News in Ophthalmology**

**VII CORSO AVANZATO DI DIAGNOSTICA STRUMENTALE E LIVE SURGERY | 1 OTTOBRE**

## **Nomenclatura OCT in progress: performance e biomarkers retinici**



Centro d' Eccellenza Zeiss per la Diagnostica

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# Disclosure

Alfa Intes  
Carl Zeiss  
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## References

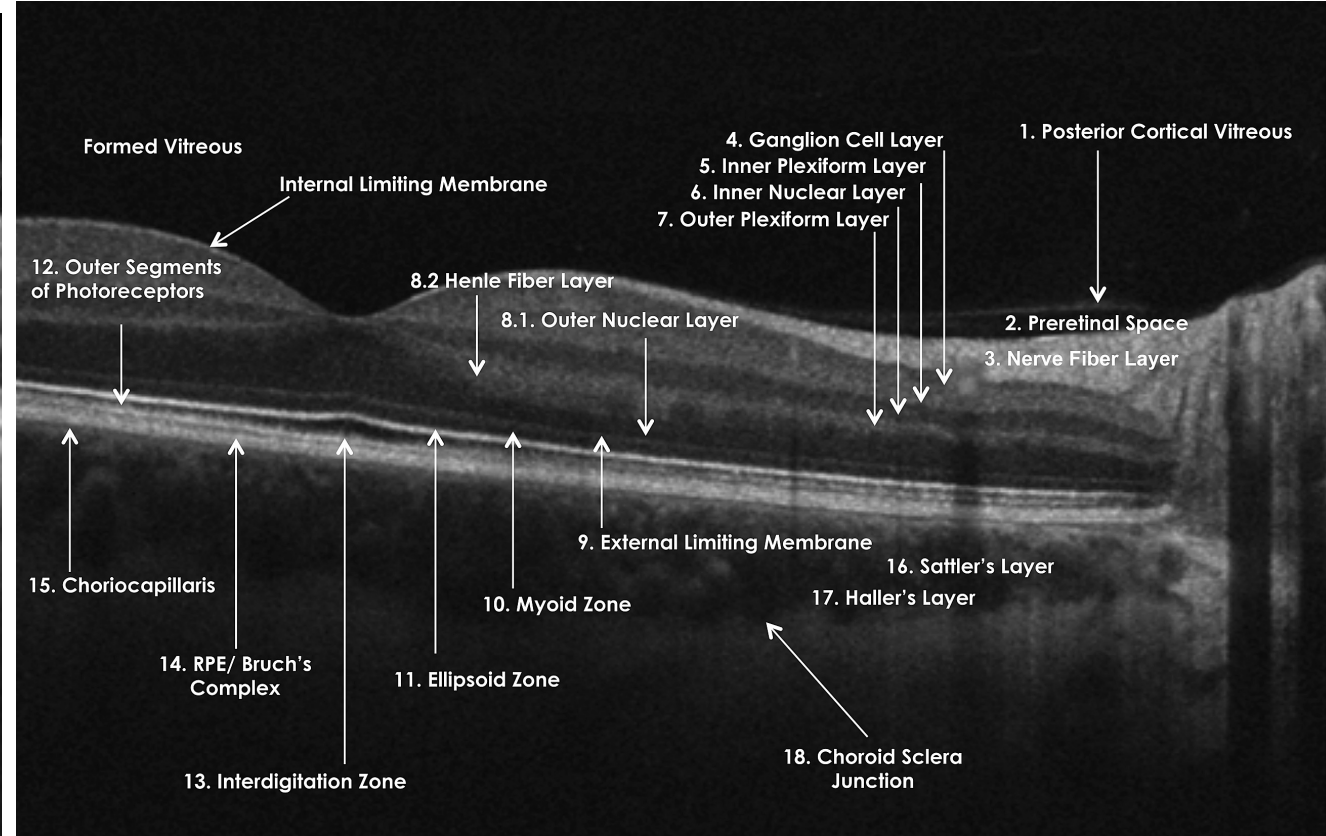
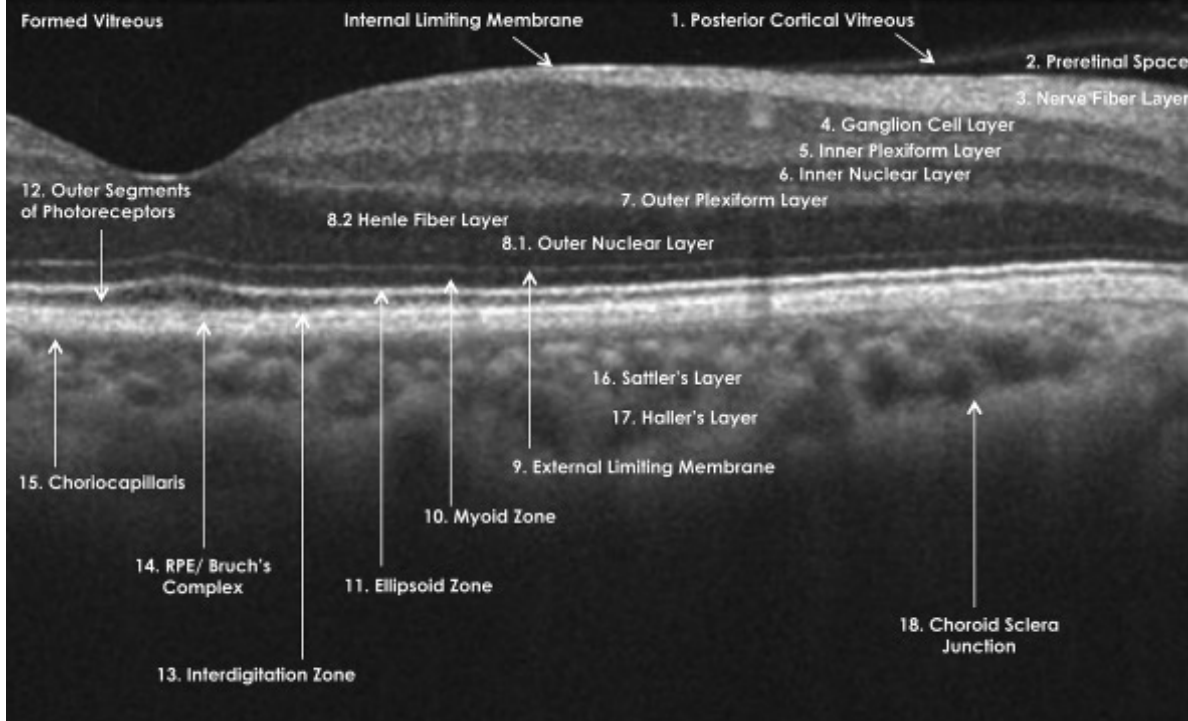
1. Spaide RF. Questioning optical coherence tomography. *Ophthalmology* 2012;119:2203–e1.
2. Spaide RF, Curcio CA. Anatomical correlates to the bands seen in the outer retina by optical coherence tomography: literature review and model. *Retina* 2011;31:1609–1619.
3. Litts KM, Zhang Y, Freund KB, Curcio CA. Optical coherence tomography and histology of age-related macular degeneration support mitochondria as reflectivity sources. *Retina* 2018;38:445–461.
4. Staurengi G, Sadda S, Chakravarthy U, et al. Proposed lexicon for anatomic landmarks in normal posterior segment spectral-domain optical coherence tomography: the IN\*OCT consensus. *Ophthalmology* 2014;121:1572–1578.
5. Jonnal RS, Kocaoglu OP, Zawadzki RJ, et al. The cellular origins of the outer retinal bands in optical coherence tomography images. *Invest Ophthalmol Vis Sci* 2014;55:7904–7918.
6. Spaide RF. Outer retinal bands. *Invest Ophthalmol Vis Sci* 2015;56:2505–2506.
7. Cuenca N, Ortuño-Lizarán I, Pinilla I. Cellular characterization of OCT and outer retinal bands using specific immunohistochemistry markers and clinical implications. *Ophthalmology* 2018;125:407–422.
8. Curcio CA, Sparrow JR, Bonilha VL, et al. Re: Cuenca et al.: cellular characterization of OCT and outer retinal bands using specific immunohistochemistry markers and clinical implications (*Ophthalmology*. 2018;125;407-422). *Ophthalmology* 2018;125:e47–e48.
9. Bloom SM, Singal IP. The outer Bruch membrane layer: a previously undescribed spectral-domain optical coherence tomography finding. *Retina* 2011;31:316–323.
10. Huang D, Swanson EA, Lin CP, et al. Optical coherence tomography. *Science* 1991;254:1178–1181.
11. Nakanishi H, Hangai M, Unoki N, et al. Spectral-domain optical coherence tomography imaging of the detached macula in rhegmatogenous retinal detachment. *Retina* 2009;29:232–242.
12. Kroll AJ. Secondary retinal detachment. Electron microscopy of retina and pigment epithelium. *Am J Ophthalmol* 1969;68:223–237.
13. Steinberg RH, Wood I, Hogan MJ. Pigment epithelial ensheathment and phagocytosis of extrafoveal cones in human retina. *Philos Trans R Soc Lond B Biol Sci* 1977;277:459–474.
14. Wilk MA, McAllister JT, Cooper RF, et al. Relationship between foveal cone specialization and pit morphology in albinism. *Invest Ophthalmol Vis Sci* 2014;55:4186–4198.
15. Li M, Dolz-Marco R, Huisingh C, et al. Clinicopathologic correlation of geographic atrophy secondary to age-related macular degeneration. *Retina* 2019;39:802–816.
16. Zhang QX, Lu RW, Messinger JD, et al. In vivo optical coherence tomography of light-driven melanosome translocation in retinal pigment epithelium. *Sci Rep* 2013;3:2644.
17. Steven M. Bloom, Inder P. Singal. Revisited Classification of the optical coherence tomography outer retinal bands based on central serous chorioretinopathy analysis. *Retina* 41:181–188, 2021
18. Lucente A. Le cellule retiniche della glia e la membrana limitante interna. [www.ofthalmologiadomani.it](http://www.ofthalmologiadomani.it) Anno XII - 2021
19. Lucente A. Interpretazioni tomografiche della retina fotorecettoriale e valore funzionale della membrana limitante esterna. [www.ofthalmologiadomani.it](http://www.ofthalmologiadomani.it) Anno XII - 2021

# The IN•OCT Consensus 2014

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## International Nomenclature for OCT Meeting Consensus Normal OCT Terminology



**Heidelberg Consensus** Proposed Lexicon for Anatomic Landmarks in Normal Posterior Segment Spectral-Domain Optical Coherence Tomography

**Zeiss Consensus** Proposed Lexicon for Anatomic Landmarks in Normal Posterior Segment Spectral-Domain Optical Coherence Tomography

Spectralis HRA+OCT (Heidelberg Engineering, Heidelberg, Germany); Cirrus HD-OCT (Zeiss Meditec Inc, Dublin, CA)

# Consensus IN•OCT International Nomenclature for Optical Coherence Tomography by Stauerndghi et al. 2014

OLM Outer Limiting Membrane, MLE Membrane Limiting External, ELM External Limiting Membrane

18 slabs with Spectralis HRA+OCT Heidelberg and Cirrus HD-OCT Zeiss

**1 Hyperreflective Posterior cortical vitreous**

2 Hyporeflective Pre-retinal space

**3 Hyperreflective Nerve fiber layer**

4 Hyporeflective Ganglion cell layer

**5 Hyperreflective Inner plexiform layer**

6 Hyporeflective Inner nuclear layer

**7 Hyperreflective Outer plexiform layer**

8 Hyporeflective band Inner half: Henle's nerve fiber layer; outer half: outer nuclear layer

**9 Hyperreflective External limiting membrane**

10 Hyporeflective Myoid zone of the photoreceptors

**11 Hyperreflective Ellipsoid zone of the photoreceptors**

12 Hyporeflective Outer segments of the photoreceptors

**13 Hyperreflective Cone interdigitation with RPE**

**14 Hyperreflective band RPE/Bruch's membrane complex. On occasion this can be separated into more than 1 band**

15 Thin layer of moderate reflectivity in inner choroid Choriocapillaris

**16 Thick layer of round or ovalshaped hyperreflective profiles with hyporeflective cores in mid-choroid Sattler's layer**

17 Thick layer of oval-shaped hyperreflective profiles with hyporeflective cores in outer choroid Haller's layer

**18 Zone at the outer choroid with a marked change in texture in which large circular or ovoid profiles abut a homogenous region of variable reflectivity Choroidal-scleral juncture**

### Strati della retina e della coroide

Si può osservare, dall'alto in basso, lo strato delle fibre del nervo ottico con la limitante interna formata da fibrille di cellule di Müller.

Strato delle cellule ganglionari, i cui assoni formano lo strato delle fibre ottiche.

Plessiforme interna, dove si connettono le cellule bipolari e ganglionari. Vi sono strutture orizzontali formate in parte da fibrille delle cellule di Müller.

Strato nucleare interno delle cellule bipolari.

Strato plessiforme esterno, dove si connettono fotorecettori e cellule bipolari. Sono presenti anche strutture orizzontali delle cellule orizzontali e fibrille delle cellule di Müller.

Strato dei nuclei dei fotorecettori.

La membrana della limitante esterna, formata da fibrille provenienti dalle fibre di Müller, forma una rete che circonda coni e bastoncelli.

Giunzione segmento interno e segmento esterno dei fotorecettori.

Segmento esterno dei coni e dei bastoncelli.

Giunzione fra estremità esterna dei coni e dei bastoncelli e fibrille delle cellule epiteliali.

Corpo delle cellule epiteliali.

Membrana di Bruch e coriocapillare.

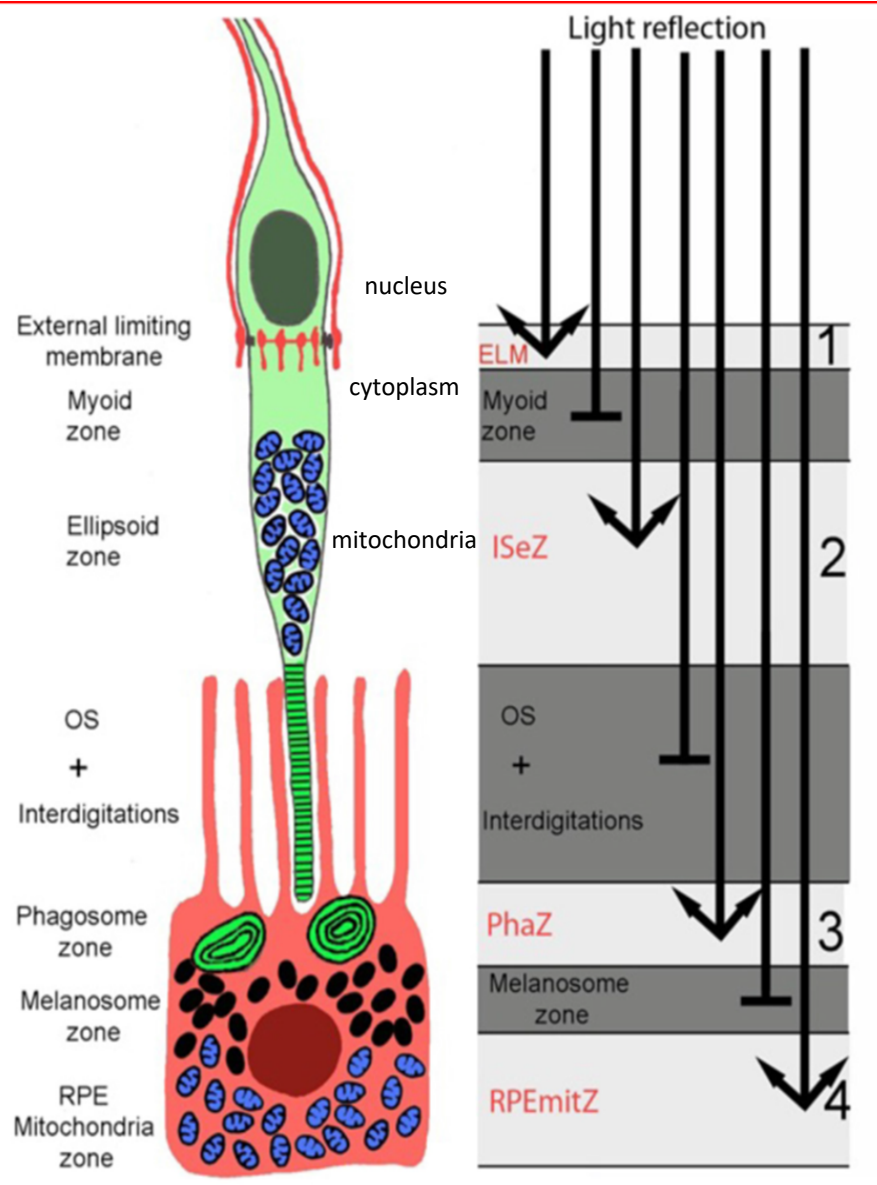
Strato di Sattler dei piccoli vasi della coroide.

Strato di Haller dei grandi vasi della coroide.

Interfaccia fra coroide e sclera.

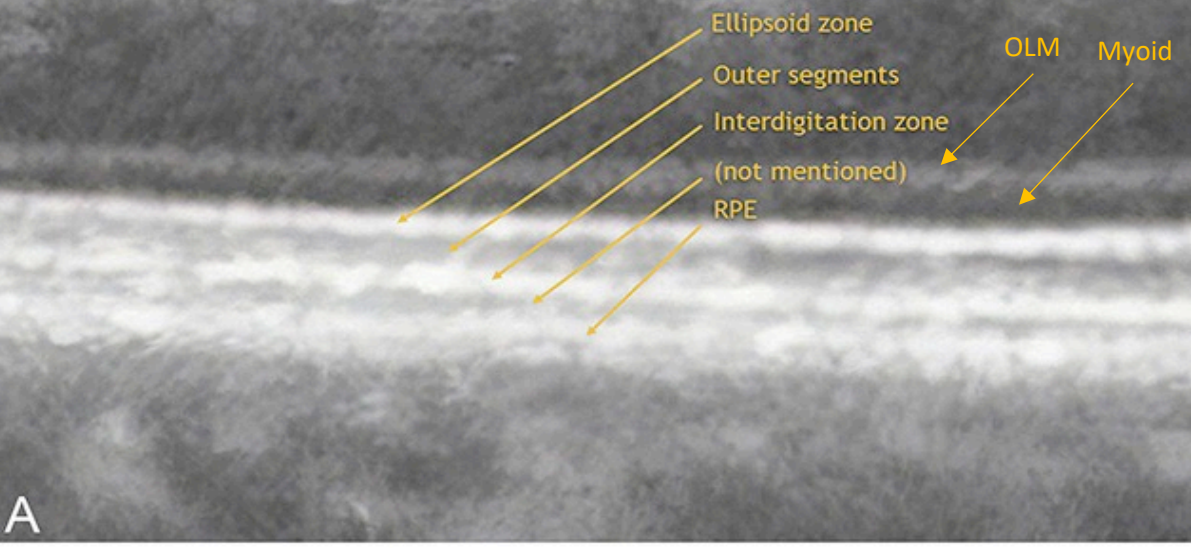
Sclera.

MLE  
EZ  
IZ  
EPR Bruch

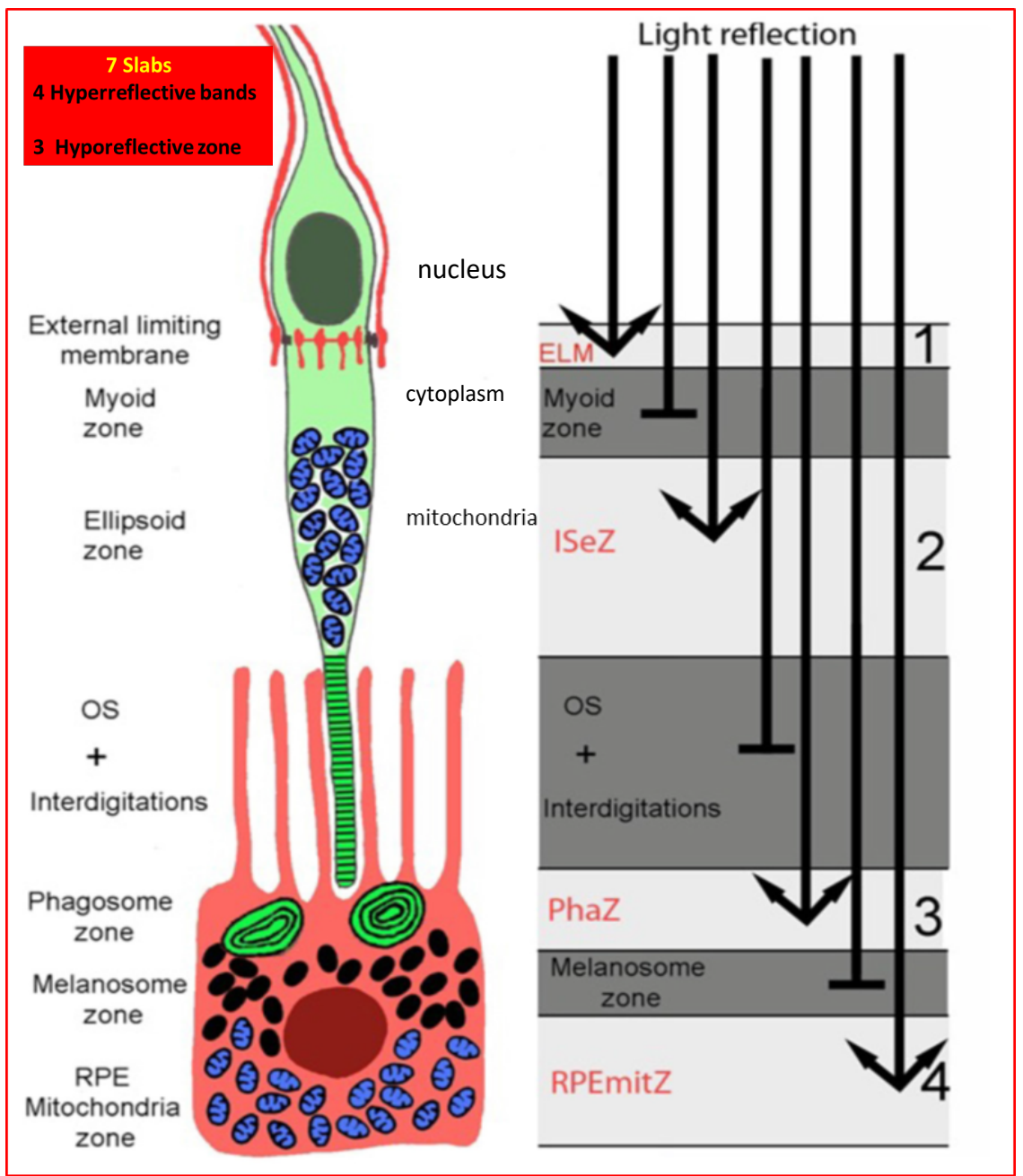
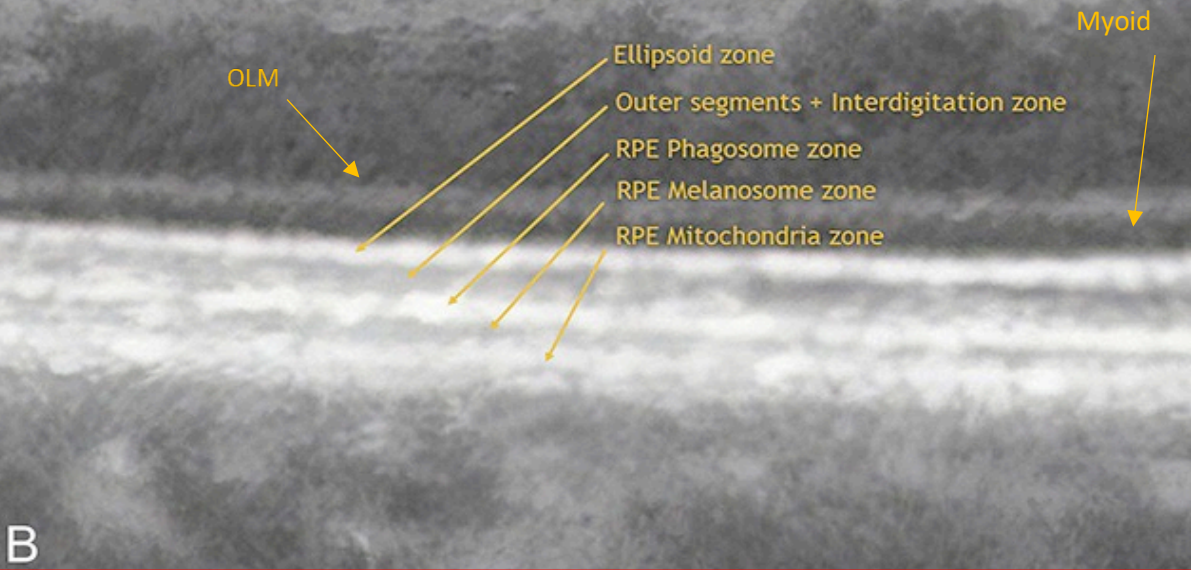


- 1) La membrana limitante esterna (ELM) si trova al confine tra i corpi cellulari (nuclei) e i segmenti interni dei fotorecettori e comprende gruppi di complessi giunzionali tra le cellule Müller e i fotorecettori.
- 2) La Zona Ellissoidale (EZ), precedentemente indicata come giunzione del segmento interno /segmento esterno del fotorecettore (IS /OS), è ora pensata per essere formata principalmente dai mitocondri all'interno dello strato ellissoidale della porzione esterna dei segmenti interni di i fotorecettori. In una fovea normale, la distanza dalla linea EZ all'ELM è inferiore a quella dalla linea EZ all'EPR
- 3) La Zona di Interdigitazione (IZ) corrisponde al cilindro di contatto rappresentato dagli apici delle celle EPR che racchiudono parte dei segmenti esterni del cono. Questo strato era precedentemente indicato come punte del segmento esterno del cono (COST) o punte del segmento esterno dello stelo (ROST), e non è sempre distinguibile dal livello RPE sottostante, anche nei soggetti normali.
- 4) La banda epiteliale del pigmento retinico è formata dall'EPR e dalla membrana di Bruch (indistinguibili l'una dall'altra in uno stato normale utilizzando gli attuali sistemi SD-OCT). Nella fovea, questa banda è più spessa, il che indica che le strutture coroidali possono anche contribuire all'iper-riflettività della banda RPE in questa posizione

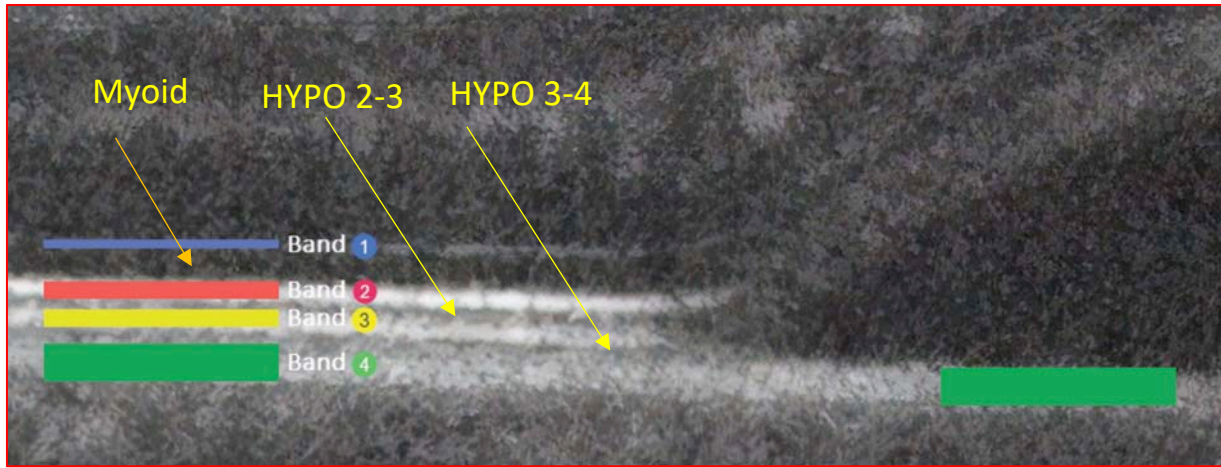
**A. Bande retiniche esterne by IN • OCT Consensus**



**B. Bande retiniche esterne by Cuenca et al.**



OLM Hyperreflective Myoid Zone Hyporeflexive EZ Ellipsoid Zone Hyperreflective Outer Segment photoreceptors Hyporeflexive Interdigitation with RPE Hyperreflective Not mentioned band Hyporeflexive RPE/Bruch complex Hyperreflective



by Steven M. Bloom and Inder P. Singal

**Magnified view-+ of the transition zone from attached to detached retina**

**Band 1 blue line ELM**

Myoid

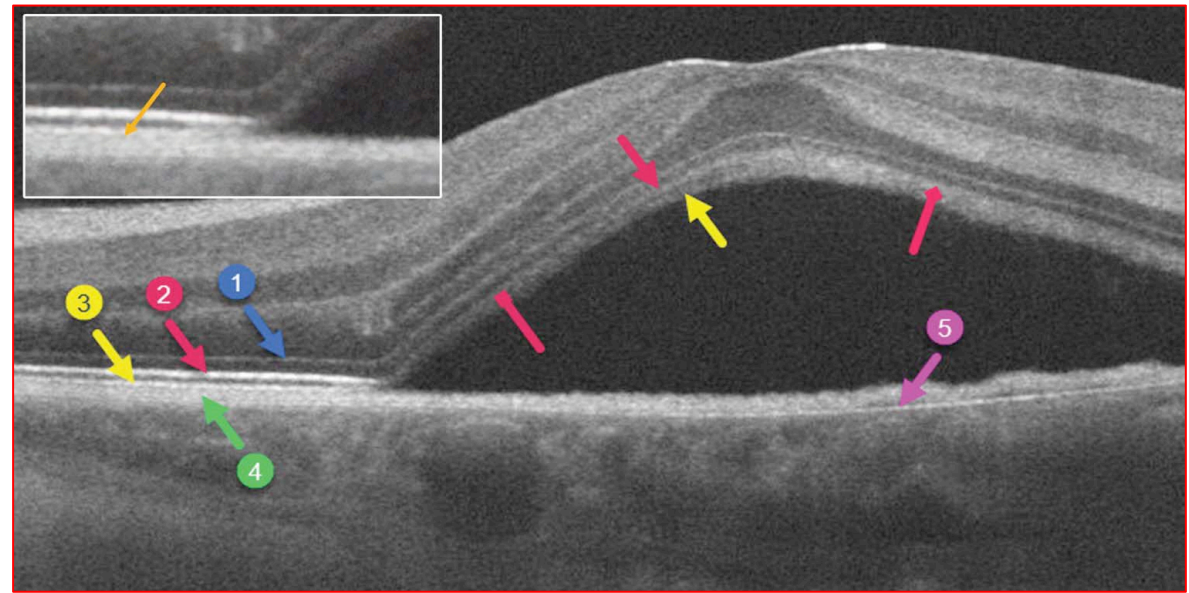
**Band 2 red line EZ**

Bands 2-3 HYPO

**Band 3 yellow line IZ**

Bands 3-4 HYPO in attached retina initially merge into a single thickened line within the detachment

**Band 4 green line RPE** continues into the detachment unchanged



by Steven M. Bloom and Inder P. Singal

**Band 1 (blue arrow, ELM)**

**Band 2 (red arrow, EZ)**

**Bands 2 and 3 (2-3 HYPO)**

**Band 3 (yellow arrow, IZ)**

**Bands 3 and 4 (3-4 HYPO) (inset)**

**Band 4 (green arrow, RPE)**

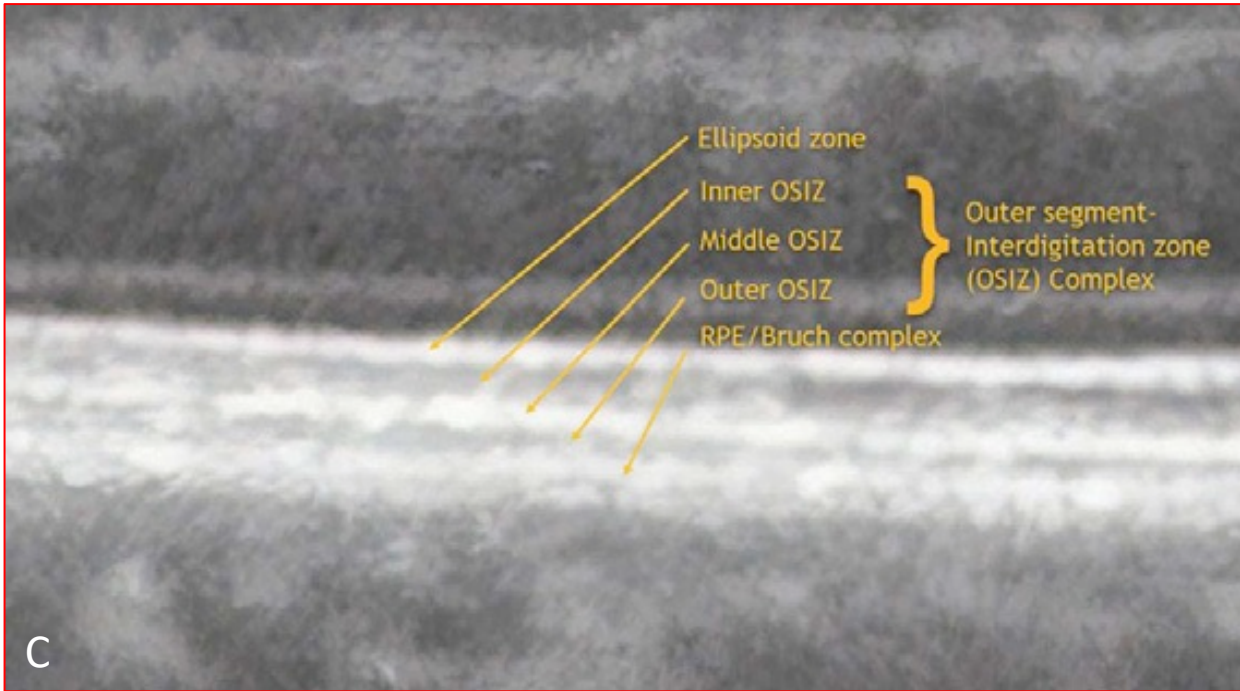
**Band 5 (pink arrow, Bruch membrane)**

**Myoid zone 12–14 μm**

**Ellisoide zone 16–20 μm**

**RPE 14 μm**





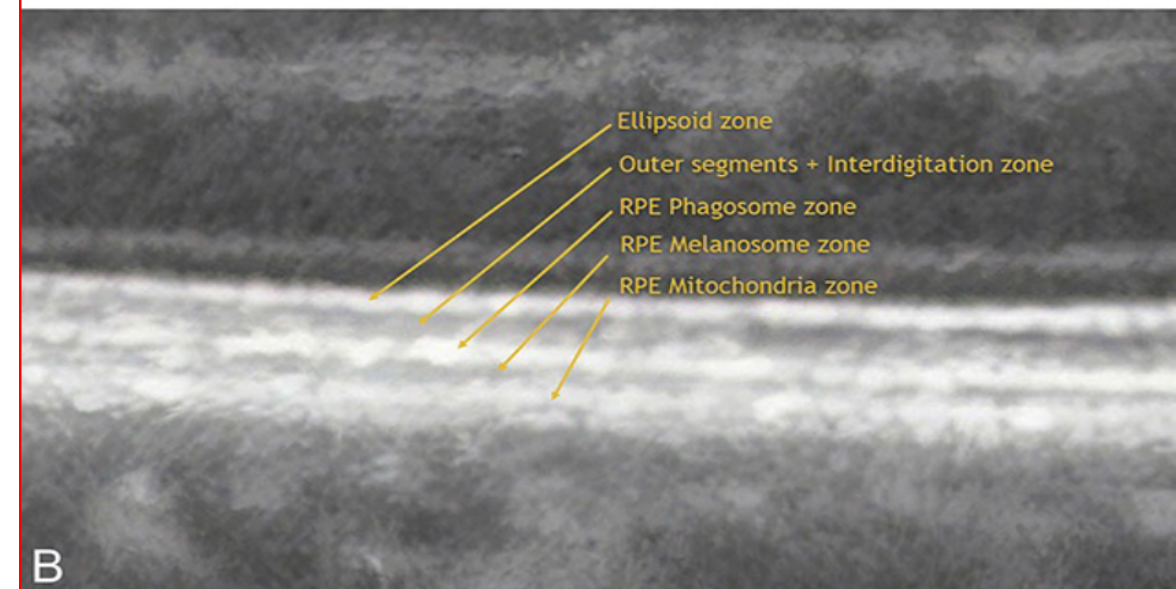
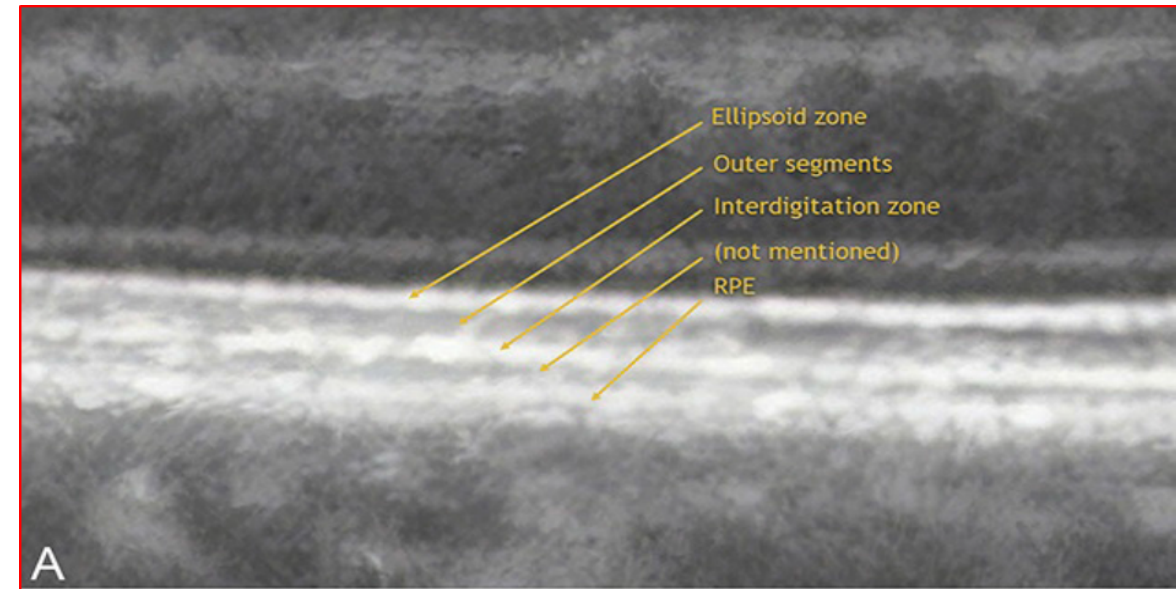
C by Steven M. Bloom and Inder P. Singal RETINA 41:181–188, 2021

Myoid to be **12–14 μm**

EZ Ellipsoid (Band 2) to be **16–20 μm**

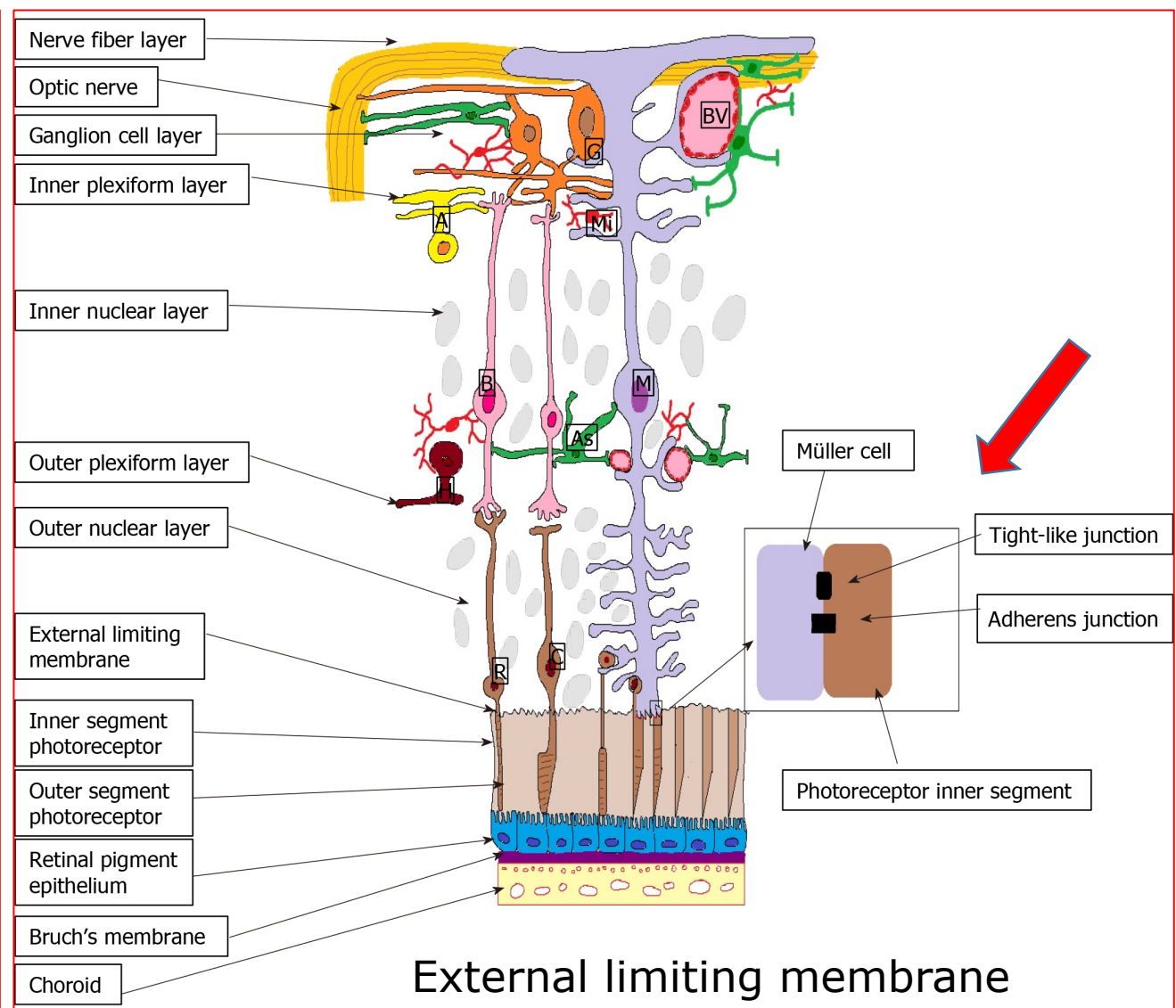
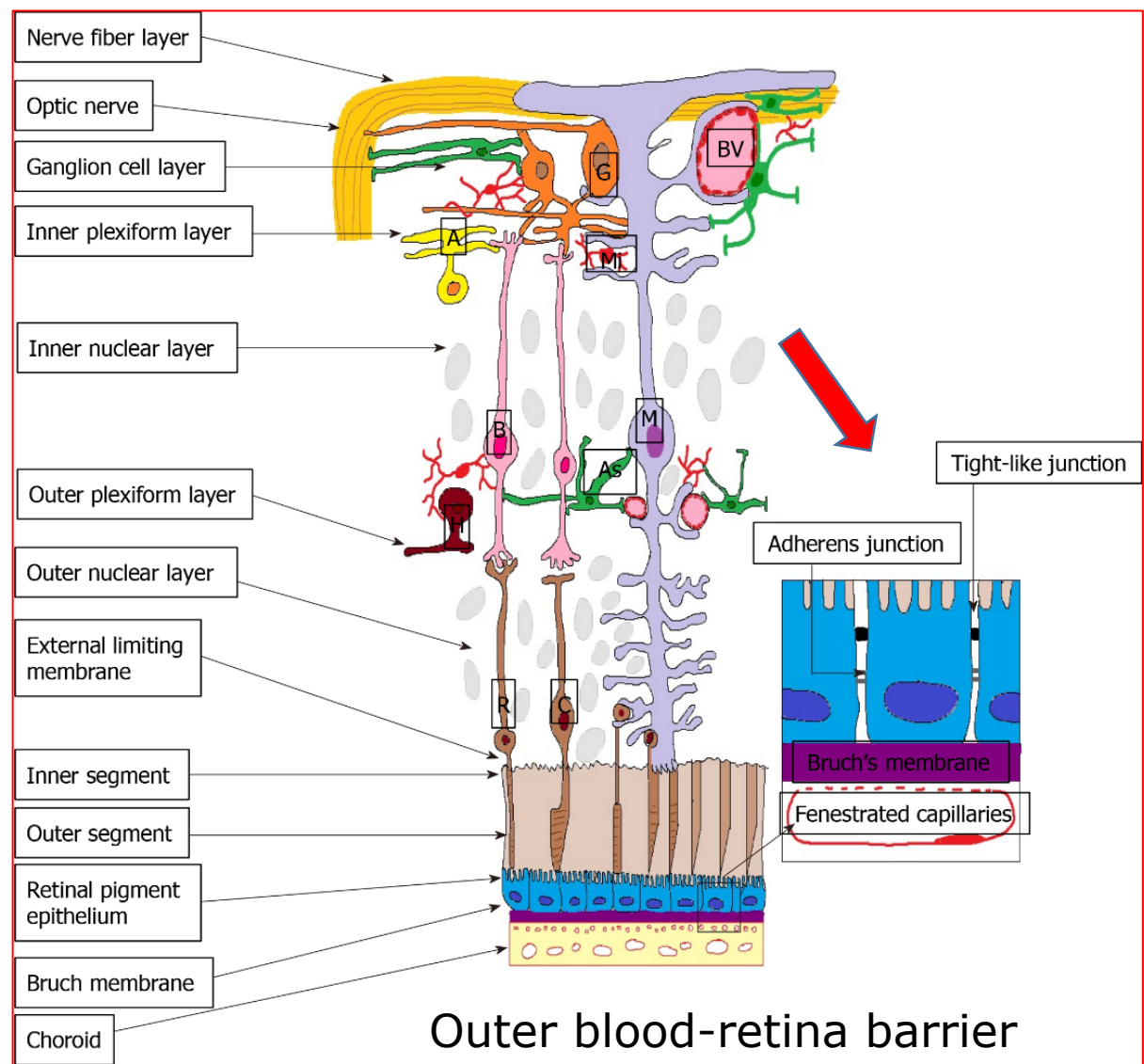
The trilaminar Outer Segment–Interdigitation Zone OSIZ Complex should therefore be about **45 μm** in length

RPE height (Band 4) measures **10–14 μm**



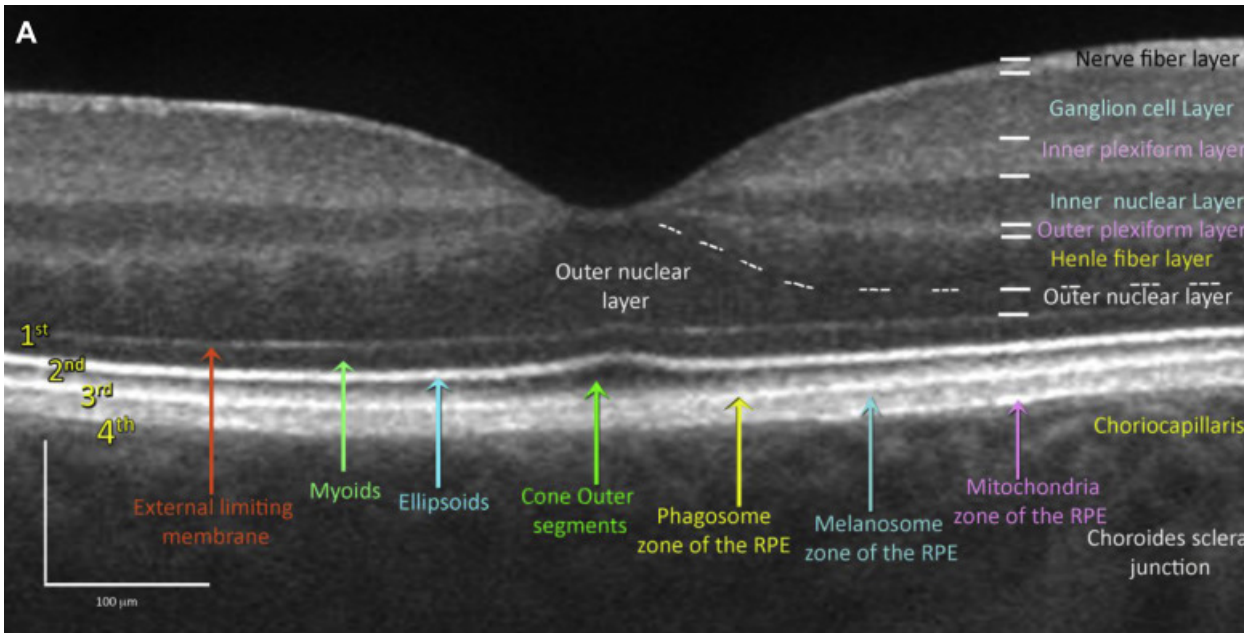
A by IN • OCT Consensus

B by Cuenca et al.



M: Müller cells; A: Amacrine cells; G: Ganglion cells; BV: Blood vessels; As: Astrocyte; B: Bipolar cells; R: Rods; C: Cones; H: Horizontal cells; Mi: Microglia; ON: Optic nerve; NFL: Nerve fibre layer; GCL: Ganglion cell layer; IPL: Inner plexiform layer; INL: Inner nuclear layer; OPL: Outer plexiform layer; ONL: Outer nuclear layer; ELM: External limiting membrane; IS: Inner segment photoreceptors; OS: Outer segment photoreceptors; RPE: Retinal pigment epithelium; BM: Bruch's Membrane; Ch: Choroid.  
 by: Țălu Ș, Nicoara SD. Malfunction of outer retinal barrier and choroid in the occurrence and progression of diabetic macular edema. World J Diabetes 2021; 12(4): 437-452

# Biomarkers

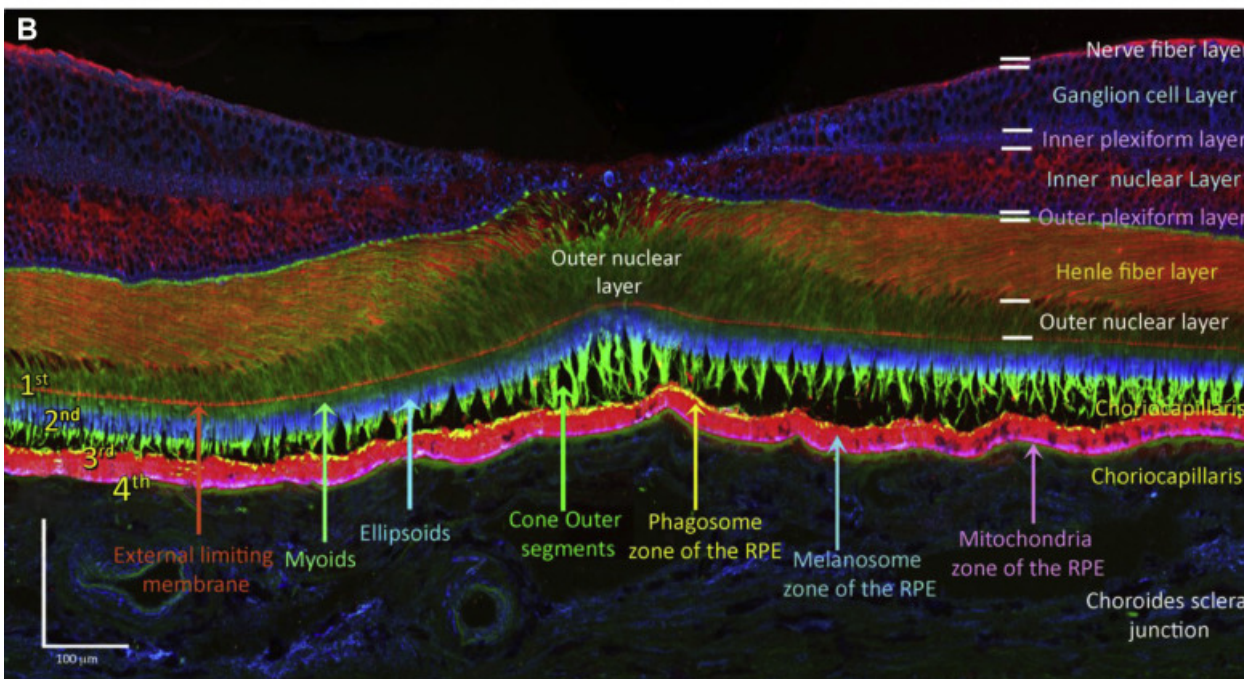


**OLM, EZ, IZ** nelle maculopatie degenerative subiscono danni in modo interdipendente; la banda a subire per prima una disorganizzazione è IZ, segue EZ ed infine OLM

Aizawa S, Mitamura Y, Hagiwara A, et al. Changes of fundus autofluorescence, photoreceptor inner and outer segment junction line, and visual function in patients with retinitis pigmentosa. Clin Experiment Ophthalmol 2010;38(6):597-604.

**OLM** è la prima a recuperare dopo la chiusura del foro maculare, considerato un segno indiretto di integrità fotorecettoriale e delle cellule del Müller

Bottoni F, De Angelis S, Luccarelli S, et al. The dynamic healing process of idiopathic macular holes after surgical repair: A spectral-domain optical coherence tomography study. Invest Ophthalmol Vis Sci 2011;52(7):4439-46.



Il recupero dell'EZ è limitato alle aree retiniche dove **OLM** è integra; dopo interventi per foro maculare o membrana epiretinica il ripristino di **IZ** è osservato solo in presenza di **EZ** e **OLM** intatte

Shimozono M, Oishi A, Hata M, et al. The significance of cone outer segment tips as a prognostic factor in epiretinal membrane surgery. Am J Ophthalmol 2012; 153:698-704, e1.



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Thank you for your kind attention!



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