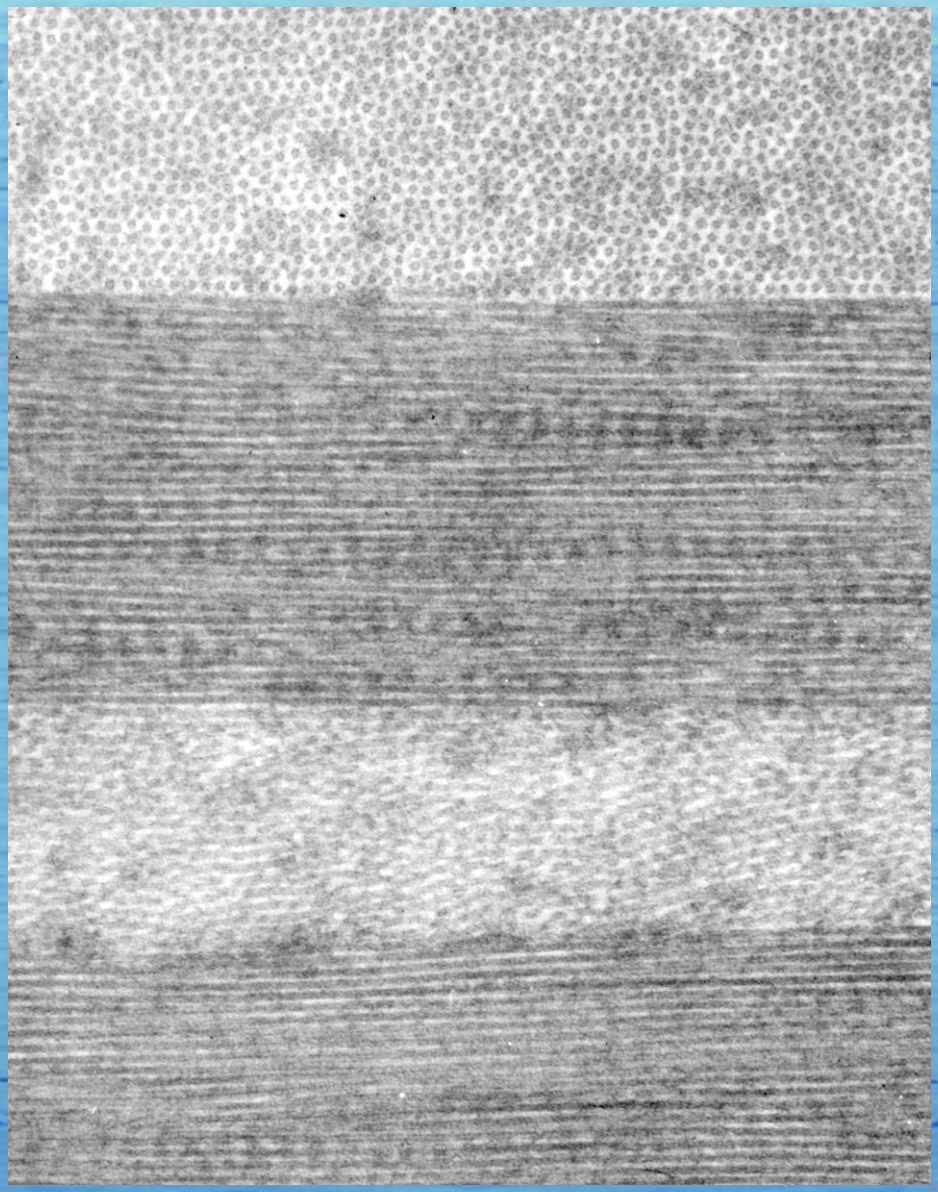
Physical and Chemical Features of the Cornea

Schwind 15th International User Meeting Vancouver 18th July 2014

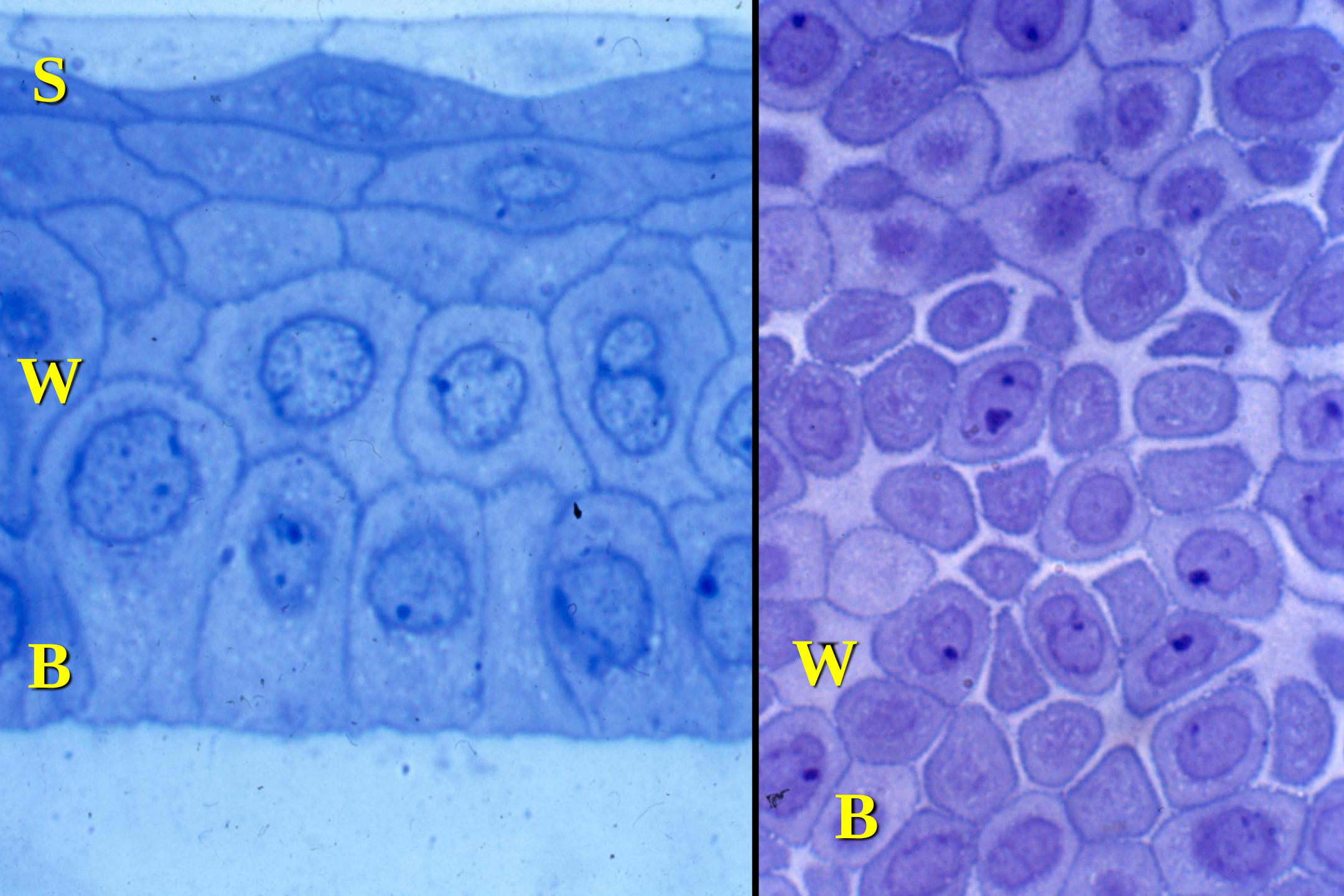
1

2



3

4 5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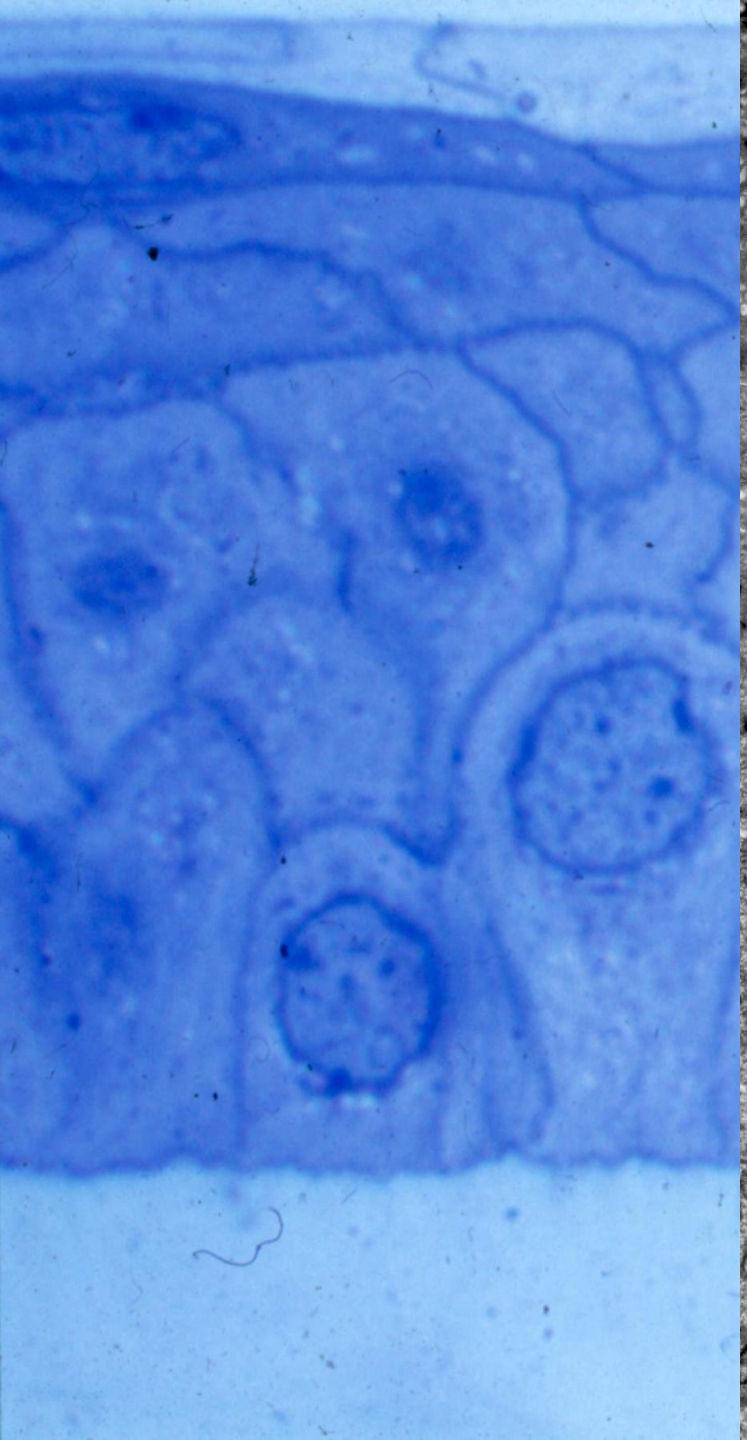
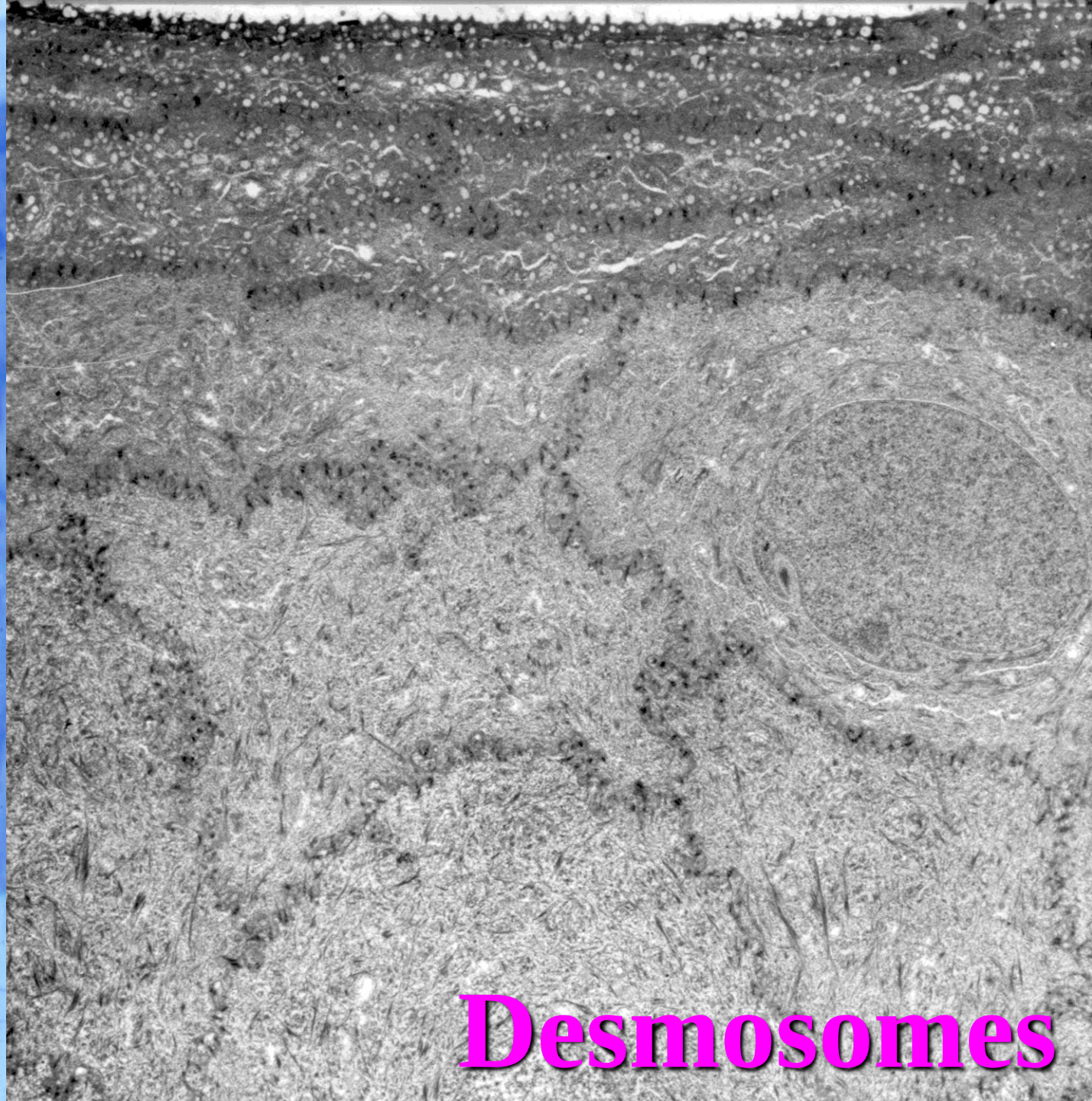
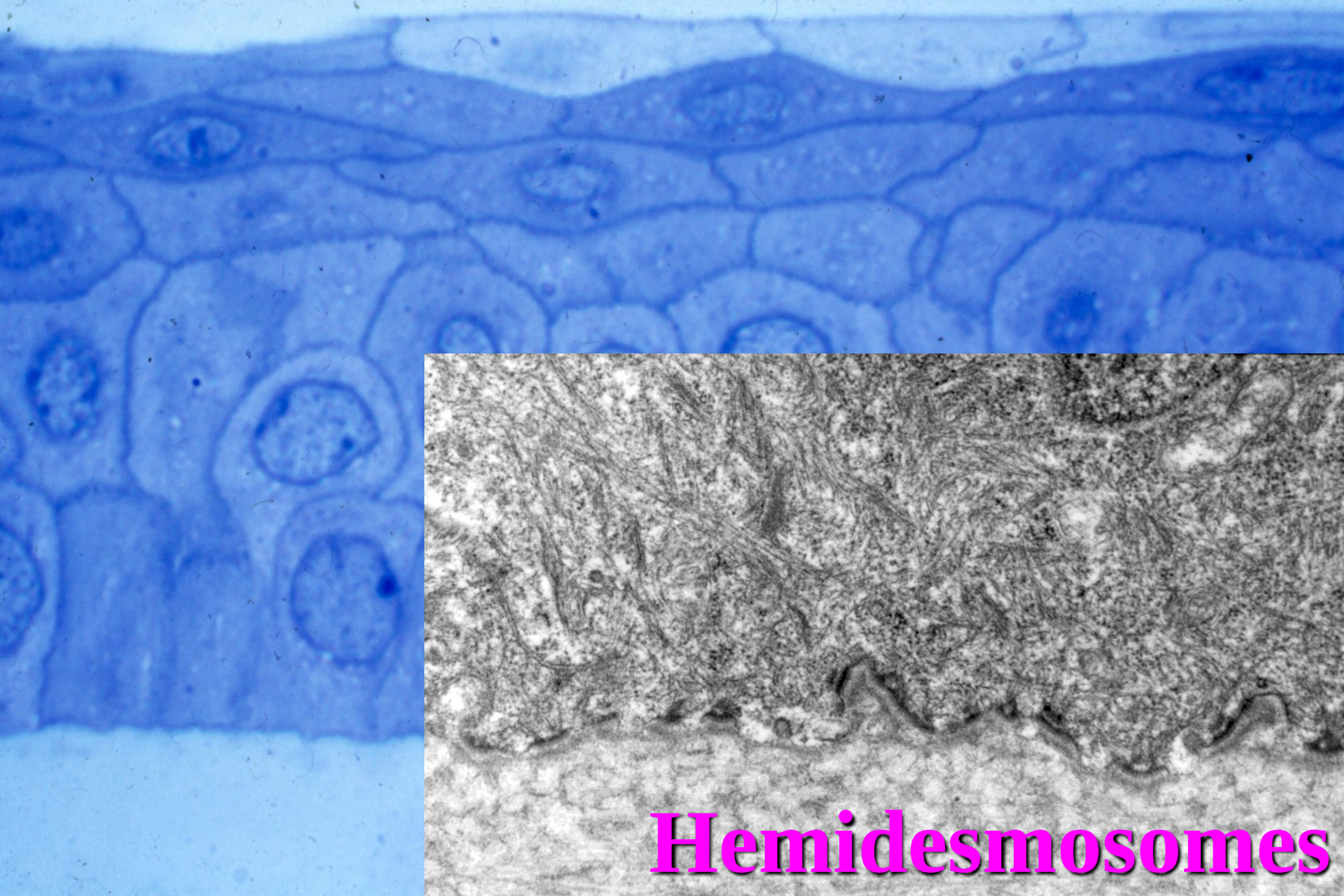
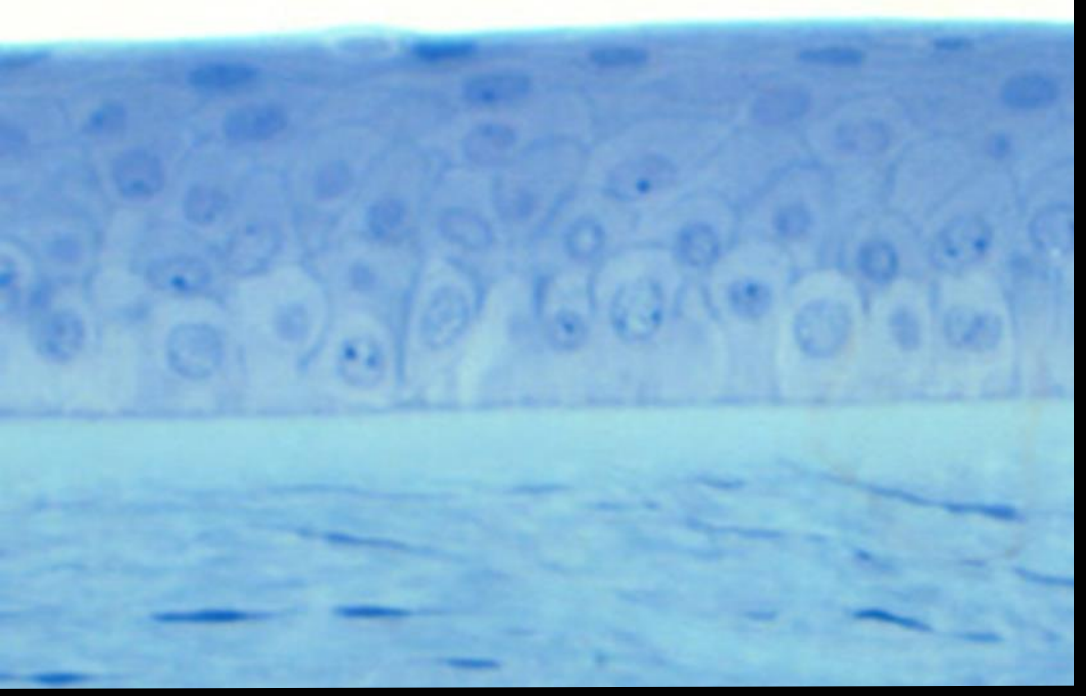
W
B
W
B

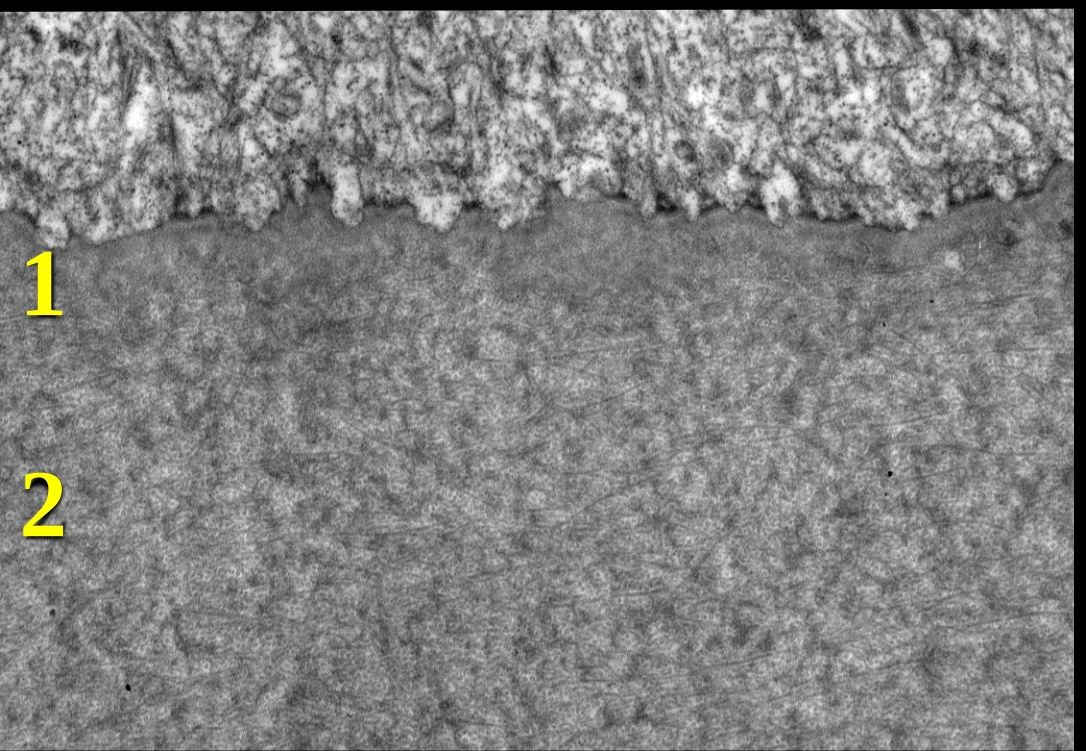




Desmosomes


Hemidesmosomes

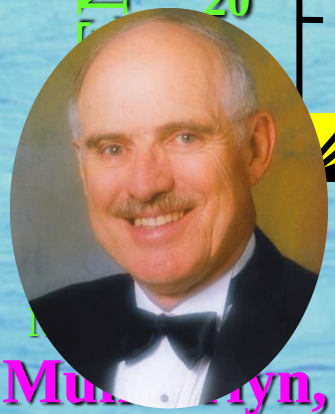




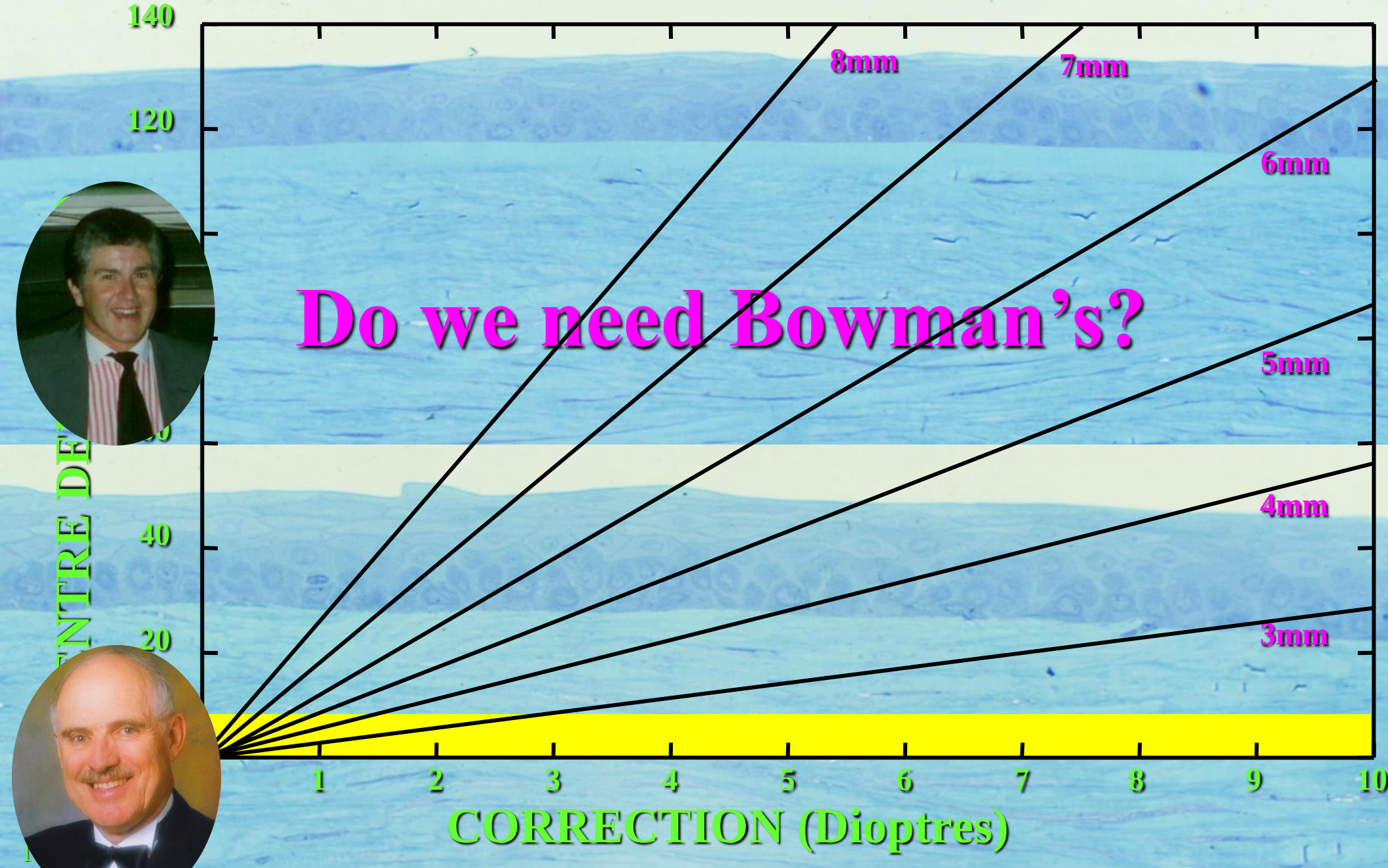
1

2

Smooth Template
Barrier to Diffusion
Barrier to Infection
Elastic Memory
Surface Rigidity

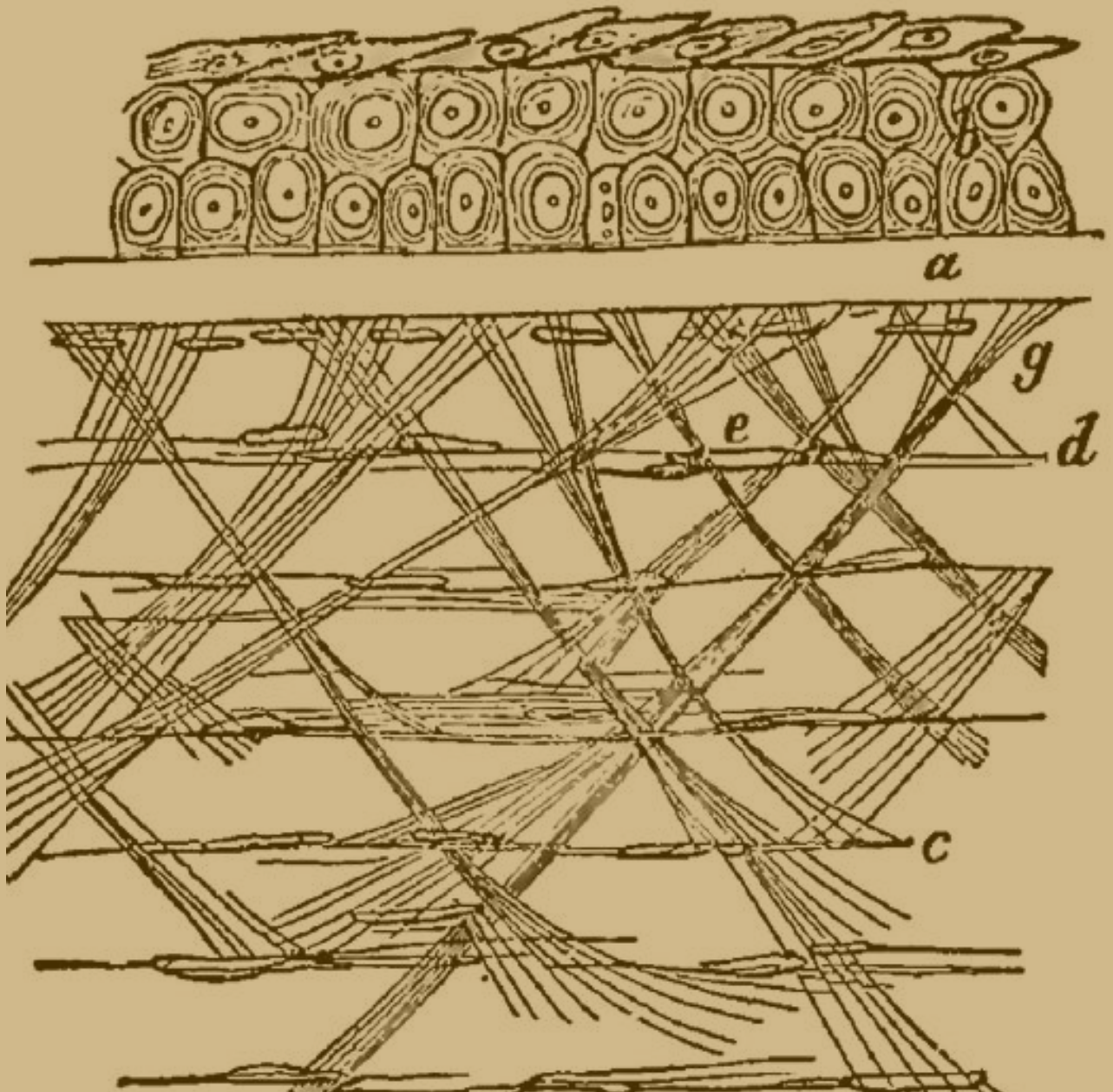


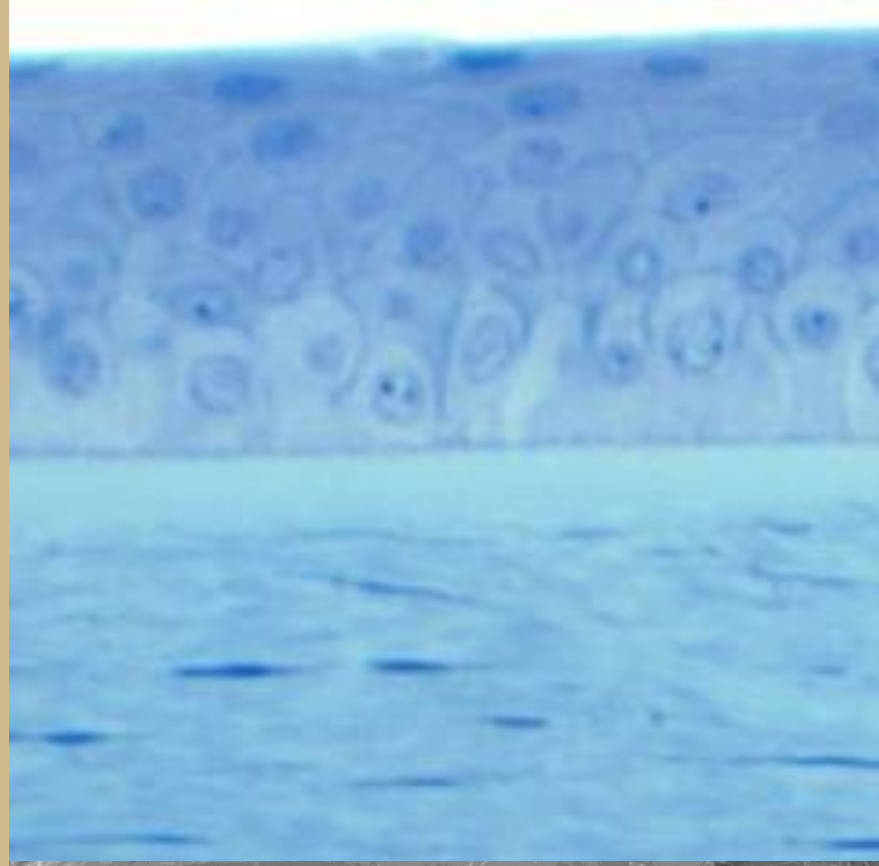
Do we need Bowman's?

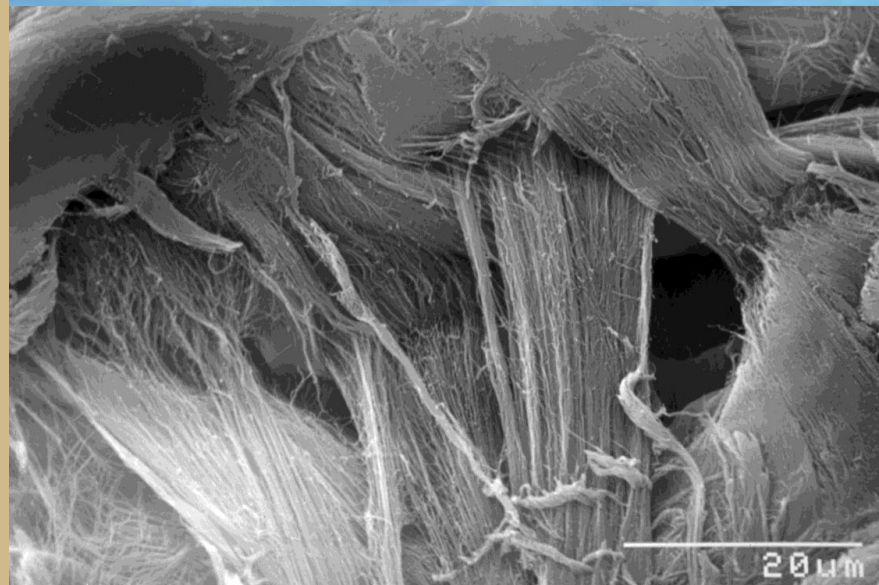


Mu[illegible]yn, Koons, Marshall (1985!) J. Cataract Refract. Surg. 14 46-52, 1988

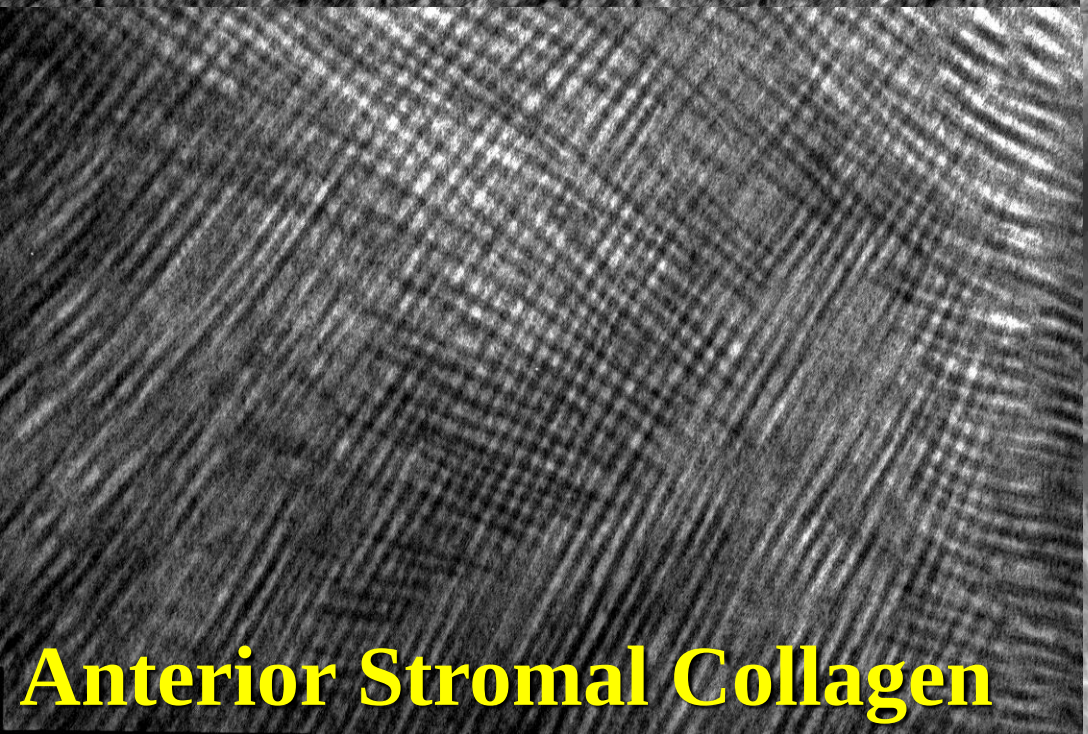
William Bowman's drawing 1847

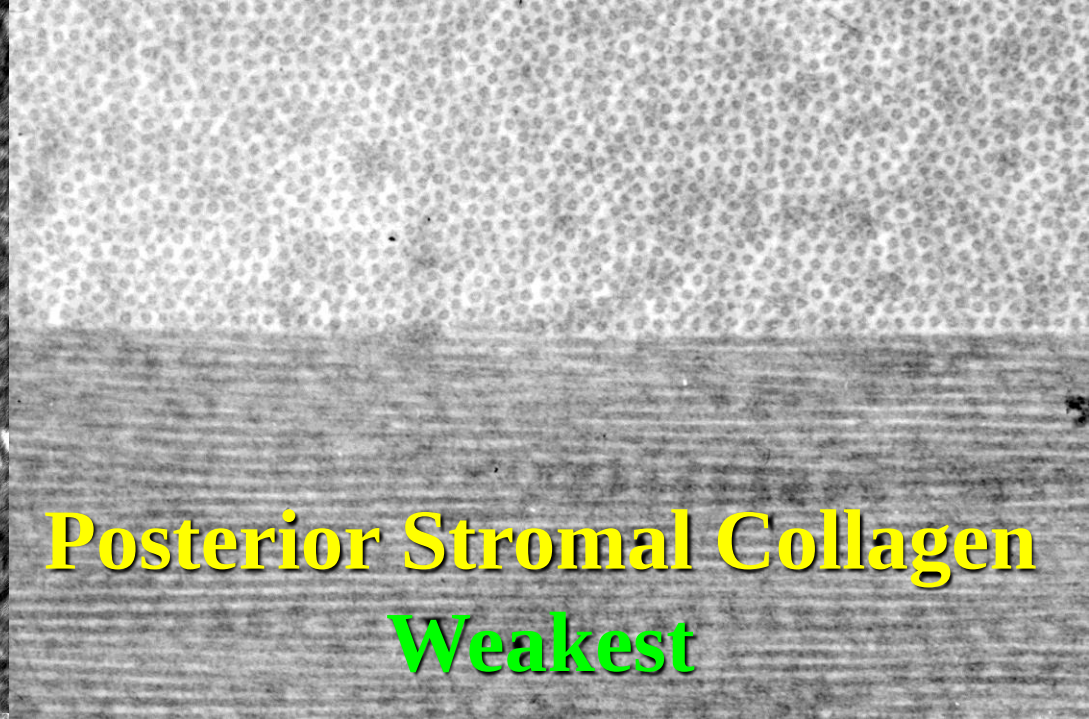




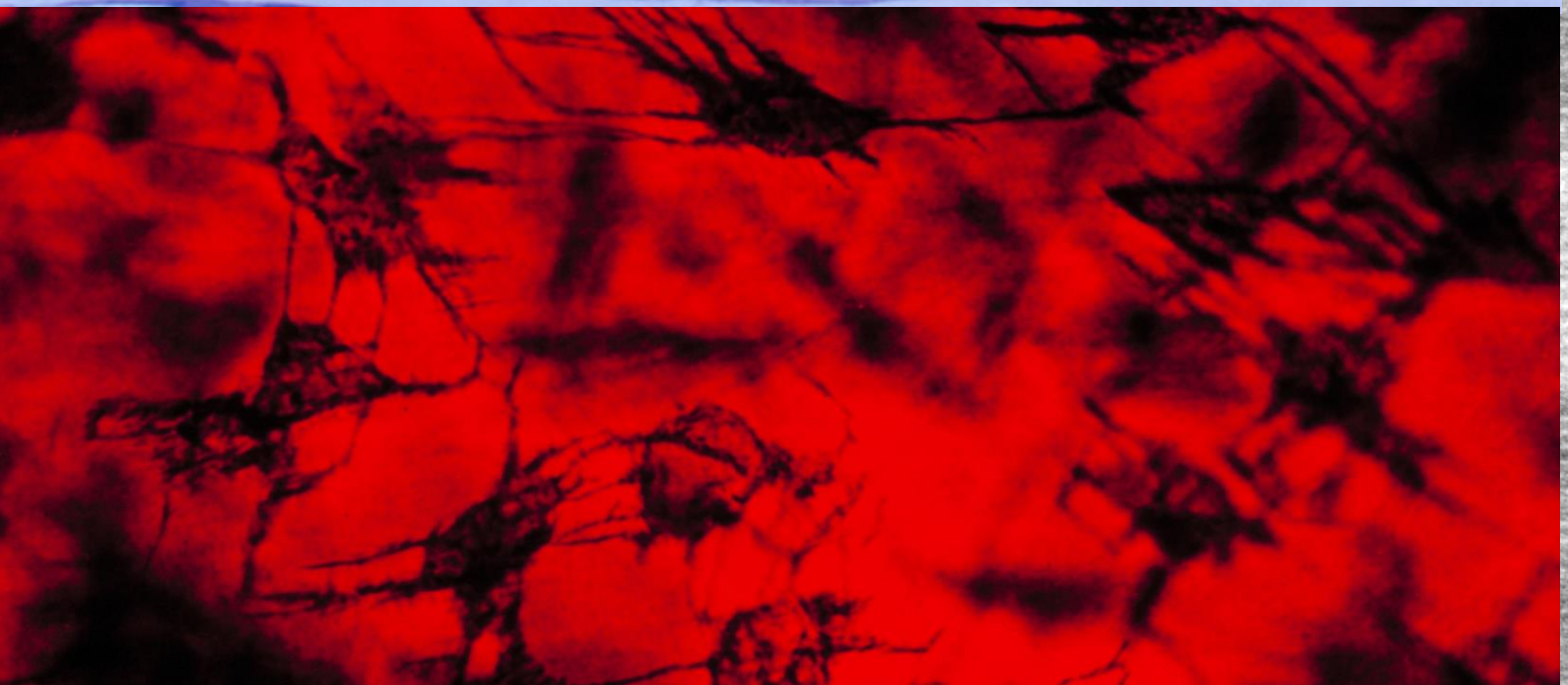


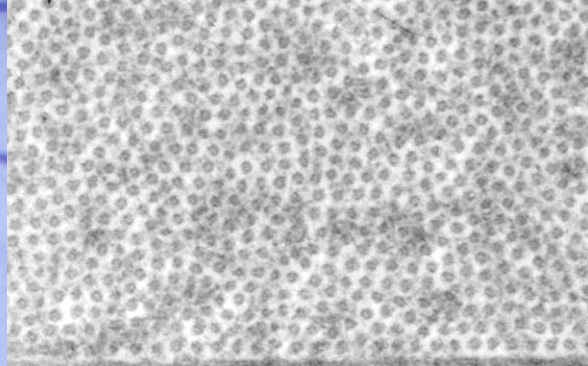
Bowman's Membrane
Strongest

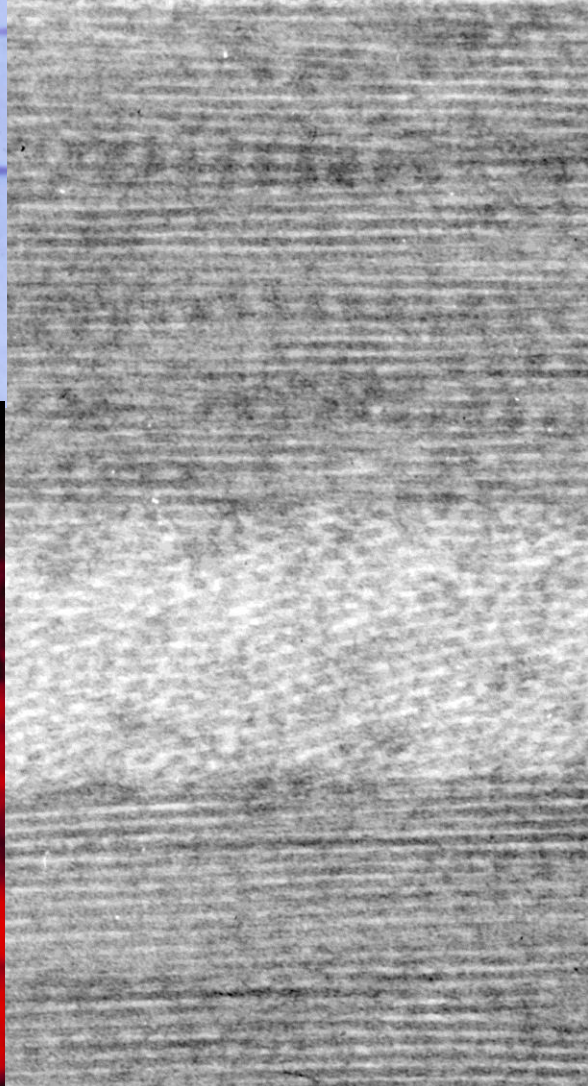

Anterior Stromal Collagen

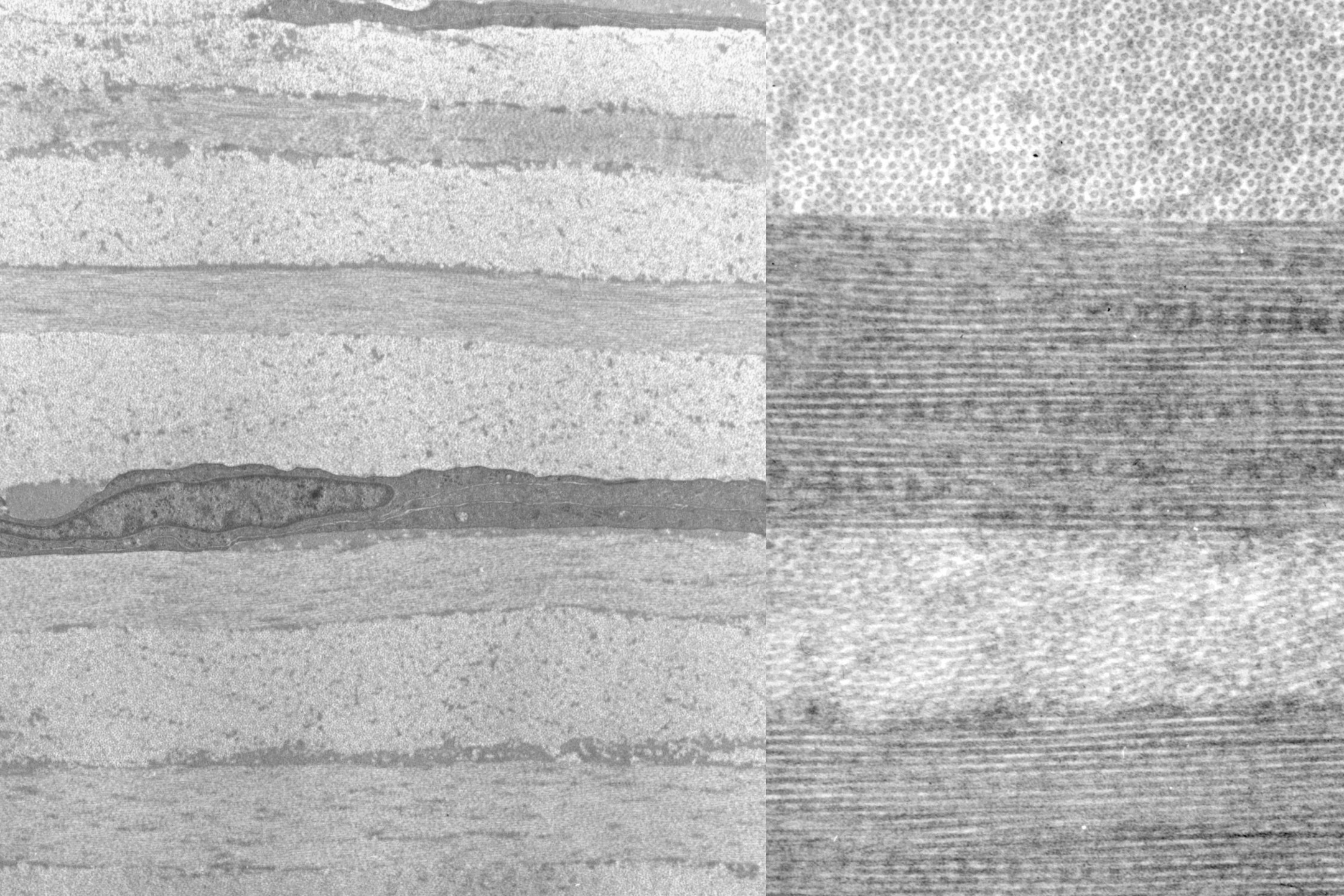

Posterior Stromal Collagen
Weakest

Anterior Stromal Collagen



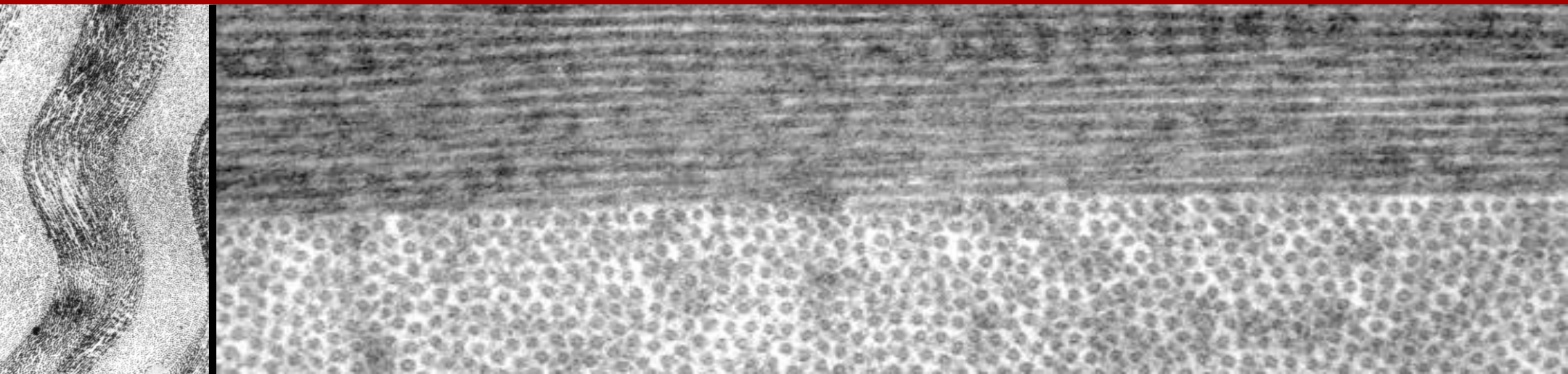




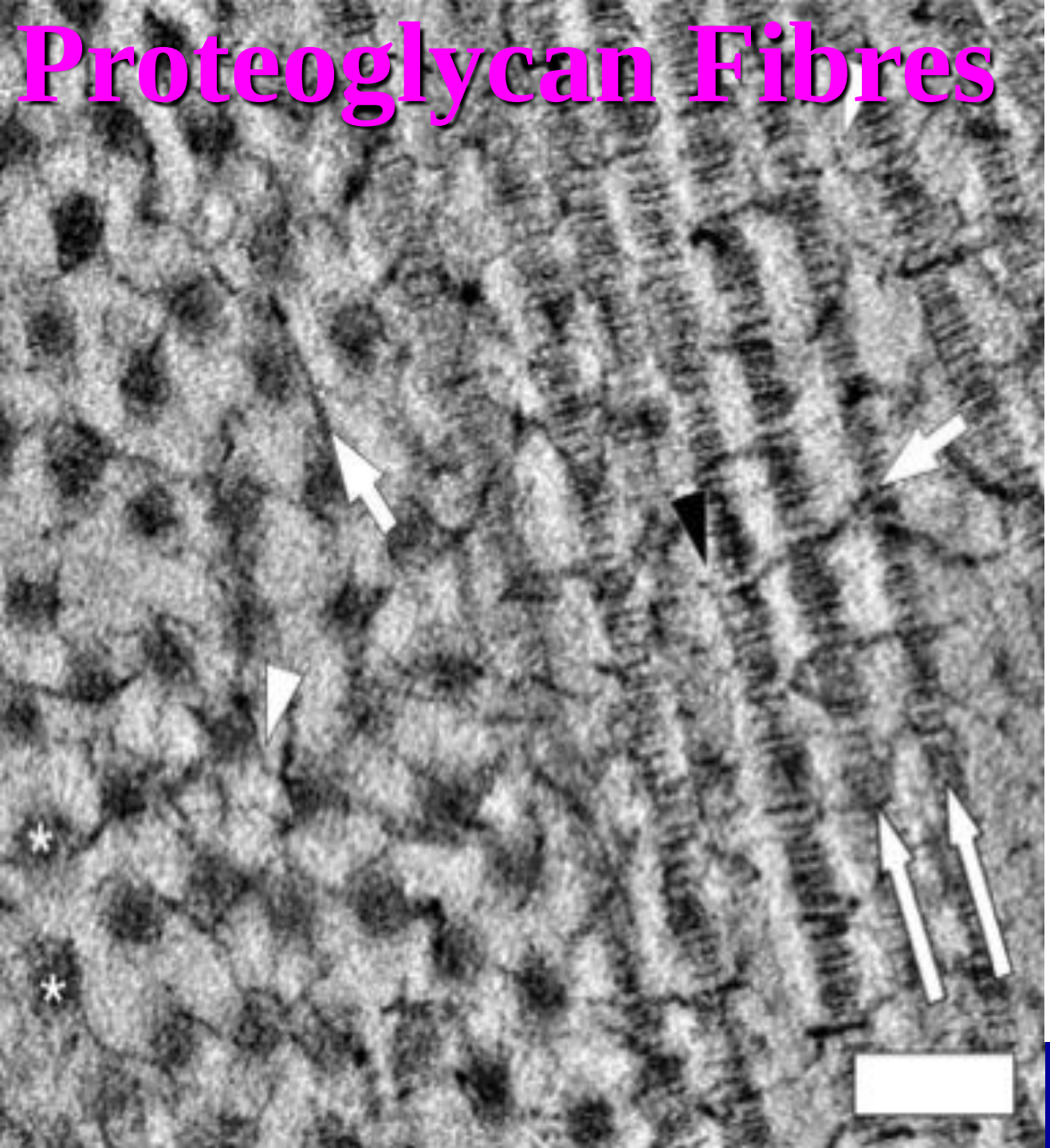


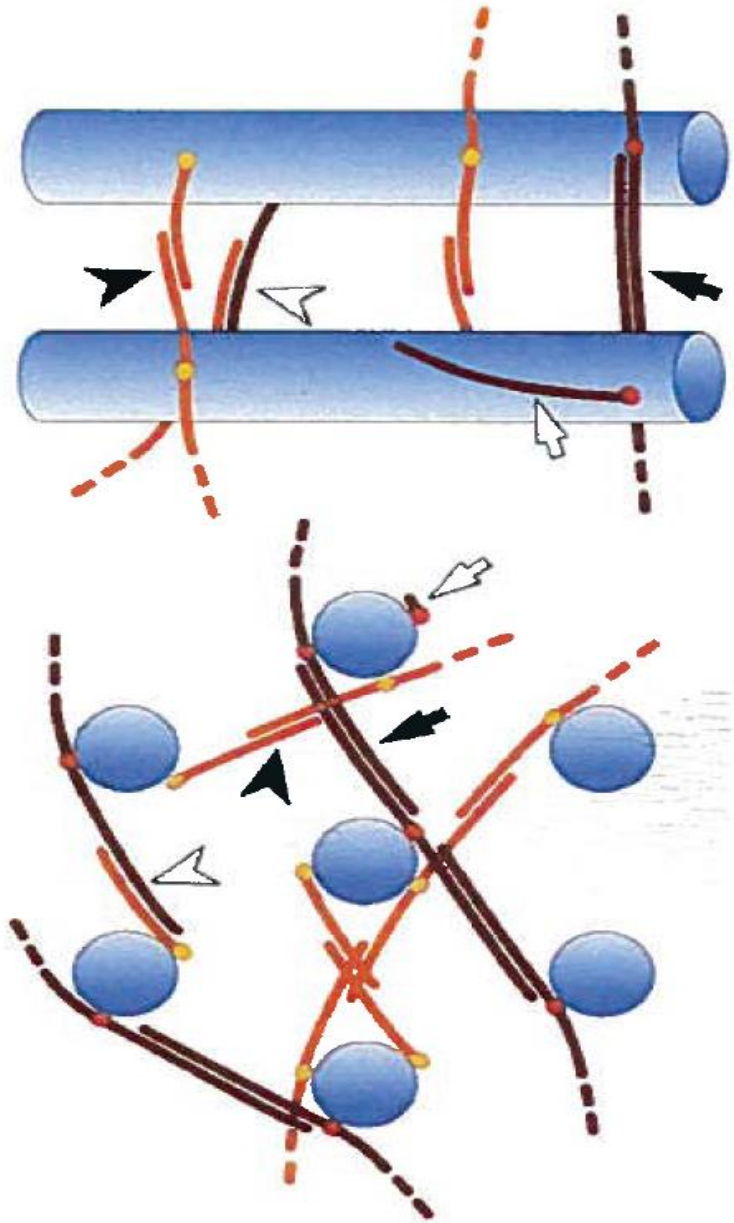
Molecule	Collagen	Keratocan	Lumican	Mimecan	Decorin	Keratin Sulphate	Chondroitin Sulphate
Collagen	Y	N	N	Y	Y	N	N
Keratocan	N	Y	-	-	-	-	-
Lumican	N	-	Y	-	-	-	-
Mimecan	Y	-	-	Y		-	-
Decorin	Y	-	-	-	Y - dimer		
Keratin Sulphate	N	-	-	-		N	N
Chondroitin Sulphate	N	-	-	-		N	N

Zhang et al, J Biol Chem 2011, Meek & Hayes, Ophthal & Phys Optics 2013



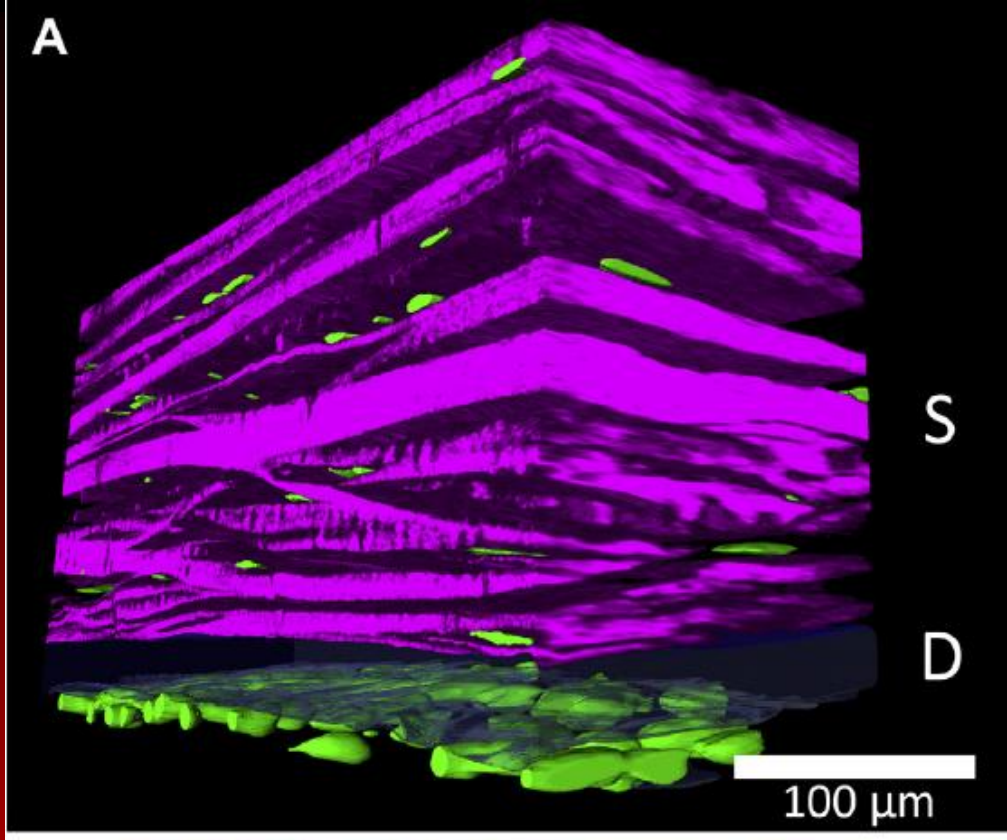
Proteoglycan Fibres

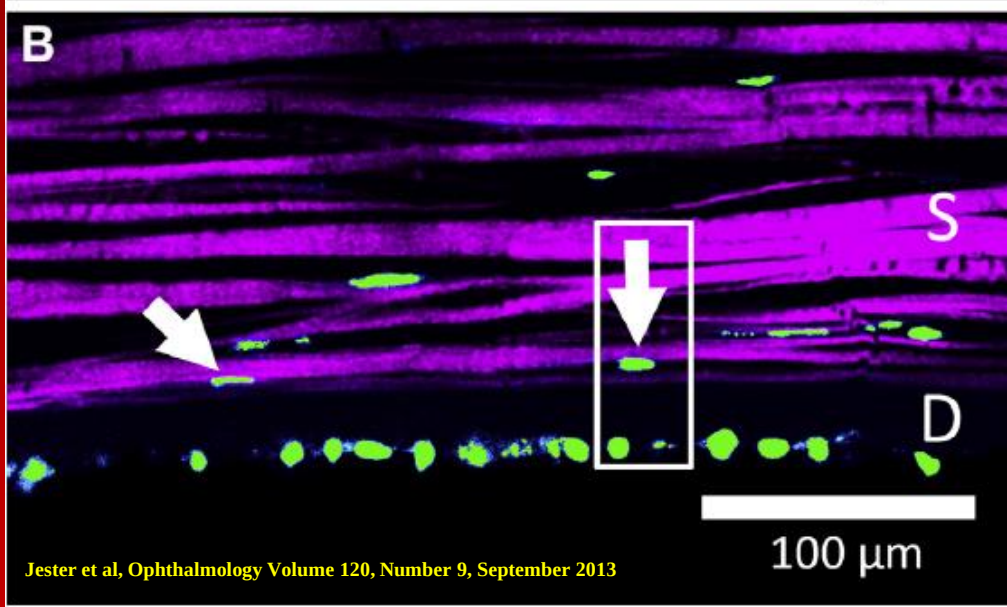




Lewis, Pinali, Young, Meek, Quantock & Knupp.
Structure 18, 239-245 2010

Werner Kokott 1938

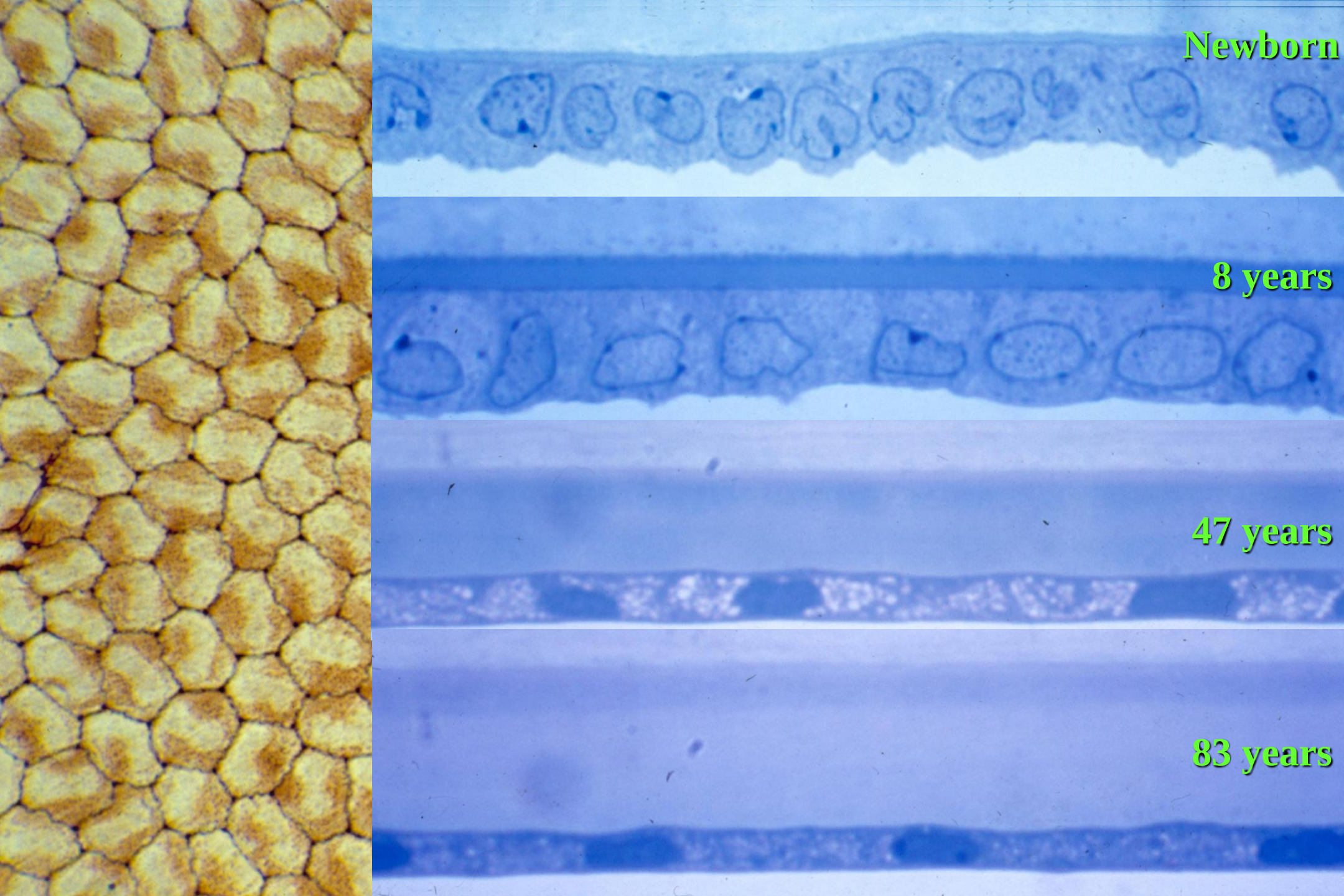




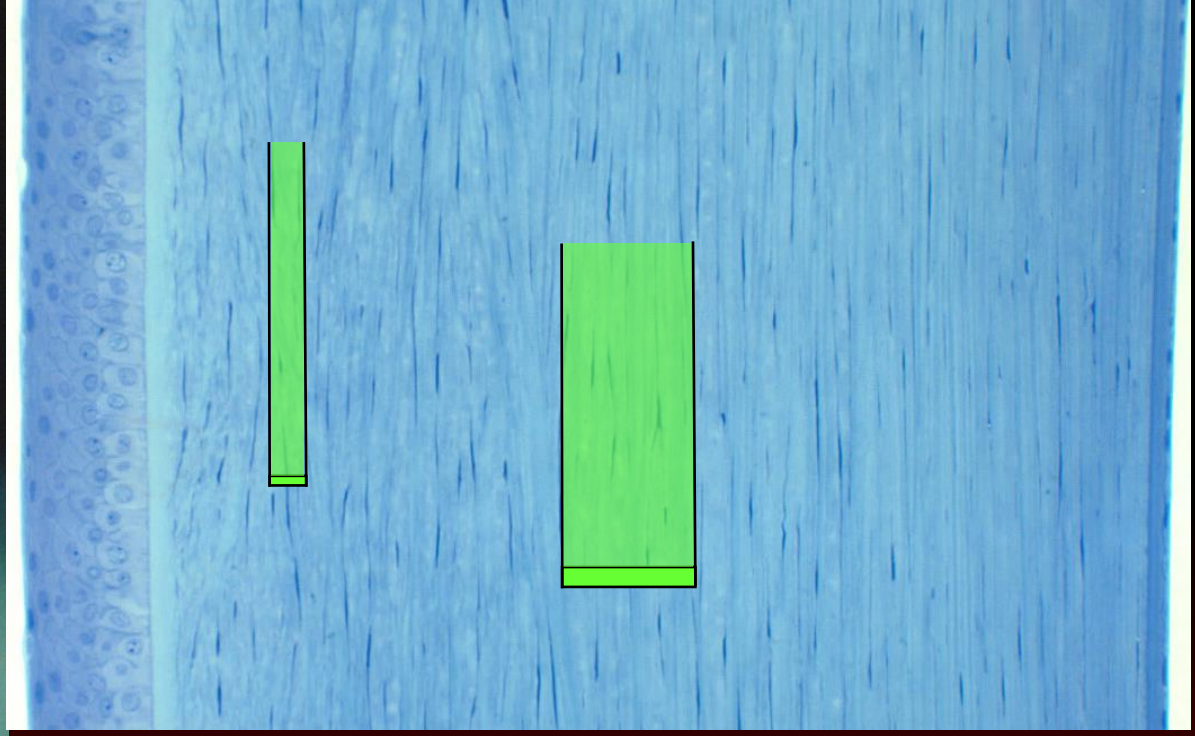
Jester et al, Ophthalmology Volume 120, Number 9, September 2013

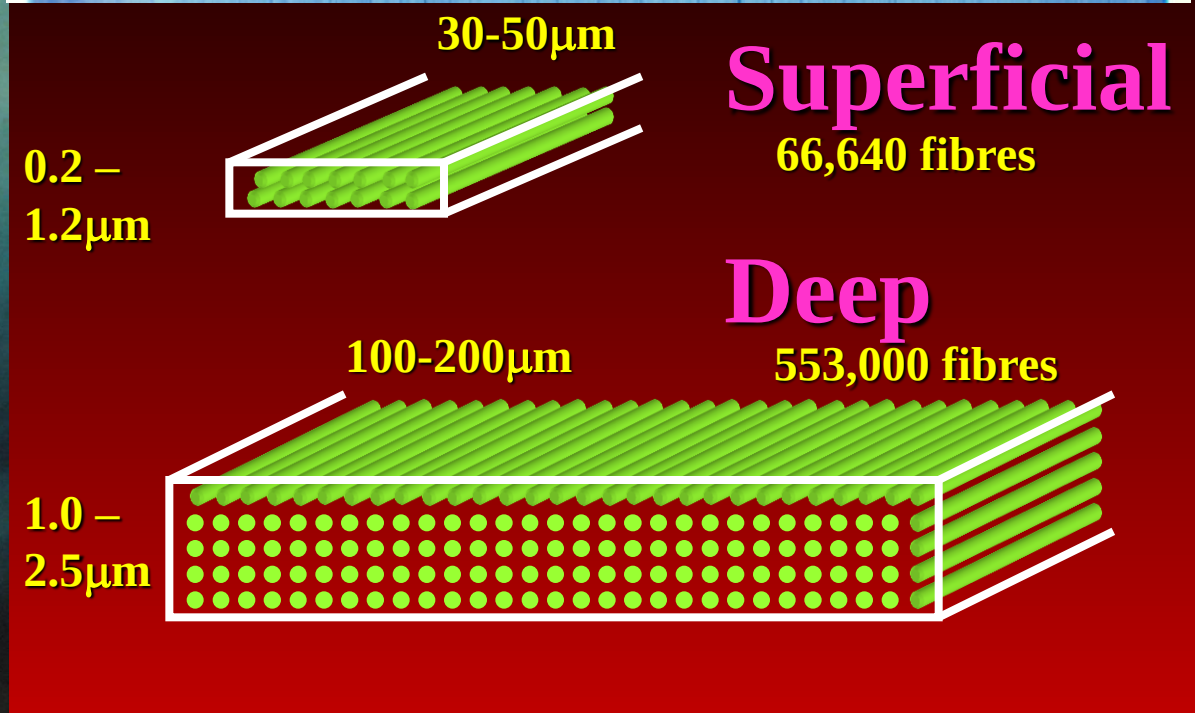
Dua's "Membrane"

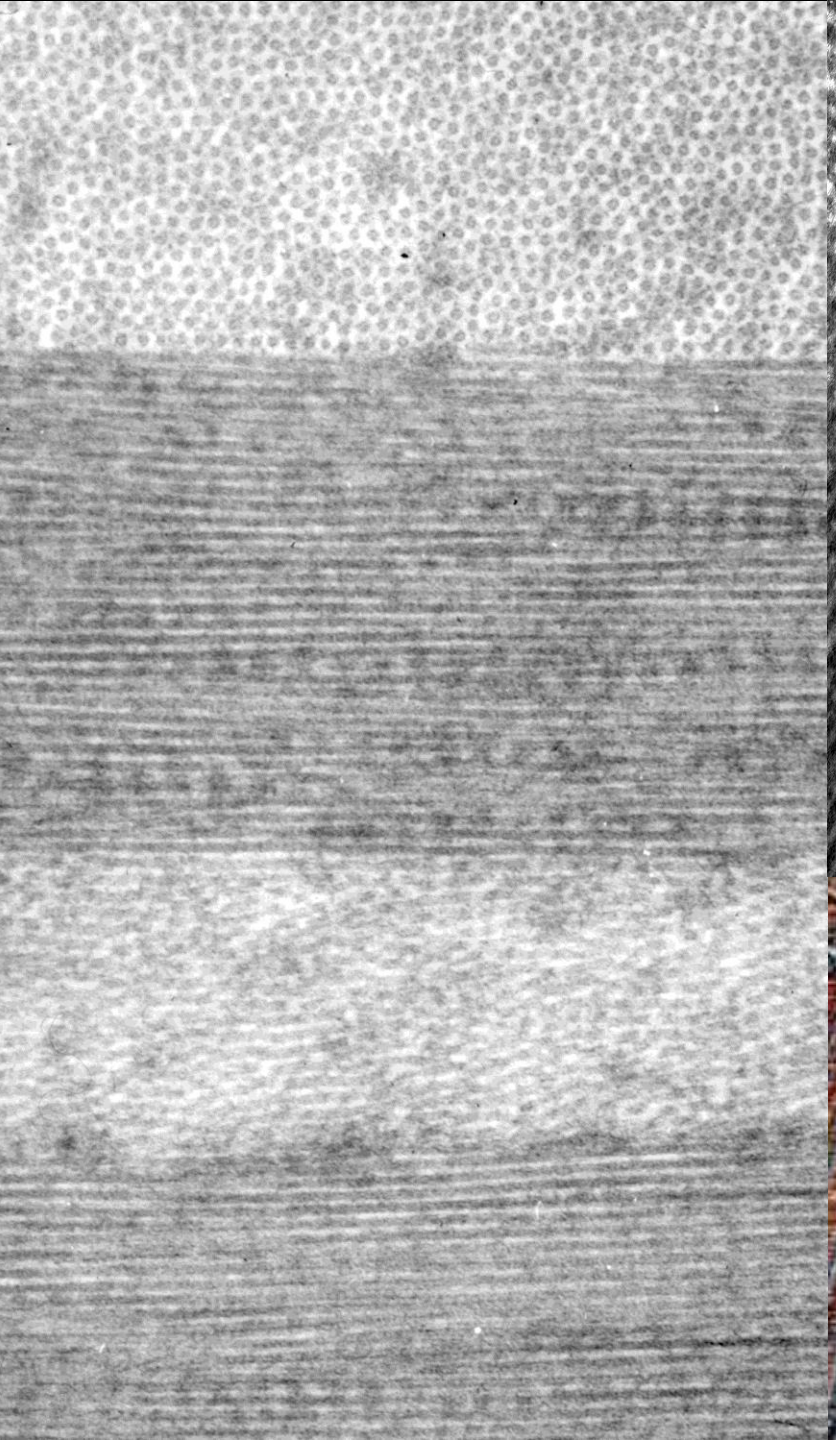
Dua HS et al (September 2013). *Ophthalmology* 120 (9): 1778–85

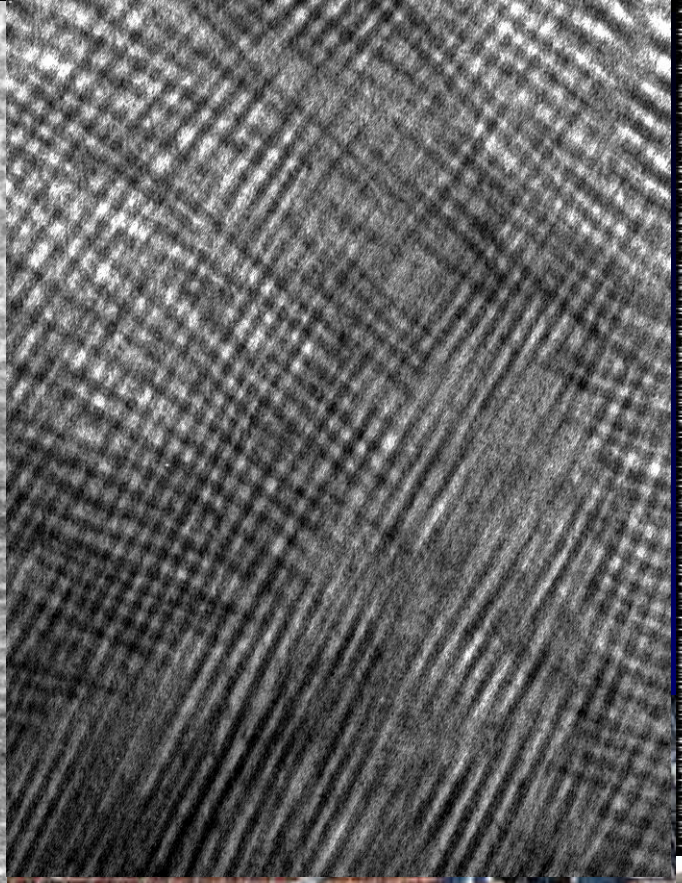

Newborn
8 years
47 years
83 years

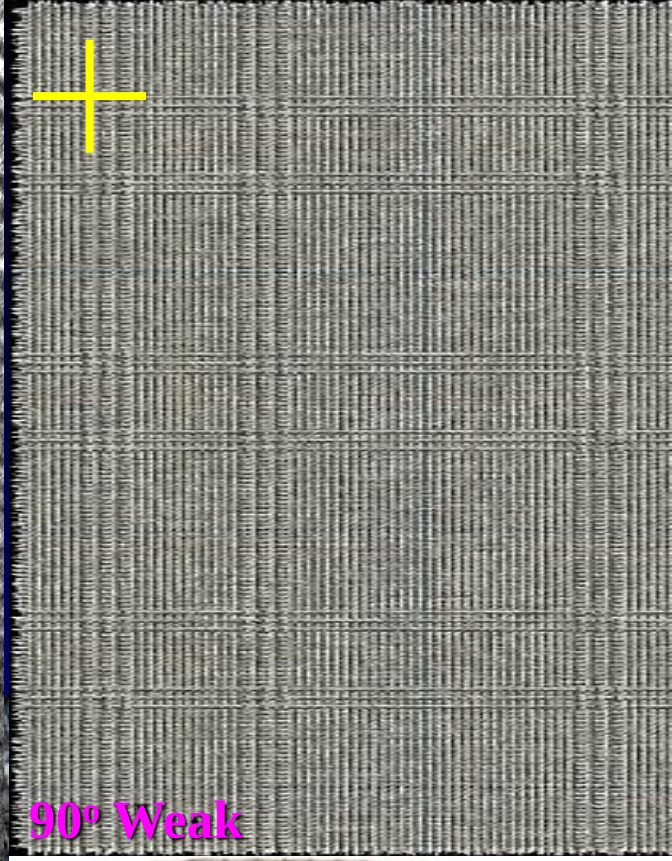
12.25mm
30 nm
1 cm
4.1 km




30-50µm
Superficial
66,640 fibres
0.2 –
1.2µm
Deep
100-200µm
553,000 fibres
1.0 –
2.5µm

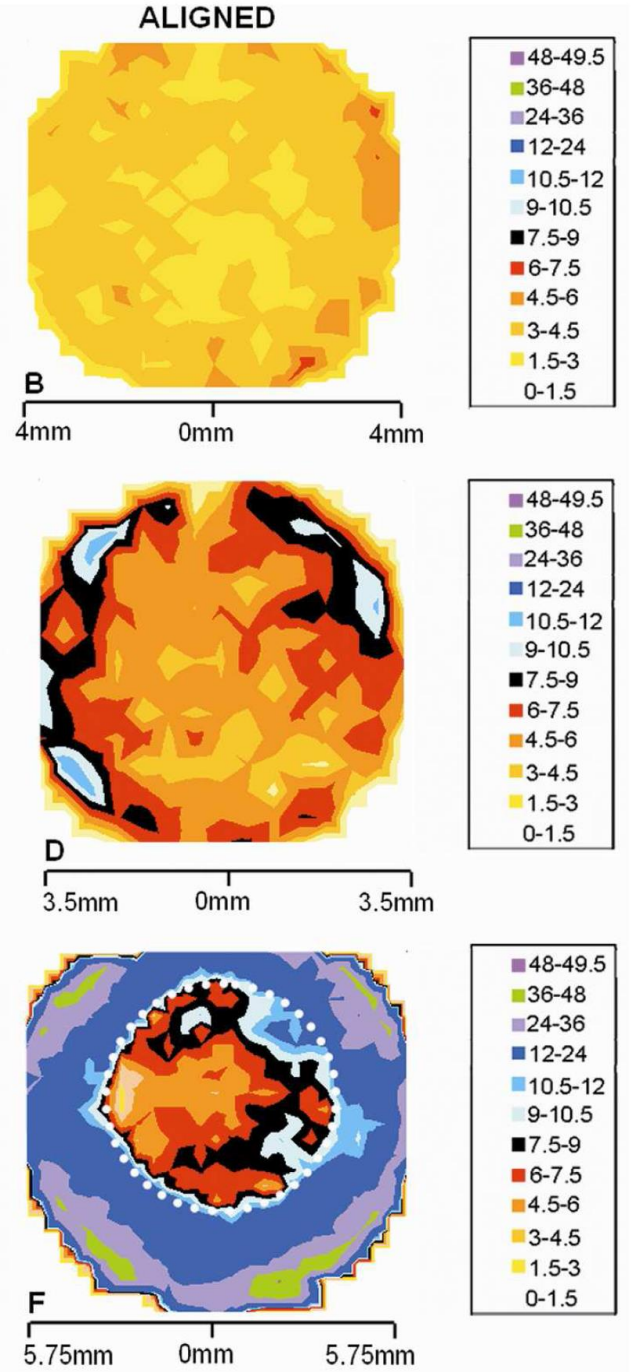


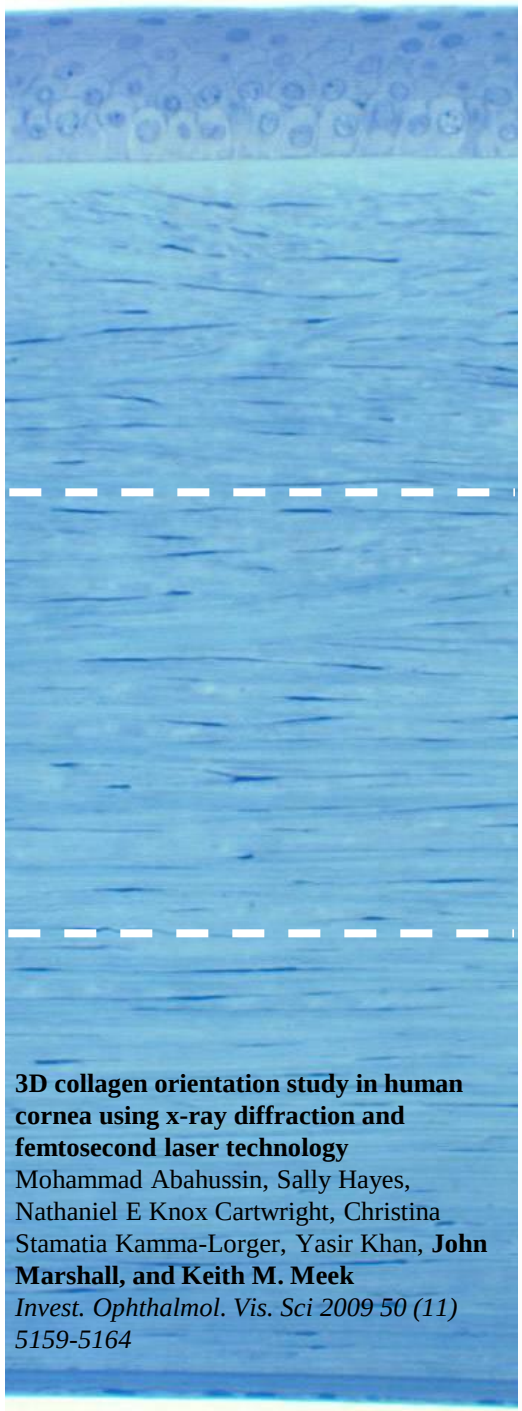



90° Weak

120 °

120° Strong

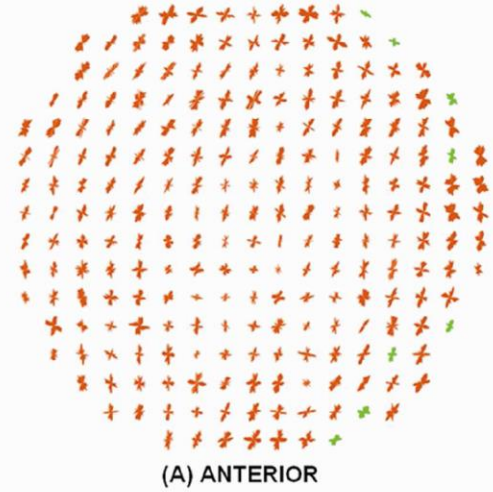


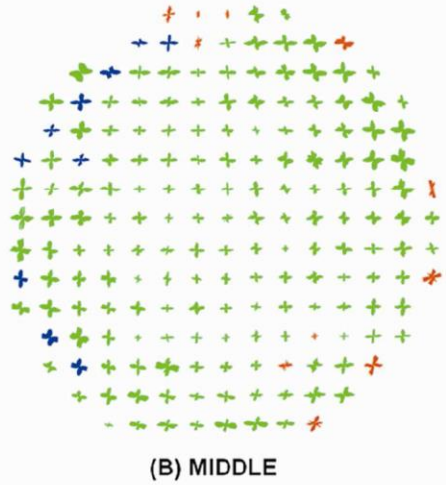


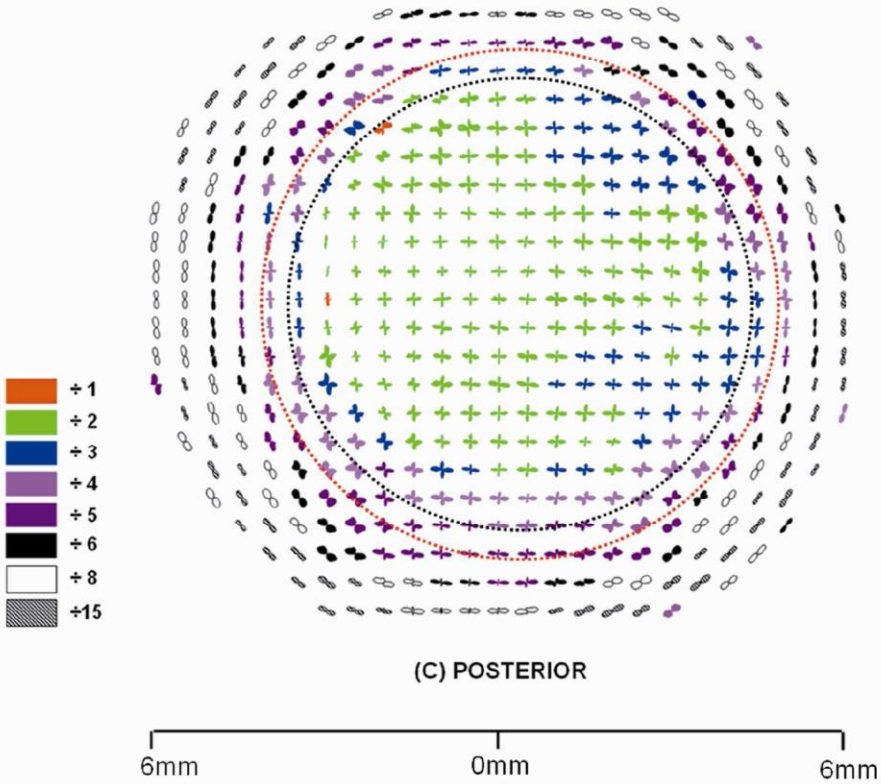
3D collagen orientation study in human cornea using x-ray diffraction and femtosecond laser technology

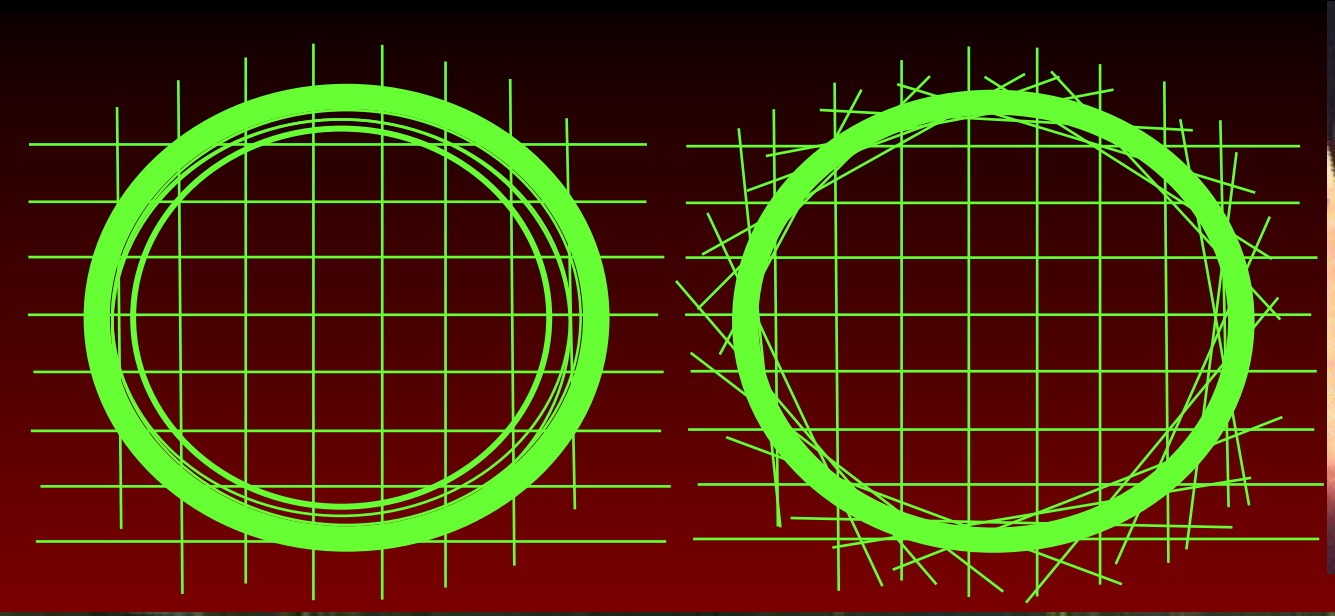
Mohammad Abahussin, Sally Hayes, Nathaniel E Knox Cartwright, Christina Stamatia Kamma-Lorger, Yasir Khan, **John Marshall, and Keith M. Meek**

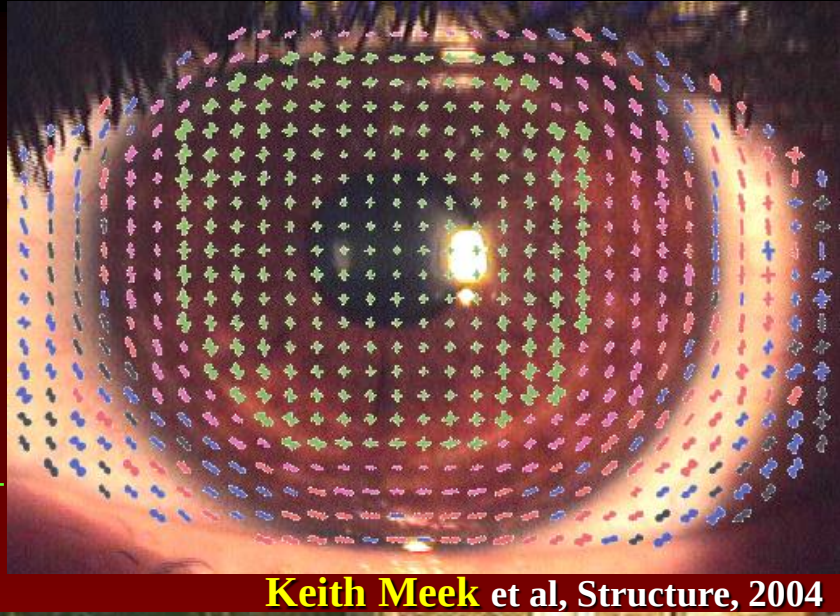
Invest. Ophthalmol. Vis. Sci 2009 50 (11) 5159-5164











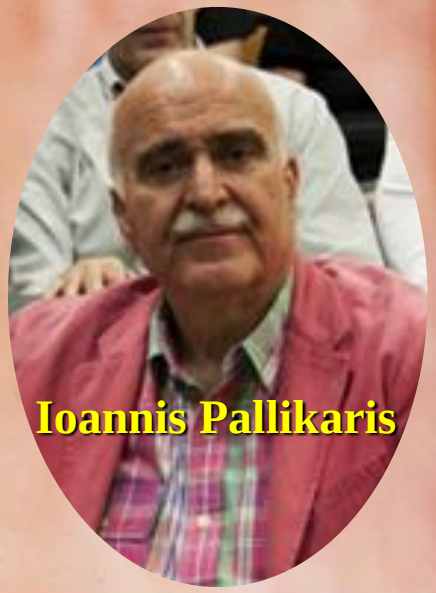
Keith Meek et al, Structure, 2004

Newton's Bridge, Queens College Cambridge

LASIK

Lucio Burrato

Public Range



Ioannis Pallikaris

Private Optometrists

State Certified PRK

Retrospective

“No” Pain

“No” Haze

Keith Meek

Weak
6mm

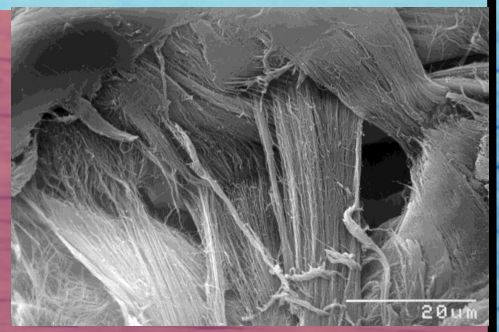
Strong
8-12mm

Tensile Strength (g/mm)

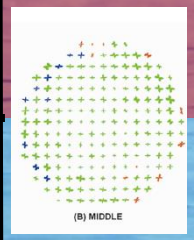
60 50 40 30 20 10 0

0%
20%
40%
60%
80%
100%

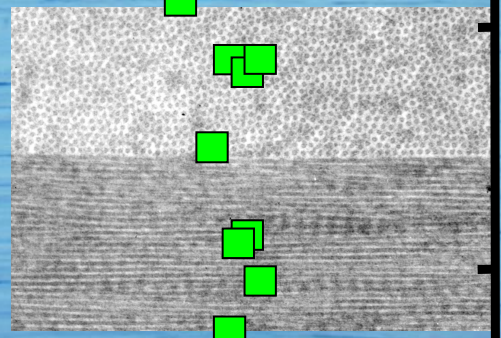
Percent Depth (A-P)

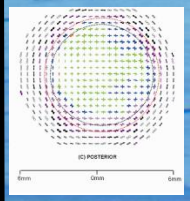


"Strong"
150 µm

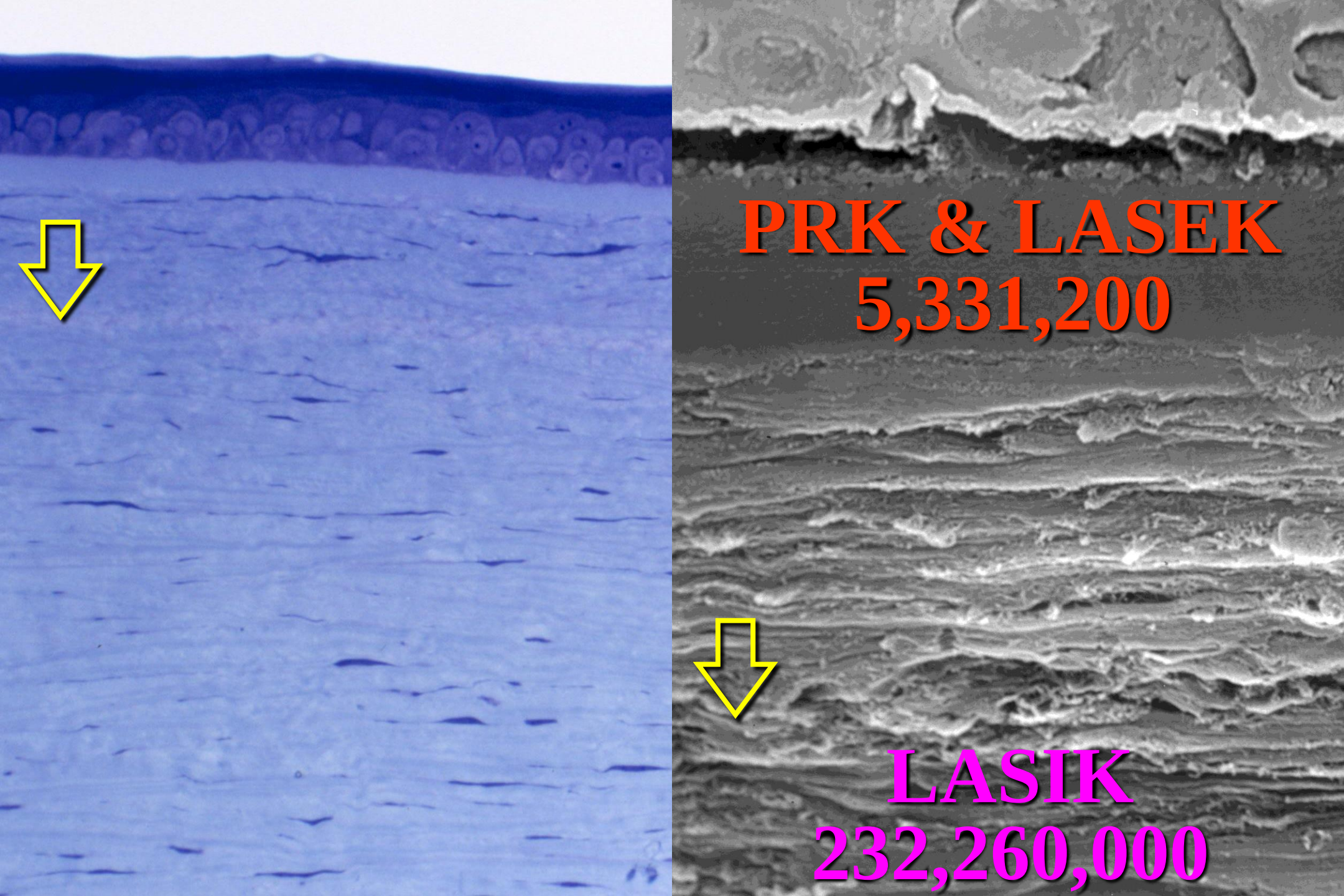


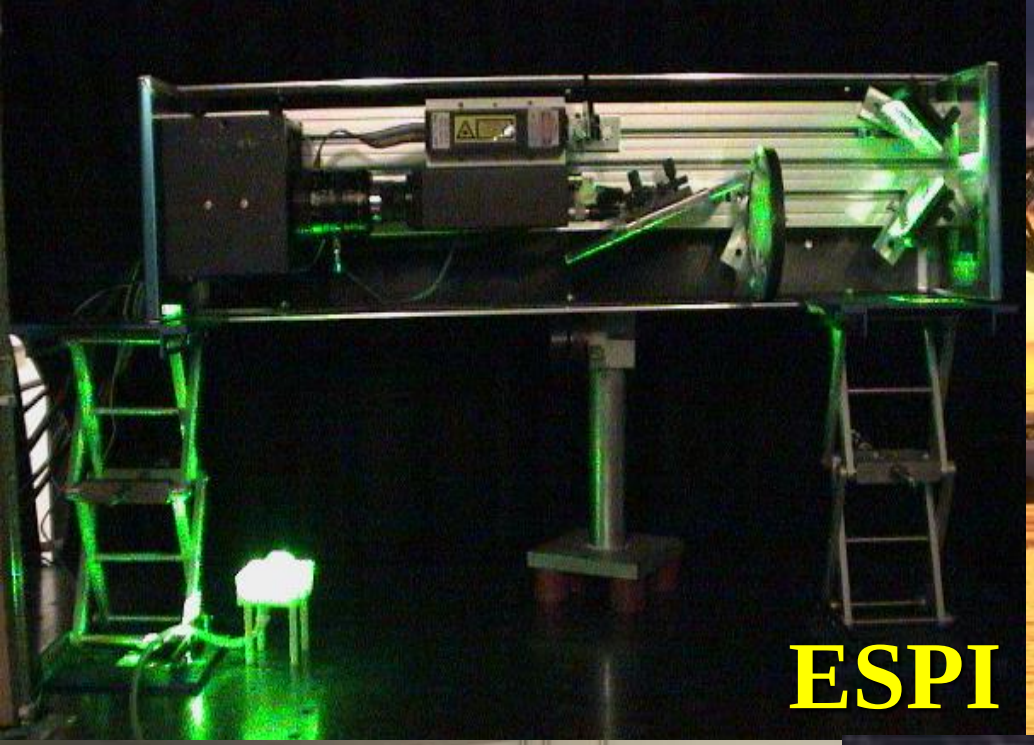
"Weak"
350 µm





Abahussin M. Hayes S. Knox Cartwright NE. Kamma-Lorger CS. Khan Y. Marshall J. Meek KM. *Investigative Ophthalmology & Visual Science. 50(11):5159-64, 2009 Nov.*


PRK & LASEK
5,331,200
LASIK
232,260,000


ESPI

John Tyrer

Jaycock P, Lobo L, Ibrahim J,
Tyrer J & Marshall J
J Cataract & Refract Surg 31 175-184 2005

LASIK

Phil
Jaycock

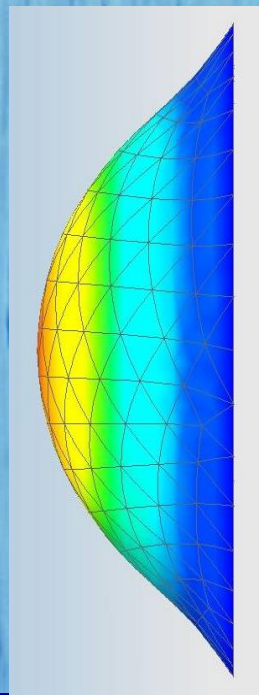
Nat
Knox-Cartwright

14%
80µm

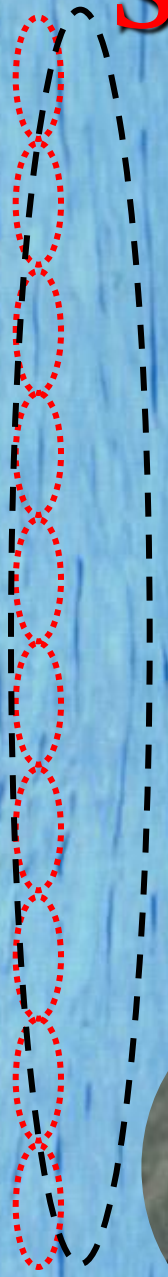
25%
140µm

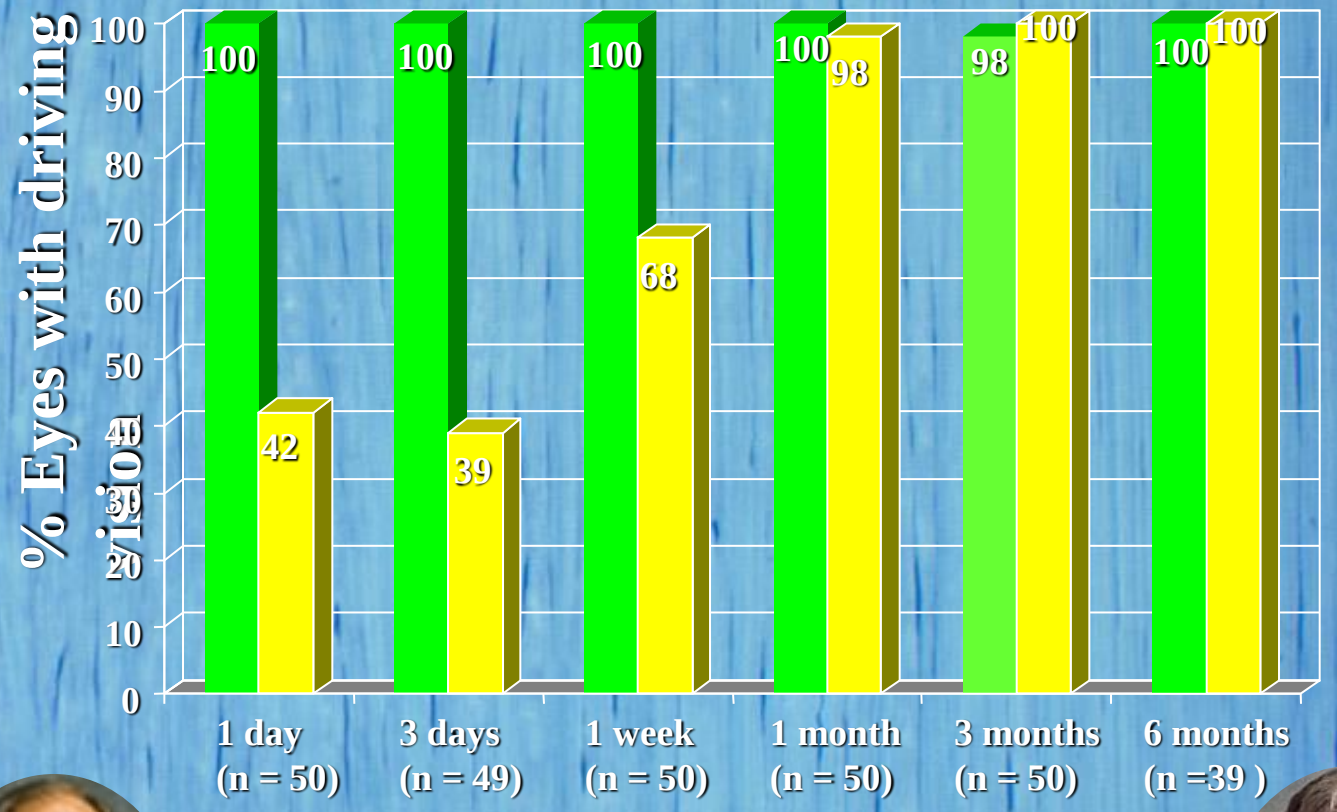
29%
160µm

33%
180µm



Sub-Bowman's Keratomileusis (SBK)

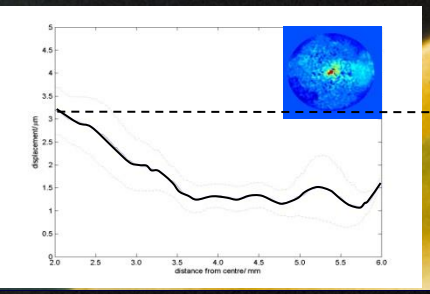


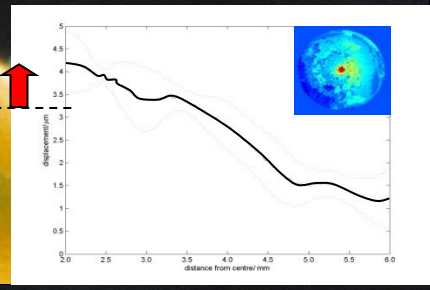


Durrie D, Slade S & Marshall J *J Refract Surg 24 77-84 2008*

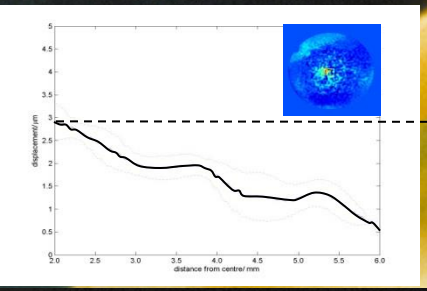
90 µm

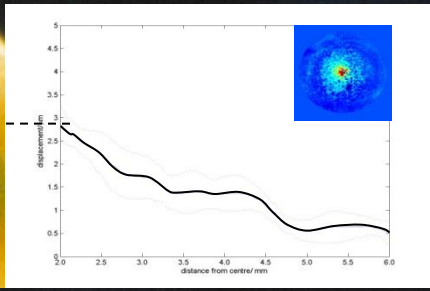
160 µm



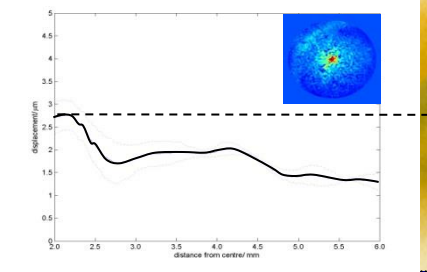


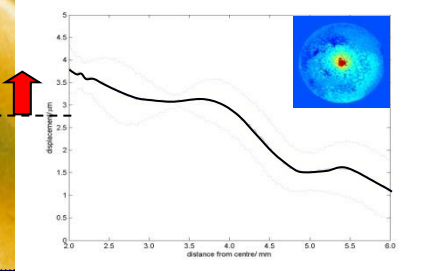
LASIK flap





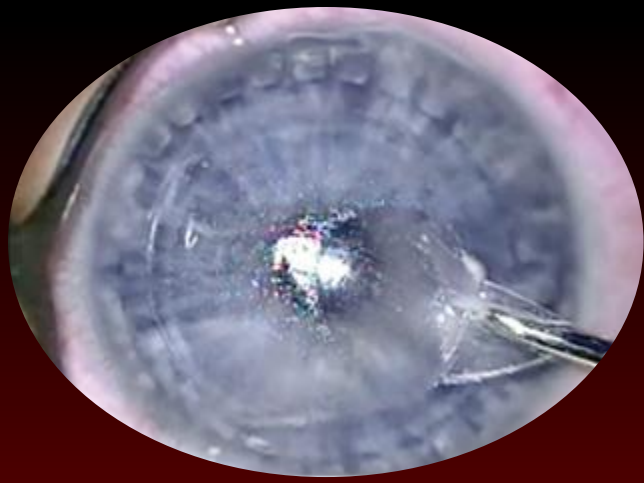
Delamination only

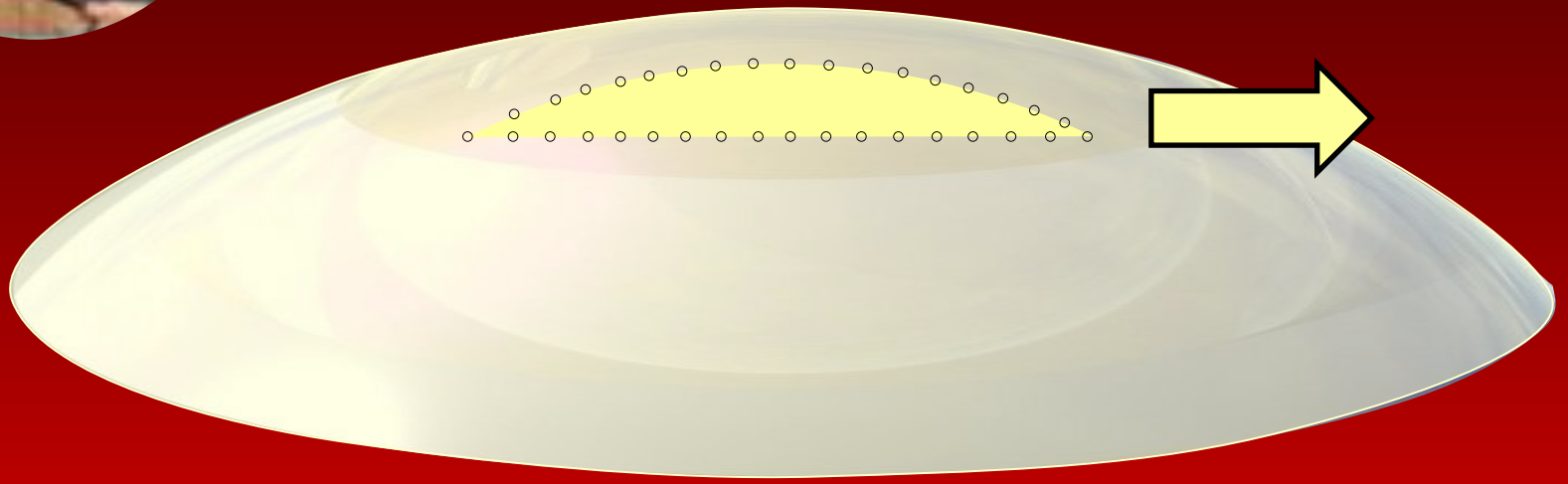




Side cut only

SMall-Incision Lenticule Extraction (SMILE)





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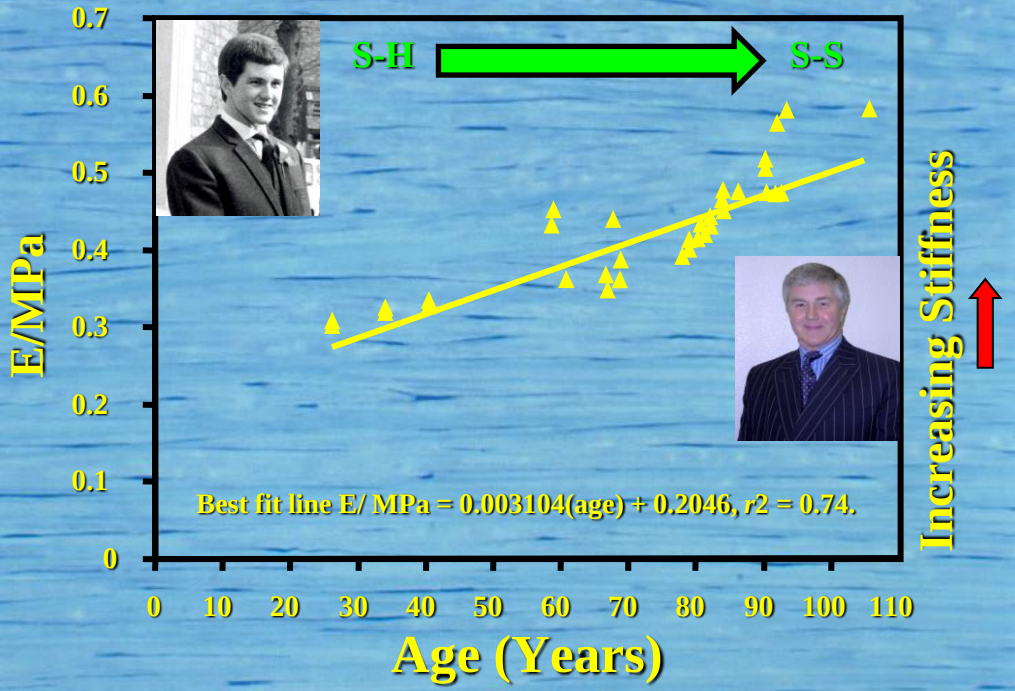
Young's modulus against donor age



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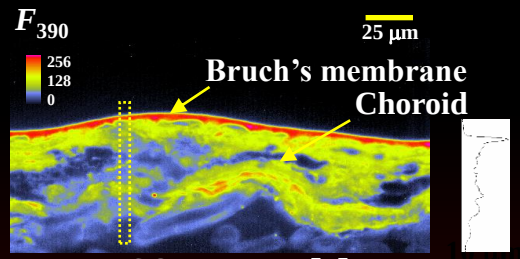
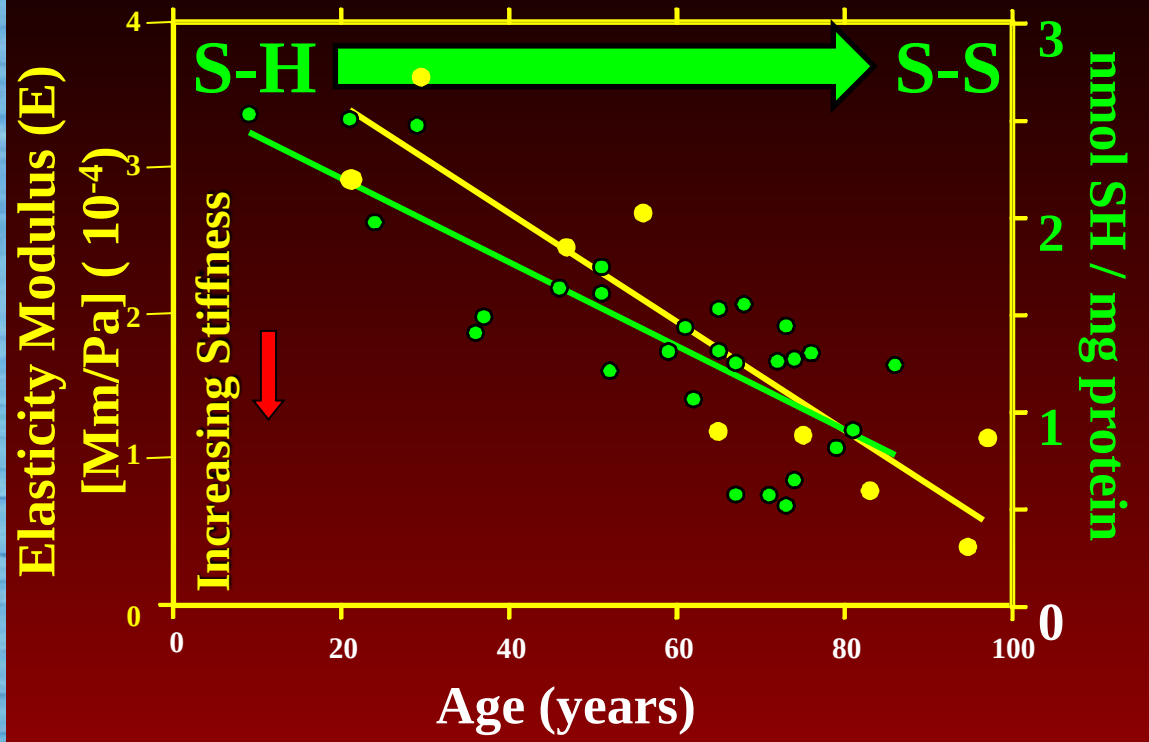


Fluorescence S-H (thiols)

68 year old



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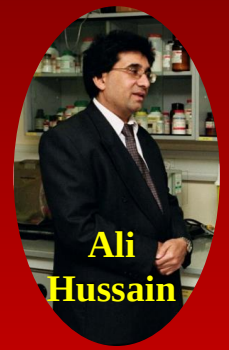


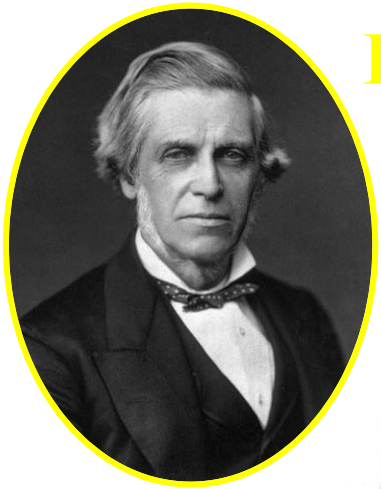
100% LASIK EYES WEAK

Strength Reduced by 25% -30%

LASIK Xtra

Strength Increased by 300% - 400%

100% CROSS-LINKED EYES STRONG

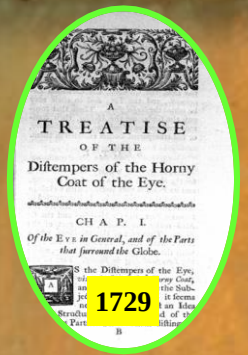


Sir William Bowman
(1816-1892)

Bowman's

Descemet's

Capsule



Benedict Duddell

Jean (Joannes) Descemet (1732-1810)

Pierre Demours (1702 – 1795)

Rufus of Ephesus 100 AD

Christophorus Scheiner (1575-1650)

Antony van Leeuwenhoek (1638-1731)

Johann Gottfried Zinn (1727-1759)

Bruch's

Duddell

Descemet

Frederik Ruysch
(1638 – 1731)

Karl Wilhelm
Ludwig Bruch
(1819 – 1884)