2.4.2.3 Pupillary Response

Pupillary response or **pupil light reflex** is a physiological response that leads to a change in the pupil diameter (size). While the pupil diameter (PD) is about 3.5 mm, the pupil constricts under a bright light to 1.5 or 2 mm in diameter and expands under dim light up to 8 mm.

Pupil constriction and dilation can be brought about by the contraction of the sphincter and the dilator pupillae, two antagonistic autonomic (reflex) muscles. The sphincter muscle (*σφιγκτήρας*), innervated by the parasympathetic nervous system, is a circumferential muscle that forms a ring around the iris edge; its contraction leads to pupil constriction. The dilator muscle (*διαστολέας*), innervated by the sympathetic nerve system, forms radially from the iris edge into the ciliary body; its contraction leads to excitation of the radial fibers of the iris, which leads to an increased pupillary aperture.

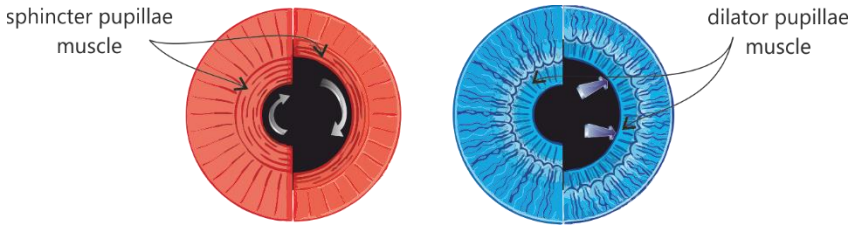

Figure 2-42: Pupillae muscles driving pupil response.

Pupil size may be pharmacologically induced: It may constrict (miosis) in response to agents such as opiates/opioids or anti-hypertension medication. The pupil may dilate (mydriasis) by anticholinergic agents and amphetamines that block the responses of the ciliary muscle during accommodation (cycloplegia, § 7.1) and also act on the sphincter muscle, producing mydriasis. A pharmacologically mydriated pupil remains dilated even in bright light. Anticholinergic and alpha-1 adrenergic agonists are used as mydriatic agents.

The highlighted sentence has been amended as written here.

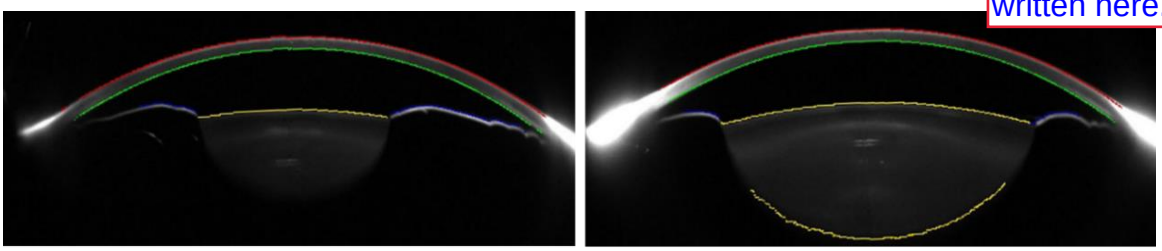

Figure 2-43: Scheimpflug images taken before (left) and after (right) pharmacologic mydriasis.[158]

[158] Razeghinejad MR, Lashkarizadeh H, Nowroozzadeh MH, Yazdanmehr M. Changes in ocular biometry and anterior chamber parameters after pharmacologic mydriasis and peripheral iridotomy in primary angle closure suspects. J Optom. 2016; 9(3):189-95.

The clinical presentations of photokeratitis include ocular pain, tearing, conjunctival chemosis, blepharospasm, and deterioration of vision typically several hours after exposure. The presentation can be transient (recessing as the epithelium regenerates)[212] but can also be long term.[213] Chronic UV-B exposure is associated with abnormal cornea conjunctiva growth such as pterygium.[214, 215] UV exposure may lead to the irrevocable loss of corneal endothelial cells,[216] since these non-regenerating cells are very susceptible to UV radiation.[217]

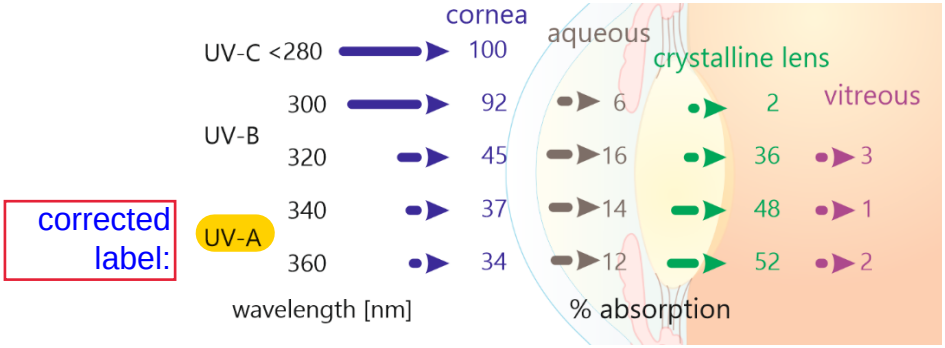

Figure 2-68: Absorption of UV bands by various components of the human eye.

The crystalline lens of the eye strongly absorbs UV, mainly due to its longer optical path (being much thicker than the epithelium). UV absorption by the lens is associated with cataract development: Studies suggest that doubling the lifetime of UV-B exposure increases the risk of cortical and posterior subcapsular cataract by 60%;[218] other studies conclude that individuals with a high, long-term UV-B exposure have over 3× increased chance of developing a cortical cataract.

While the UV radiation is strongly absorbed (1% remaining) before reaching the retina, even this small fraction, if phototoxic, is of concern.[219, 220, 221] Lens removal by cataract surgery leads to an increase in the UV that reaches the retina if the IOL does not effectively block it.[222]

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[216] Spoerl E, Mrochen M, Sliney D, Trokel S, Seiler T. Safety of UVA-riboflavin cross-linking of the cornea. Cornea. 2007; 26(4):385-9.

[217] Cullen AP, Chou BR, Hall MG, Jany SE. Ultraviolet-B damages corneal endothelium. Am J Optom Physiol Opt. 1984; 61(7):473-8.

[218] Taylor HR. The biological effects of UV-B on the eye. Photochem Photobiol. 1989; 50(4):489-92.

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[220] Zuclich JA. Ultraviolet induced damage in the primate cornea and retina. Curr Eye Res. 1984; 3(1):27-34.

[221] Youn HY, McCanna DJ, Sivak JG, Jones LW. In vitro ultraviolet-induced damage in human corneal, lens, and retinal pigment epithelial cells. Mol Vis. 2011; 17:237-46.

[222] Longstreth J, de Gruijl FR, Kripke ML, Abseck S, Arnold F, Slaper HI, Velders G, Takizawa Y, van der Leun JC. Health risks. J Photochem Photobiol B. 1998; 46(1-3):20-39.

32) Nausicaa is wearing her proper contact lens correction (recall, she is a +3.00 hyperope), while hanging Odysseus' clothing 50 cm away. What is her accommodative demand?

a) +1.92 D
b) +2.00 D
c) +2.14 D
d) +3.00 D
e) +5.00 D
f) +7.00 D The decimal point was missing.

33) What would have been Nausicaa's spectacle lens correction at a 12 mm vertex distance?

a) +2.00 D
b) +2.89 D
c) +3.00 D
d) +3.11 D

34) Wearing the spectacle correction identified in Q 33, what would be Nausicaa's accommodative demand when she gazes 50 cm from her corneal plane?

a) +1.92 D
b) +2.00 D
c) +2.14 D
d) +3.00 D
e) +5.00 D

35) Diomedes, a +1.25 hyperope, is fitted with a +0.75 D contact lens. What is his accommodative demand when viewing a target 10 cm from his corneal plane?

a) 9.75 D
b) 10.0 D
c) 10.5 D
d) 11.25 D

36) Which hero demands more accommodation [D] than the same numerical convergence [MA] when viewing the same fixation point 40 cm in front of their eye, placed on the medial plane?

a) Nausicaa (+3.00 hyperope)
b) Odysseus (emmetrope)
c) Circe (–1.50 myope)
d) Penelope (–5.00 myope)

37) Laertes, an uncorrected –1.00 myope, is fixating on a medial plane target placed 50 cm in front of his eyes. What is the accommodative demand [D] and the convergence effort [MA]?

a) 4 D; 2 MA
b) 1 D; 1 MA
c) 1 D; 2 MA
d) 2 D; 1 MA

38) Back to Q 37. When expressed in [$^{\Delta}$], what is Laertes' convergence effort (approximately)?

a) 2^{Δ}
b) 4^{Δ}
c) 6^{Δ}
d) 8^{Δ}
e) 12^{Δ}

39) Calypso, an uncorrected +2.00 hyperope, is fixating on a medial plane target placed 50 cm in front of her eyes. What is the accommodative demand [D] and the convergence effort [MA]?

a) 4 D; 2 MA
b) 1 D; 1 MA
c) 1 D; 2 MA
d) 2 D; 1 MA

40) Which hero experiences increased convergence demand when wearing his/her spectacles instead of wearing his/her contact lenses and fixating at the same distance?

a) Nestor (+4.00 hyperope)
b) Calypso (+2.00 hyperope)
c) Tiresias (–2.00 myope)
d) Arete (–4.00 myope)

41) Which of the following myopic heroes experiences increased accommodative demand when he/she is wearing his/her contact lenses?

a) Tiresias (–2.00 myope)
b) Arete (–4.00 myope)
c) Penelope (–5.00 myope)
d) Achilles (–6.00 myope)

42) Eurymachus is a +7.00 D hyperope with a 15.0 D amplitude of accommodation. What is his near point when he is not wearing correction?

a) 15 cm
b) 14.2 cm
c) 12.5 cm
d) 8 cm

43) When not wearing correction, what amount of accommodation does Eurymachus use to fixate at infinity?

a) 0.00 D
b) 7.00 D
c) 8.00 D
d) 15.00 D

c) @ 180°; it has the most plus corrective power
d) @ 180°; it has the most corrective power

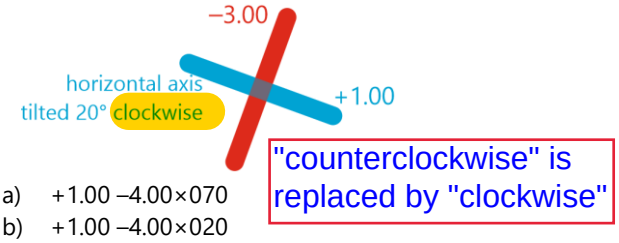
25) Back to Q 22. What is the type of astigmatism?
a) WTR compound hyperopic
b) WTR simple myopic
c) ATR compound hyperopic
d) ATR simple myopic
e) WTR mixed

26) Back to Q 22. What is Sturm's interval?
a) 1.00 D
b) 3.00 D
c) 4.00 D
d) 5.00 D

27) What is unusual about this lens cross +0.25 @ 10° / –1.50 @ 80°?
a) Nothing is unusual!
b) Both power signs should be either – or +.
c) The meridians are not perpendicular.
d) The flat power cannot be +0.25.

28) In compound myopic astigmatism, the most minus corrective power is along the …
a) flat meridian
b) steep meridian
c) bisector between flat and steep
d) perpendicular to steep meridian

29) What is the plus Rx form of this lens cross?



a) +1.00 –4.00×070
b) +1.00 –4.00×020
c) +1.00 –4.00×160
d) +1.00 +4.00×160
e) –3.00 +4.00×070
f) –3.00 +1.00×070
g) +1.00 +4.00×020

30) Back to Q 30. What is the minus Rx form?
a) +1.00 –4.00×070
b) +1.00 –4.00×020
c) +1.00 –4.00×160
d) +1.00 +4.00×160
e) –3.00 +4.00×070
f) –3.00 +1.00×070

31) Back to Q 30. What is the type of astigmatism?
a) WTR compound hyperopic
b) WTR simple myopic
c) ATR compound hyperopic
d) ATR simple myopic
e) WTR mixed

32) Back to Q 30. Which meridian is the flat one?
a) @ 20°
b) @ 70°
c) @ 160°
d) @ –20°

33) Back to Q 30. What is Sturm's interval?
a) 1.00 D
b) 3.00 D
c) 4.00 D
d) 5.00 D

34) In this Rx (plano) –1.25×180, where is the vertical focal line formed (state dioptric values)?
a) –1.25 D (in front of the retina)
b) 0.00 D (on the retina)
c) +0.625 D (behind the retina)
d) +1.25 D (behind the retina)

Prescriptions and Forms

35) Sancho's Rx is –2.50 –1.00×180. The spherical equivalent is …
a) –3.50 D
b) –3.00 D
c) –2.50 D
d) –2.00 D
e) –1.50 D
f) –1.00 D

36) The spherical equivalent for Florisea's Rx (+1.50 –1.00×090) is …
a) –1.00 D
b) –0.50 D
c) +0.50 D
d) +1.00 D

37) During phoropter refraction examination, you just added a –0.50 D cylinder. To maintain the circle