The Fascinating Intersection of Genetics, Color Vision, & Modern Myopia Management

COPE Pending = 2.0 hrs

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Course Description:

Modern myopia management continues to evolve with off-label and pipeline pharmaceuticals, FDA-approved spectacle lens designs, soft contact lenses and Ortho-K options, and light-based therapies. Join this expert panel to discuss the genetics behind syndromic high myopia, how fascinating color vision research is progressing and impacting myopia management, and the myriad of options available to prevent, control, and potentially one day reverse myopia.

Learning Objectives:

- Discuss gene therapy for color vision & its role in identifying genetic defects leading to syndromic high myopia
- Discuss contrast theory and subsequent development of Diffusion Optics Technology spectacle lenses, and Stellest lens technology
- Review clinical studies for DOT spectacle lenses & Stellest spectacle lenses and their practical implications for doctors of optometry
- Review contact lens therapies for myopia management with pros & cons for each design
- Present clinical pearls for management of myopia with contact lenses & future potential combination therapies
- Discuss pharmaceutical management of myopia with atropine & clinical trial results for various concentrations, including rebound risk
- Discuss dopamine's potential role in myopia regulation, with behavioral modification recommendations
- Review red light therapy and its potential utilization in myopia management

Course Outline:

I. Overview/Introduction – Chris Wroten, O.D./Moderator

II. Part I - Gene Therapy, Opsin Genetics, & the Origins of Contrast Theory – Jay Neitz, Ph.D.

A. Introduction

Today I want to tell you a story—how we went from curing color blindness in monkeys to uncovering the genetic basis of a severe X-linked high myopia, to building a new theory of eye growth, and ultimately to developing a new class of myopia-control spectacles. Then I'll talk about what this means for your practices right now in 2026

B. Color Vision Gene Therapy (Nature, 2009)

i. Adult male squirrel monkeys born colorblind gained full trichromatic color vision through viral delivery of an L-opsin gene

ii. Before/after videos demonstrate functional color vision restoration

iii. Insight: Our extensive research on cone opsin genetics made the success possible

C. Opsin Gene Polymorphism was discovered to be extremely common

i. Caused by extensive exon-level intermixing of red and green opsin genes on the X-chromosome

ii. Raised the concern that common splicing variants could alter photopigment expression even in color-normal individuals

D. Bornholm Eye Disease (BED) and High Myopia (MYP1)

E. Severe high myopia linked to a specific exon-3 haplotype (LVAVA) that causes exon skipping

F. Result: Reduced photopigment → excess contrast signaling.

G. Key turning point: A defect in cone photopigment expression leading to axial elongation through contrast pathways, not blur; this discovery seeded contrast theory

III. Part II — Contrast Theory and the DOT Lens Concept

A. Core Idea of Contrast Theory

i. Axial growth is driven by activity in contrast-sensitive retinal pathways.

ii. Childhood hyperopia produces high peripheral contrast → stimulates growth

iii. As the eye approaches emmetropia, peripheral contrast naturally declines → growth slows

iv. Evidence from BED: Cones with reduced photopigment produce spurious contrast, driving excessive elongation

B. DOT Lens Design (Diffusion Optics Technology)

i. Incorporates thousands of microscopic scattering elements that gently lower contrast; natural binocular vision, excellent tolerability

ii. Millions of children are now wearing DOT lenses (mostly in China)

IV. Part III — Clinical Evidence & Comparison to Stellest

A. Current DOT Outcomes

i. ~67% slowing of myopia progression over two years

ii. Strong tolerability and high wear compliance

B. Stellest Lenses (FDA approved) and Converging Mechanisms

i. FDA authorization means spectacle-based myopia control is now recognized in U.S. regulatory frameworks

ii. Other spectacle treatments—including DOT—are expected to follow via substantial equivalence

iii. Stellest uses microlenslets based on defocus theory

iv. Both Stellest and DOT reduce peripheral contrast, despite different theoretical origins

v. Emerging findings: Negative-power lenslets can match or exceed positive-power performance—challenging defocus explanations and supporting contrast mechanisms

C. Demonstration

i. Show DOT lenses to illustrate clarity and distribution of scattering elements

V. Part IV — The Coming Myopia-Control Revolution

A. Why Spectacle-Based Control Will Transform Practice

i. Myopia onset peaks in 3rd grade; axial length growth is most rapid between ages 7–10

ii. Contact lens therapies often begin too late

iii. Spectacle-based control enables treatment at first diagnosis

B. Practical Impact for Optometrists

i. Every new myope becomes a candidate for treatment

ii. Strong parental acceptance; simple adoption

iii. Potential population-level reduction of future high myopia by 30–50%

iv. Long-term reduction in risks such as retinal detachment and myopic maculopathy

C. Barriers to Adoption

XIII. Conclusion

The progression from gene therapy and opsin genetics to contrast theory and DOT lenses illustrates how foundational science can reshape clinical practice. With spectacle-based myopia control now validated and expanding, optometrists can intervene at first diagnosis—ushering in a new era in combating the myopia epidemic.

XIV. Contact Lens Options for Myopia Management – Ashley Wallace-Tucker, O.D.

A. Overview

i. Goal: Slow axial elongation and refractive progression in pediatric myopia.

ii. Mechanisms of Action:

a. Create myopic retinal defocus (peripheral or simultaneous).

b. Reduce hyperopic peripheral blur to slow eye growth.

c. Provide continuous optical treatment during waking or sleeping hours

B. Primary Contact Lens Modalities

i. Orthokeratology (Ortho-K)

a. Design: Reverse-geometry RGP lenses worn overnight; temporarily reshape cornea for daytime clear vision.

b. Mechanism: Induces central flattening and midperipheral steepening → peripheral myopic defocus.
c. Efficacy: ~40–60% reduction in axial elongation vs. single vision correction.
d. Ideal Candidates:
    - Ages 6–14 with ≤ –6.00 D myopia and ≤ 1.75 D astigmatism (toric OK for higher cyl).
    - Motivated families seeking non-daytime wear.
e. Advantages: Drug-free, reversible, effective for moderate myopia.
f. Limitations: Nightly compliance, lens care, infection risk, contraindicated in poor hygiene

C. Dual-Focus/Multifocal Soft Lenses
  i. Design: Concentric or aspheric zones alternating distance and treatment power.
  ii. Mechanism: Simultaneous retinal myopic defocus during wear.
  iii. Key Options:
    a. MiSight 1 day (CooperVision) – FDA-approved; ~50–59% efficacy over 3 yrs
    b. NaturalVue Multifocal (Visioneering) – off-label; extended depth-of-focus design
    c. Biofinity Multifocal "off-label" fits with center-distance optics
  iv. Ideal Candidates:
    a. 7–14 yrs with mild-to-moderate myopia, active lifestyles, parents preferring daily disposables
  v. Advantages: Easy adaptation, daily replacement, low risk
  vi. Limitations: Cost, reduced distance vision in some cases, off-label status (except MiSight)

D. Toric and Specialty Designs
  i. Historically excluded from clinical trials; new designs enable combined myopia + astigmatism correction
  ii. Toric Ortho-K and Toric Soft Multifocals show promising equivalence to spherical models
  iii. Important for expanding access to children with > 1.50 D astigmatism

E. Combination & Future Therapies
  i. Combination strategies: Low-dose atropine + Ortho-K or soft multifocals may yield additive effects

F. Clinical Pearls
  i. Start early – greatest benefit in younger children (<10 yrs)
  ii. Set expectations: Slowing, not stopping, progression
  iii. Measure outcomes: Axial length, cycloplegic refraction, compliance review every 6 months
  iv. Educate families on hygiene, wear schedule, and evidence\

XV. Pharmaceutical Management of Myopia (Including Red Light Therapy) – Shane Kannarr, O.D.

A. **Goal:** Review evidence-based pharmaceutical options for slowing myopia progression and introduce emerging red light therapy as an adjunctive tool

B. Introduction & Background
   i. Define myopia as progressive axial elongation of the globe.
   ii. Emphasize public health impact: by 2050, half of the global population may be myopic (Holden et al., Ophthalmology 2016)
   iii. Highlight treatment goal: slow progression, reduce lifetime risk of myopic maculopathy and retinal detachment

C. Pharmaceutical Therapies Overview
   i. **Low-Dose Atropine**
      a. Mechanism: Muscarinic M1/M4 receptor blockade → reduced scleral remodeling + dopamine modulation
   ii. Concentrations: 0.01%, 0.025%, 0.05%
      a. Efficacy: 50–67% reduction in axial elongation (LAMP & ATOM2 studies)
      b. Side Effects: Mild photophobia, decreased accommodation
      c. Rebound: Dose-dependent; greater with higher concentrations
         d. Table 1: Comparison of Atropine Concentrations

Concentration	Efficacy (% Reduction)	Common Side Effects	Rebound Potential
0.01%	40–50%	Minimal	Low
0.025%	55–60%	Mild photophobia	Moderate
0.05%	60–67%	Slight blur/photophobia	Higher

   iii. Combination & Clinical Considerations
      a. Initiation Age: 5–15 years
      b. Duration: 2–5 years, until progression <0.25 D/year or axial length stabilizes
      c. Adjuncts: Orthokeratology, multifocal soft lenses, defocus spectacles
      d. Monitoring: Axial length every 6 months; visual acuity and accommodation annually

D. Dopamine's Role in Myopia Regulation
      i. Dopamine is a key neuromodulator in the retina, primarily released by amacrine and interplexiform cells in response to light stimulation
      ii. Acts as a 'stop signal' for ocular growth by inhibiting axial elongation
      iii. Low retinal dopamine levels correlate with higher myopia progression
      iv. Light exposure increases dopamine release, influencing scleral remodeling and choroidal thickening

v. Atropine may indirectly enhance dopamine signaling by reducing muscarinic inhibition

vi. **Clinical Implications:**

a. Outdoor exposure (≥2 hr/day) naturally increases retinal dopamine, slowing progression

b. Red light therapy may amplify this effect via photic stimulation

c. **Supporting Evidence:**

• Feldkaemper & Schaeffel, Prog Retin Eye Res, 2013 – Dopamine acts as an inhibitory neuromodulator for ocular elongation

Zhou et al., Exp Eye Res, 2021 – Dopamine agonists reduce form-deprivation myopia

He et al., JAMA Ophthalmol, 2020 – RLRL benefit likely linked to dopamine activity

d. This establishes dopamine as a unifying pathway between pharmacologic and light-based therapies

E. Red Light Therapy (RLRL / LLLT)

i. Concept: Two 3-minute sessions/day using ~650 nm low-level red light

ii. Mechanism: Stimulates retinal dopamine → suppresses axial elongation

iii. Evidence: He et al., JAMA Ophthalmology 2020 – 69% reduction in axial elongation

iv. Safety: Mild afterimages, transient photic discomfort; no retinal injury reported

v. Devices: Eyerising RLRL; adherence critical for efficacy

F. Case Study: Integrating Pharmacologic & Light Therapy

Patient: 8-year-old female, Asian descent

Baseline: −1.75 D OU, axial length 24.5 mm, progressing −0.75 D/year

Family history: Both parents myopic

Treatment Plan:

• Atropine 0.025% QHS OU
• Red light therapy (RLRL) twice daily
• Outdoor activity ≥2 hr/day

Follow-up:

• 6 mo: −0.25 D change; axial elongation slowed to 0.09 mm/6 mo
• 12 mo: stable, minimal accommodation loss

Outcome: Combination therapy reduced progression by ~70%.

G. Rebound Risk Overview

Therapy Type	Typical Rebound on Cessation	Risk Level	Notes
Atropine 0.05%	+0.35 D/year	High	Gradual taper recommended
Atropine 0.025%	+0.20 D/year	Moderate	Rebound less pronounced

Atropine 0.01%	Minimal	Low	Often used for maintenance
Ortho-K / Multifocals	Mild in 6 months	Moderate	Axial growth resumes
Red Light Therapy	0.2–0.3 D rebound	Low-Moderate	Under study
7-Methylxanthine	Limited data	Unclear	Research ongoing

E. Key Points:

i. Rebound = acceleration of progression once therapy stops

ii. Always taper gradually or switch to maintenance therapy

iii. Monitor axial length 6 months post-discontinuation

F. Summary & Clinical Application

i. Low-dose atropine remains the gold standard for pharmaceutical myopia control

ii. Dopamine plays a central role in ocular growth regulation and links pharmacologic and light-based strategies

iii. Red light therapy is a promising, non-invasive adjunct

iv. Combination and tapering strategies minimize rebound and maximize stability

v. Early intervention and individualized treatment are key to long-term outcomes

XVI. Conclusion/Q&A – Chris Wroten, O.D.