

On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Conference Advisory Board considers content and speakers for future meetings to provide you with the best education possible.



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Speaker Financial Disclosure

Bob Alexander has no financial interests to disclose.

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Night Vision

Using proper eyewear during the day to improve dark adaptation

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### Objectives

At the end of this presentation, you will be able to:

- Differentiate photopic, scotopic and mesopic vision
- Describe how photoreceptors react to light and how that reaction relates to dark adaptation
- Define 'night blindness' or *retinitis pigmentosa*
- Recognize positive and negative influences on dark adaptation
- Discuss what does and does not help dark adaptation

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Differentiate photopic, scotopic and mesopic vision.

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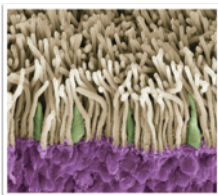
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### Photoreceptor Cells



**Microscopic cross section of retina**

- Rods are shown in white
- Cones are in green
- We have 17 rods for every 1 cone

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## Candela

A Candela (or Candle) is the basic unit of Luminous Intensity.




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## Photopic

Photopic vision = light adapted vision.




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## Scotopic

Scotopic vision = dark adapted vision.




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## Mesopic

Mesopic vision = in between  
or, combination vision.



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Describe how photoreceptors react to  
light and how it relates to dark adaptation.

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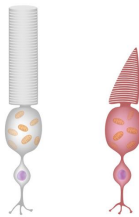
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## Rods & Cones



Rods and Cones are distinctly different  
in both shape, location, and function.

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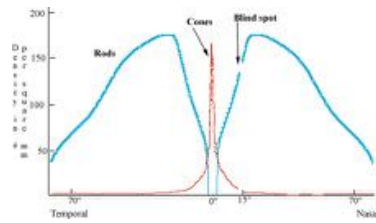
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### Rods & Cones



#### The distribution of rods and cones

- Cones are concentrated in the central fovea
- Rods are concentrated 17° away from center

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### Rods & Cones

To see the figure on the left, focus on the tree in the center.



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### Opsins

- From the Greek Opsis – sight
- Proteins within a photo-sensitive cell
- When combined with retinal
  - Become pigmented
  - Can absorb photons
- There are 4 different opsins in rods & cones
  - Each absorbs a different part of the visual spectrum



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## Opsins

The tube feet of sea urchins are covered in photo-receptive cells.



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## Retinol

- A specific form of vitamin A
- Required to produce retinal, the visual pigment
- Can be ingested from animal products
  - Meat
  - Dairy
- Can be produced by the body
  - From  $\alpha$ -carotene,  $\beta$ -carotene or  $\beta$ -cryptoxanthin



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## Retinal Reacts to Light

When a photon strikes a photoreceptive cell, a rod or a cone, it causes the separation of the retinal from the opsin.

This is the first in a chain of chemical reactions that leads to visual perception.



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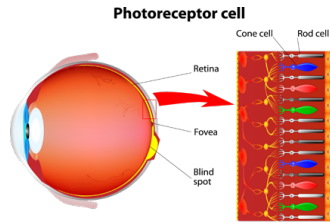
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### Opsins in Rods & Cones

- There are 4 Opsins.
- 3 for color vision in cones
  - 1 in rods



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### Opsins in Cones

- There are 3 Opsins in cones
- L – Long Wavelength – Red light
  - M – Mid Wavelength – Green light
  - S – Short Wavelength – Blue light

L = 64%    M = 34%    S = 2%



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### Opsins in Rods

- Rhodopsin
- From the Greek Rodon – Rose
- Reddish purple in appearance
- Also known as visual purple
- Rods 1,000x more light sensitive than cones



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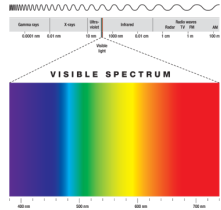
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### Peak Sensitivity

Cone sensitivity peaks at 555 nm  
Rod sensitivity peaks at 505 nm



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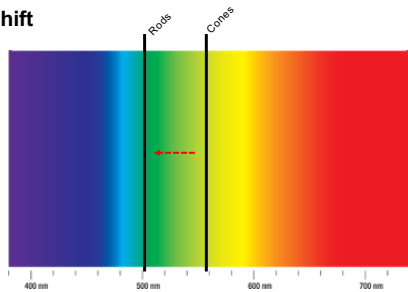
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### Purkinje Shift

Change in peak sensitivity.



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### Optic Yellow

Optic yellow tennis balls were introduced in 1972 after research showed that they made it easier for TV viewers to follow the game.



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### Dark Adaptation Speed

De-generation takes 30 picoseconds.

Photopsin re-generation takes 3 to 5 minutes.

Rhodopsin re-generation takes 30 to 45 minutes.



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### Dark Adaptation Speed

Speed of dark adaptation depends on the duration & intensity of light exposure.

It may take days to recover from prolonged, intense exposure.



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### Dark Adaptation Speed

The time needed for regeneration of bleached photopsin, and rhodopsin leads to an optical illusion known as –  
After Image



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Define 'night blindness' or *retinitis pigmentosa*.

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### Night Blindness

True night blindness is considered rare in the US and almost always caused by genetic disorder.

Night blindness caused by vitamin A deficiency is common during pregnancy and lactation where malnutrition is prevalent.



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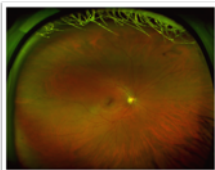
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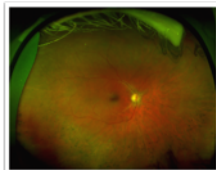
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### Night Blindness



Fundus image of a healthy retina.



Fundus image of a retina with retinitis pigmentosa, notice the darkly pigmented spots.

Retinitis pigmentosa

Images courtesy of [Quora](#)

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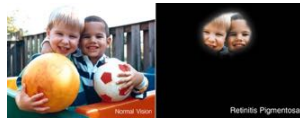
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## Night Blindness

### Retinitis pigmentosa

- Patients are eventually left with tunnel vision
- Most are legally blind by age 40
- There is no cure
- Vitamin A supplements have been shown to slow the decline of visual function



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Recognize positive and negative influences on adaptation.

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## Nutrition



Beef liver



Skim Milk



Tuna

250,000 to 500,000 malnourished children go blind each year from vitamin A deficiency.

Meat, dairy and fish are good direct sources of retinol.

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### Nutrition



Skim Milk contains more than 4X as much vitamin A per cup as whole milk!

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### Nutrition



Blackberries



Squash



Spinach

The body can produce retinal from plant containing  **$\alpha$ -carotene**,  **$\beta$ -carotene** or  **$\beta$ -cryptoxanthin**.

Dark colored fruits and vegetables are good sources

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### Sun Protection

High quality sunglasses help maintain dark adaptation!




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### Sun Protection

High quality sunglasses help maintain vision by protecting eye health!

- UV exposure is linked to formation of cataracts
- Cataract care costs US tax payers 6.8 billion each year\*
- Cataracts can result in decreased nighttime vision



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### Smoking

Smoking has been shown to depress carotenoid concentration in the blood and retina

- Smoking & passive exposure to cigarette smoke have both been shown to have a causal relationship to AMD\*



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### Age

Gradual changes in the eye reduce dark adaptation.

- Maximum pupil size decreases
- The crystalline lens becomes yellowish and saturated
- The density of photoreceptive cells decreases
- Rhodopsin regeneration slows



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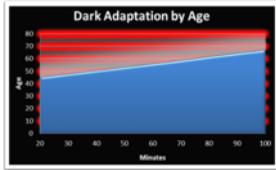
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## Age



There is a 2.76-minute increase in time to full dark adaptation per decade of age.

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Discuss what does and does not help dark adaptation.

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## What Doesn't Help



Excessive vitamin A from self-prescribed supplements.

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### What Doesn't Help



Using only red light for illumination.

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### What Doesn't Help



"Night Vision" glasses that further reduce visible light.

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### What Does Help

**Eat This**



**Not This**



Proper nutrition from food

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### What Does Help

Making sure as much light as possible reaches the eye.




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### What Does Help



Protecting eyes from sun during the day!

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### What Does Help



Knowing how scotopic vision works.

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### What Does Help

Consider an eye patch!



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