Color Vision
Do You See What I See?

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Phernell Walker, MBA, ABOM, LDO

- Master in Ophthalmic Optics
- Master in Business Administration
- Bachelor of Science in Business
- Associate of Science in Opticianry
- Past Adjunct Professor – Pacific University College of Optometry
- ABO & NCLE Certified
- Author of text-book, *Pure Optics*
- Joe Bruneni Award in Optics, Association of Schools Colleges of Optometry
- Beverly Meyers Achievement Award in Ophthalmic Optics

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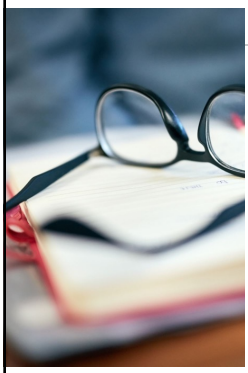

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Reference Resource

Pure Optics

by

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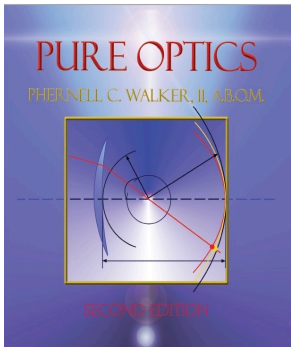

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Objectives

- Components of Light
- Measuring Light
- Light Propagation
- Photoreceptors
- Color Vision

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Light Propagation

- Light is composed of particles of energy called light quantum or photon
- A light quantum has energy with zero mass

Light Ray

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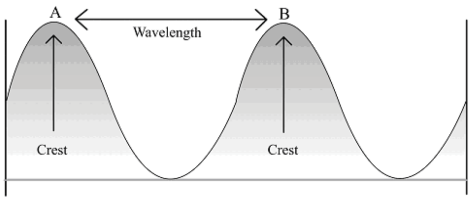
Measuring Light



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Measuring Light

Metric Comparison

1 meter	=	1 billion nanometers
1,000 nanometers	=	1 millimeter
1 meter	=	1000 millimeters
1meter	=	100 centimeters
1 meter	=	39.37 inches
25.4 mm	=	1 inch

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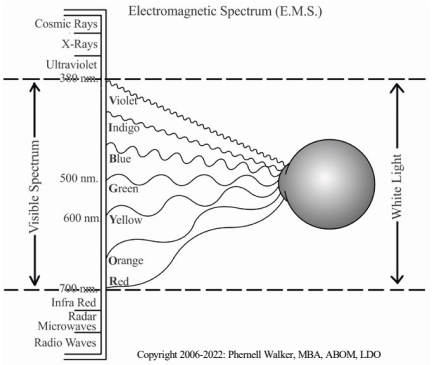
Electromagnetic Spectrum



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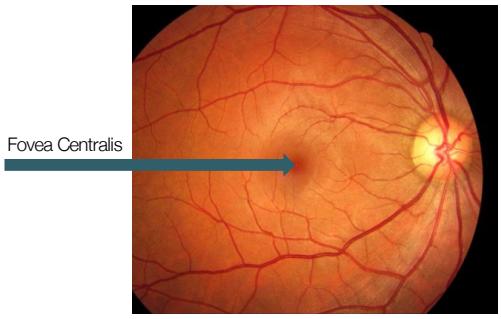
Macula Fovea Centralis



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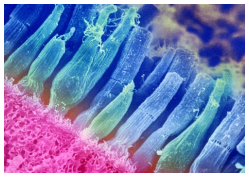
Photoreceptors

Photoreceptors collect light and transform the light energy into chemical energy.

- Rods (125 million) - cylindrical shaped. Detects movement, peripheral and night vision (photopigment rhodopsin)
- Cones (6 million) - conic share receptors located at the macula fovea centralis (photopigment iodopsin)



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Photoreceptors

- Cones (6 million) - conic share receptors located at the macula fovea centralis
- Photopigment iodopsin
- Three different types of cones:

Cone Types		
S	detects Blue	460nm
M	detects Green	525nm
L	detects Red	650nm

Approximately 60% of the cones are red, 30% are green, and only 2% are blue sensitive. The remaining 8% is a blend

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Visual Pathway

- Ganglion cells - located in the inner retina. Responsible for sending the in formation in the form of chemical energy to the optic nerve
- Optic Nerve - sends the data to the brain for interpretation in the visual cortex

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Color Deficiency

Dichromatic Deficiency

- Protanopia- Red
- Deuteranopia- Green
- Tritanopia- Blue

Monochromat & Trichromat

- Monochromat- sees shades of grey
- Trichromat- has all three pigments (normal)

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ICD-10

H53.50 **billable diagnosis code** used to specify a medical diagnosis of unspecified color vision deficiencies

H53.53 deuteranopia

H53.54 protanopia

Valid during the fiscal year 2021 from October 01, 2020, through September 30, 2021, for the submission of HIPAA-covered transactions.

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Pseudoisochromatic Plates

- Ishihara Plates
- Hardy-Rand-Rittler Plates
- Farnsworth D-15 Dichotomous

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Farnsworth D-15 Dichotomous

- Color arrangement test
- Focus on color likeness
- Performed with a dark back ground
- Colorblindness type
- Colorblindness severity
- 1988 by Vingrys and King-Smith

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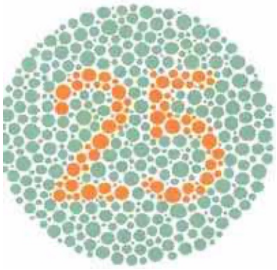
Pseudoisochromatic Plates



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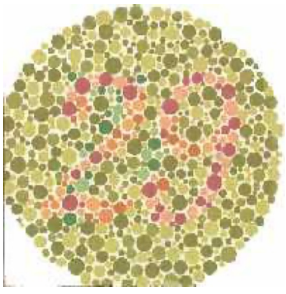
Pseudoisochromatic Plates



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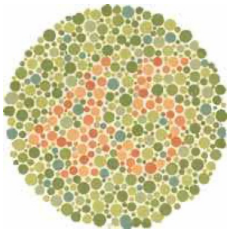
Pseudoisochromatic Plates



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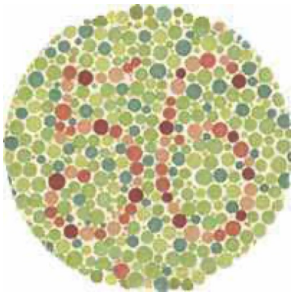

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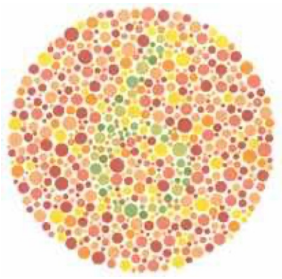

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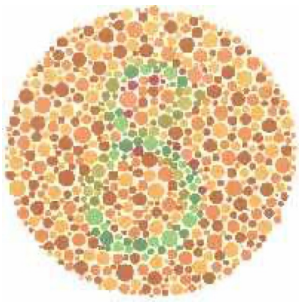
Pseudoisochromatic Plates



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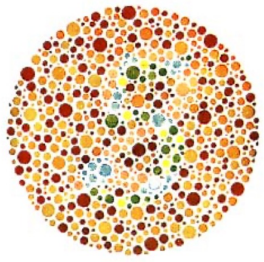
Pseudoisochromatic Plates



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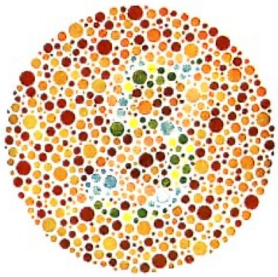
Pseudoisochromatic Plates

- Normal color vision will see a 5 revealed in the dot pattern
- Persons with red - green color blindness will see a 2 revealed in the dots



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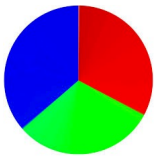
Primary Colors

Primary colors - include colors that can be combined to create a series of colors

- Red
- Green
- Blue



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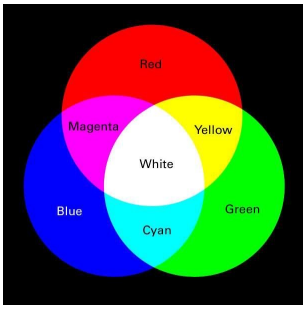
Additive Colors

RGB Color Model

- **Red**
- **Green**
- **Blue**



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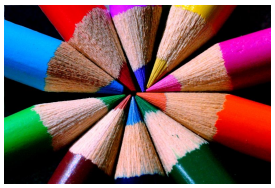
Seeing in Color

- Objects do not have color
- Color is in the light that shines upon it and is ultimately reflected to our eyes



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Seeing in Color

When visible light strikes an object and a specific frequency becomes absorbed, that frequency of light will never make it to our eyes

Any visible light that strikes the object and becomes reflected to our eyes will contribute to the color appearance of that object. So the color is not in the object itself, but in the light that strikes the object and ultimately reaches our eye

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Color Absorption

- Objects contain atoms capable of selectively absorbing one or more frequencies of the visible light that shine upon it
- If an object absorbs all of the frequencies of visible light except for the frequency associated with blue light, then the object will appear blue

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Transparent Substrates

Transparent substrates allow one or more visible frequencies light through them

Colors not transmitted are absorbed

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Cognitive Load

Red, Blue, Green, Green, Blue, Red, Red, Blue, Green, Green

Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue

Blue, Red, Green, Green, Blue, Red, Green, Blue, Red, Blue

Green, Blue, Green, Blue, Red, Red, Green, Blue, Red, Green

Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue

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Decreased Cognitive Load

1. Red, Blue, Green, Green, Blue, Red, Red, Blue, Green, Green
2. Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue
3. Blue, Red, Green, Green, Blue, Red, Green, Blue, Red, Blue
4. Green, Blue, Green, Blue, Red, Red, Green, Blue, Red, Green
5. Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue

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Increased Cognitive Load

1. Red, Blue, Green, Green, Blue, Red, Red, Blue, Green, Green
2. Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue
3. Blue, Red, Green, Green, Blue, Red, Green, Blue, Red, Blue
4. Green, Blue, Green, Blue, Red, Red, Green, Blue, Red, Green
5. Blue, Blue, Red, Green, Blue, Blue, Green, Red, Red, Blue

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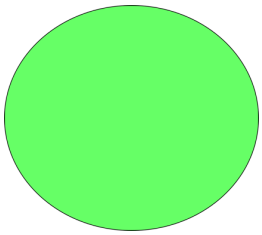
Photoreceptor Exhaustion



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What Color Do You See?

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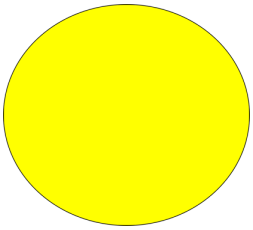
Photoreceptor Exhaustion



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What Color Do You See?

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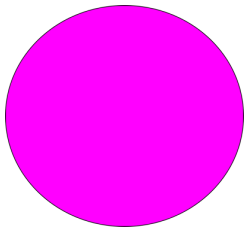
Photoreceptor Exhaustion



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What Color Do You See?

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Questions

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