

# 色盲眼鏡研究開發

(亞洲矽谷智慧醫療技術研討會)

輔仁大學 物理系  
光學薄膜實驗室

徐進成

Tel: 02-29053765

Email: 054326@mail.fju.edu.tw

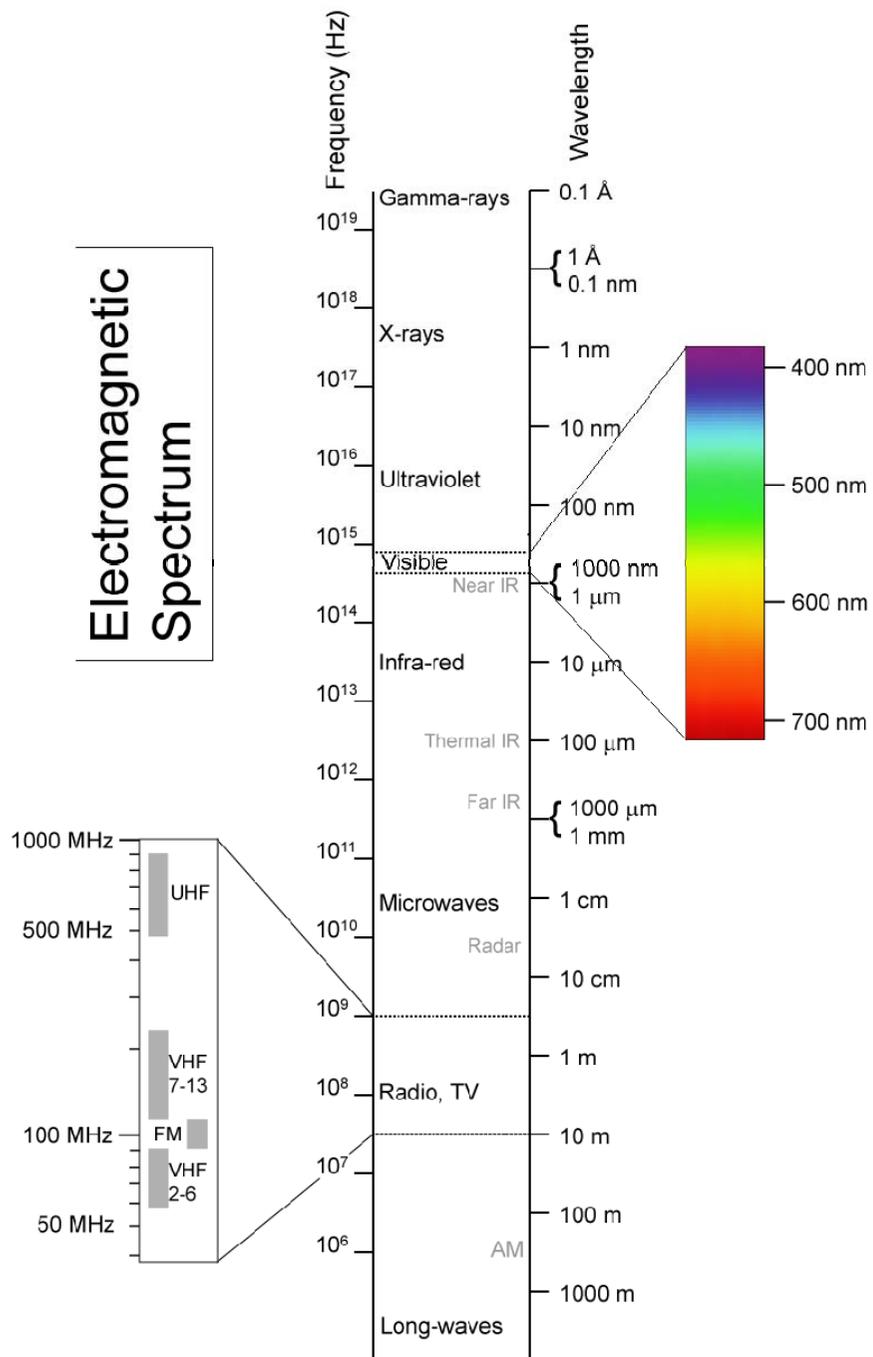
# 摘要

- 前言
- 人眼錐狀細胞與桿狀細胞
- 色盲與色弱
- 色盲遺傳
- 色盲矯正鏡片
- 研究與期待

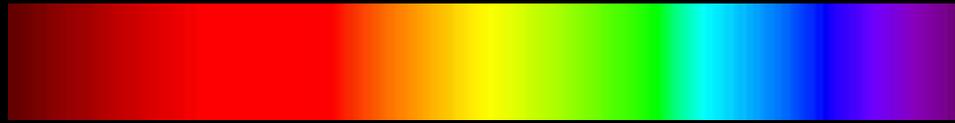
# 前言

- 人的眼睛是很精密的器官，依靠眼睛分辨顏色，但是有些人，看到的世界跟一般人不一樣。

# Electromagnetic Spectrum



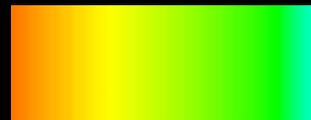
# Primary Colors



White



Red



Green



Blue



Yellow

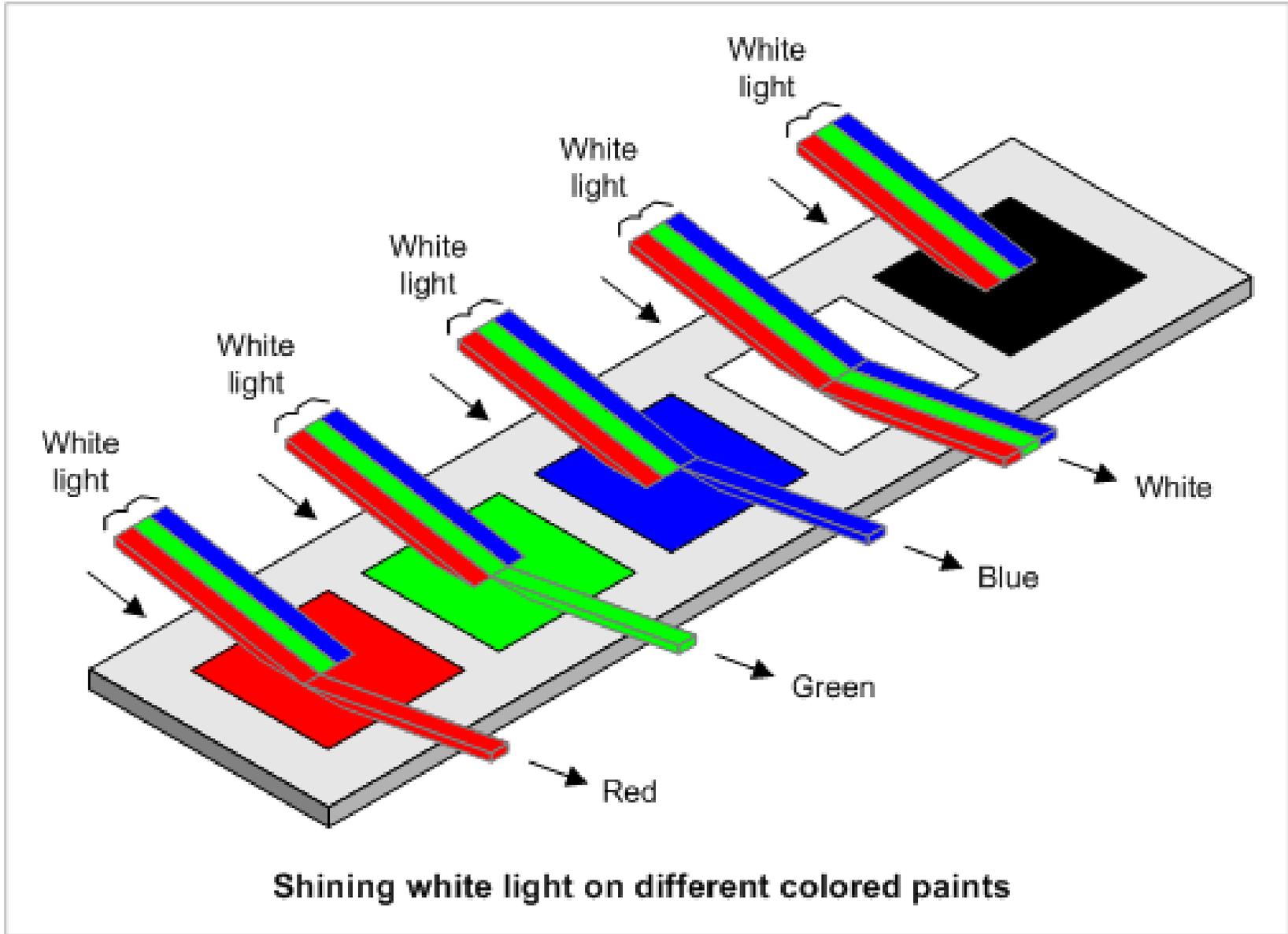


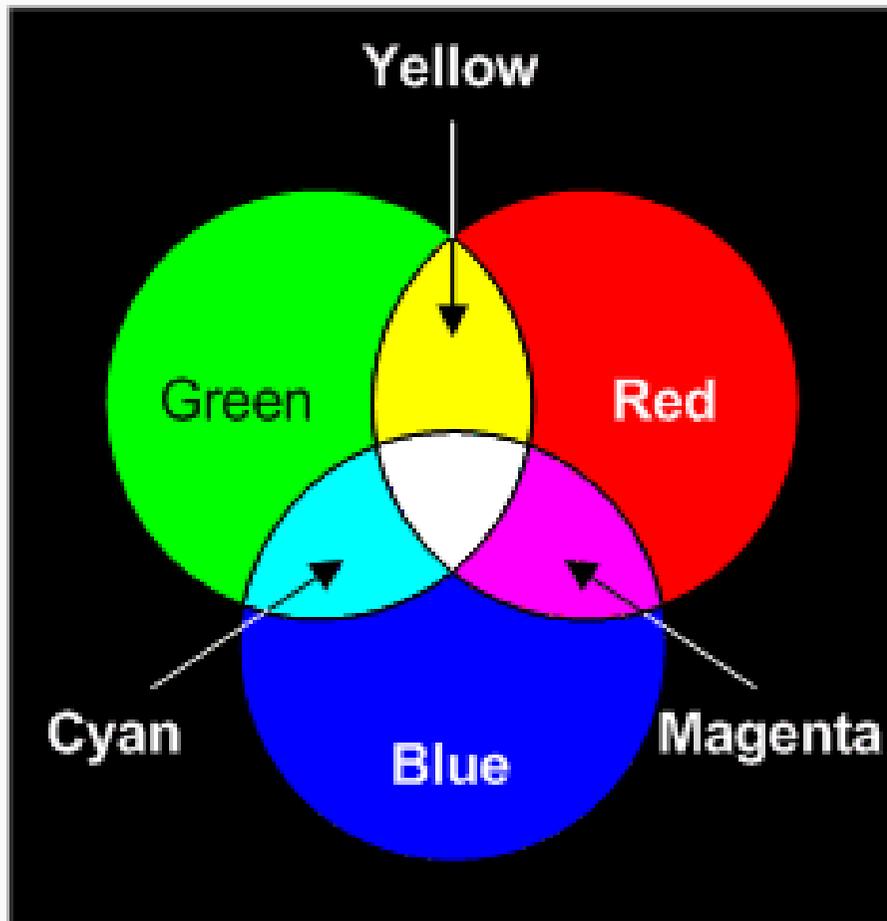
Cyan



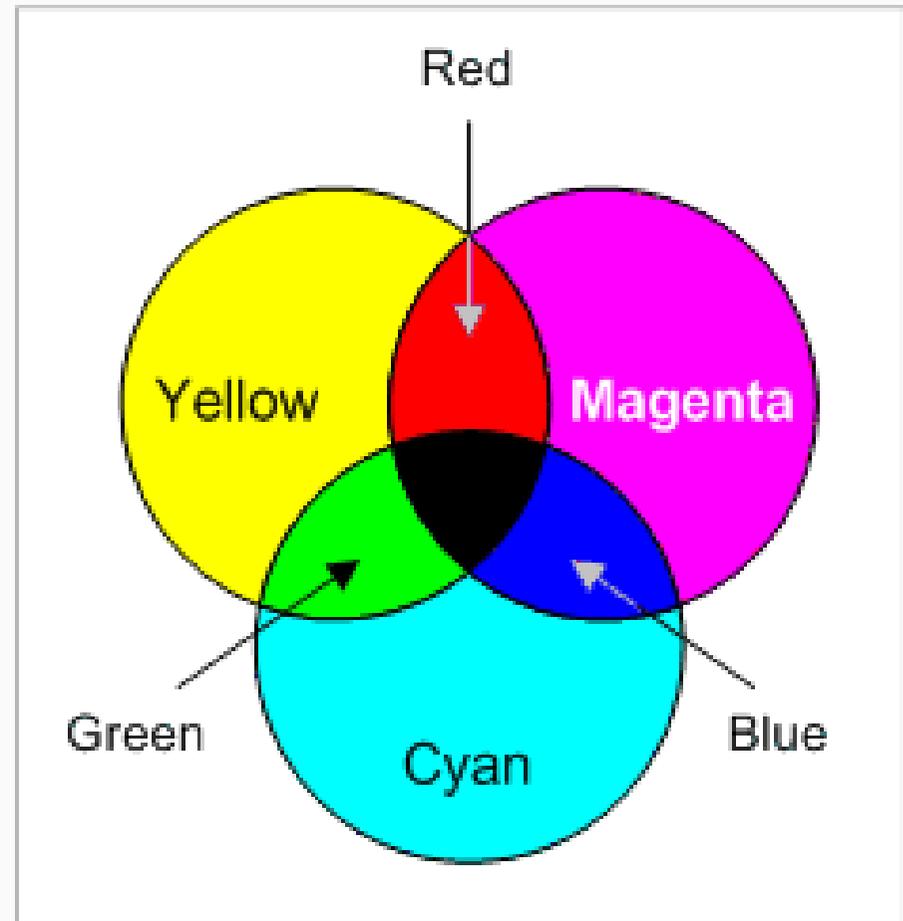
Magenta







Additive (light)

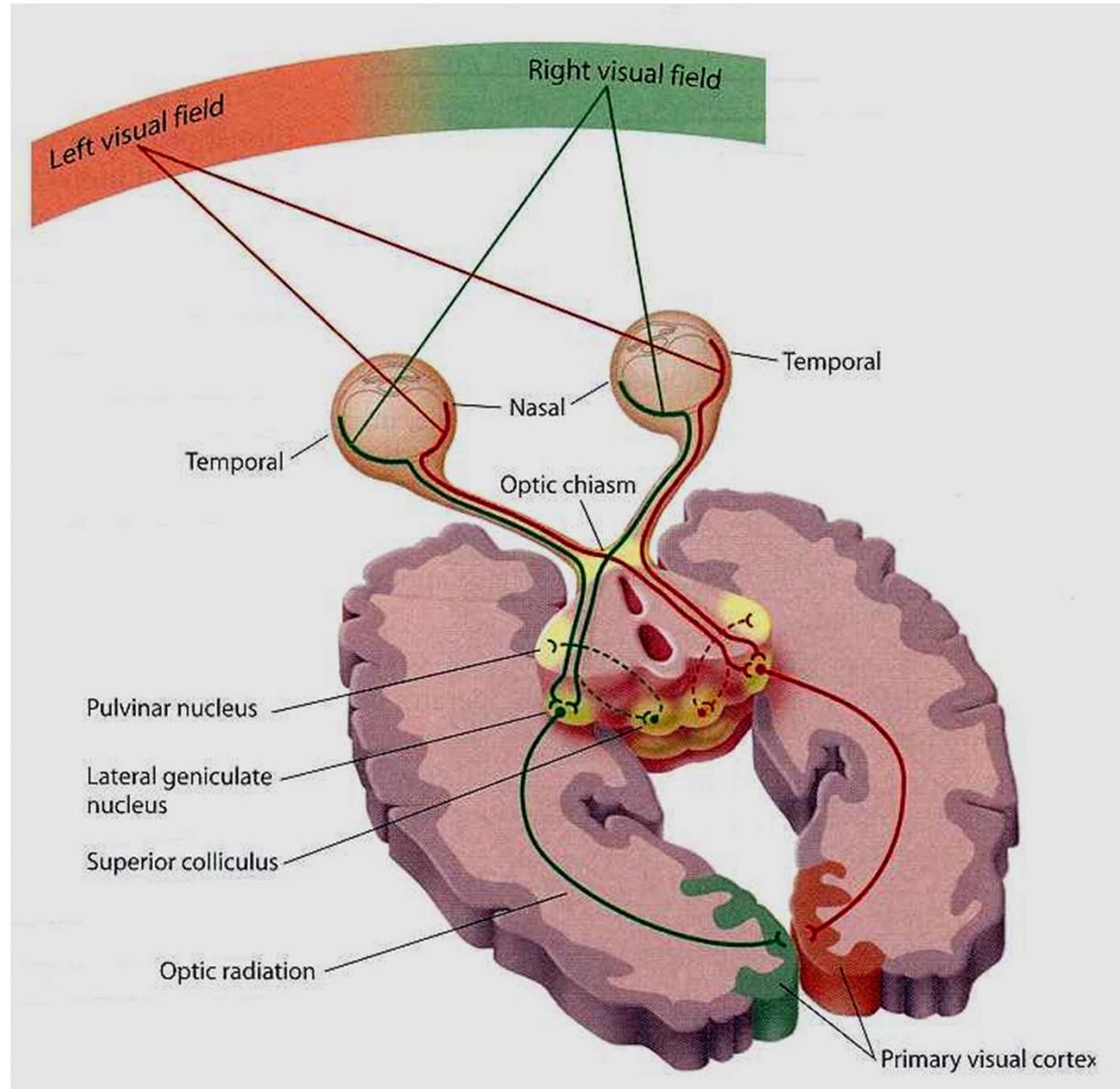


Subtractive (paint)

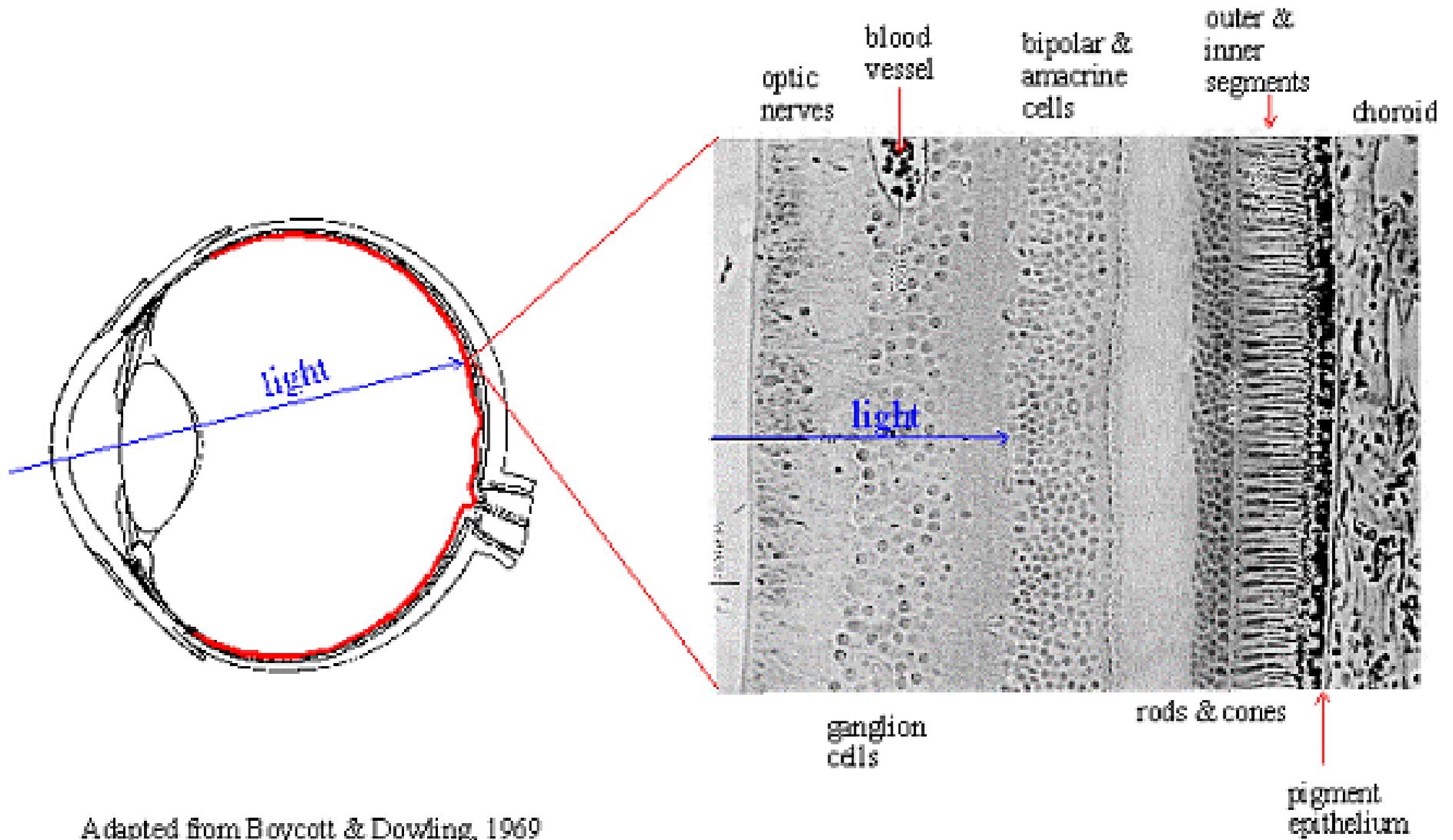
**Slightly different representation of additive and subtractive color combinations**

# 人類的視覺歷程

- 物理階段
- 生理階段
- 心理階段



# 人眼錐狀細胞與桿狀細胞



Adapted from Boycott & Dowling, 1969

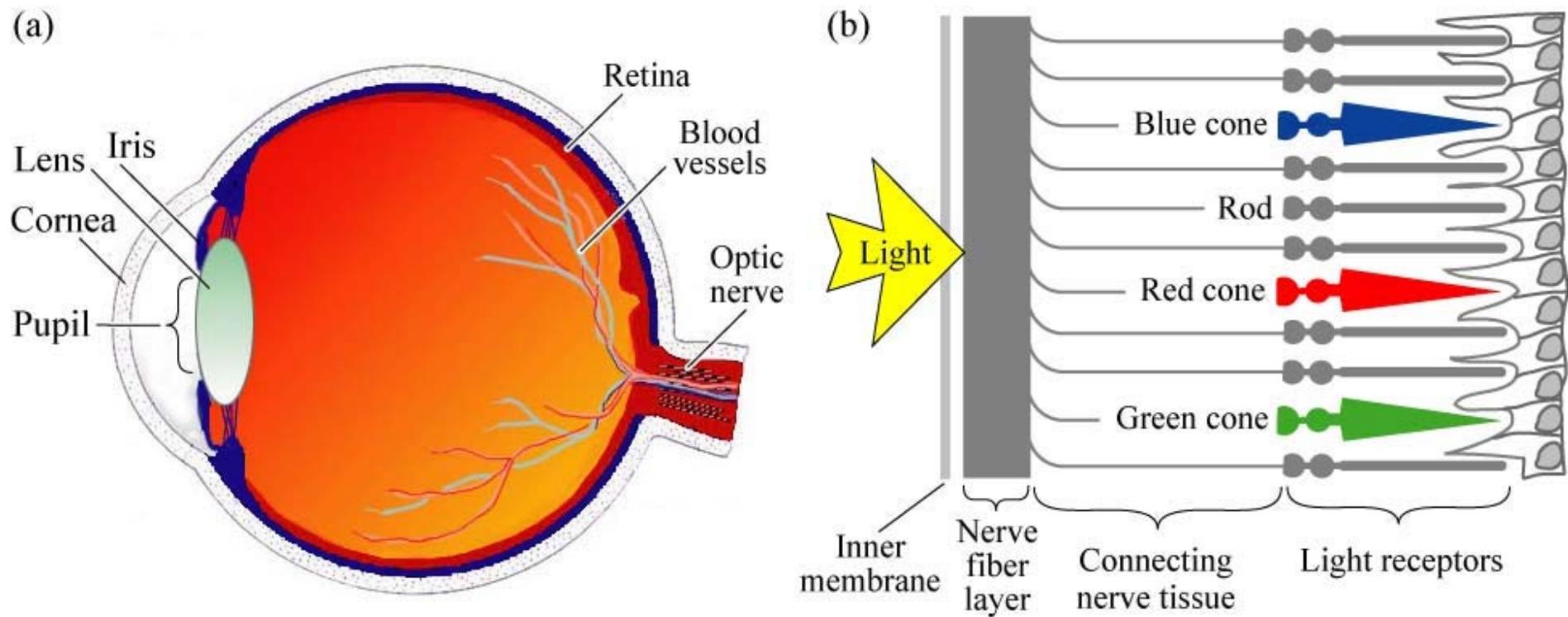
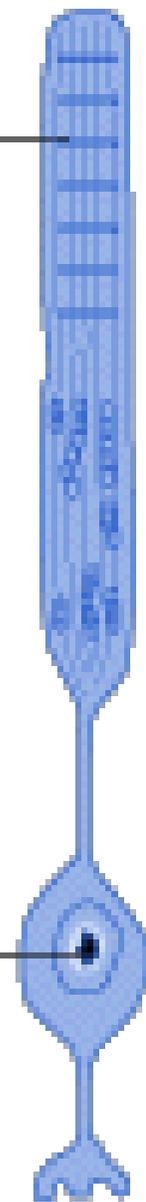


Fig. 16.1. (a) Cross section through a human eye. (b) Schematic view of the retina including rod and cone light receptors (adapted from Encyclopedia Britannica, 1994).

E. F. Schubert  
*Light-Emitting Diodes* (Cambridge Univ. Press)  
[www.LightEmittingDiodes.org](http://www.LightEmittingDiodes.org)

Outer segment  
of rod cell  
containing  
photosensitive  
chemicals

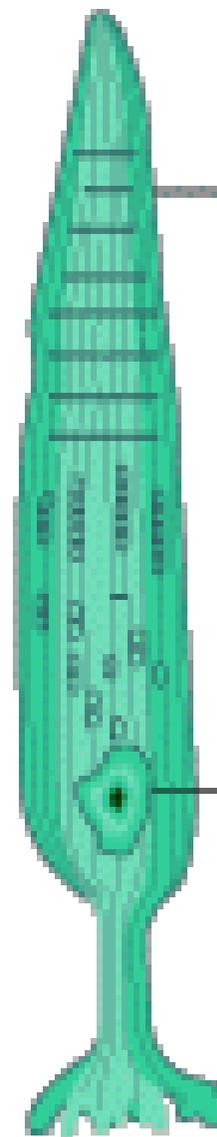
Nucleus



Rod

Outer segment  
of cone cell  
containing  
photosensitive  
chemicals

Nucleus



Cone

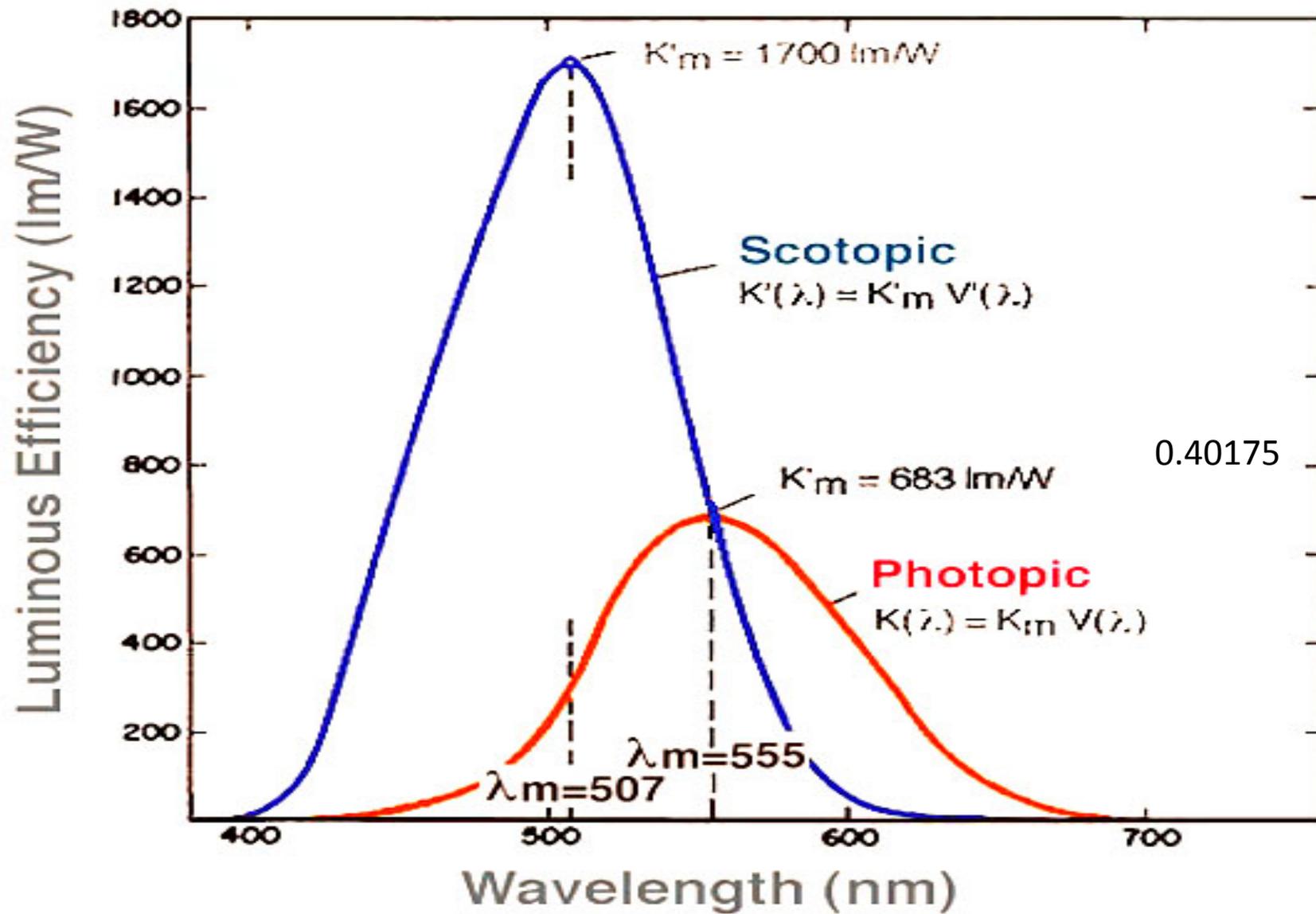
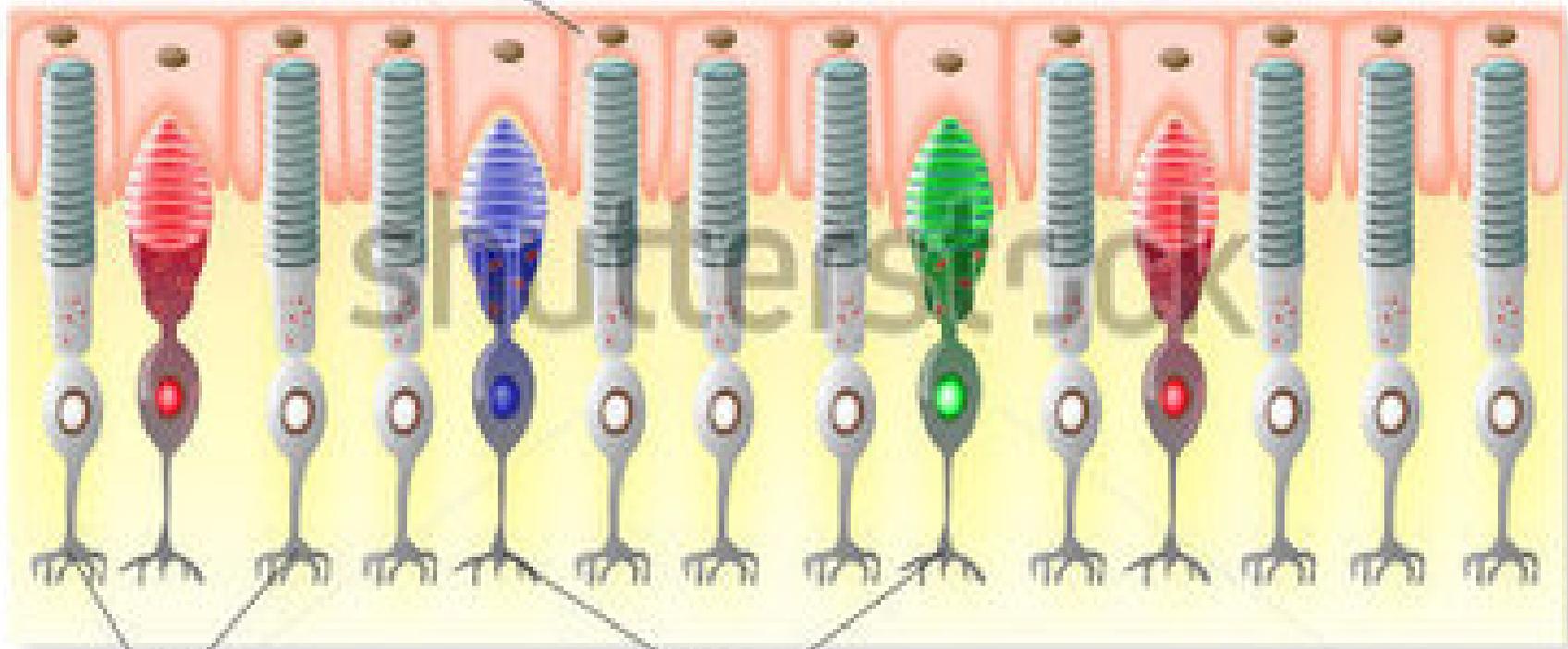


Figure 9. The scotopic and the photopic curves of spectral luminous efficacy (non-normalised values).

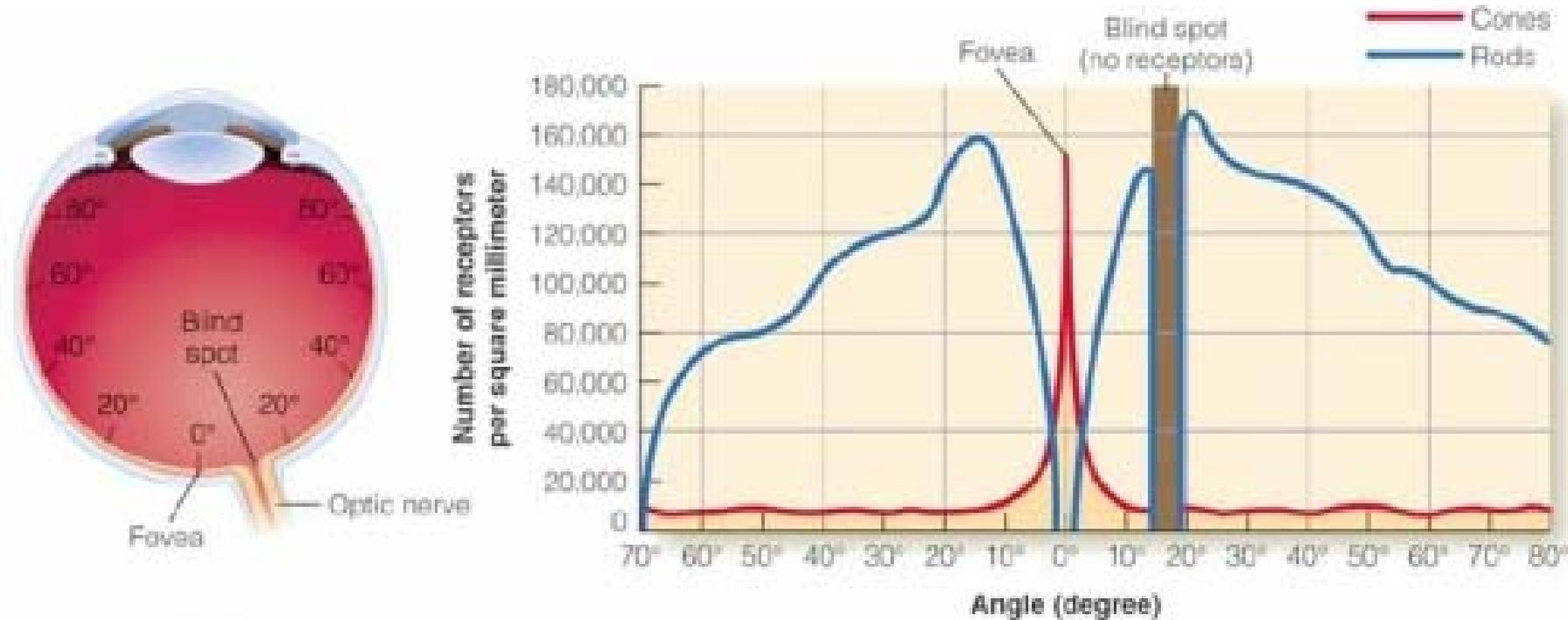
# STRUCTURE OF THE RETINA

Pigment epithelium



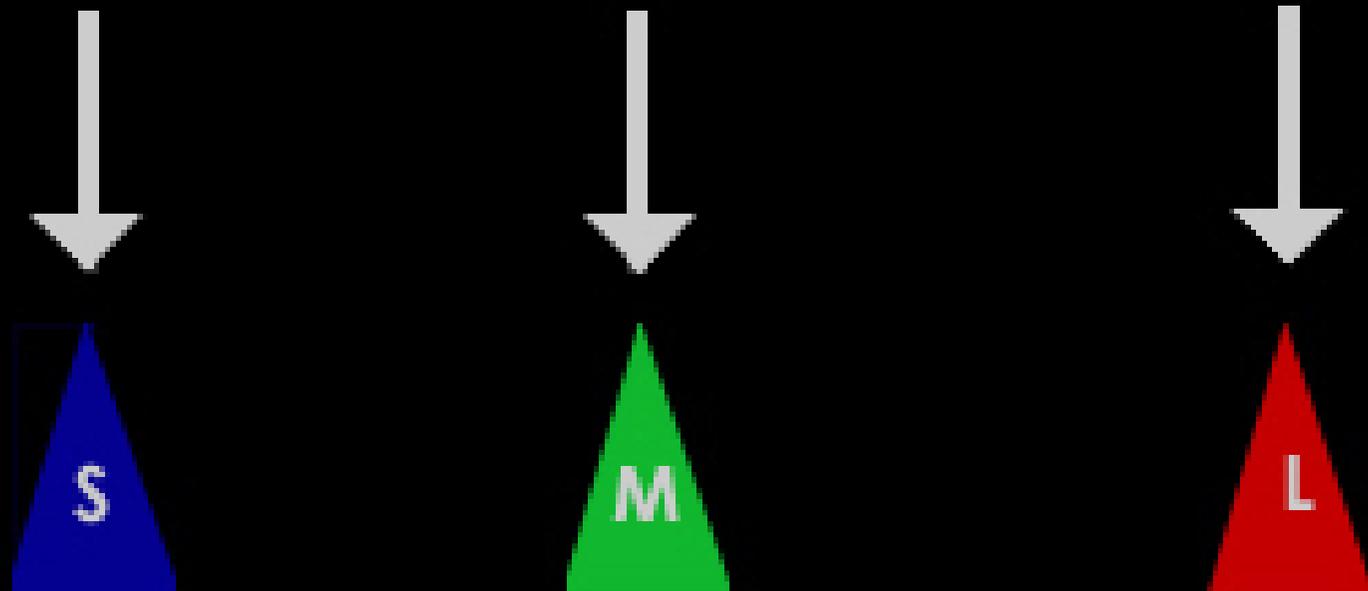
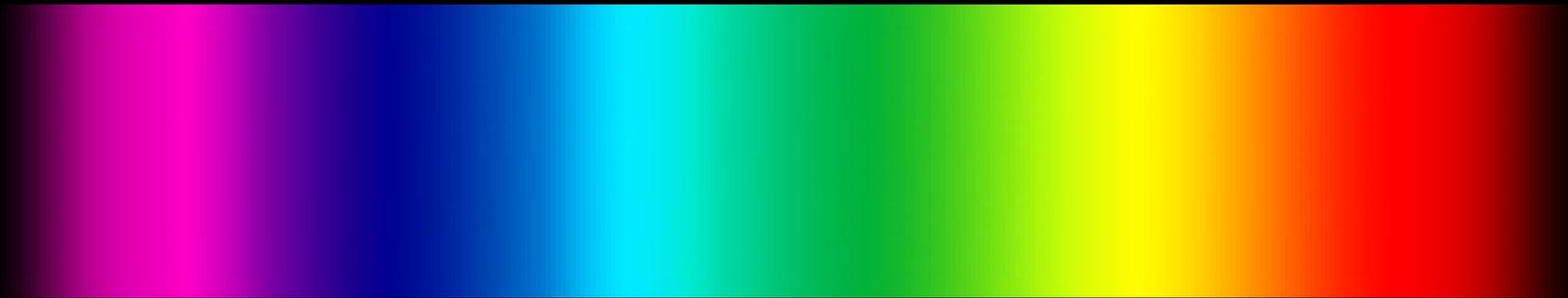
Rod

Cone

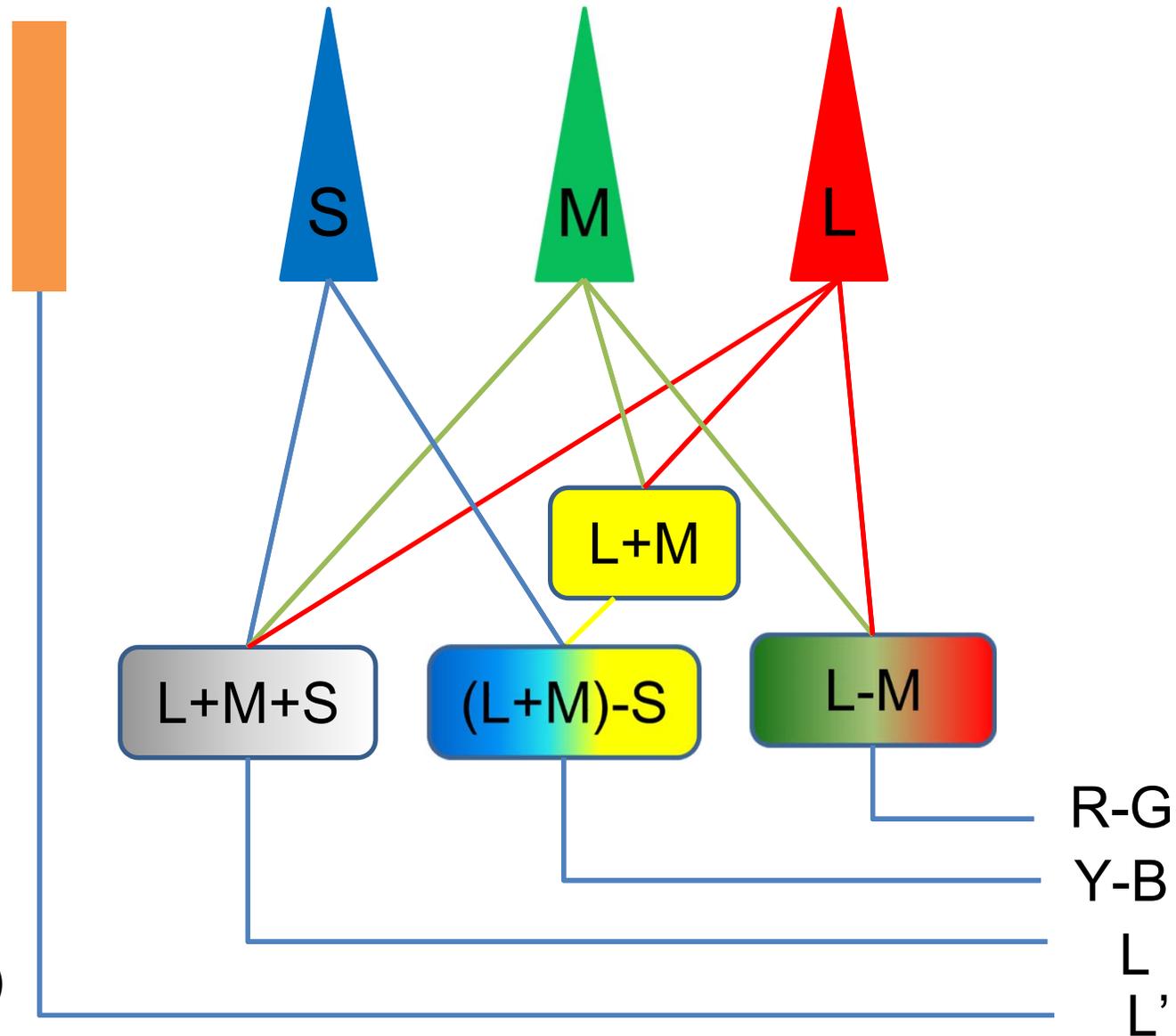


[http://www.skybrary.aero/images/thumb/Vis\\_Fig2.jpg/500px-Vis\\_Fig2.jpg](http://www.skybrary.aero/images/thumb/Vis_Fig2.jpg/500px-Vis_Fig2.jpg)

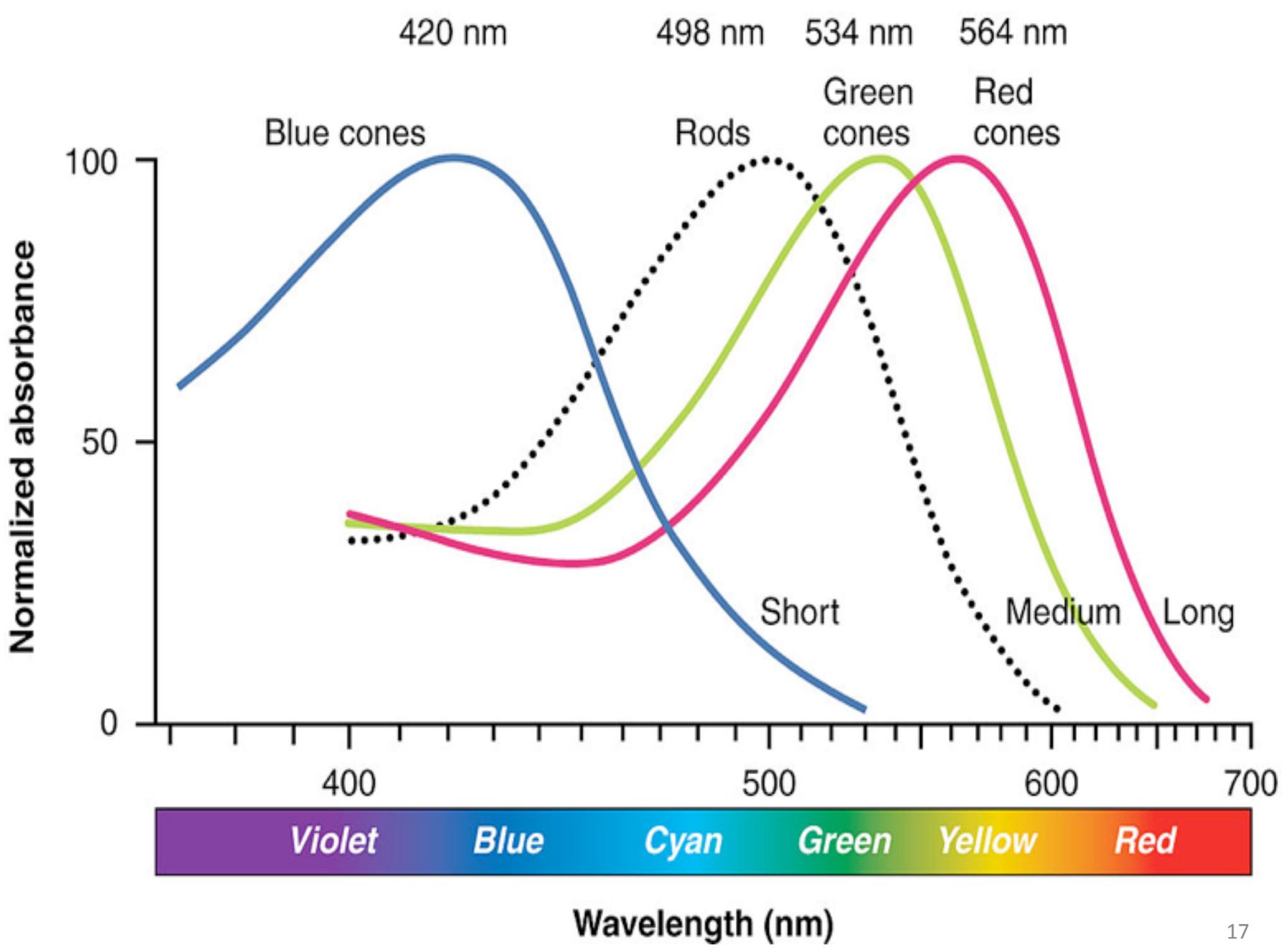
# Trichromatic Theory



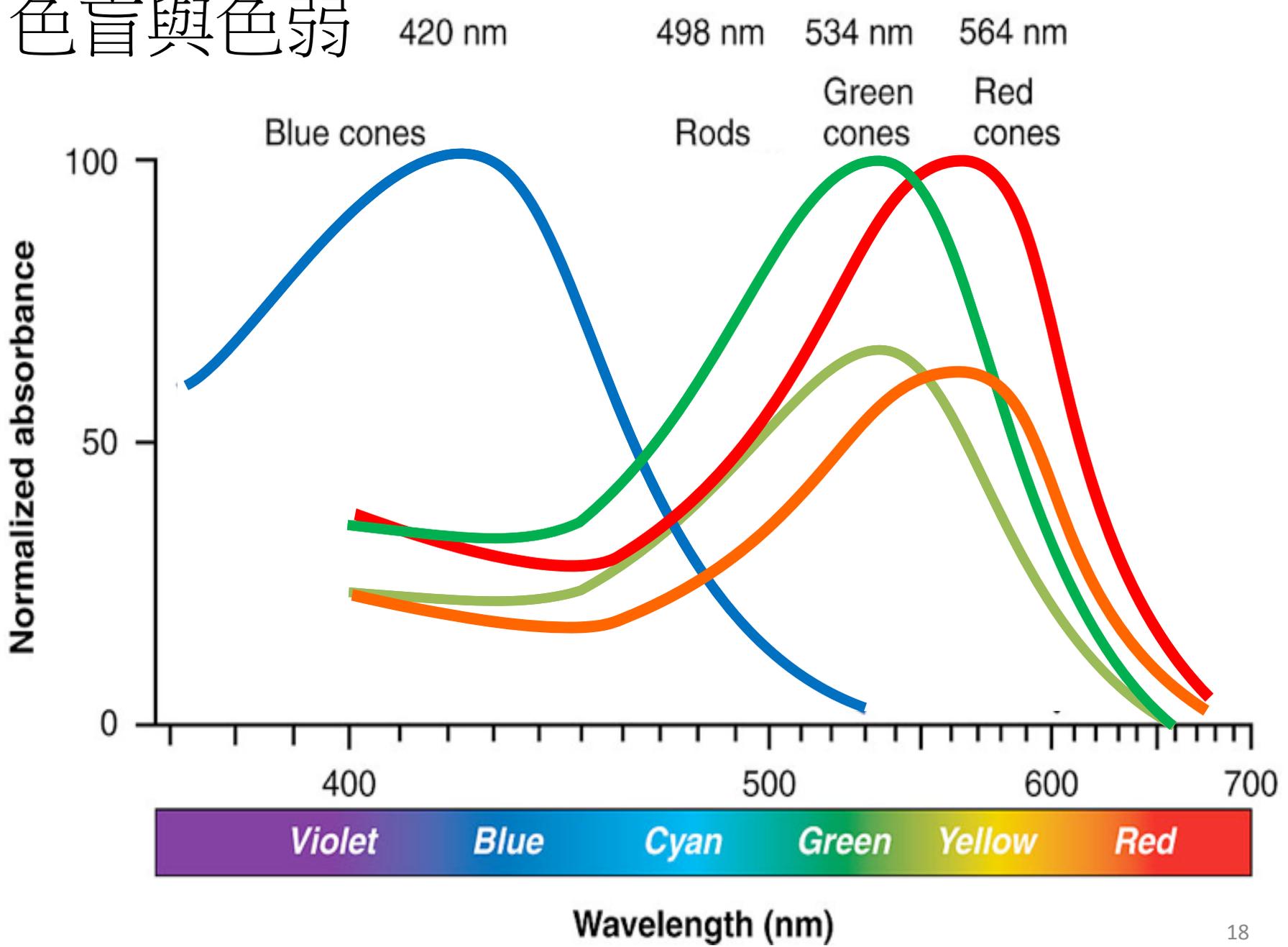
# 階段説(stage theory)



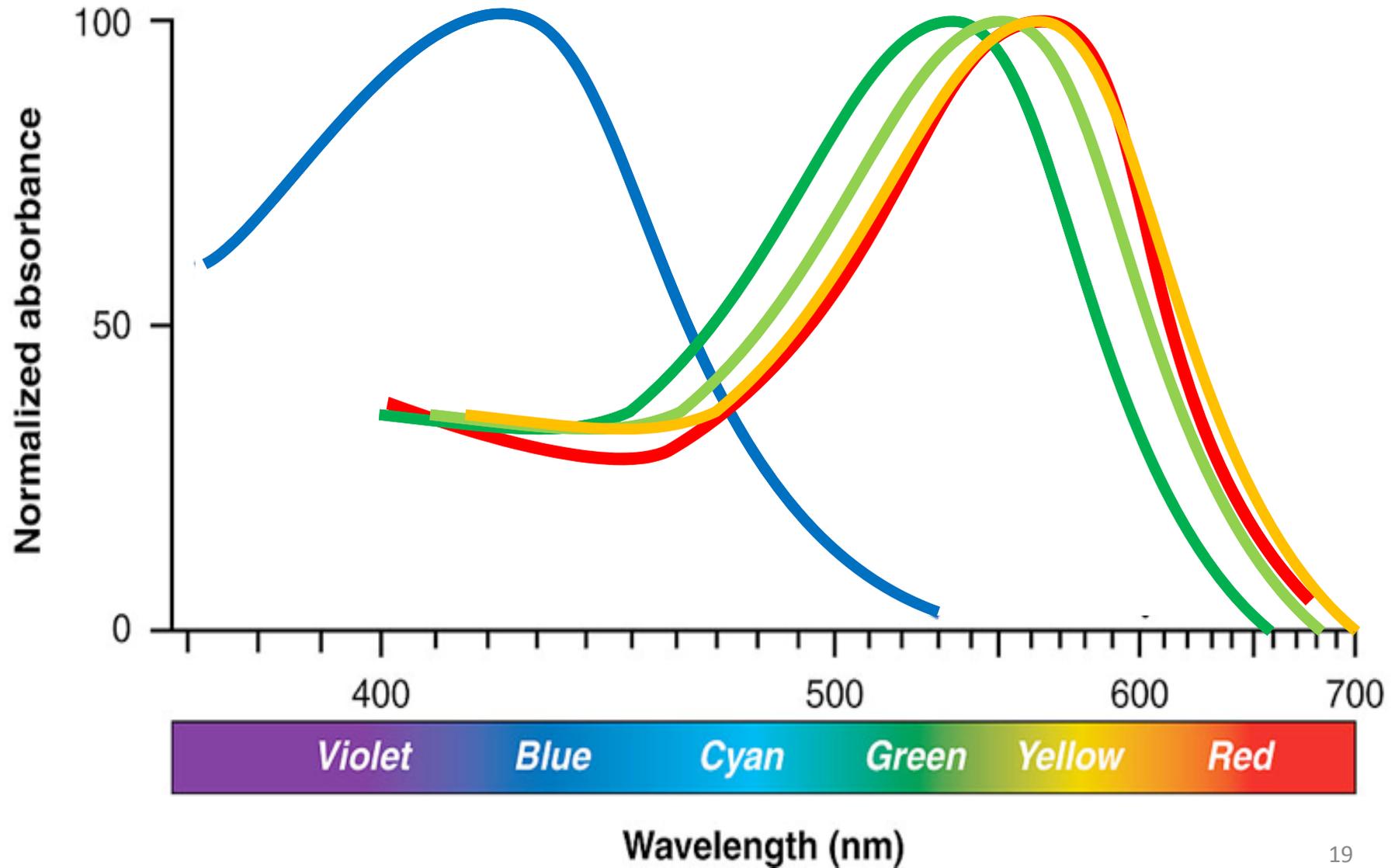
赫林(1834-1918)

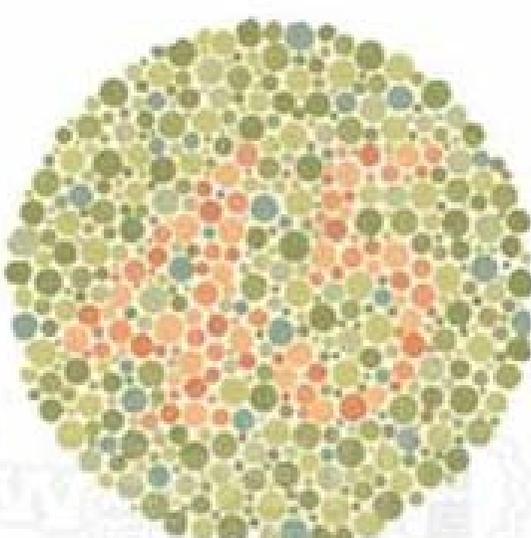
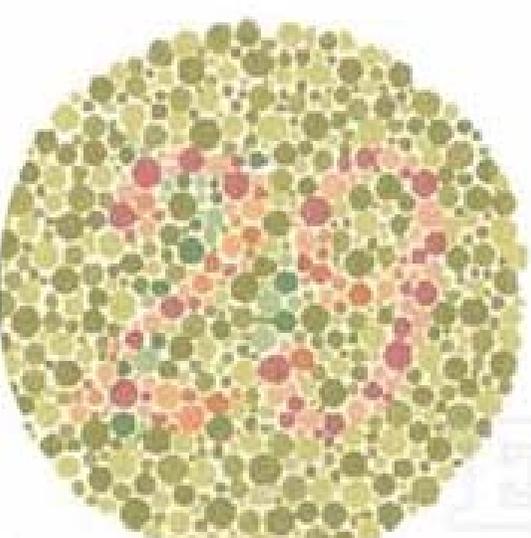
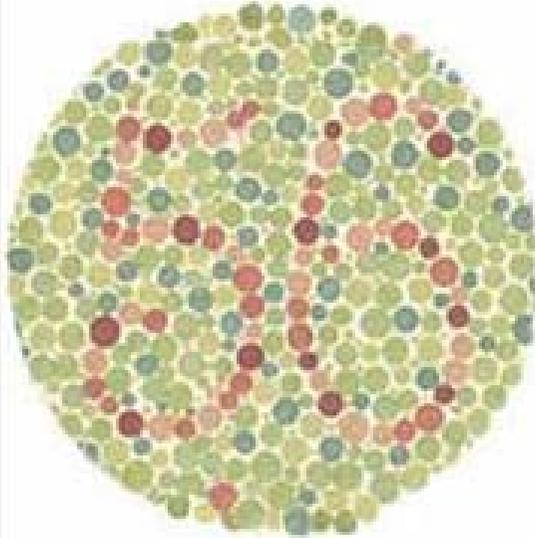
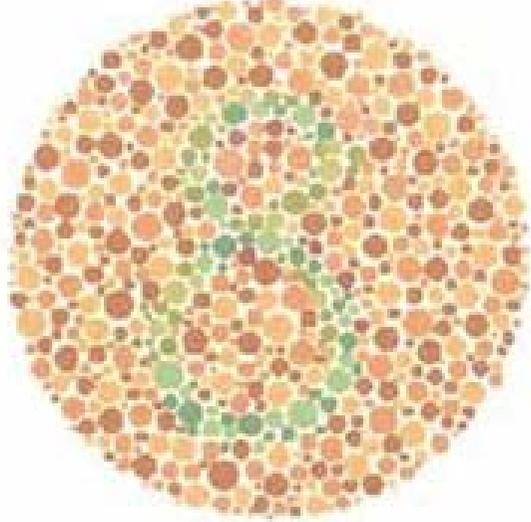
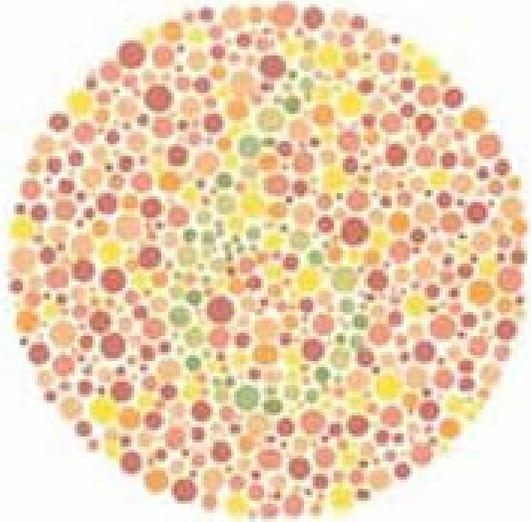
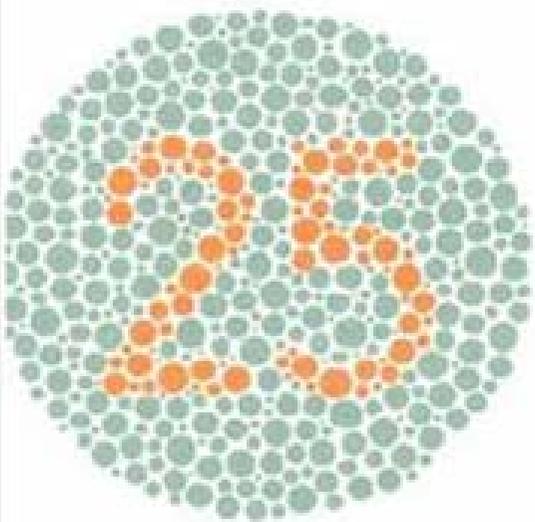


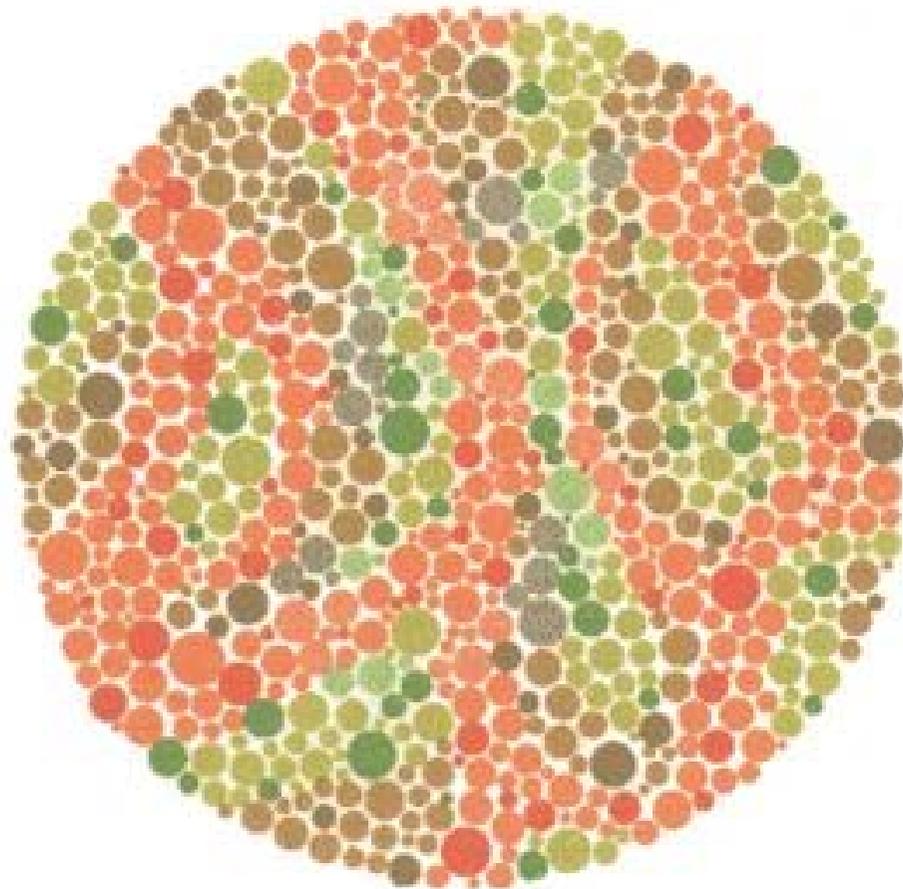
# 色盲與色弱

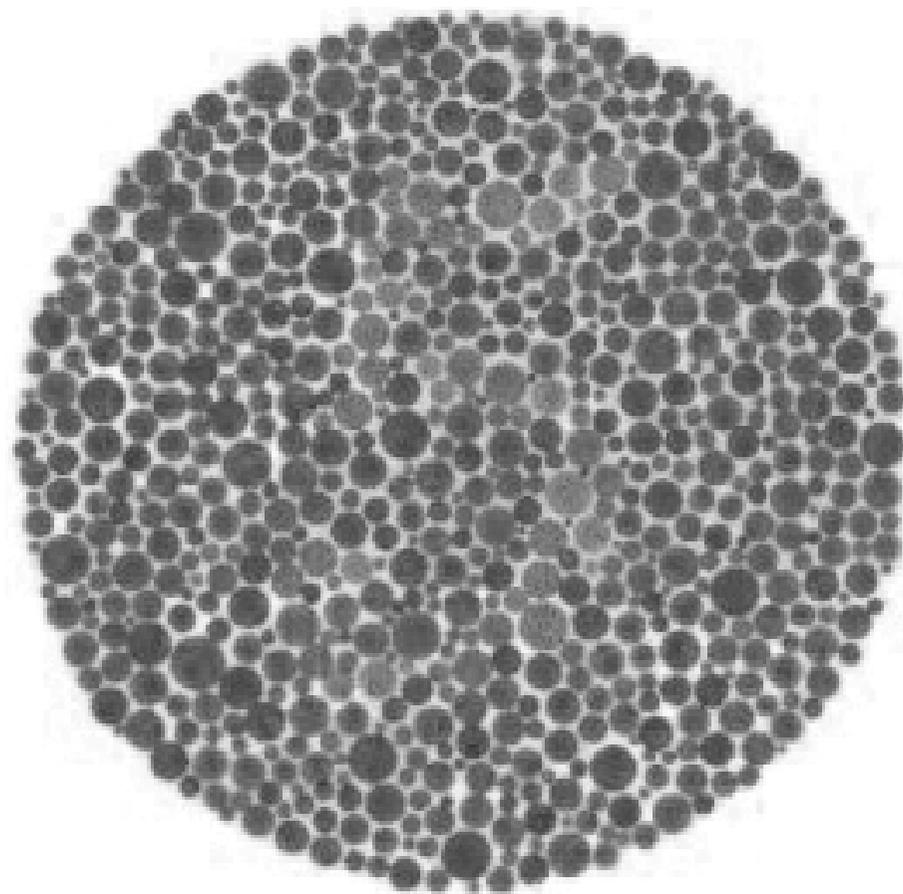


# Anomalous Trichromat

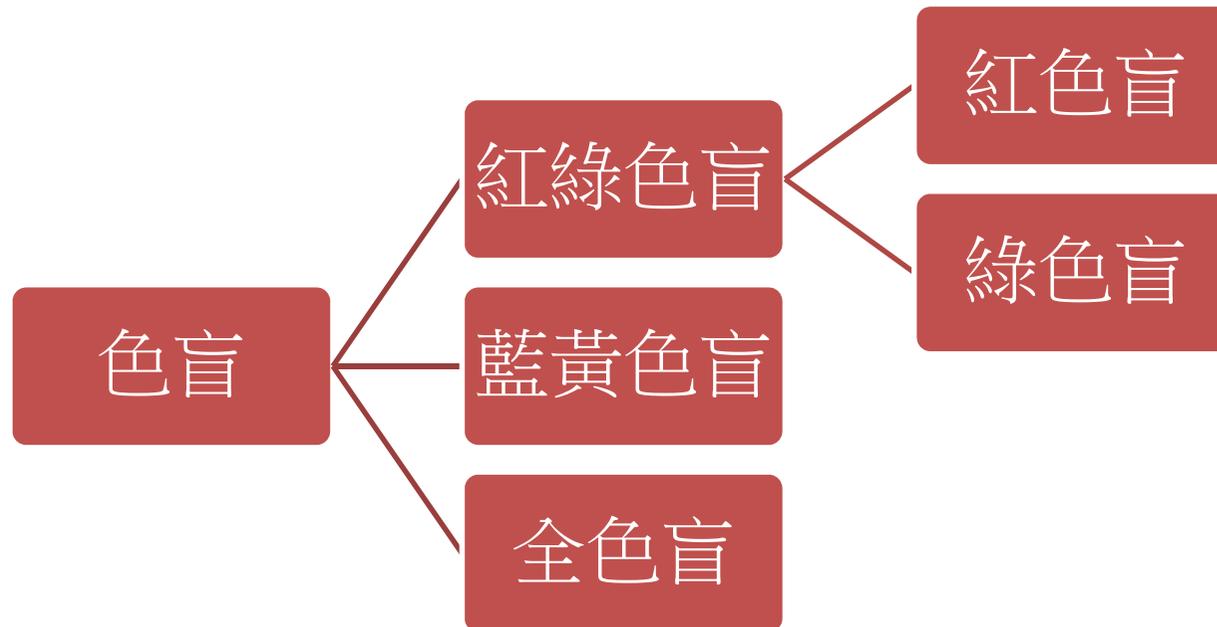




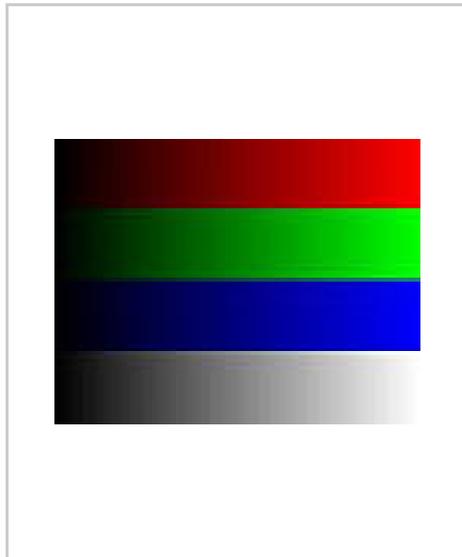




# 色盲分類



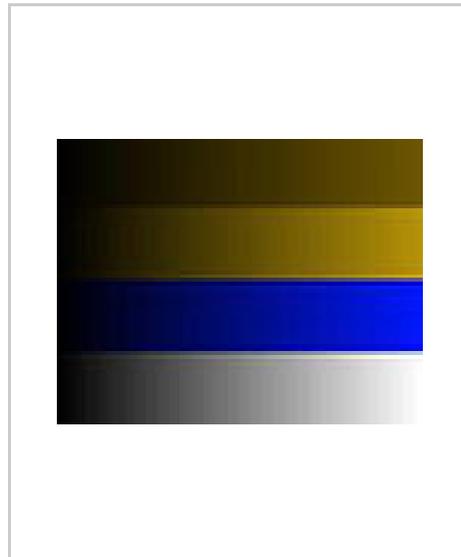
# 色盲所見的世界



無色盲的人所看到的  
RGBW顏色



紅色盲的人所見到的  
RGBW顏色



綠色盲的人所見到的  
RGBW顏色



藍色盲的人所見到的  
RGBW顏色

- 紅色盲(protanopia)
  - 紅橙黃看起來一樣
  - 紅色變成黑白灰
  - 紅色素基因缺失、錯位或突變
- 綠色盲(deuteranopia)
  - 紅橙黃看起來一樣
  - 綠色變成黑白灰
  - 綠色素基因缺失、錯位或突變
- 藍黃色盲(tritanopia)
  - 清楚辨識紅綠
  - 藍黃色辨認不佳

原始图像



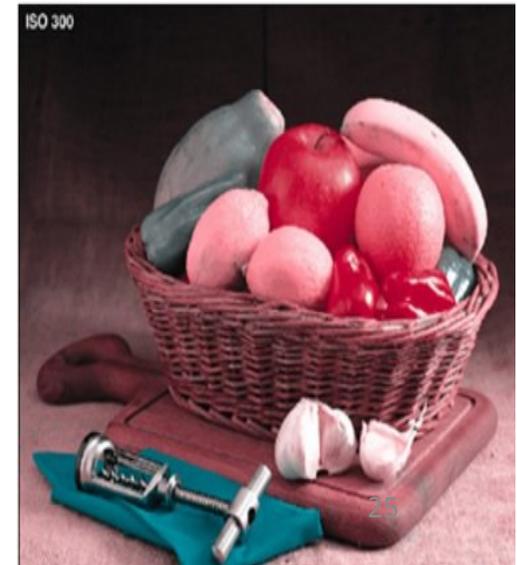
紅色盲 (P型) 视图



綠色盲 (D型) 视图



藍色盲 (T型) 视图



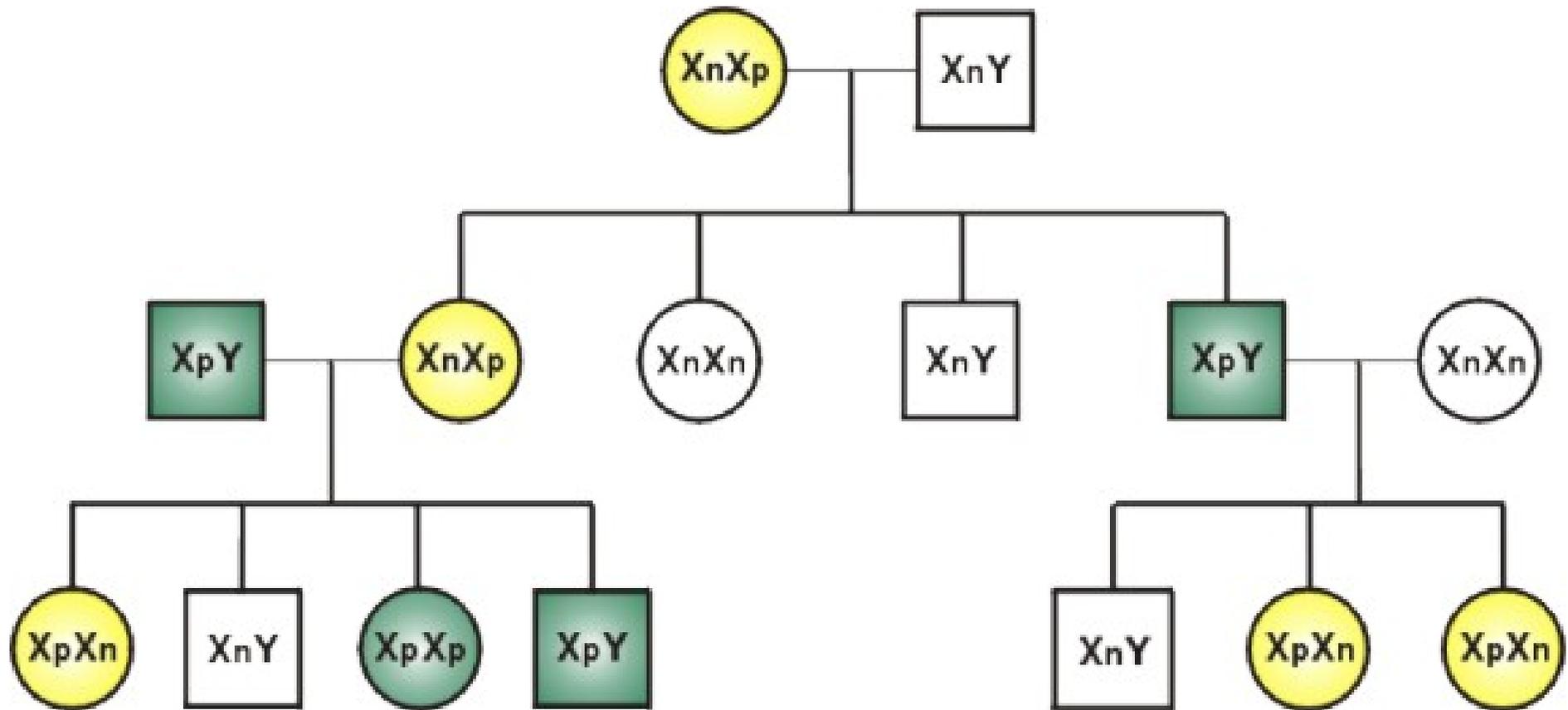
# 色盲原因

- 色盲(color blindness)
- 也稱為「色覺辨認障礙」(color vision deficiency)
- 指無法正確感知部分或全部顏色間區別的缺陷。
- 色盲發生的原因
  - 先天遺傳：有關人類辨識顏色的基因是來自X染色體。
  - 後天性：與視網膜、視神經病變或腦部損傷有關
  - 例如外傷、青光眼。

# 色盲遺傳

- 臨床調查顯示，男性色盲佔4·9%，女性色盲僅佔0.18%。
- 紅綠色盲是X染色體遺傳基因隱性遺傳病。

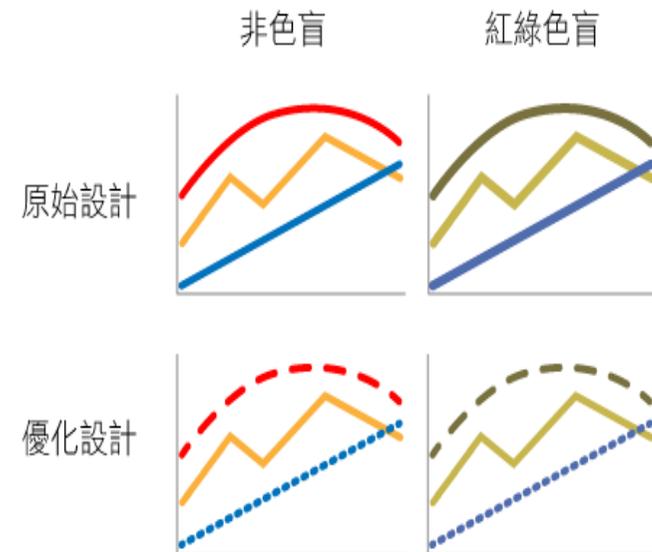
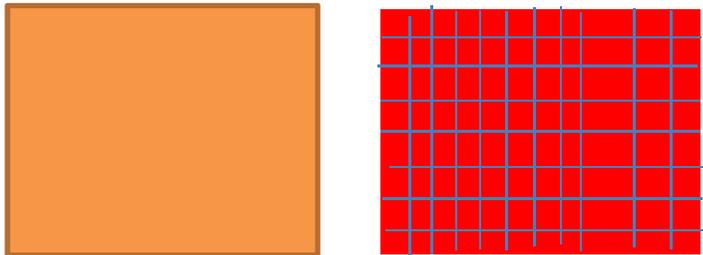
# Color Deficiency-pedigree



-  - carriers
-  - affected male
-  - normal male
-  - affected females
-  - normal females

# 社會適應—貼心設計

- 避免只使用色彩作為資訊的辨別依據
- 使用不同造型的圖表、線條圖
- 色塊加上材質



# 看見彩色世界的感動

- 分辨出不同顏色對一般人可說是理所當然。
- 但對於色盲患者卻是一個遙不可及的夢想。
- 而且世界上仍有大約三億人為色盲所苦。
- [https://www.youtube.com/watch?v=csx\\_PHKJei8](https://www.youtube.com/watch?v=csx_PHKJei8)

# 色盲矯正眼鏡

- 色盲眼鏡是根據補色原理，在鏡片上進行特殊光學多層膜鍍製，使某部分可見光波長適當反射。色盲患者戴上適合的矯正色盲眼鏡片，提高物體的色差達到分辨紅綠色彩的效果。

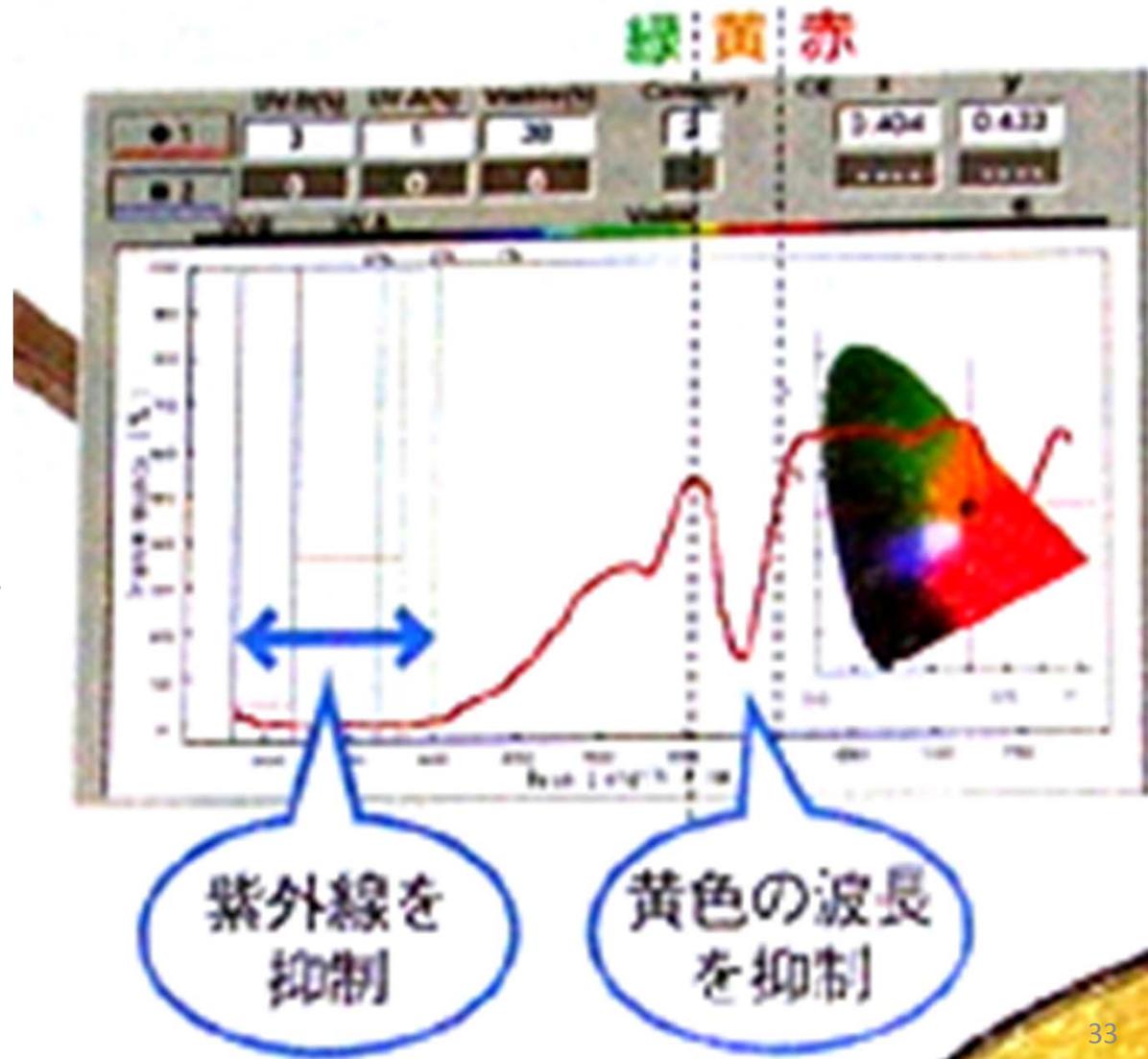
# 製作

- 測出色盲需矯正的三基色值。
- 改變物體色入射人眼的三基色分量比例趨於正常
- 畫成糾正光譜曲線圖
- 製鍍符合色盲特性的光學濾鏡片。

# 日本專利No. 3044017

抑制黃色波長  
(575~585nm)

凸顯綠色波長  
(500~575nm)  
及紅光(600~740nm)。



- 中國子軼光學公司推出的明魅色盲色弱矯正隱形眼鏡(簡稱明魅色盲片)，針對紅綠色盲色弱設計，能有效改善患者的色覺，提高對顏色的辨別能力。



非光學鏡片

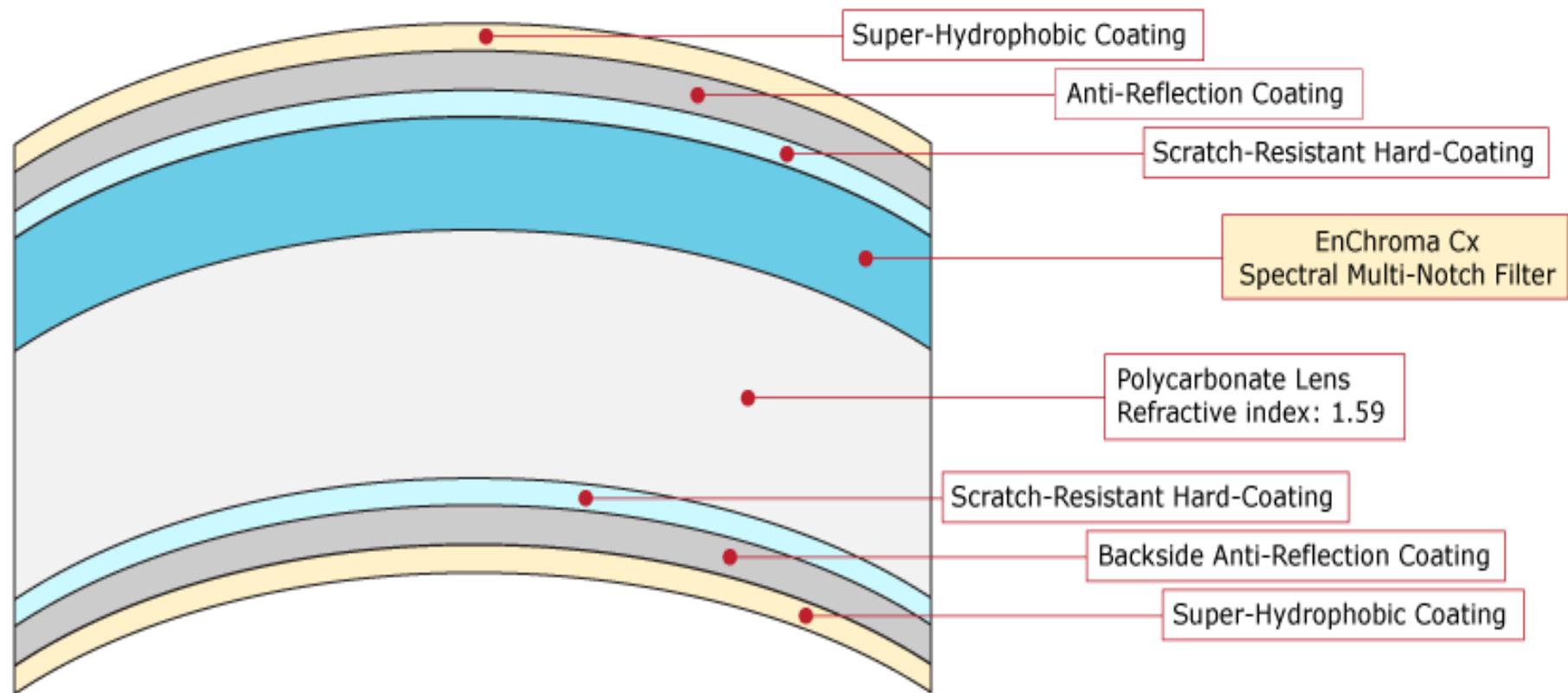




光學鏡片

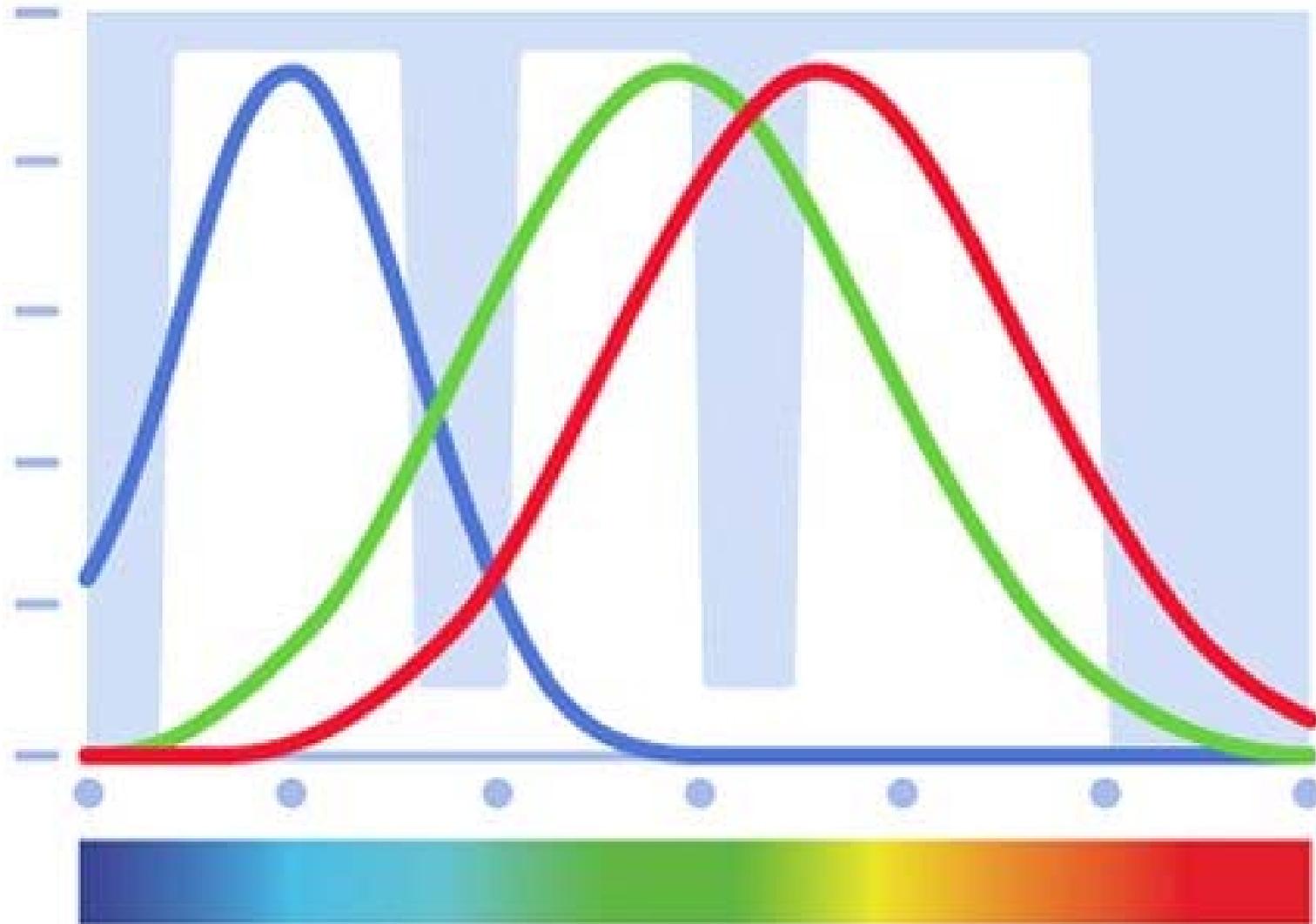
# Enchroma 矯色眼鏡



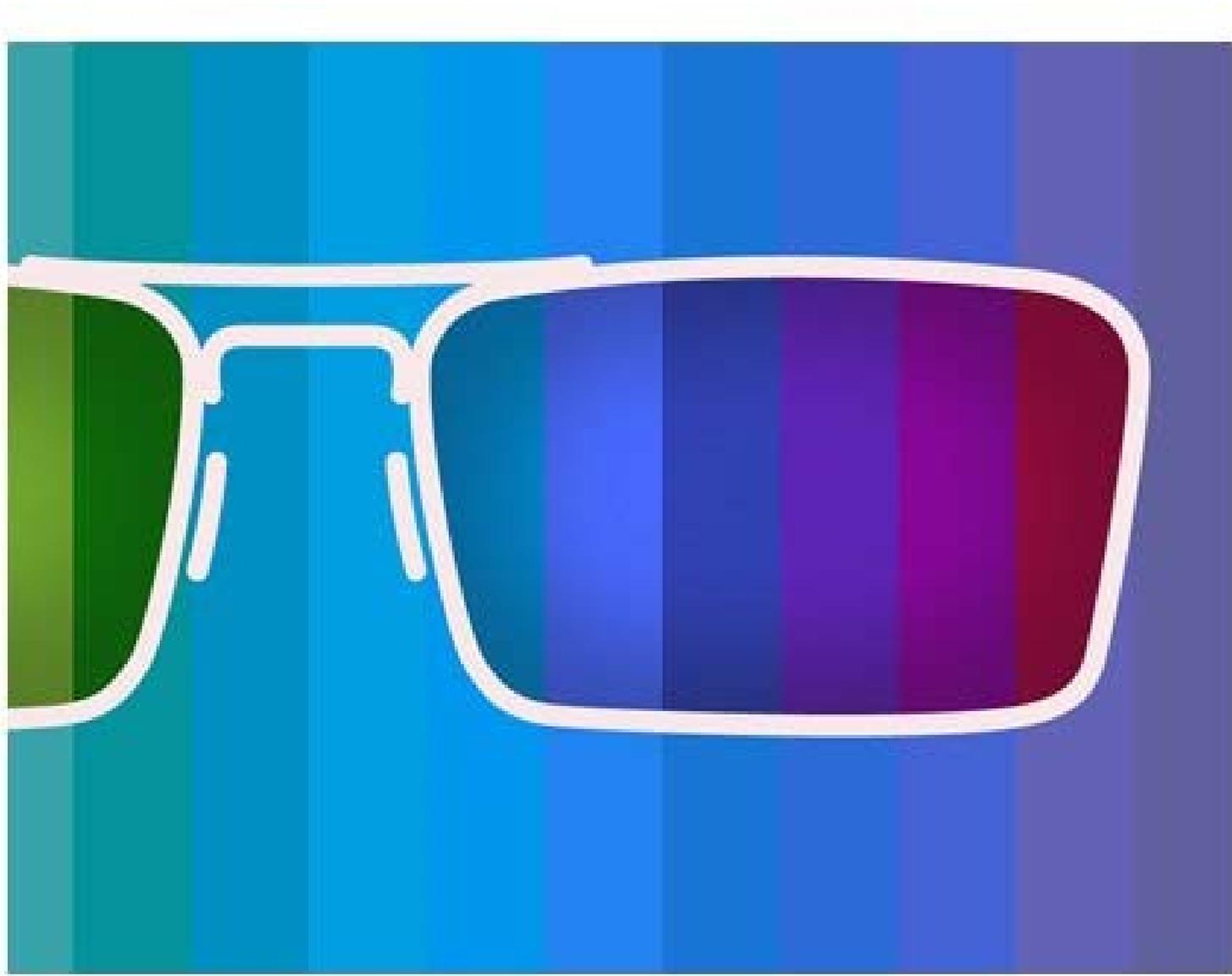


Specification for EnChroma Cx Prescription Lens as of Jan 1 2015. Specifications are subject to change.  
Lens internal diagram for illustrative purposes only and is not drawn to scale.

# Multi-notch filter

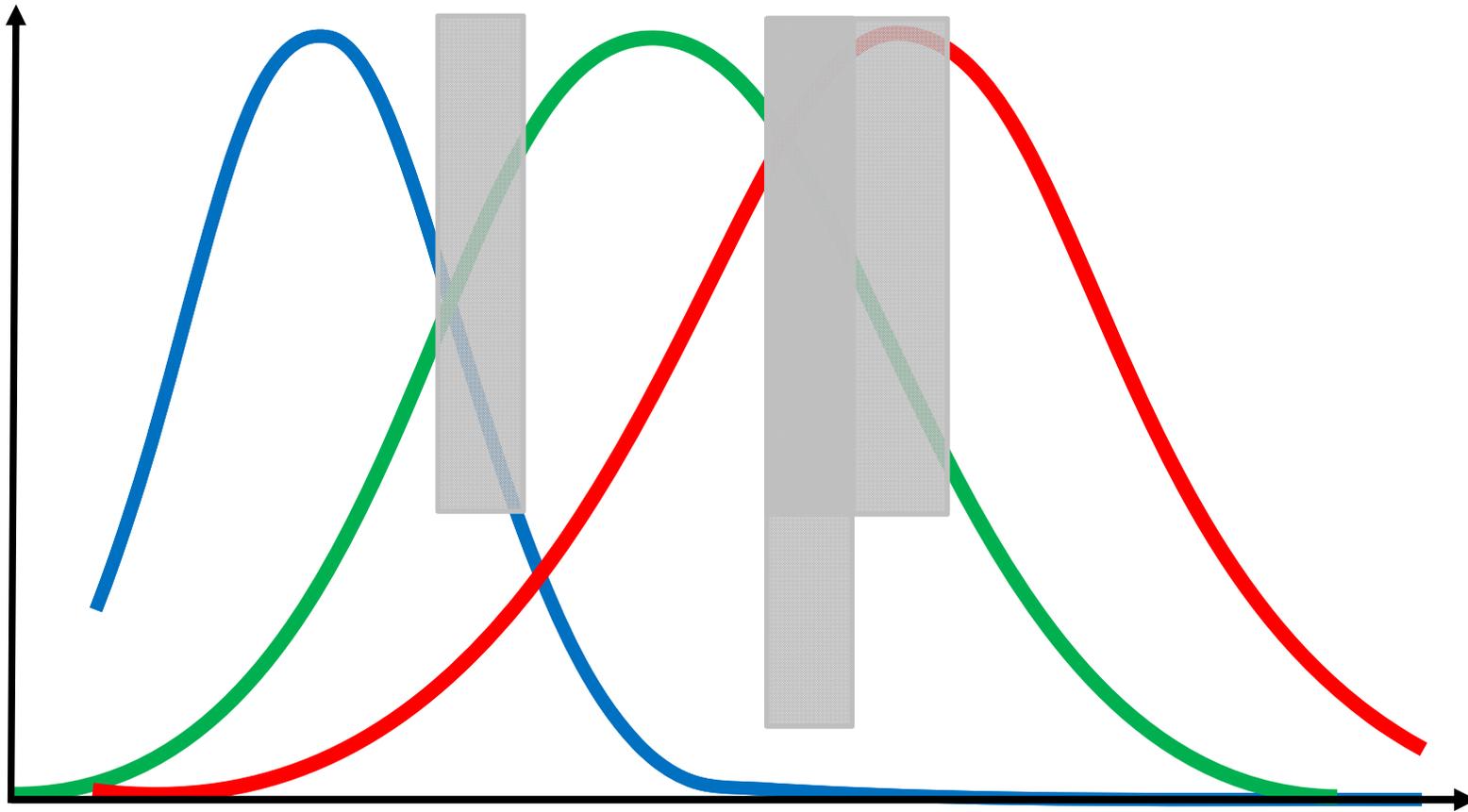


Enchroma



Enchroma

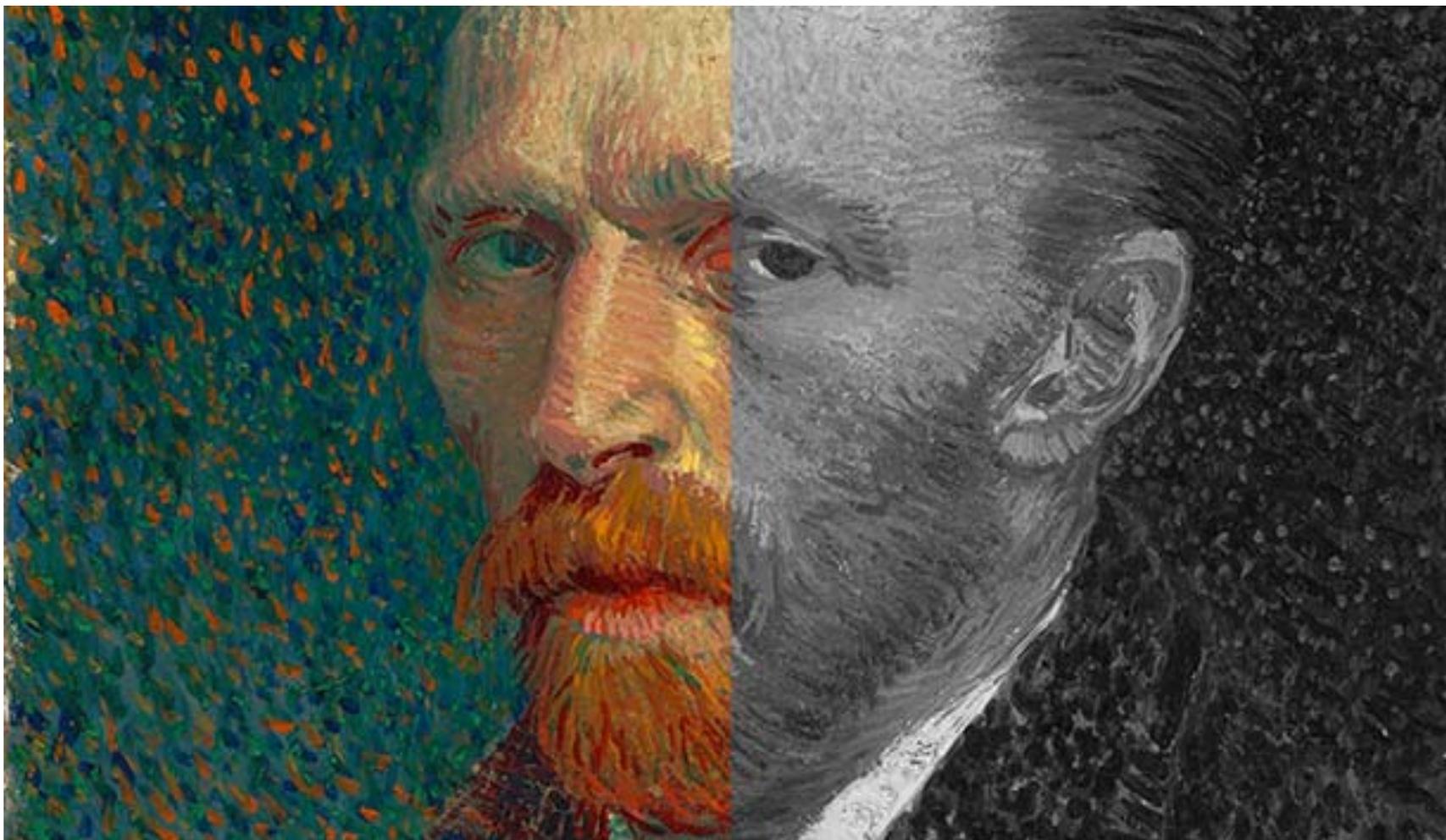
# 研究與期待





© Jay Neitz, 1999.



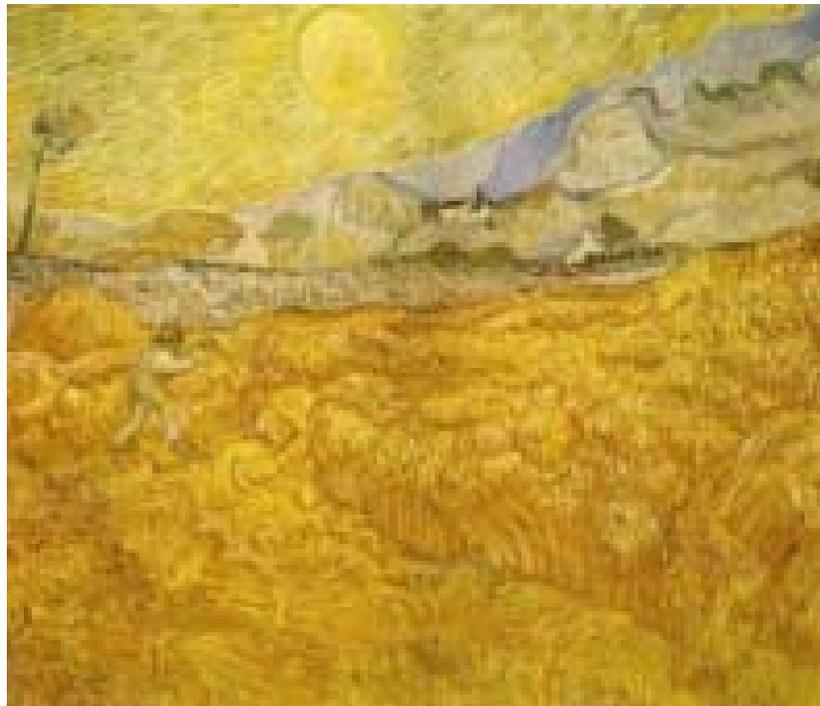


日本化學家及詩人Kazunori Asada認為世界知名的藝術家梵谷其實並不是藝術革命者，不過是一名視覺損傷的殘疾人。



《聖-保羅醫院後有收割人的  
麥田》  
(Wheat Field behind Saint-  
Paul Hospital)

梵谷“缺陷”意味著對紅  
色缺乏的感受。



# 參考資料

- TechNews科技新報
- 衛生署學生健康服務網
- Sm88色盲資訊網
- B.C. & Lowy資訊網
- <http://big5.made-in-china.com/gongying/meirong1668-tbDmuhUCXIVd.html>
- <http://enchroma.com/technology/>
- [http://pureartgallery.blogspot.com/2012/09/blog-post\\_6.html](http://pureartgallery.blogspot.com/2012/09/blog-post_6.html)
- [http://pureartgallery.blogspot.com/2012/09/blog-post\\_6.html](http://pureartgallery.blogspot.com/2012/09/blog-post_6.html)

# 研究團隊

- 輔仁大學物理系光學薄膜實驗室
  - －徐進成、陳昶豪(研究生)
- 輔仁大學數學系
  - －嚴健彰教授、闕昱哲(研究生)
- 輔仁大學醫學系
  - －陳志明 醫師
- 產業界
  - －陳立仁

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