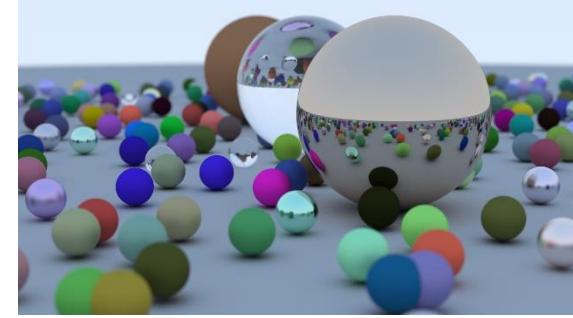


# Comp4422

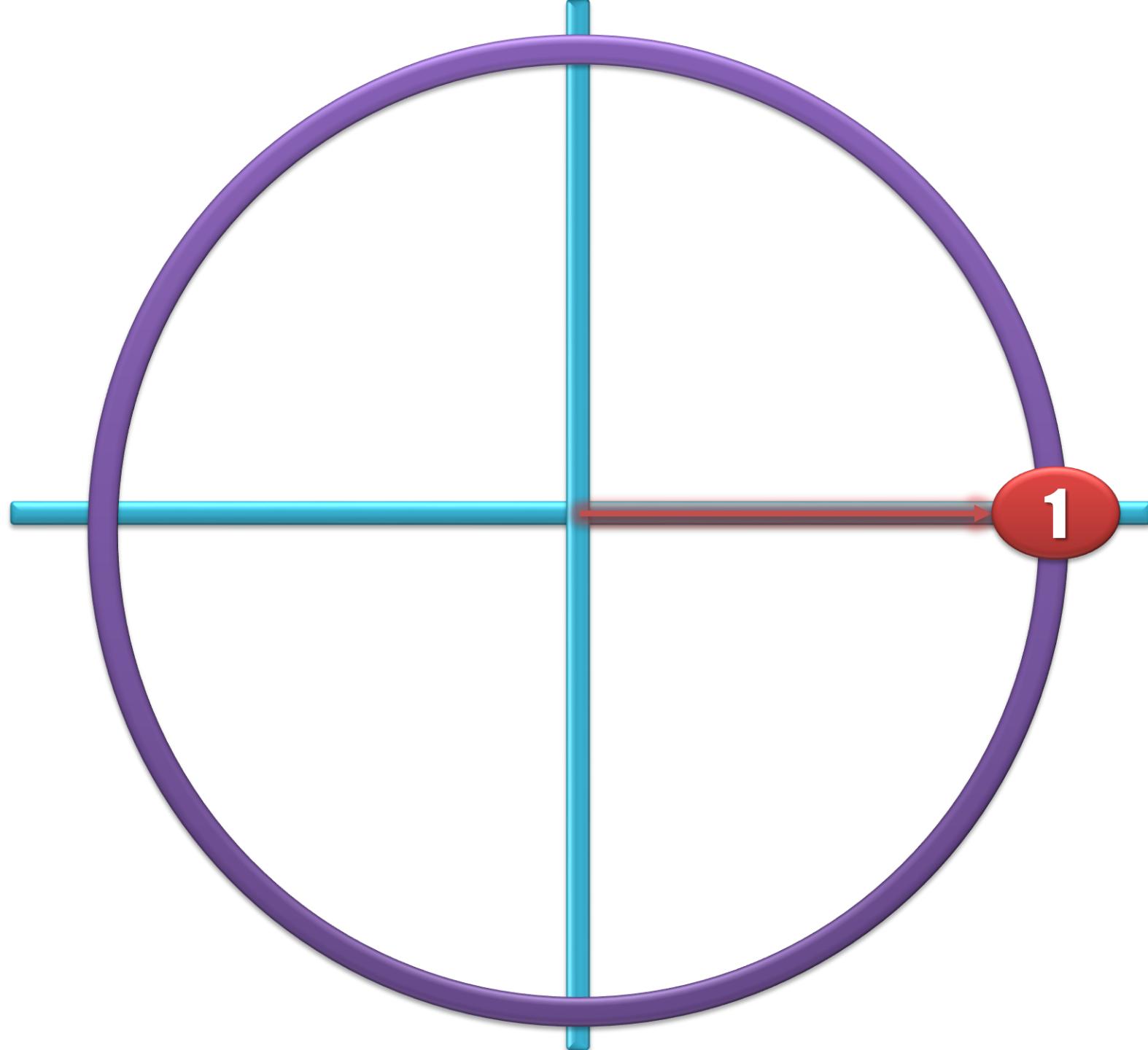


# Computer Graphics

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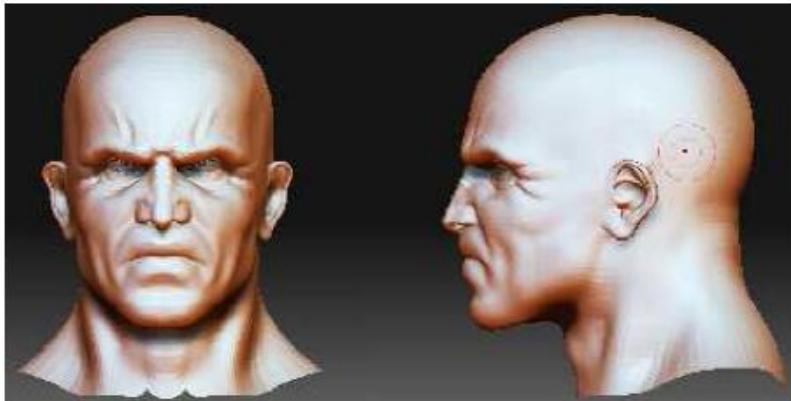
## Lecture 01: Introduction





# What is Computer Graphics?

# Graphics is ... Modeling



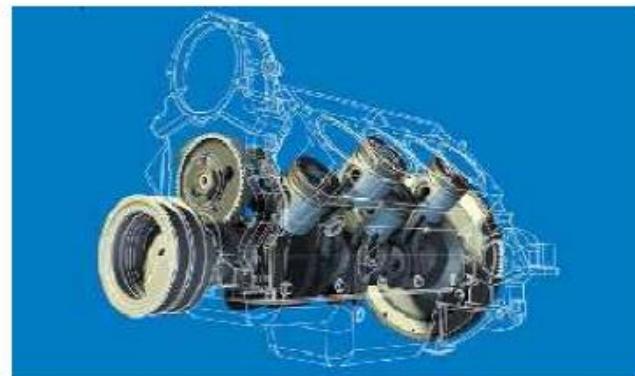
Human head modeled in ZBrush (Shon Mitchell)



Trees generated with L-systems (Talton et al., 2010)



Procedurally generated model of Zurich  
(Parish and Müller, 2004)



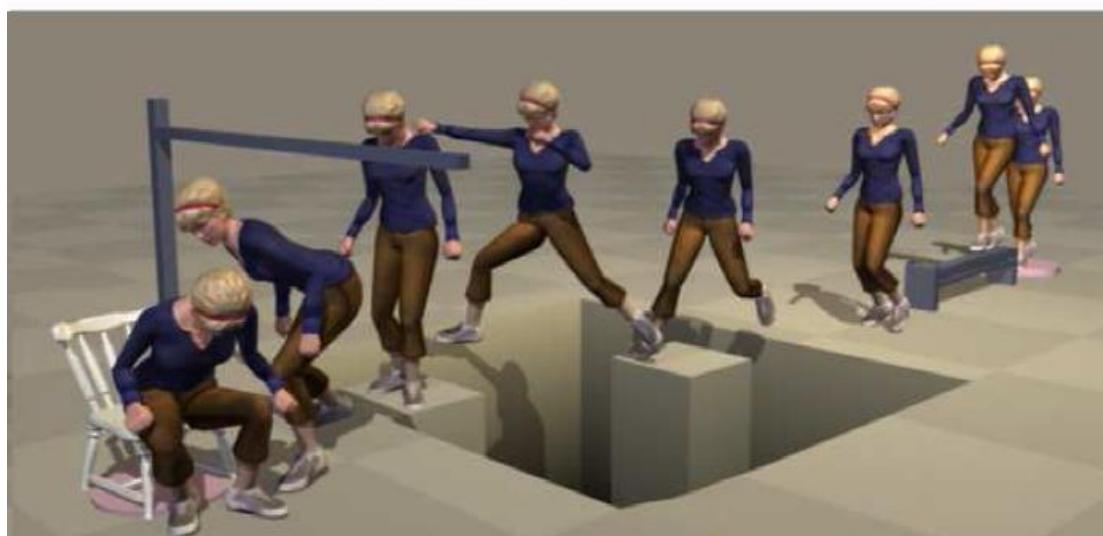
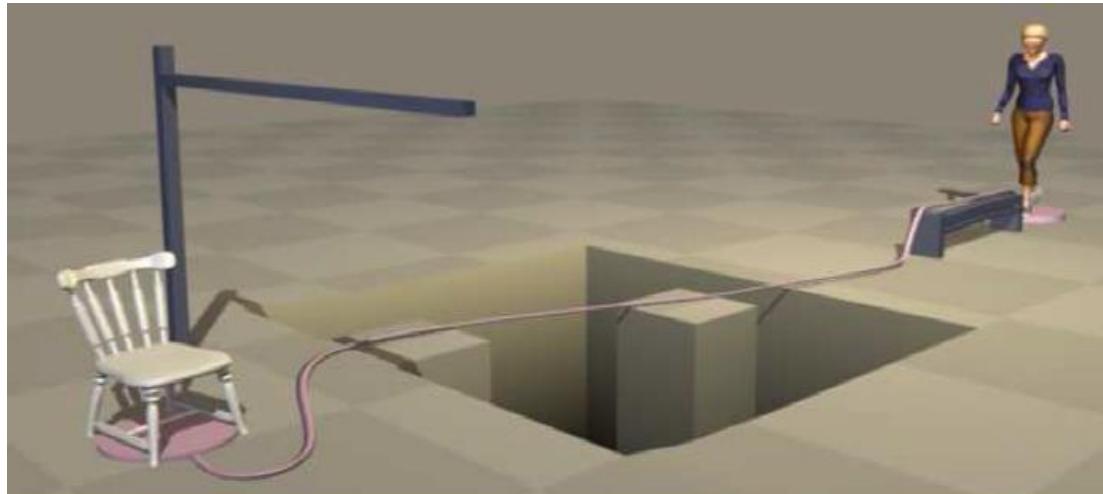
Engine CAD drawing (SolidWorks Corp.)

# Graphics is ... Rendering



Rendered in POV-Ray by Gilles Tran

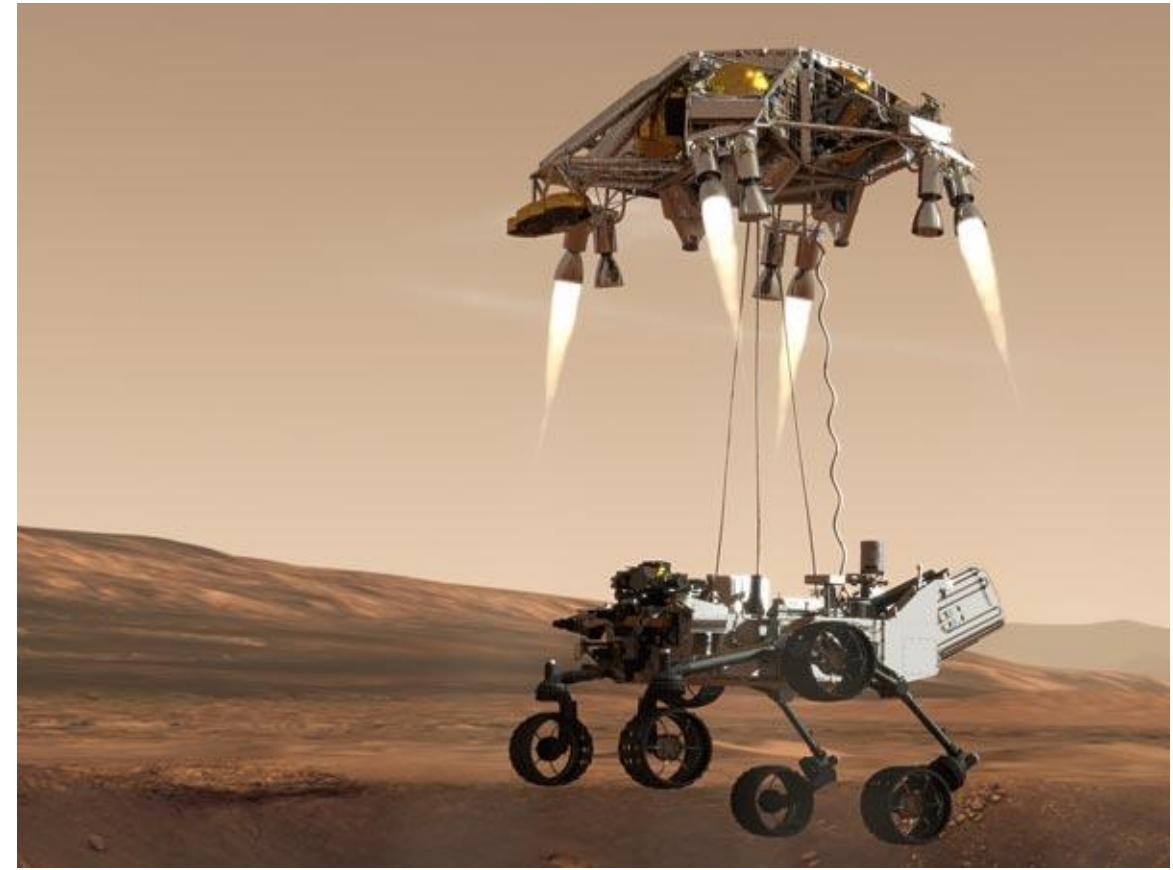
# Graphics is ... Animation



# Graphics is ... Simulation



Losasso et al., 2008



# Graphics is ... Digital Capture

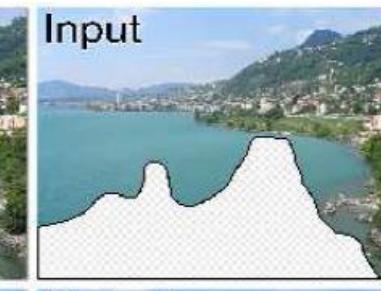


# Graphics is ...

# Image Processing

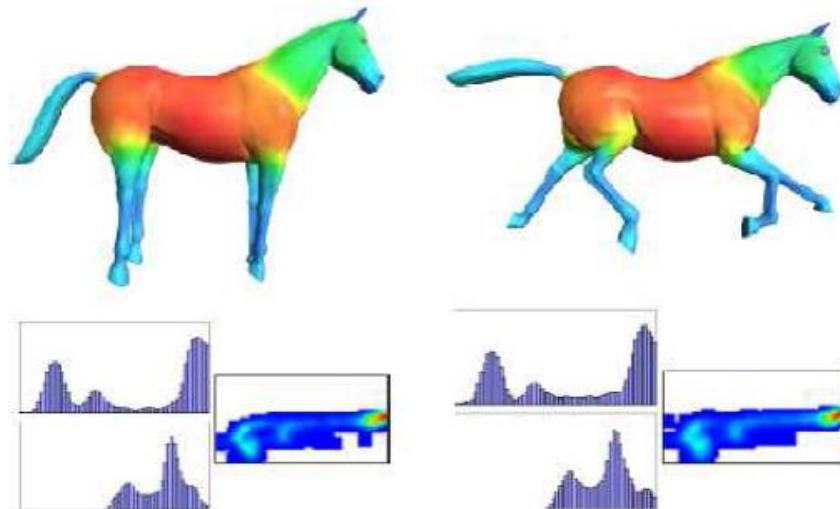


Image Analogies (Hertzmann et al., 2001)



Scene Completion with Millions of Photographs  
(Hays and Efros, 2007)

# Graphics is ... Geometry



Pose Oblivious Shape Signature (Gal et al., 2007)

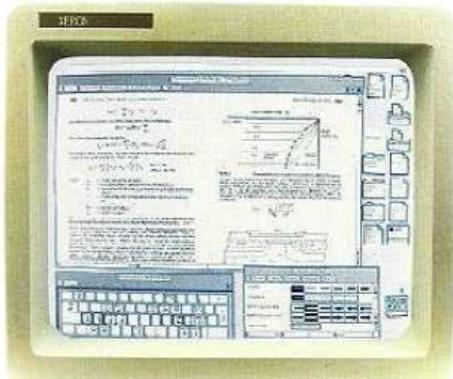


Shadow Art (Mitra and Pauly, 2009)



Discovering Structural Regularity in 3D Geometry (Pauly et al., 2008)

# Graphics is ... User Interfaces



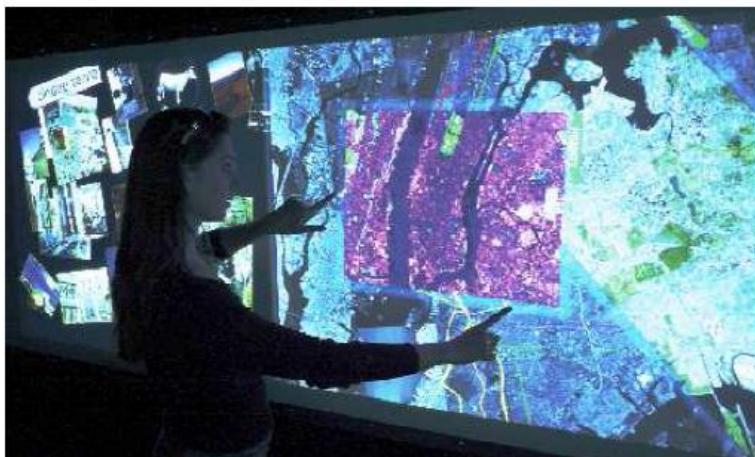
Xerox Star (Xerox, introduced 1981)



Windows 7 (Microsoft, 2009)



iPhone (Apple, introduced)



Wall-mounted multitouch display  
(Perceptive Pixel, 2007)



Virtual car design in the CAVE  
(U. Mich./Prince, 1996)

# Graphics is ... Entertainment



Jurassic Park (Universal Pictures, 1993)



World of Warcraft (Blizzard, 2004)

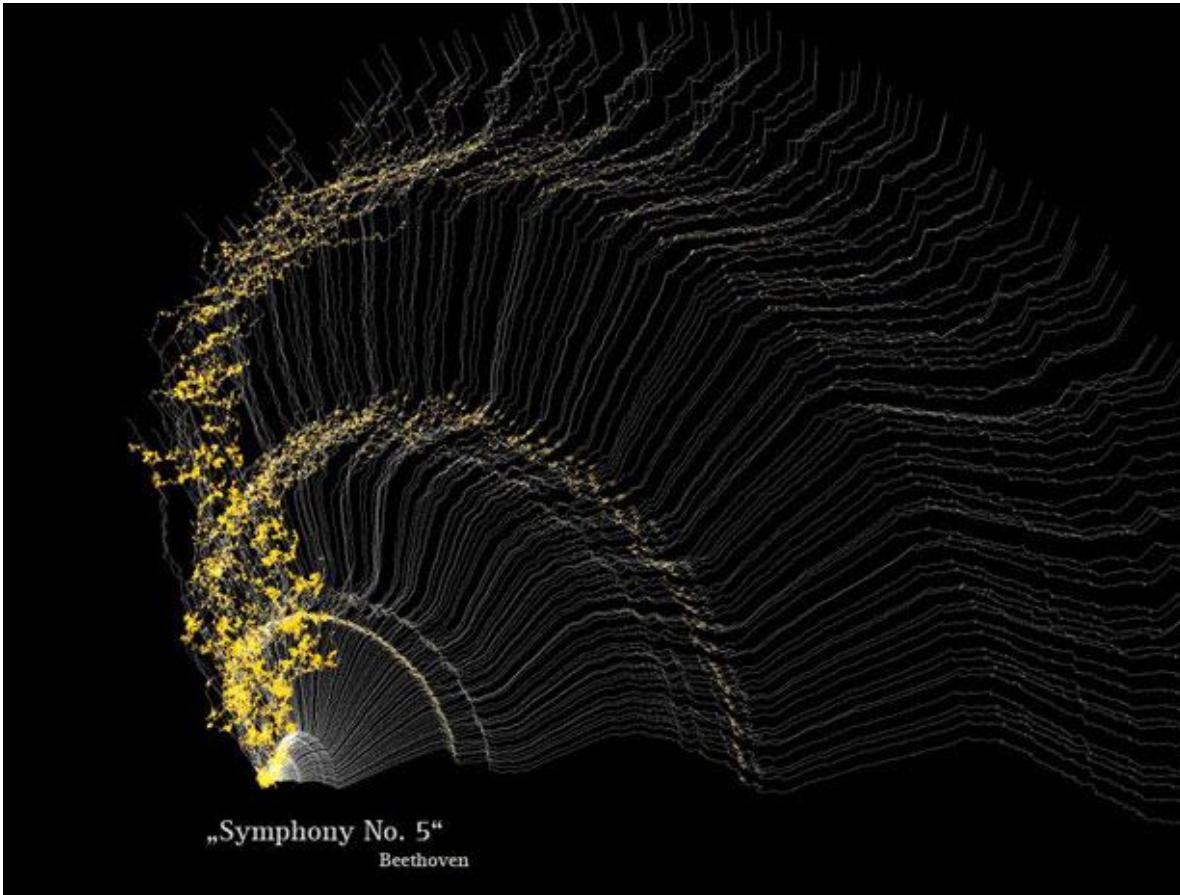


Toy Story, the first full length film produced entirely on computers (Pixar/Disney, 1995)

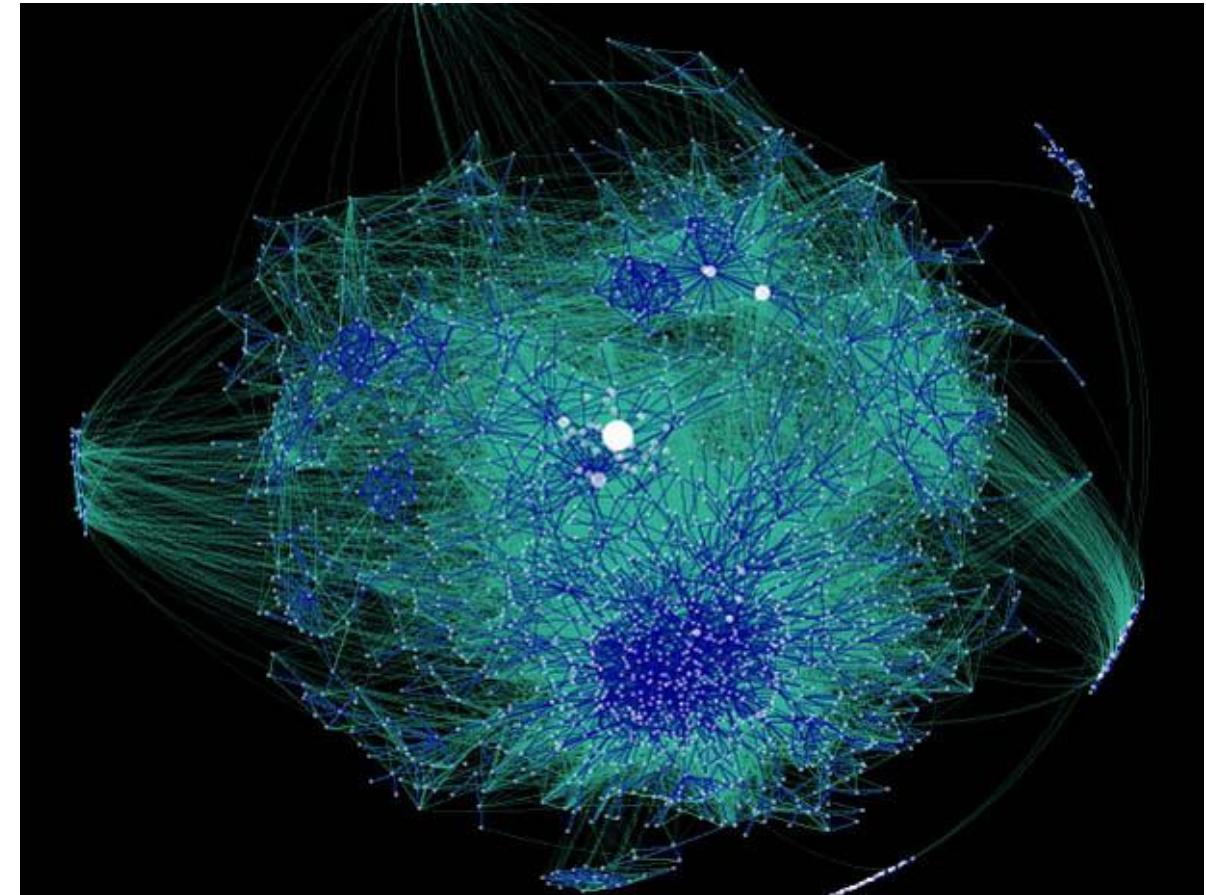


Crysis (Crytek/EA, 2007)

# Graphics is ... visualization



Liveplasma: show musical patterns



Blogosphere/Internet

# Graphics is ... Design



# Graphics is ... Hardware

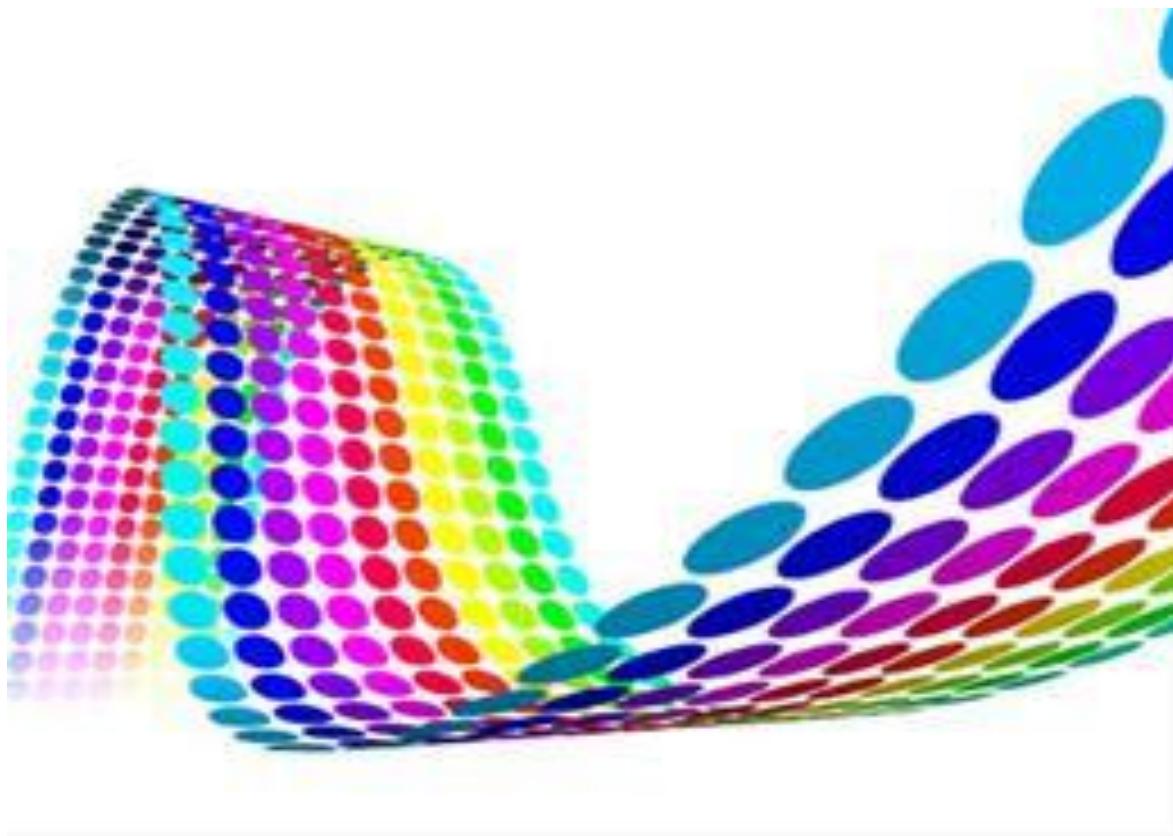


NVIDIA Titan X



GPU Raster Engines

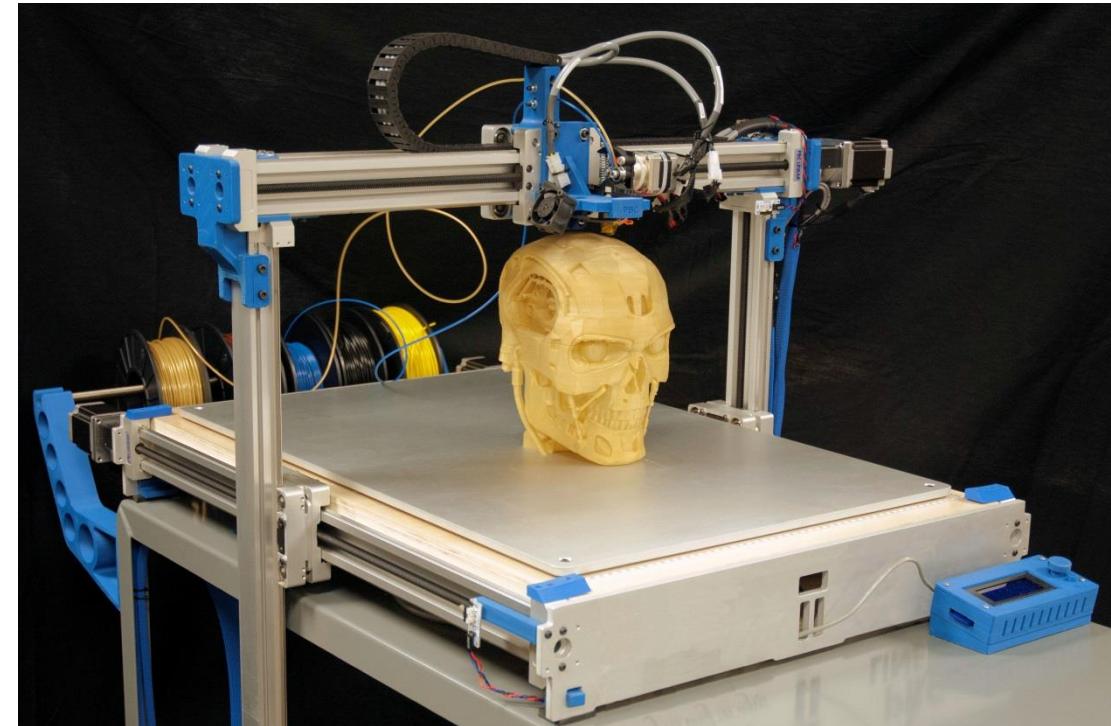
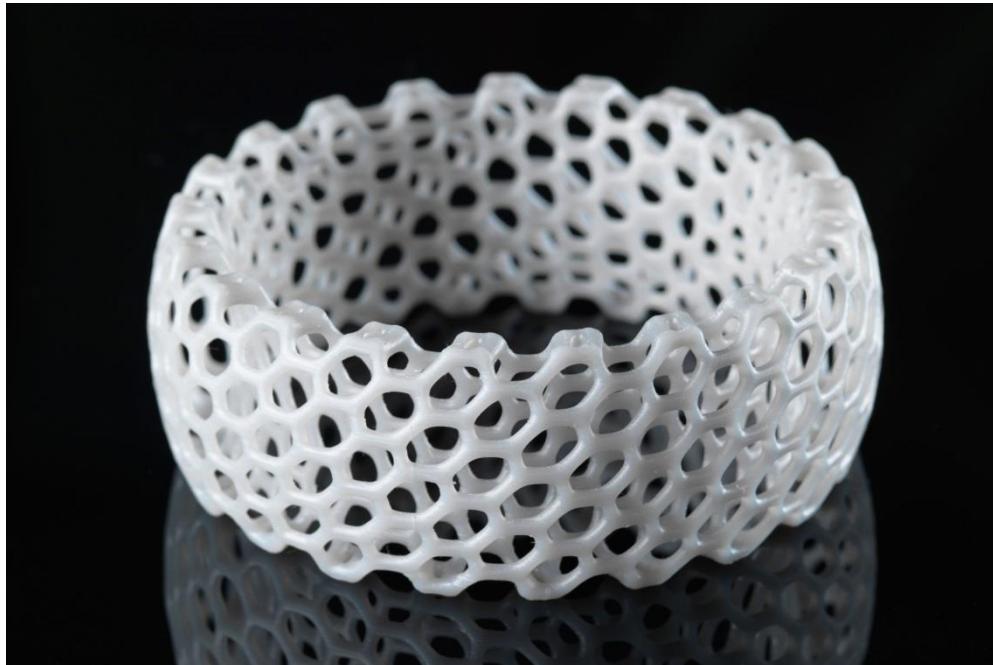
# Graphics is ... PRINTING



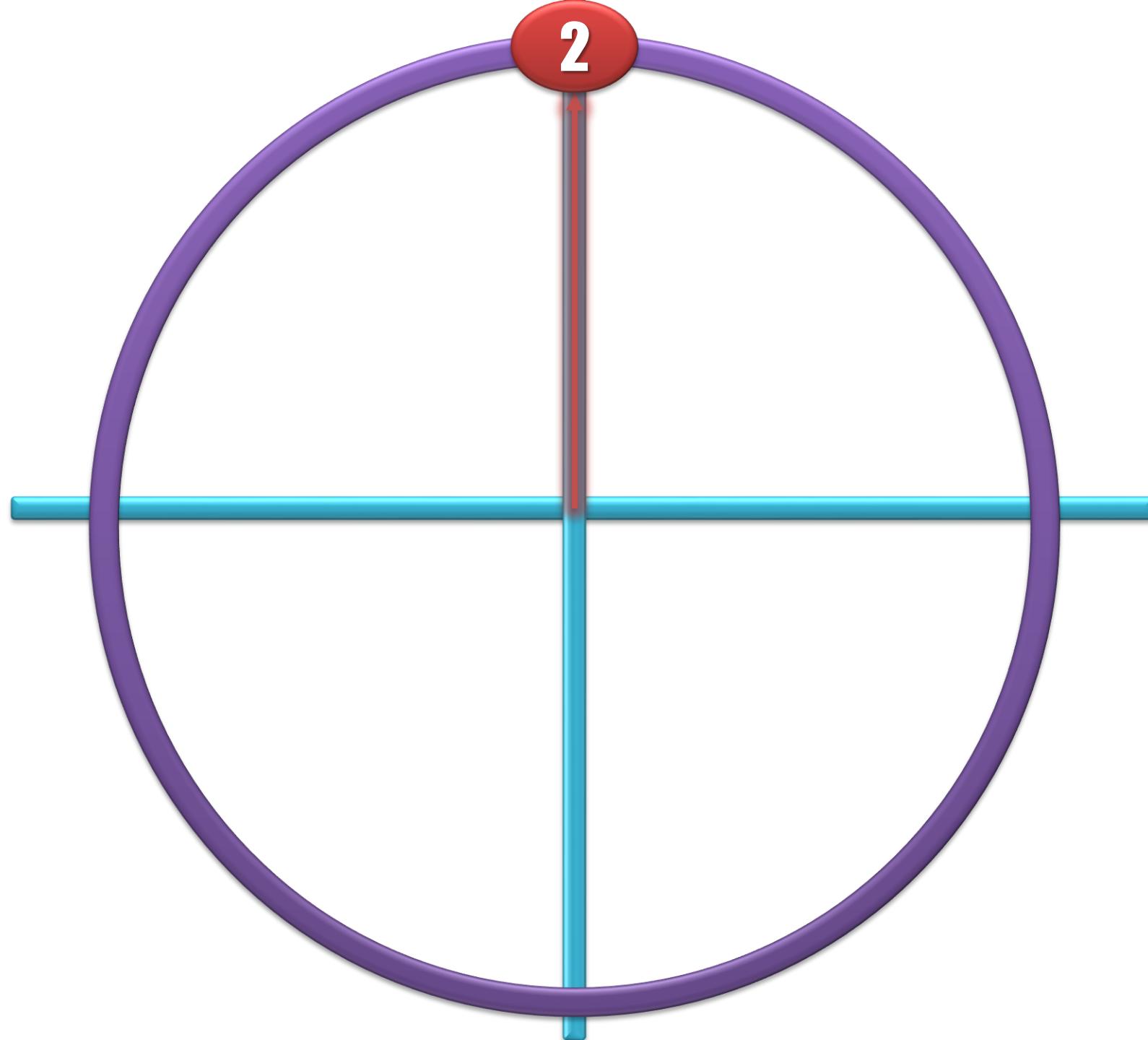
GRAPHIC DESIGN & PRINT  
CORPORATE IDENTITY  
DC-Graphics creating solutions  
MENUS TECHNICAL ILLUSTRATION  
NEWSLETTERS IMAGE MANIPULATION

Creative Large Format Graphics  
Brochures Leaflets & Flyers  
Catalogues Logo Design  
Typography

# Graphics is ... 3D PRINTING

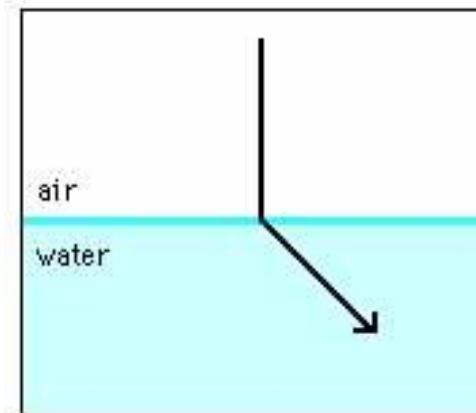


**But, the best way  
to understand CG  
is to imagine ...**

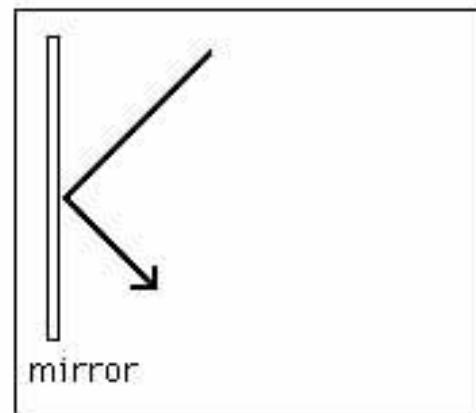


# Simple Light Physics

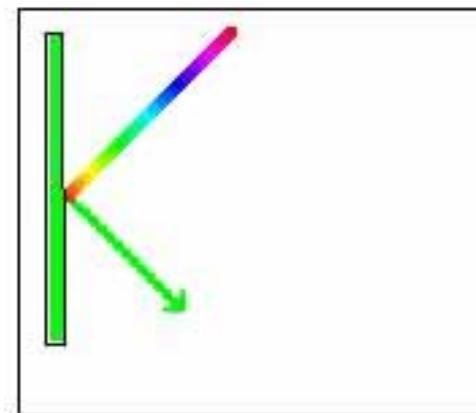
- Four basic light-object interactions:



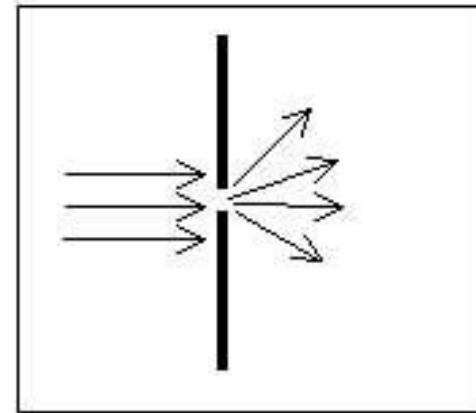
Refraction



Reflection



Absorption



Diffraction

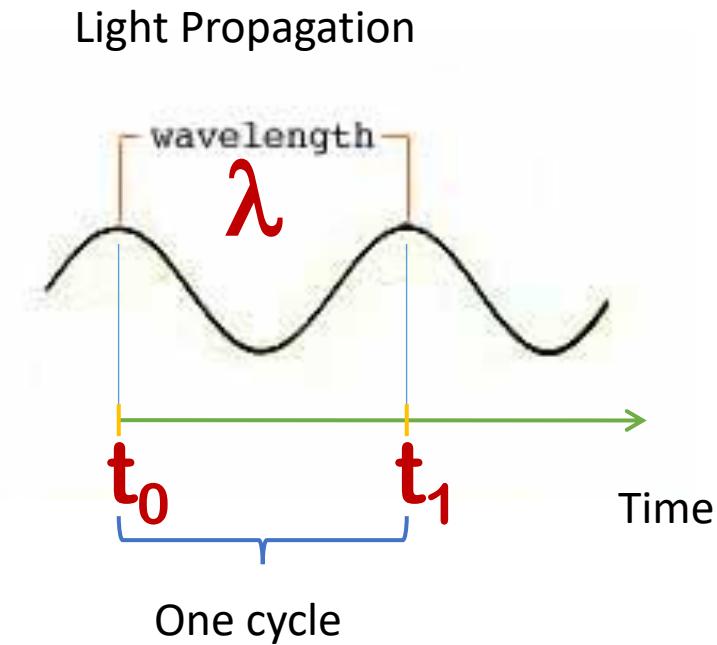
# Light as a Wave

- Light propagation

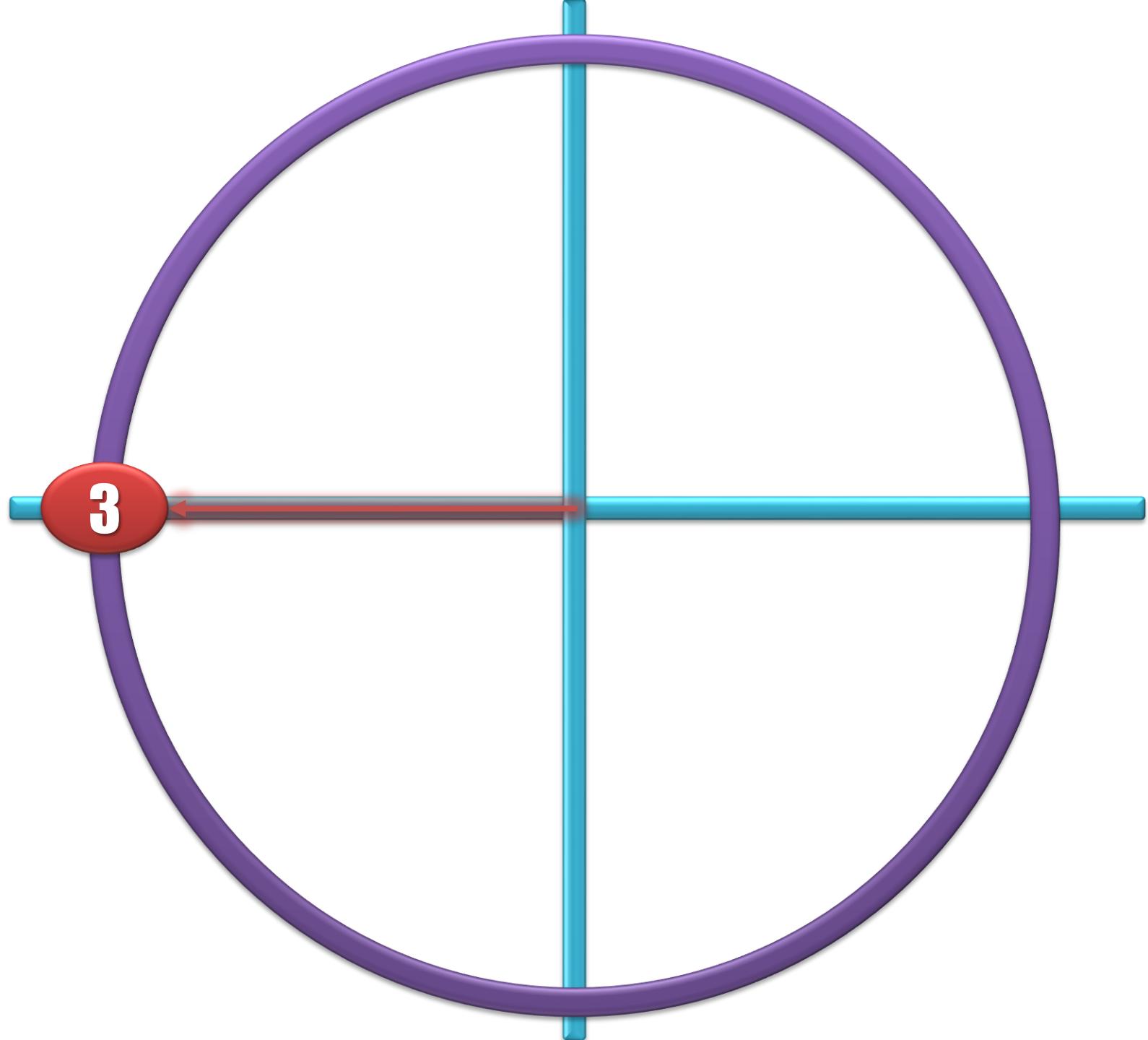
$$c = f\lambda = 3 \times 10^8 \text{ m / s}$$

- This means that

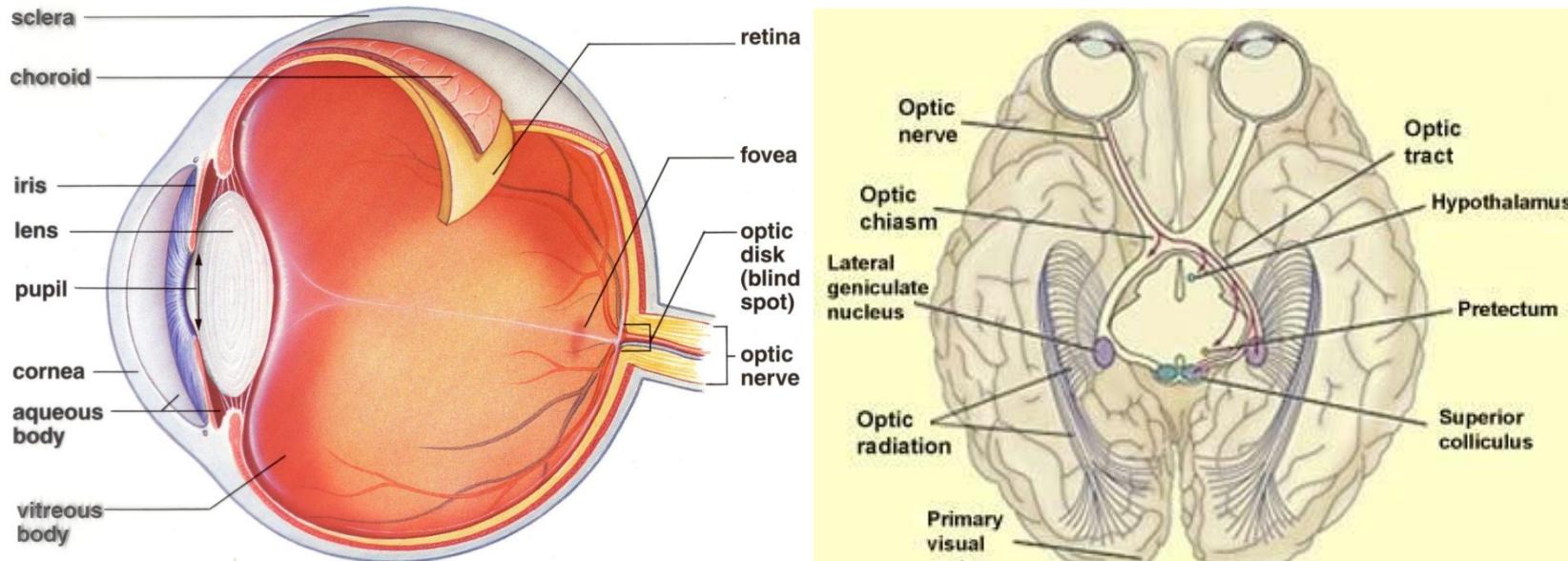
$$\frac{c}{f} = \lambda$$



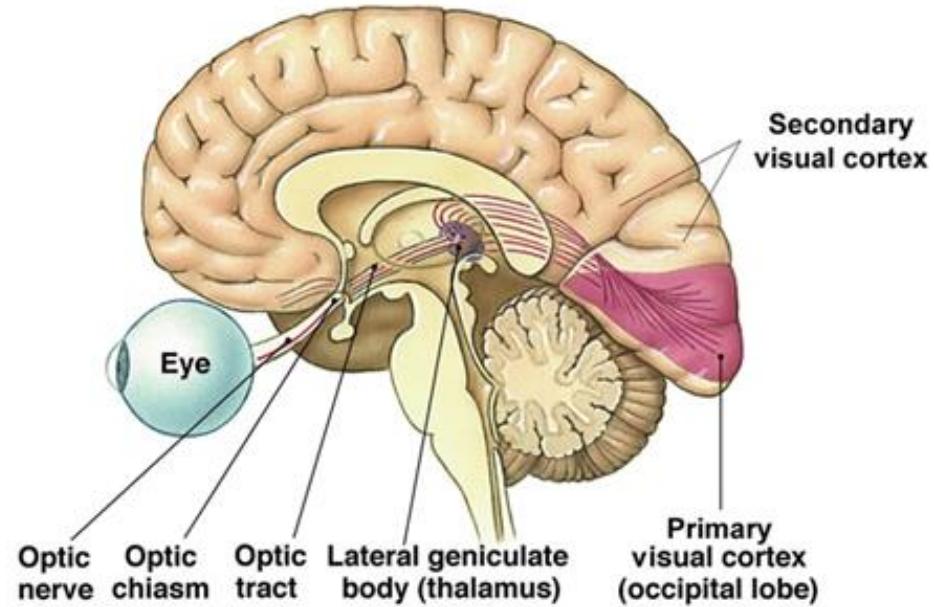
$$\Delta T = t_1 - t_0$$



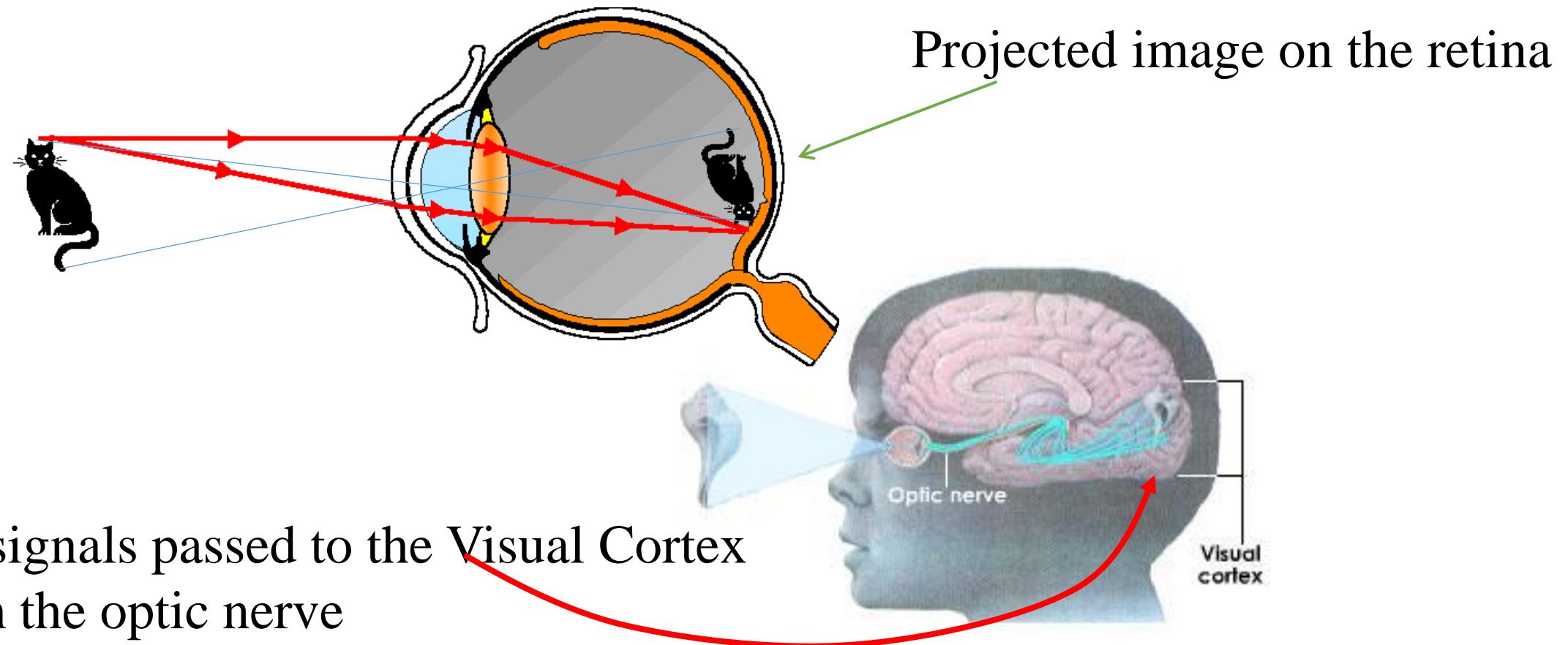
# Human Vision



# Human visual system

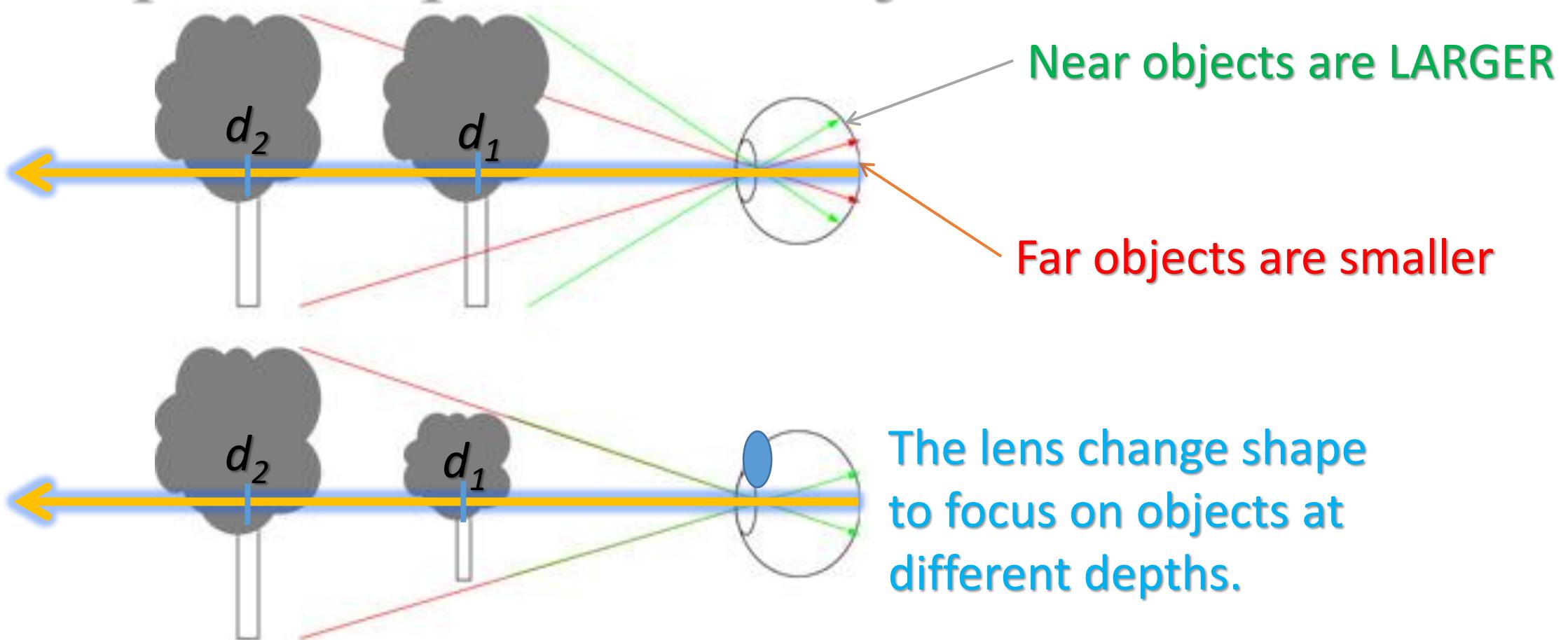


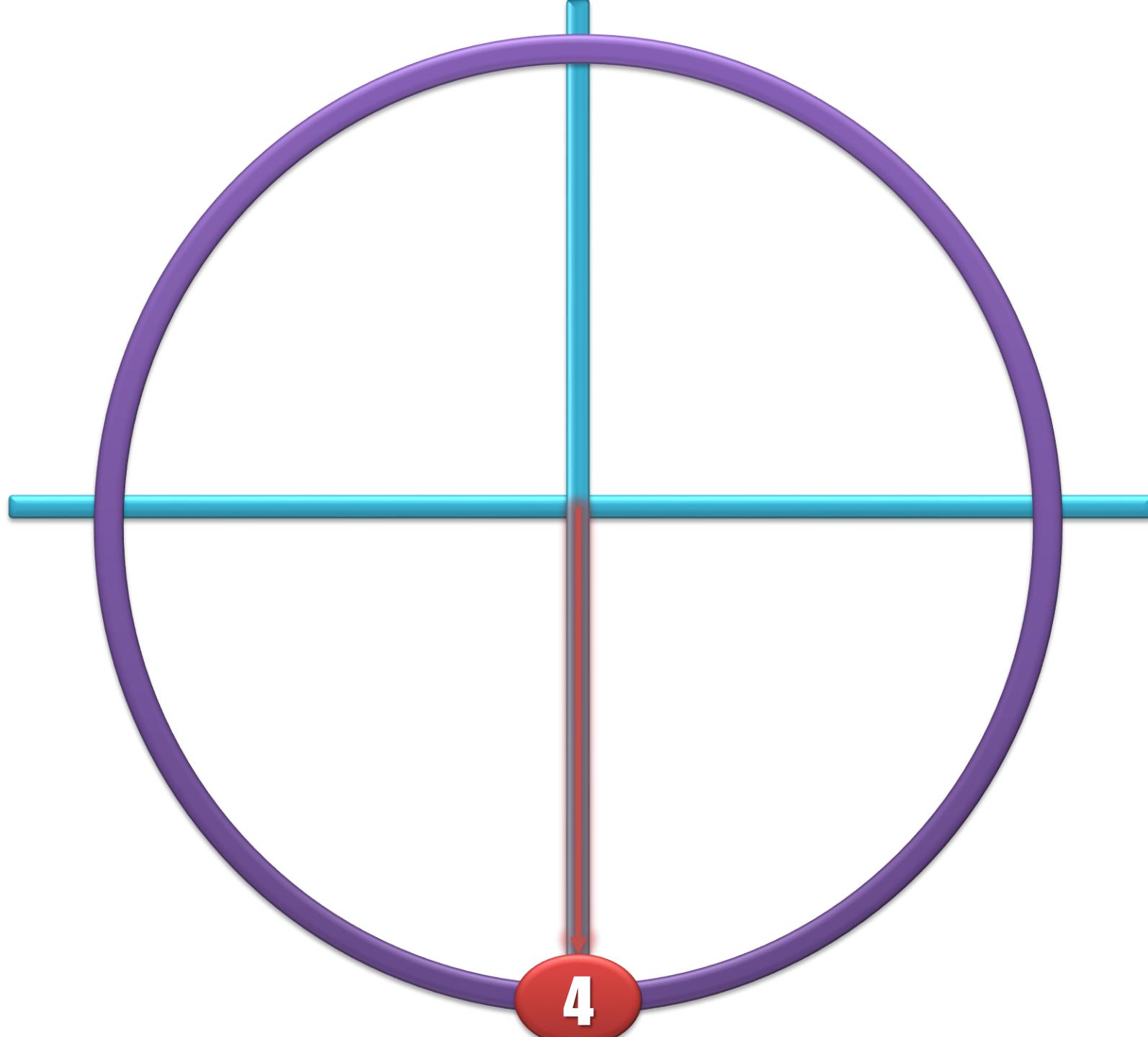
# Image Formation



# Depth

- Depth and perceived object size

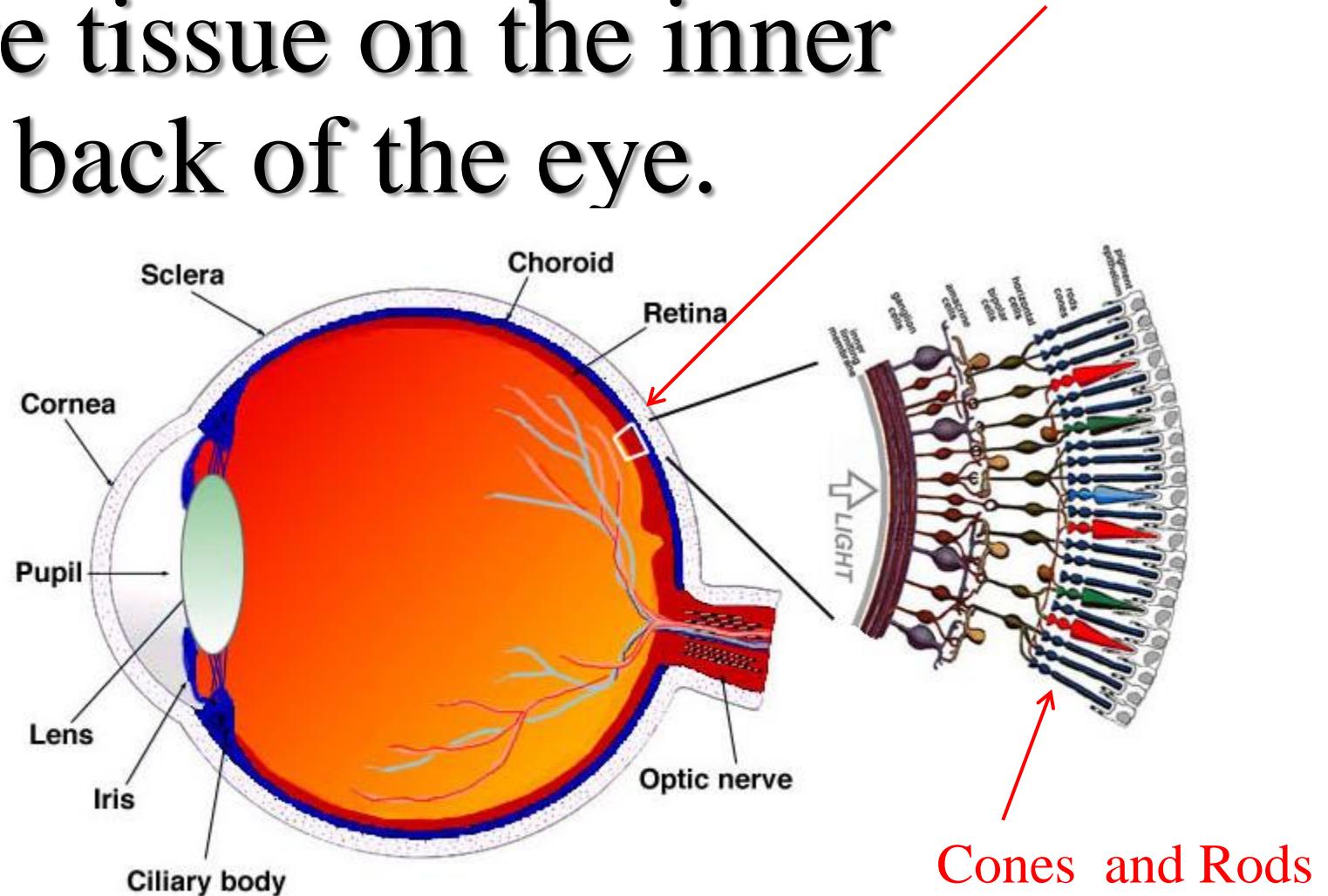




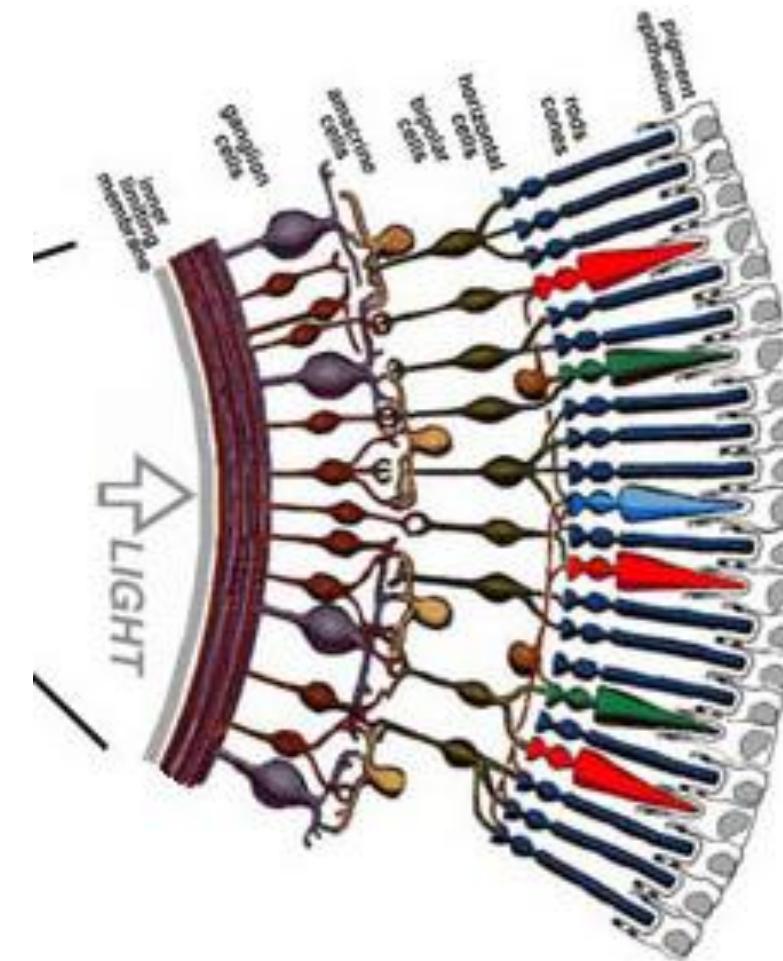
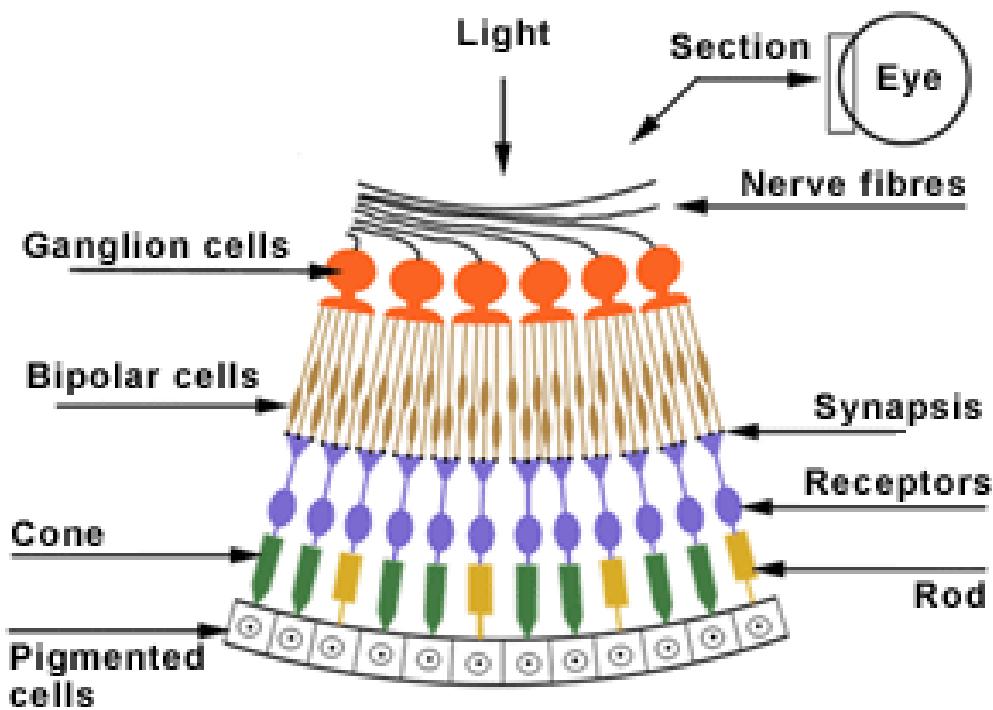
# Retina

Tiny area on the Retina is like a pixel on the screen

- Light-sensitive tissue on the inner surface of the back of the eye.



# Rods and Cones



# What do Rods do?

- About **120** million rod cells
- Photoreceptors sensitive to **low** illumination
- 100 times **more sensitive** than cones
- Concentrate at the **outer edges** of the retina
- Responsible for **peripheral vision**
- Responsive in the **498nm** wavelength
- **Slower** response than cones i.e. 100ms.



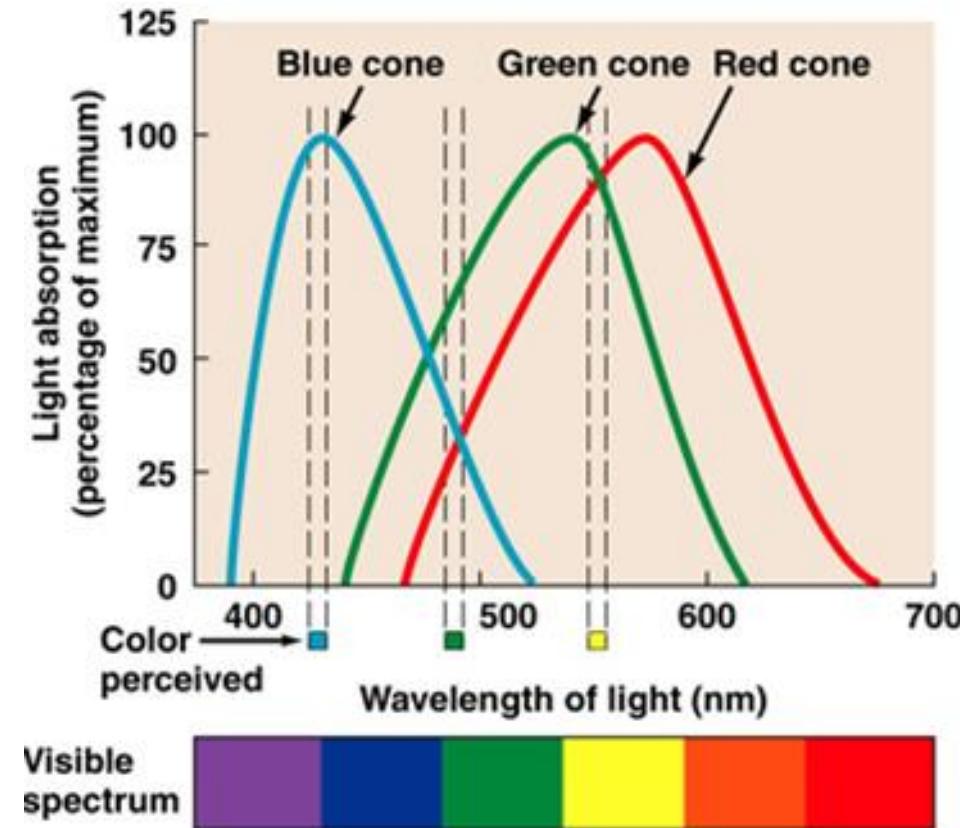
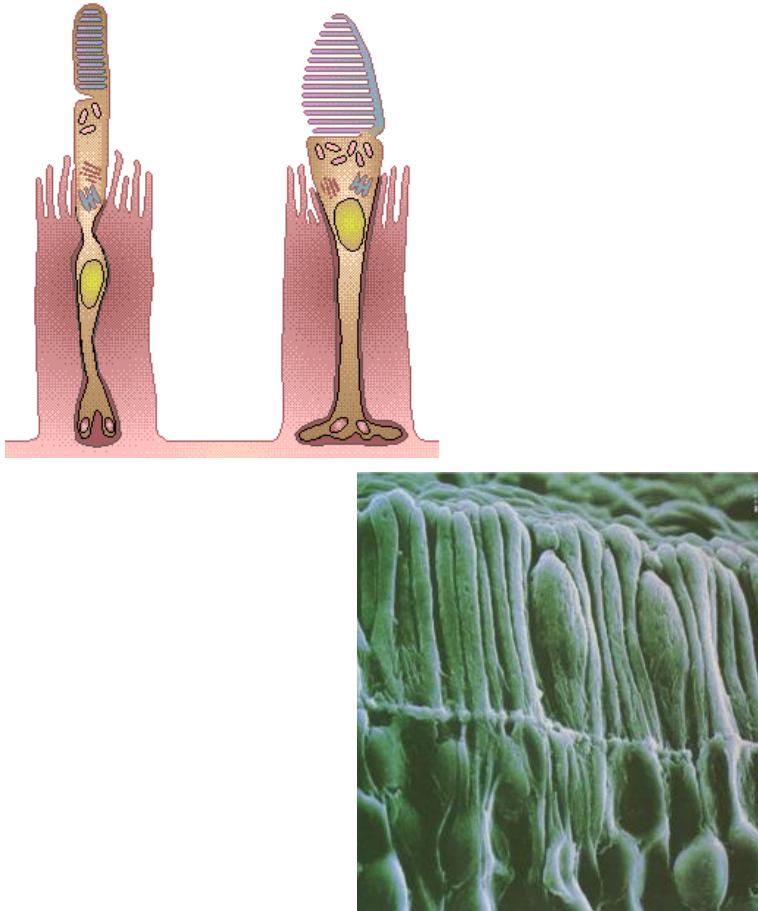
# What do Cones do?



- About **6** million cone cells.
- Responsible for **bright** light.
- Responsible for **color vision**.
- **Less sensitive** to dim light.
- **Faster** response to changes in light.
- **Sensitive** to **moving objects**

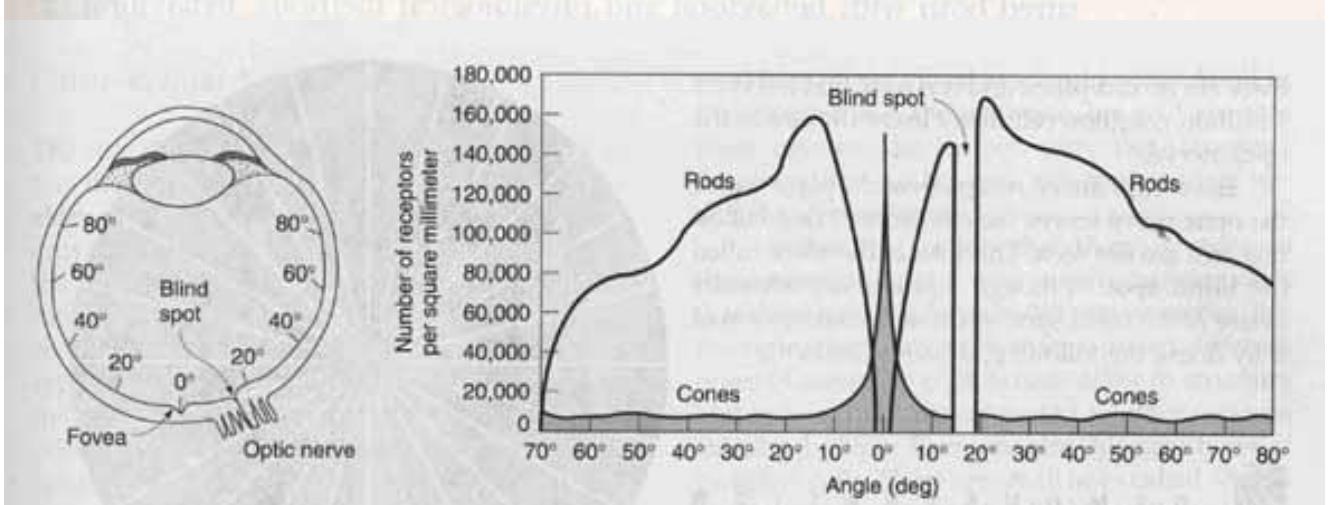
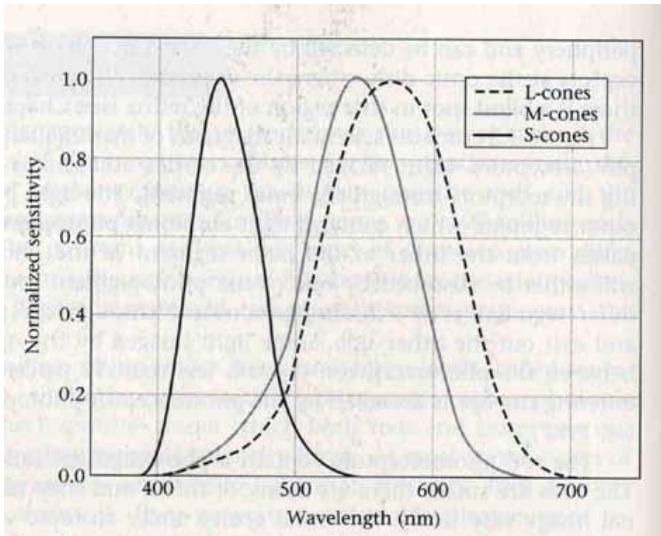
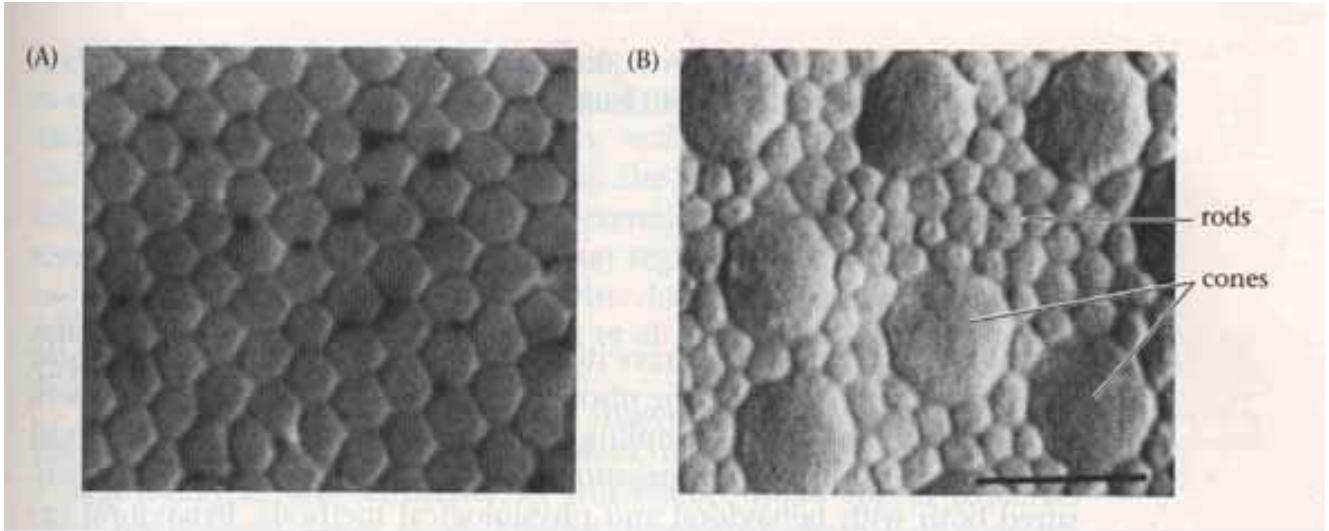
# Cones

- Sensitivity to EM Spectrum



# Three Types of Cones

- L-cones
- M-cones
- S-cones



# Cone Types

- L-Cones: Long – respond to light of long wavelengths:  $564\text{-}580\text{nm}$  = yellow
- M-Cones: Medium – respond to light of medium wavelength:  $534\text{-}545\text{nm}$  = green
- S-Cones: Short – respond to light of short wavelength:  $420\text{-}440\text{nm}$  = violet

# How do cones work?

- The cones perform **spectral filtering** in three ranges of wavelengths of light.

