Single Lens Imaging System

Figure 29.8B

Retina
Optic nerve
Fovea
Optic nerve fibers
Photoreceptors
Cone, Rod
Neurons
Retina
Optic nerve
Fovea

AQUEOUS
LENS
CORNEA
IRIS
LIGAMENTS
MUSCLE
SCLERA
VITREOUS
RETINA
MACULA-FOVEA
OPTIC NERVE
BLIND SPOT

Object plane
Aperture plane
Image plane

Object plane
Aperture plane
Image plane

Object plane
Aperture plane
Image plane

Object plane
Aperture plane
Image plane
Human photoreceptor cells are named for their shapes
- Rods
- Cones

Vertebrate Eye

Three Cone Opsins (red, green, blue)
Robert Hooke (1635 - 1703)

Built one of the first useful compound microscopes
Observed structure of cork
Coined the term “Cell”.
Published *Micrographia* (1665)

1665  Hooke publishes *Micrographia*
1678  van Leeuwenhoek observes protozoa (“little animals”)  
1838-9  Schleiden & Schwann proposed “Cell Theory”  
1860  Pasteur confirms Cell Theory  
1931  Ruska invents electron microscope  
1932  Zerniki develops phase contrast microscopy  
1955  Minsky invents the laser scanning microscope (LSM)  
1989  Webb, Denk & Strickler invent multiphoton LSM

![Robert Hooke's microscope](image1)

![Robert Hooke's microscope](image2)

![Von Leeuwenhoek Microscope](image3)

![Robert Hooke's microscope](image4)
Anatomy of a Compound Microscope

- Janssen Compound Microscope (circa Early 1600s)
  - Objective
  - Body Tube
  - Eyepiece

- Hooke Microscope circa 1670
  - Oil Lamp
  - Water Flask
  - Specimen Holder

- Zeiss Laboratory Microscope circa 1830s
  - Focus
  - Mechanical Stage
  - Condenser

- Anatomy of a Compound Microscope
  - Eye piece
  - Objective turret
  - Stage
  - Substage
  - Condenser
  - Base
  - Lamp housing
  - Stand
Contrast Microscopy

Koehler Illumination
Dark Field
Phase Contrast
Differential Interference Contrast
Hoffman Modulation

Condensers
Koehler Illumination

Condenser lens is adjusted so that an image of the field diaphragm is focused onto the object (specimen) plane.

1. focus specimen
2. stop down field diaphragm until edges are visible
3. focus condenser until image of field diaphragm is sharp
4. open field diaphragm until edges are no longer visible
Conjugate Planes of Focus

Path of “Imaging Rays”

Conjugate Planes

Path of “Illuminating Rays”

Light Paths

Illuminating and imaging rays do not share conjugate planes
Projector vs Microscope

Microscope produces a virtual image of the back focal plane of the objective
Histochemistry

Hematoxylin & Eosin (H & E stain)

Immunohistochemistry

Oil immersion

Effect of Oil

Contrast Microscopy

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Darkfield Images

Brightfield

Darkfield

Figure 3

Figure 4