UNDERSTANDING KERATOMETRY & SLIT LAMP BIOMICROSCOPY

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OVERVIEW

1. Describe the functions of the Keratometer
2. Identify the various components of the system
3. Discuss the methods of calibration and maintenance
5. Demonstrate the use and be able to interpret the results obtained
6. Convert the information gathered about the corneal curvature into useful information relating to contact lens fitting and problem solving

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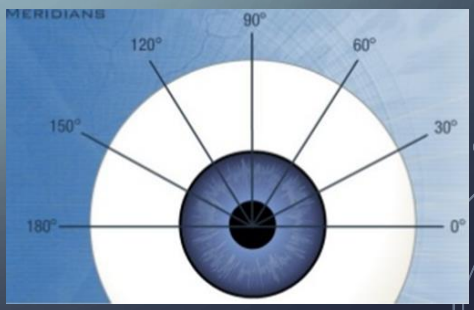
FUNCTIONS

- Measures the central anterior curvature of the cornea, detecting and measuring corneal astigmatism
  - 3mm to 3.2mm zone
- The measurement provides the dioptric power of the steepest and flattest meridians and defines its location
- A skilled operator can detect astigmatism, irregular astigmatism, oblique astigmatism and keratoconus



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KERATOMETER

COMPONENTS & OPTICAL SYSTEM

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KERATOMETER PARTS

A. Focusing Knob
B. Rotating Grip for Locating the Axis
C. Chin Rest
D. Locking Knob
E. Elevating Knob
EP. Eyepiece
G. Head Rest Adjusting Knob
H. Occluding Shield
HR. Head Rest
J. Chin Rest Adjusting Knob
K. Leveling Sight
M. Horizontal Measuring Drum
N. Vertical Measuring Drum
S. Axis Scale

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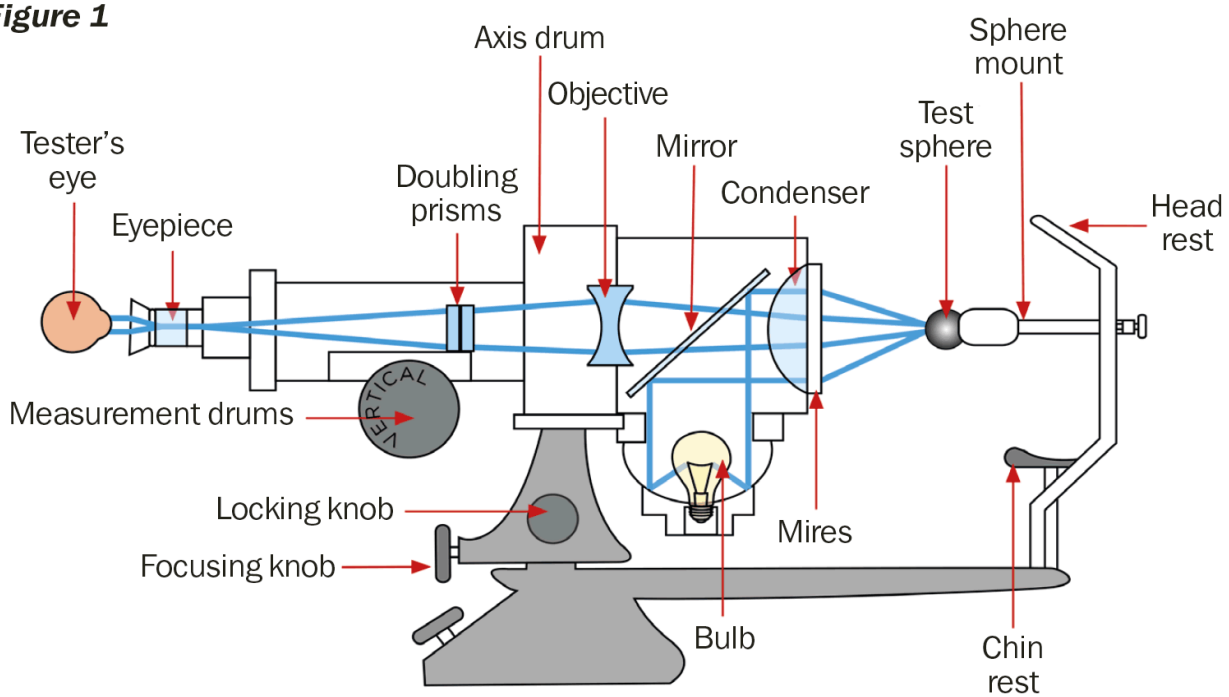
Figure 1



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KERATOMETRY

UNDERSTANDING ASTIGMATISM

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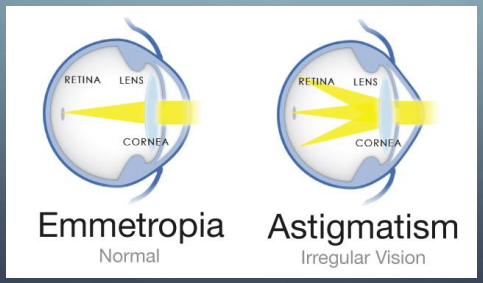
REGULAR ASTIGMATISM

- Refractive error that prevents light rays from coming to a single focus on the retina because of different degrees of refraction



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RESIDUAL/LENTICULAR ASTIGMATISM

- The remaining astigmatism correction after the corneal astigmatism is neutralized or corrected with a contact lens
- Could also be a patient with a spherical cornea but has refractive astigmatism
- Usually located in the intraocular lens of the eye

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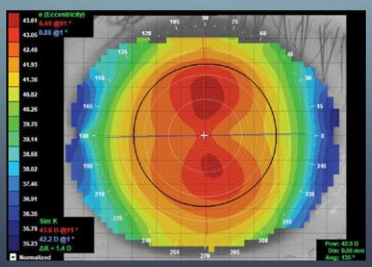
WITH THE RULE ASTIGMATISM

- Vertical meridian has the steepest curvature
- Through spectacles, the astigmatic patient will view a square that is slightly longer in the horizontal meridian



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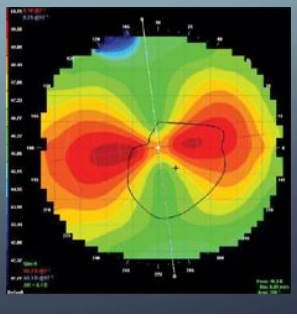
AGAINST THE RULE ASTIGMATISM

- Horizontal meridian has the steepest curvature
- Through spectacles, the patient will view a square that is slightly elongated in the vertical meridian



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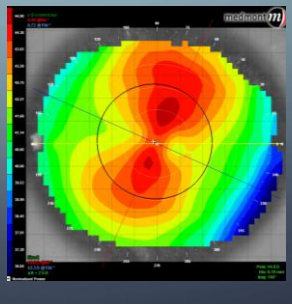
OBLIQUE ASTIGMATISM

- The greatest refractive power is within 30 degrees of the oblique meridians (axis 30-60 or 120-150)
- Through spectacles, the patient will view a square that is slightly tilted



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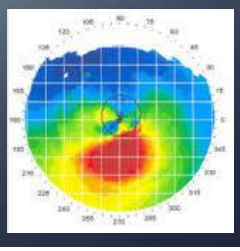
IRREGULAR ASTIGMATISM

- Often caused by trauma, inflammation, scar tissue, post refractive surgery or corneal disease such as Keratoconus.
- Most often a gas permeable lens is the only way to neutralize the irregular cornea so that the light can be focused on the retina in order to get clear vision.



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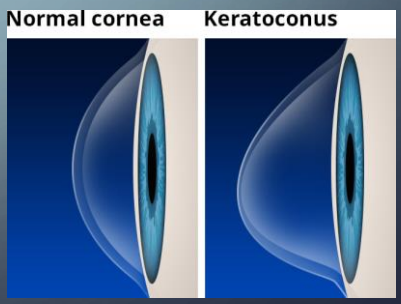
KERATOCONUS

- A degenerative corneal disease resulting in a generalized thinning and cone-shaped protrusion of the central cornea, often occurring in both eyes
- Mild: less than 45 diopters in both meridians
- Moderate: 45-52 diopters in both meridians
- Advanced: greater than 52 diopters in both meridians
- Severe: greater than 62 diopters in both meridians



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TYPES OF ASTIGMATISM

- Simple Astigmatism

  One focal line falls on the retina (one meridian is emmetropic), the other meridian may fall in front or behind the retina

  Simple astigmatism Plano -2.00 x 180

- Compound Astigmatism

  Both focal points lie either in front or behind the retina

  Compound myopic astigmatism -1.00 -2.00 x 180

  Compound hyperopic astigmatism +2.00 -1.00 x 180

- Mixed Astigmatism

  One focal point lies behind the retina and the other focal point lies in front of the retina

  Mixed astigmatism +1.00 -2.00 x 180

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USING THE KERATOMETER

MEASUREMENTS, TECHNIQUE AND RANGE

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ADJUST THE EYEPIECE

- Turn on the instrument
- Place a sheet of white paper over the back of the Keratometer
- Rotate the eyepiece fully counterclockwise
- Keep both eyes open, turn the eyepiece in the clockwise (plus) direction until the cross hairs come into sharp focus

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CALIBRATION

1. Verify and properly focus eyepiece
2. Obtain and verify readings from several steel spheres of differing radii of curvature
3. Routine measurement of bench-mark eye to verify accuracy

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STANDARD KERATOMETRY READINGS

- In the average eye, Keratometry readings are in the range of 43 to 44 diopters
- When comparing to the fellow eye, Keratometry readings and corneal cylinder should be within 1 diopter. Differences should be double checked
- Keratometry readings less that 40 and more than 47 diopters are unusual and should be double checked

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EXTENDING THE RANGE

- A +1.25D or -1.00D diagnostic lens can be held adjacent to the front of the keratometer to extend the dioptric range of the drum readings
  - +1.25D lens for steep corneas to extends range to 61 D
    - Add 9 D to actual drum reading
  - -1.00D lens for flat corneas extends range to 30 D
    - Subtract 6 D to actual drum reading
- Mathematical calculation or nomogram is used to determine the extended range keratometric reading based on the actual drum reading

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Extended Keratometer Range with +1.25D Lens		Extended Keratometer Range with -1.00D Lens	
Actual Drum Reading	**Extended Value**	**Actual Drum Reading**	**Extended Value**
45.00D	52.46D	36.00D	30.87D
45.25D	52.76D	36.25D	31.09D
45.50D	53.05D	36.50D	31.30D
45.75D	53.34D	36.75D	31.51D
46.00D	53.63D	37.00D	31.73D
46.25D	53.92D	37.25D	31.95D
46.50D	54.21D	37.50D	32.16D
46.75D	54.51D	37.75D	32.37D
47.00D	54.80D	38.00D	32.59D
47.25D	55.09D	38.25D	32.80D
47.50D	55.38D	38.50D	33.02D
47.75D	55.67D	38.75D	33.23D
48.00D	55.96D	39.00D	33.45D
48.25D	56.25D	39.25D	33.66D
48.50D	56.55D	39.50D	33.88D
48.75D	56.84D	39.75D	34.09D
49.00D	57.13D	40.00D	34.30D
49.25D	57.42D	40.25D	34.52D
49.50D	57.71D	40.50D	34.73D
49.75D	58.00D	40.75D	34.95D
50.00D	58.30D	41.00D	35.16D
50.25D	58.59D	41.25D	35.38D
50.50D	58.88D	41.50D	35.59D
50.75D	59.17D	41.75D	35.81D
51.00D	59.46D	42.00D	36.02D

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MEASURE MID-PERIPHERAL CORNEA

- Mid-peripheral readings can be taken by placing auxiliary fixation points affixed to the mire illumination plate of the keratometer
  - Place four fixation dots 4.0 mm from the edge of the 20.0 mm keratometer viewing port.
  - For example: The examiner can first record central keratometry readings followed by redirecting the patients fixation to the nasal dot to measure the temporal corneal topography with the horizontal dial of the keratometer.

When taking these mid-peripheral readings, one side of the mire falls on a steeper portion of the cornea and the other on a flatter portion of the cornea. The measurement between these two points is the mean of the two points. As you move more peripherally, the errors in the measurements will increase.

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RECORDING THE VALUES

- Horizontal Measuring Drum

The power is established for the cornea in the meridians nearest to 0-180 degrees

- Vertical Measuring Drum

The power is established for the cornea in the meridian nearest to 90 degrees

- The difference between these two readings is the amount of corneal astigmatism
- If they are the same, there is no measurable astigmatism

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CORNEAL ASTIGMATISM

- The difference between the horizontal meridian and the vertical meridian constitutes the corneal astigmatism
  - 45.25 @ 180 / 44.25 @ 090 = 1.00 D of cylinder
  - Plus cylinder
    - The axis is the axis of the higher diopter power
  - Minus cylinder
    - The axis is the axis of the lower diopter power
    - Example:
      - 45.00 @ 180 / 46.50 @ 090

        Difference is 1.50D

        Minus cylinder: -1.50 x 180

        Plus cylinder: +1.50 x 090

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KERATOMETRY

MIRES

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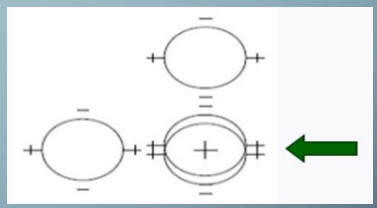
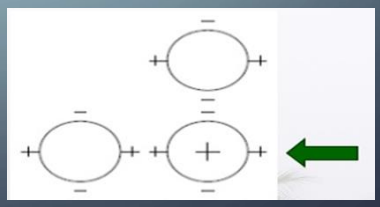
MIRES

- Appearance of mires when they are out of focus



- Appearance of mires when they are in focus
  - Note: The reticle is centered in the bottom right circle or focusing circle



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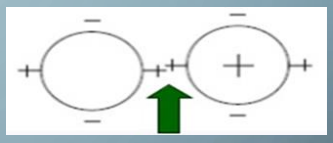
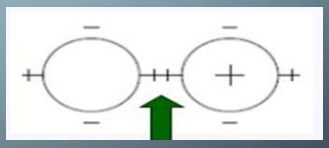
ASTIGMATISM: HORIZONTAL MERIDIAN

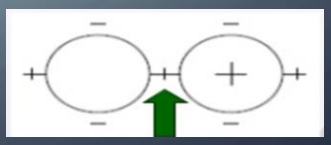
- Vertical misalignment of plus signs indicates astigmatism



- Correct axis alignment when the horizontal lines of the plus appear continuous



- Measuring the Horizontal meridian:
  - Turn the horizontal measuring drum to superimpose the plus signs
  - Leave the horizontal measuring drum in this position



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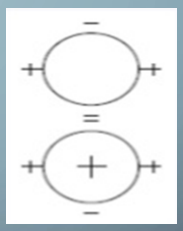
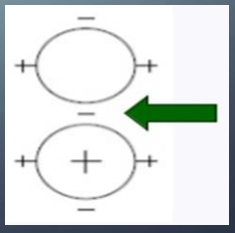
ASTIGMATISM: VERTICAL MERIDIAN

- Turn the right-hand vertical measuring drum until the minus signs are superimposed



- Note: If corneal astigmatism is present, it is impossible to get both principal meridians to focus at one time



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COMMON ISSUES

In taking keratometer readings, the majority of issues are related to:

- Inadequate instrument calibration
- Corneal Abnormalities
  - Irregular shape or contour of cornea
  - Inadequate or excessive tear film
  - Ointment on the cornea
  - Eyelid interference
- Incorrect examination technique
  - Unfocussed eyepiece
  - Distorted mires
  - Off-axis measurements

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QUESTIONS & ANSWERS

KERATOMETRY

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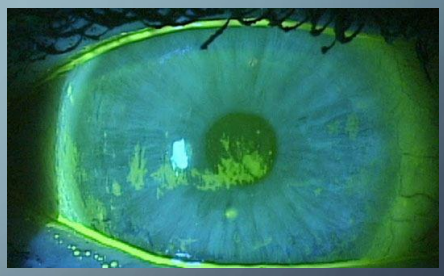
SLIT LAMP

FOR OPTICIANS



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OVERVIEW

1. Describe the functions of the slit lamp
2. Identify the various components of the system
3. Discuss the various principles of optics that are involved in the use of the slit lamp
4. Correctly position slit lamp for illuminations
5. Describe typical abnormalities detectable with the slit lamp
6. Convert the information gathered into useful information relating to contact lens fitting and problem solving

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INTRODUCTION TO SLIT LAMP

- The slit lamp is an instrument consisting of a high-intensity light source that can be focused to shine a thin beam of light into the eye.
- It is used in conjunction with a biomicroscope.
- The binocular slit-lamp provides a stereoscopic magnified view of the eye structures.
- The slit lamp facilitates examination of the eyelids, cornea, sclera, conjunctival, iris, crystalline lens, optic nerve, fovea, macula and retina.
- A second, hand-held lens is used to examine the retina in detail.

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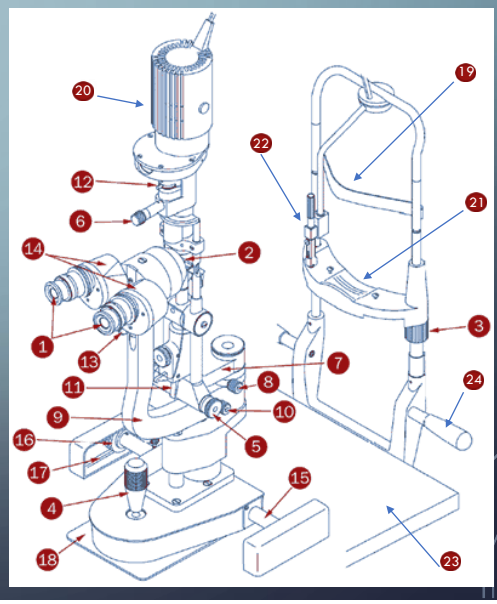
PARTS OF A SLIT LAMP BIOMICROSCOPE

1. Eyepieces
2. Reflecting mirror
3. Chin-rest adjustment knob
4. Joy stick
5. Slit width adjustment knob
6. Adjustment knob for aperture height and slit tilt
7. Illumination system arm
8. Illumination system lock knob to obs. arm
9. Observation system arm
10. Observation system lock knob to base
11. Illumination system tilt adjuster
12. Filter selector switch
13. Magnification selector
14. Binoculars, adjustment for PD
15. Base axle
16. Axle rollers
17. Rails
18. Rolling pad/plate Attached to table
19. Forehead rest
20. Light compartment
21. Chin rest
22. Fixation light
23. Adjustable table
24. Patient's grip handle



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ILLUMINATION SYSTEM CONTROLS

Height

- Can be changed using a knob placed above or adjacent to the filter turret

Width

- Controlled with the width knob placed below

Intensity

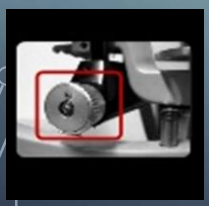
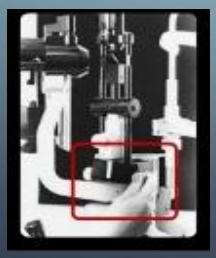
- Can be controlled with the help of the rheostat attached to the voltage box

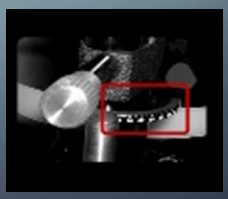
Angle

- Changed by turning the illumination desk and the projection module to match with the angles

Type

- Filter turret
  - Red-free
  - Cobalt Blue
  - Diffuse filter
  - Custom

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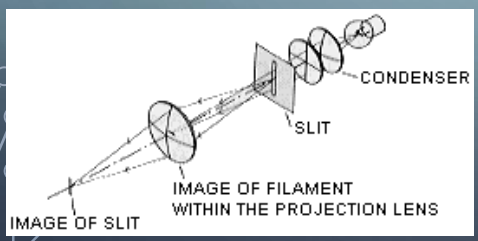
OPTICAL SYSTEM

- Telescopic Lens
- The Kohler illumination system adopted in slit-lamps
- Projection lens has a much shorter focal length
- The filament of light source is imaged by the condenser lenses at or close to the projection lens which in turn forms the image of the slit in the patient's eye



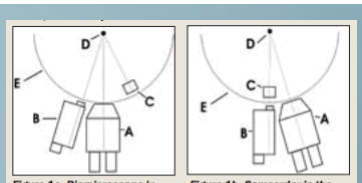
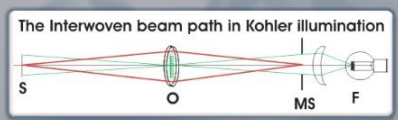


Figure 1a. Biomicroscope in the centre *Figure 1b. Camcorder in the centre*

A = Biomicroscope; B = Camcorder; C = Reflecting mirror of the slit beam; D = Central axis of rotation of all the three optical systems; E = Imaginary arc at which the front surface of all the three optical systems lie in all positions

Illumination system Principle :

Kohler illumination principle is used in both Zeiss & Haag-streit type illumination system.



The light filament (**F**) is imaged on to the objective lens (**O**) but the mechanical slit (**MS**) is imaged on on to the patient's eye (**S**)

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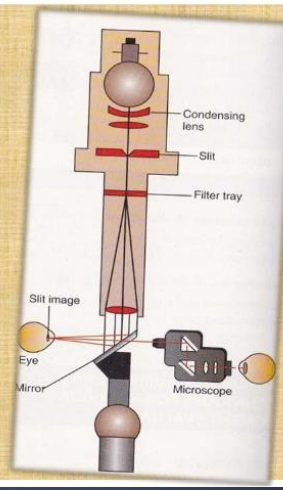
CROSS-SECTION MODERN SLIT-LAMP

Cross-section of observation system of modern slit-lamp



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ILLUMINATION TECHNIQUES

- Direct Illumination
- The illumination beam and observation focus are on the same target
  - Direct Diffuse Illumination
  - Direct Focal Broad Beam Illumination
  - Parallelpiped
  - Optic Section
  - Conical Beam

- Indirect Illumination
- The illumination beam and observation focus are not on the same target.
  - Indirect Proximal Illumination
  - Retro Illumination
  - Specular Reflection
  - Sclerotic Scatter
  - Tangential Illumination

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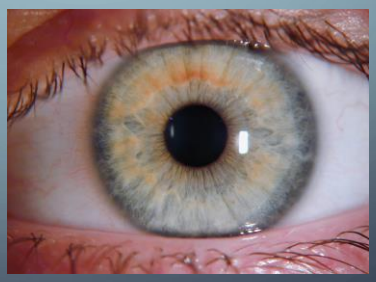
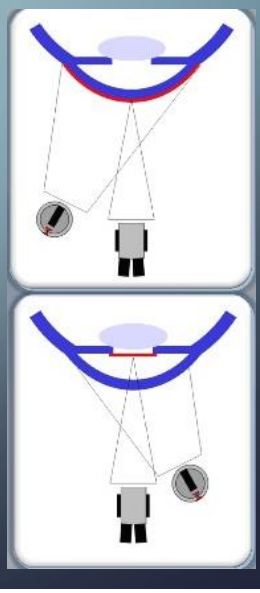
DIRECT DIFFUSE ILLUMINATION

- Gives a good overall picture of the eye, but no fine details. It is used primarily for a general survey of the eye.
- The light beam is opened all the way.
- Direct the light onto the eye at a 30 - 45 degree angle.
- The microscope is directed straight ahead.
- Magnification 6x to 10x
- General gross view of eyelids, eyelashes, caruncle, sclera, blood vessels, pupil, iris





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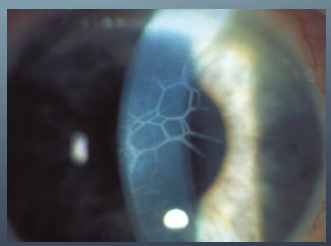
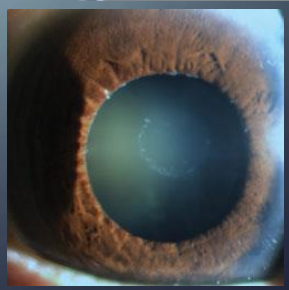
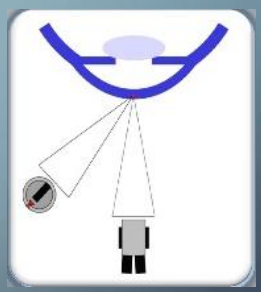
FOCAL BROAD BEAM ILLUMINATION

- The microscope is directed straight ahead
- Slit width narrow to broad
- Illumination angle is 45 to 60 degrees
- Magnification 5x – 15x

- Used to view details of the cornea, anterior chamber and crystalline lens
- Used to evaluate cell and flare in the anterior chamber







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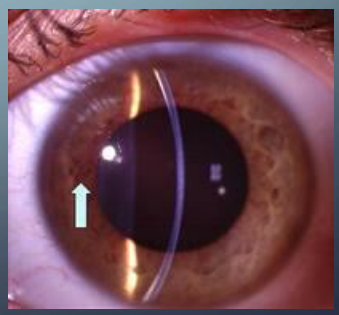
PARALLELPIPED

- Beam of light that has two parallel sides
- Slightly wide beam (2-3mm) that reveals "block" of cornea
- Provides 3 dimensional layered view (width, height, depth)
- Magnification 5x – 45x
- Illumination angle is 45
- Used to evaluate abrasions, scarring, epithelium, neovascularization, foreign body
- Used to determine the fit of a contact lens after fluorescein has been instilled in the eye.



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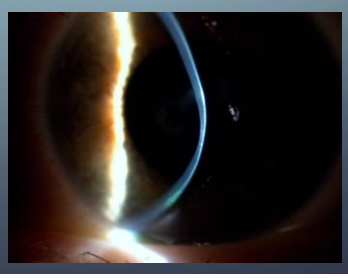
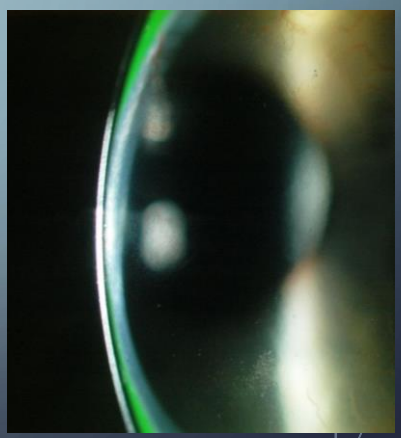
OPTIC SECTION

- Slit width is 1mm or less
- Illumination angle is 45 – 60 degrees or more
- High illumination and magnification
- Used to evaluate the corneal depth, layers, scars, vessels





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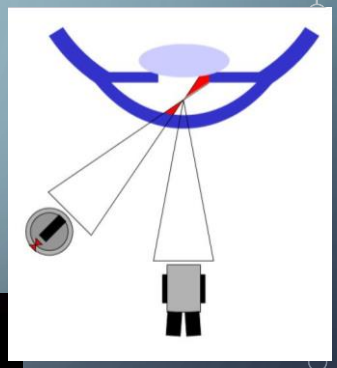
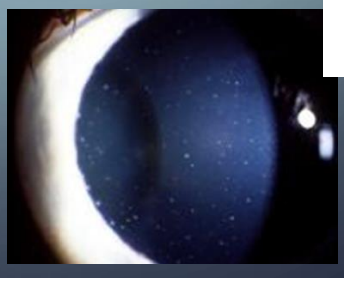
CONICAL BEAM

- Small circular illumination 0.3mm – 0.5mm
- Used to assess particles floating in the anterior chamber
- Used to evaluate inflammation cells, pigmented cells and metabolic waste





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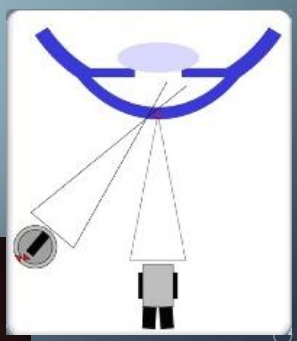
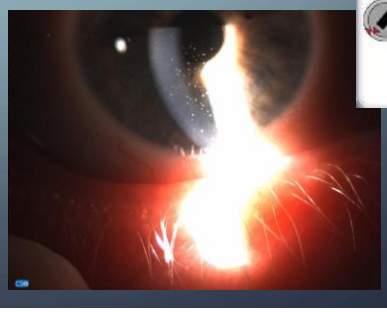
INDIRECT PROXIMAL ILLUMINATION

- The beam is focused in an area adjacent to the ocular tissue being observed
- Decentered beam
- Slit width is 2mm -4mm
- Magnification is low to medium
- Used to evaluate infiltrates, corneal scars, lens deposits and corneal defects





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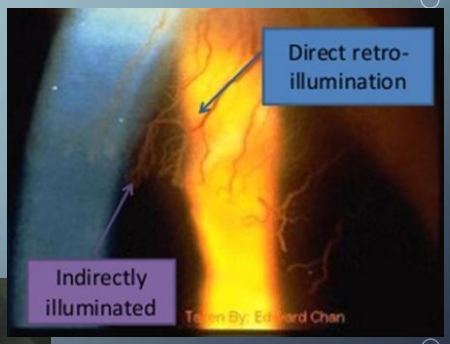
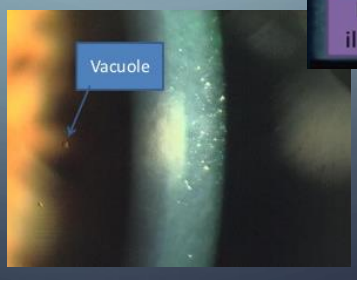
RETRO ILLUMINATION

- Light beam is reflected on iris or fundus
- Microscope is focused on the cornea
- Direct and Indirect
- Used to assess epithelial cysts, infiltrates, vacuoles, microcysts, small blood vessels, small scars





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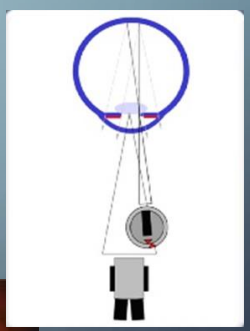
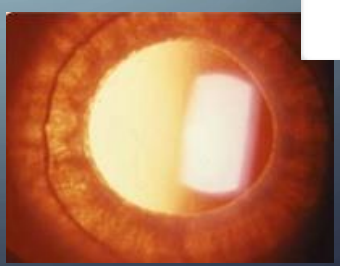
IRIS TRANSILLUMINATION

- Indirect light reflected from the fundus
- Mid-dilated pupil (3mm-4mm)
- Illumination and observation at coaxial position
- Used to visualize defects in the pigment layer of the iris





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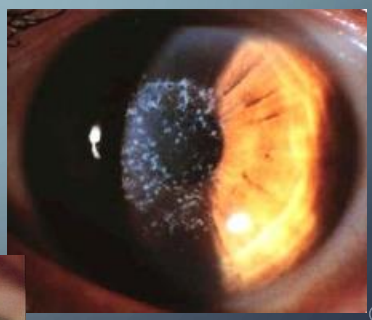
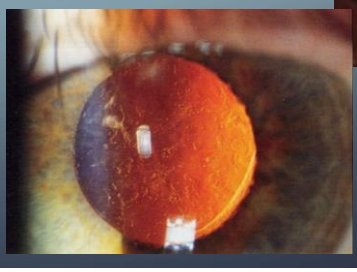
INDIRECT RETRO ILLUMINATION

- Observer to the right angle of the observed structures
- Pathology on the cornea is viewed against a dark background
- Medium slit width of 2mm to 4mm





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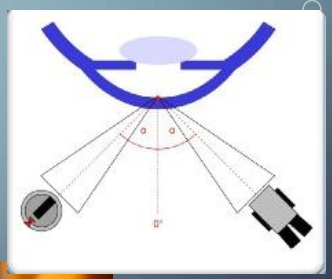
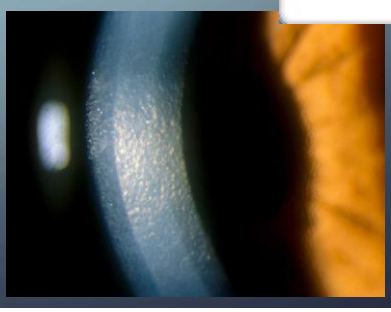
SPECULAR REFLECTION

- Angle of incidence = angle of reflection
- Observation and illumination have the same angle with perpendicular axis to each other
- Slit width < 4mm
- Magnification 25mm – 40mm
- The light reflected from the anterior or posterior corneal surface
- Used to assess corneal layers, tear film and contact lens surface





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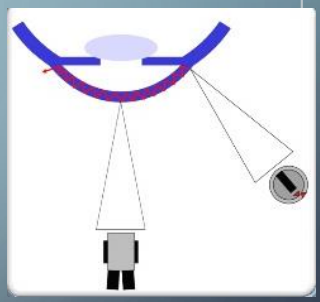
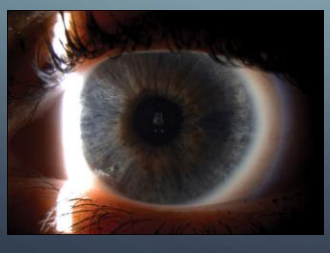
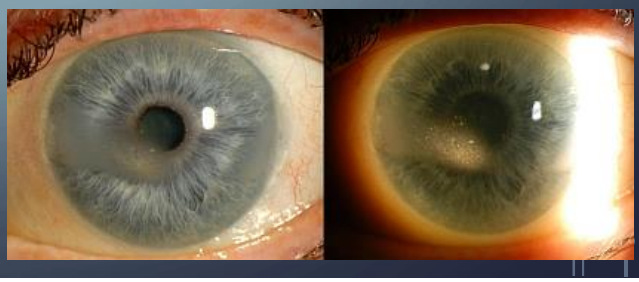
SCLEROTIC SCATTER

- Light is focused on the limbus
- Slit width is 2mm – 4mm
- Angle is 45 degrees to 60 degrees
- Microscope is focused centrally
- Total internal reflection of the corneal layers
- Used to assess scars, corneal defects, edema and corneal irregularities







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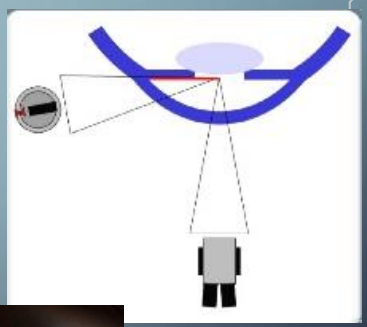
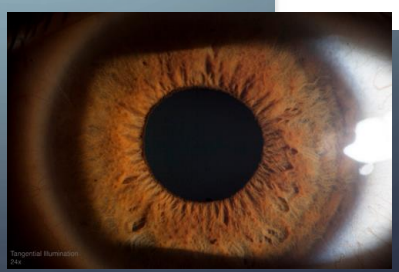
TANGENTIAL ILLUMINATION

- Narrow light beam is projected almost parallel along the structure being observed
- Elevated structures are visible by shadowing
- Illumination angle 90 degrees
- Magnification 10x – 25x
- Used to assess elevated abnormalities or changes in the iris
  - Cysts, tumors





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OSCILLATION

- A back and forth sweep between direct and indirect illuminations
- Helps to reveal fine corneal scars, opacities or lesions
- Moderate slit beam is used
- Magnification is 10x

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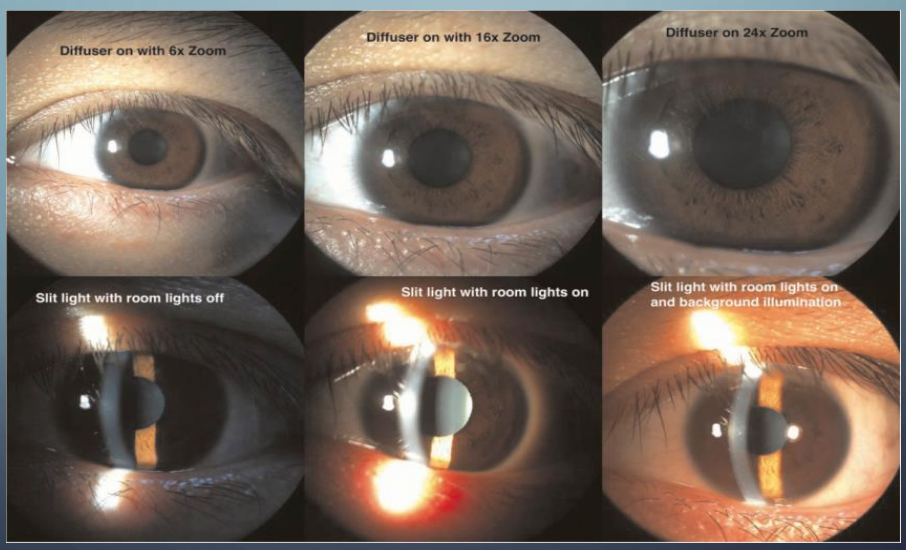
MAGNIFICATION



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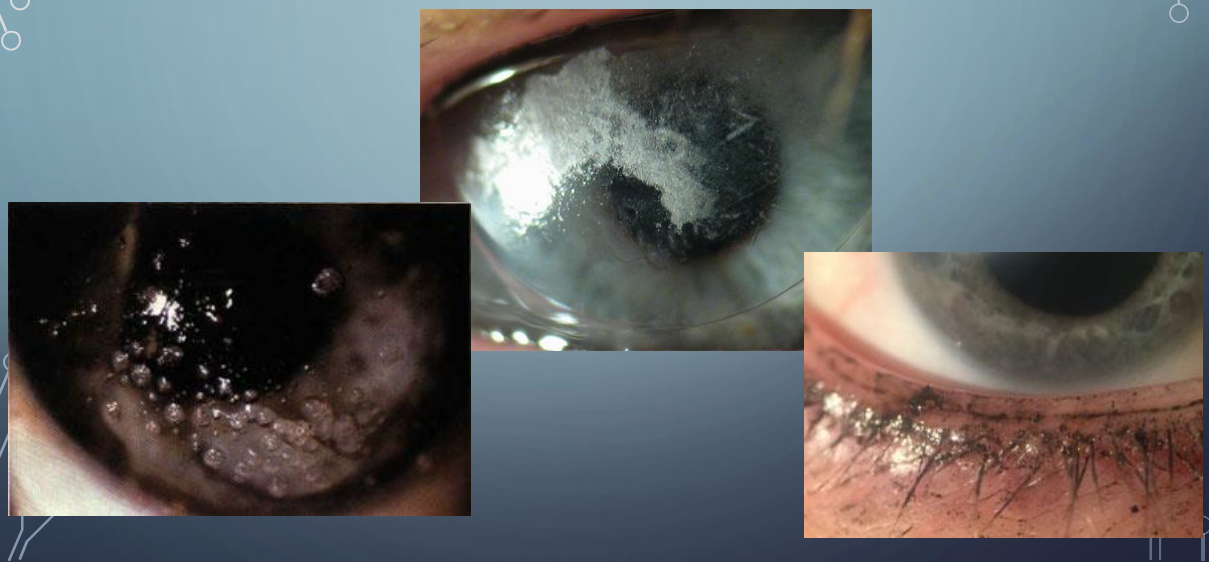
CONTACT LENS DEPOSITS



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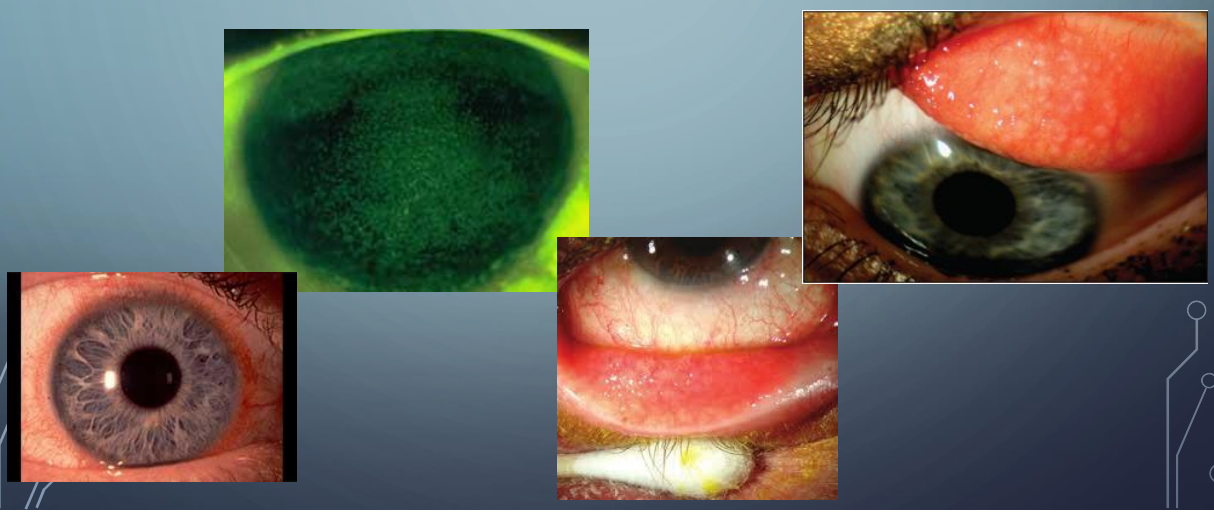
HYPERSENSITIVITY TO CONTACT LENS SOLUTION



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QUESTIONS & ANSWERS

SLIT LAMP

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