Vision

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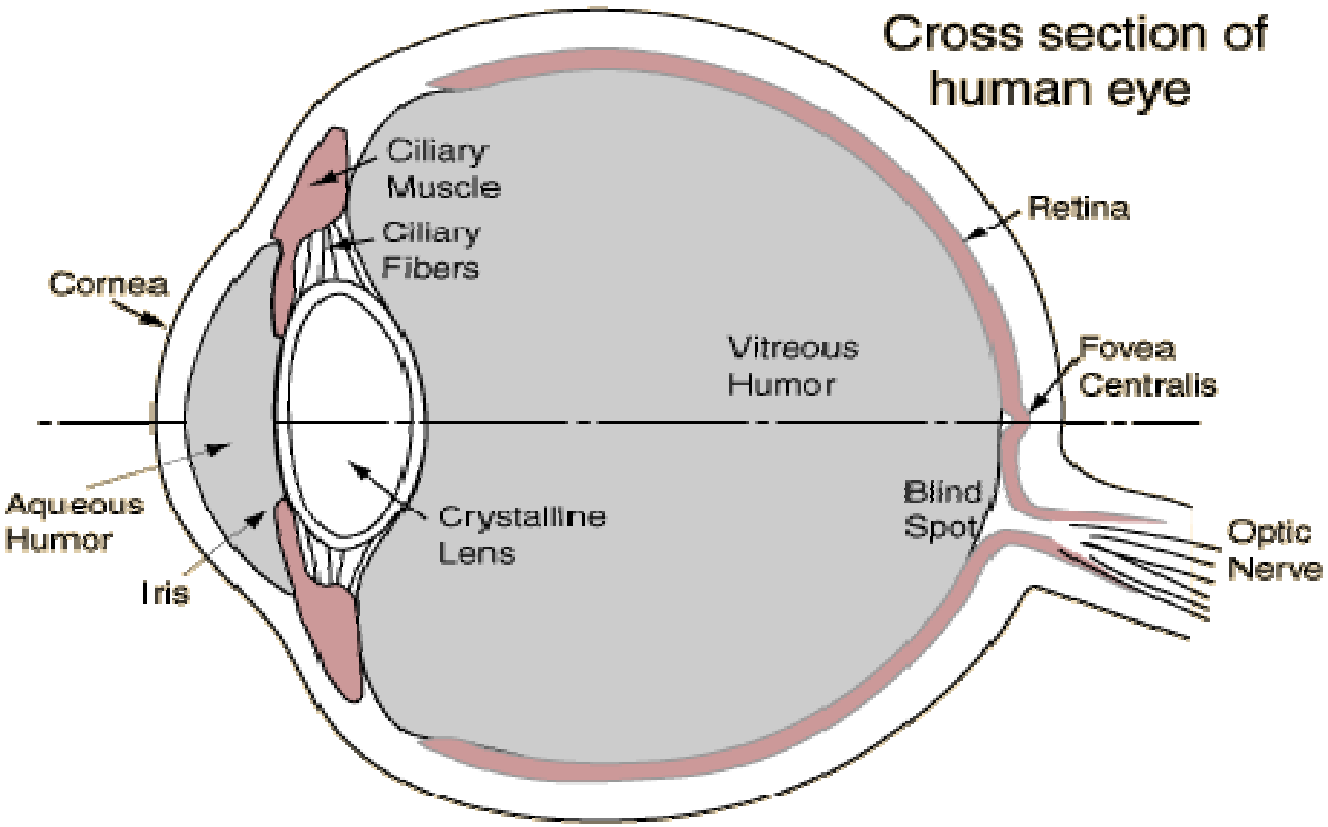
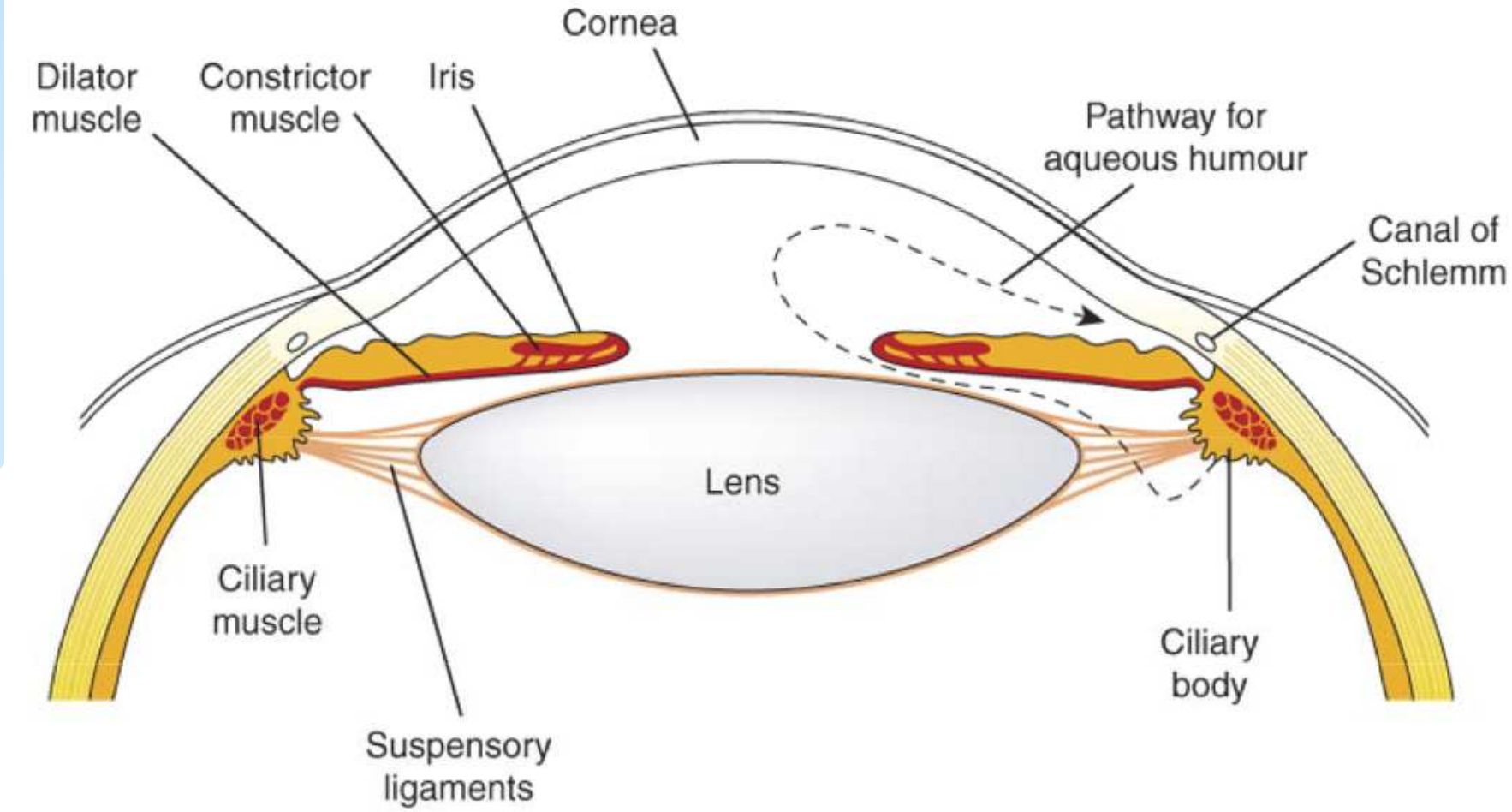
Human eye

The **eye ball** is a sensory organ serving for our **vision**. It is almost a sphere covered with an outer white layer called the **sclera**. It is elastic and relatively rigid. In the front part of the eye, the sclera becomes transparent, and it is called the **cornea**.

The optical media of the eye are the following: cornea, **aqueous humour** (a liquid between the cornea and the lens), **crystalline lens**, and **vitreous humour** (a gel-like substance which fills the eye ball). After passing through these optical media, the light rays fall on the innermost tissue layer of the eye – the **retina** – and form a **real inverted image** there.



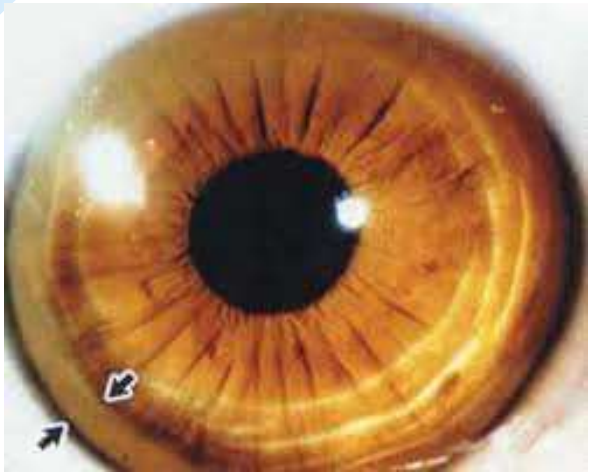
Anatomy of human eye



Anatomy of human eye

Human eye

The **resolution threshold** (the ability to distinguish two points at a small distance from each other) of the human eye is given by a viewing angle of 1’ (one minute of arc).
The **iris** regulates the amount of light entering the eyeball.



Human eye

In the retina, there are photosensitive cells called **cones** (responsible for colour vision) and **rods** (ensuring vision in darkness). The cones are concentrated in the central part of the retina, which is called the **yellow spot**. The retina has specific cones for red, green and blue colours. The excitation of the photosensitive cell is due to the photochemical disintegration of substances called **visual purples** – **rhodopsin** (in rods) or **iodopsin** (in cones).

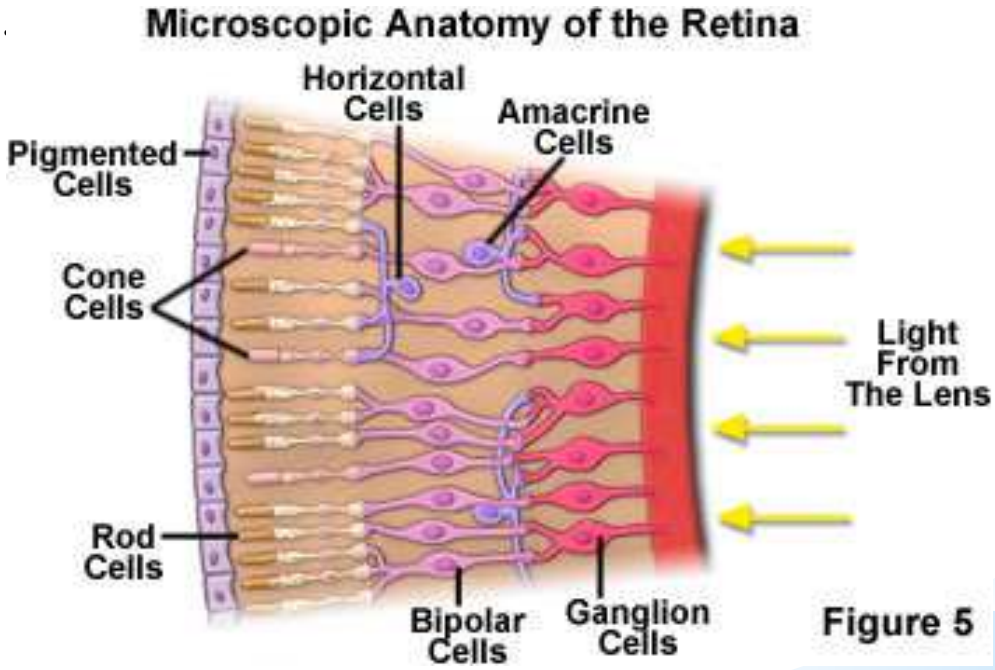
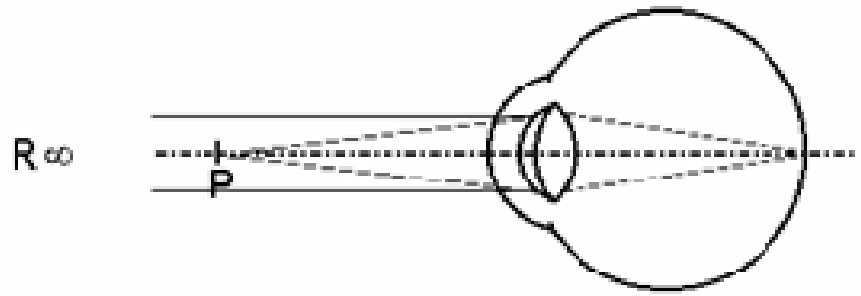


Figure 5

Human eye

Accommodation is the ability of the eye to change its dioptric power. It is ensured by a change of lens curvature due to the activity of the **ciliary muscles**. The **near point** is the minimum distance at which an object can be seen sharply, i.e. at which a sharp image is formed on the retina. Similarly, the **far point** is the maximum distance of an object allowing sharp vision. In a normally seeing eye, the far point lies at infinity. A frequently used term is the **distance of most distinct vision** (also "**convention visual distance**") which value is 25 cm.

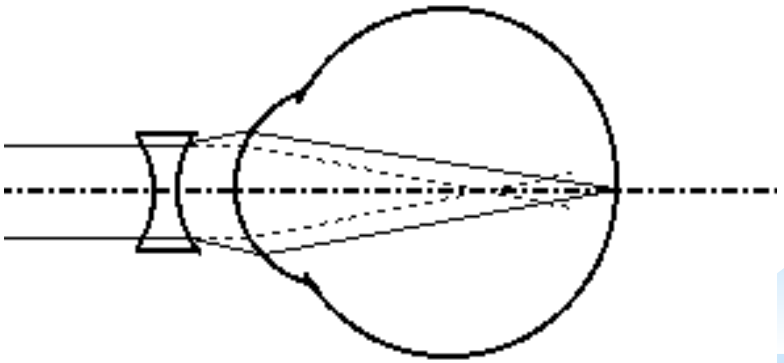


Accommodation of the eye. To see sharply the near point P (*lat. punctum proximum*), the curvature of the lens is maximal. R – far point (*lat. punctum remotum*).

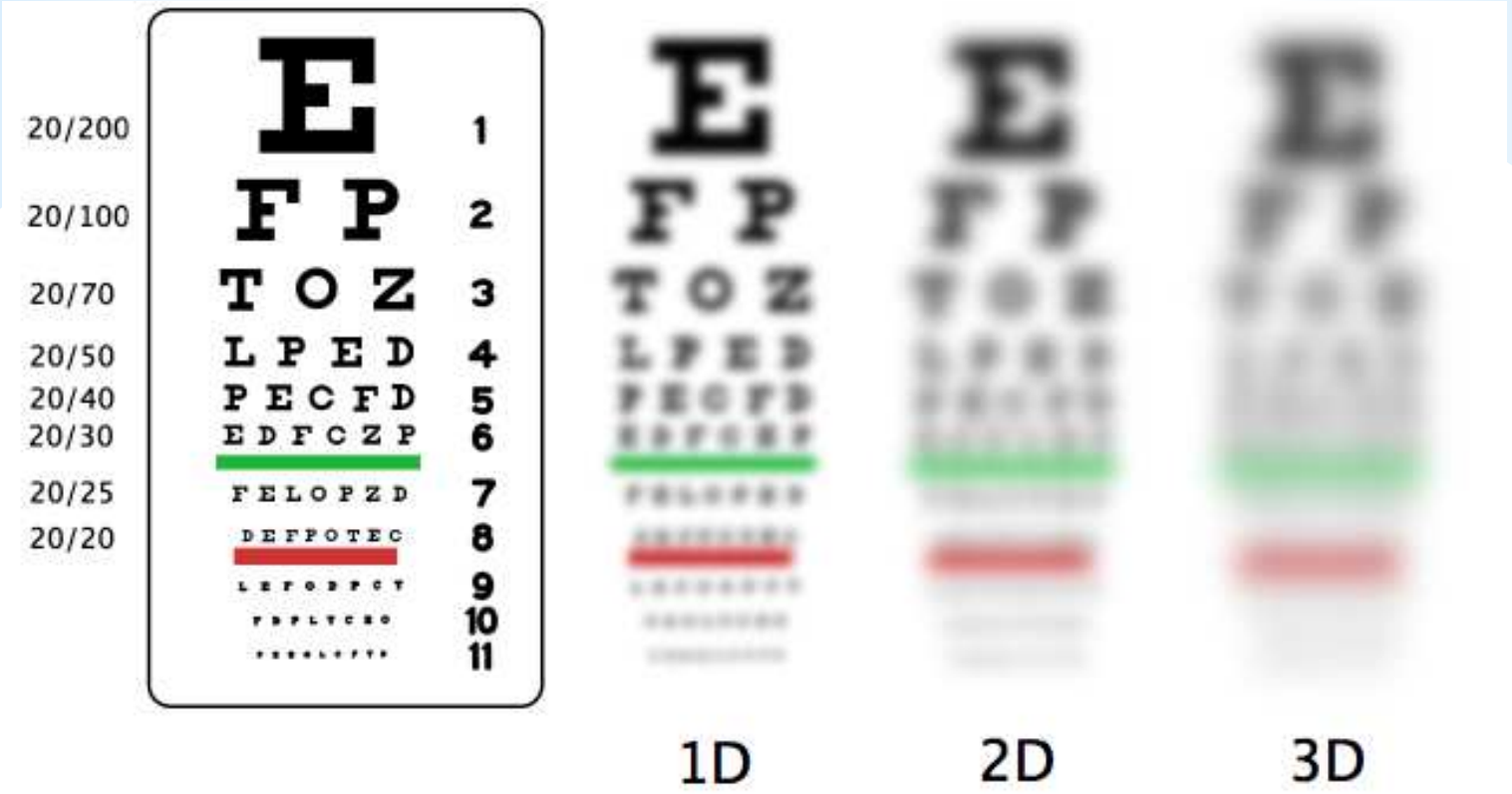
Human eye

The two most important optical aberrations of an ametropic (i.e. not normally seeing) human eye are called myopia (nearsightedness) and hyperopia (farsightedness). An eye capable of normal vision is called emmetropic.

In the case of myopia, the dioptric power of the cornea and/or crystalline lens is higher than the normal value, and „the image is formed in front of the retina“. This aberration can be corrected by a diverging lens.

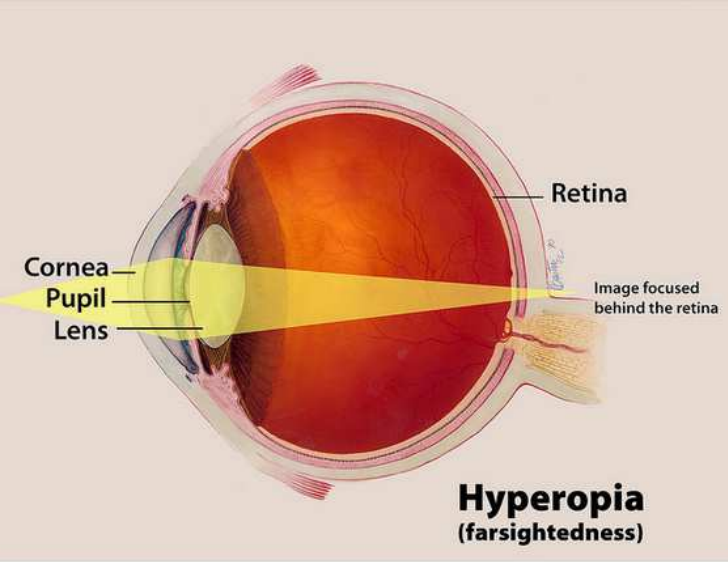


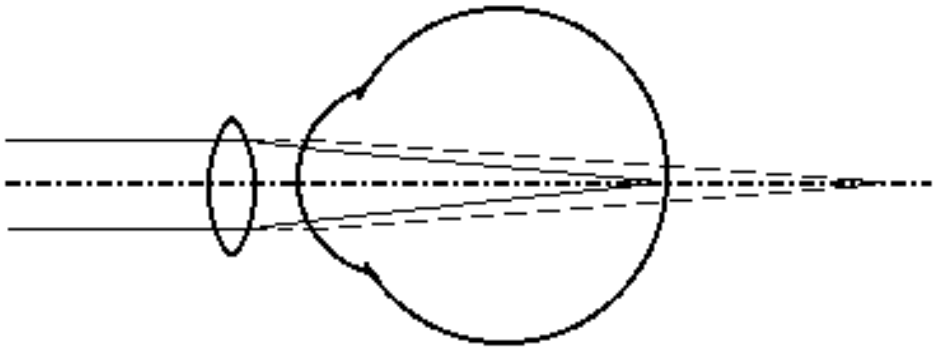
Human eye


20/200
20/100
20/70
20/50
20/40
20/30
20/25
20/20
1
2
3
4
5
6
7
8
9
10
11
1D
2D
3D

Human eye

A hyperopia, the dioptric power of the cornea and/or crystalline lens is lower than the normal value, and the image would be formed „behind the retina“. This aberration can be corrected by a converging lens.





Human eye

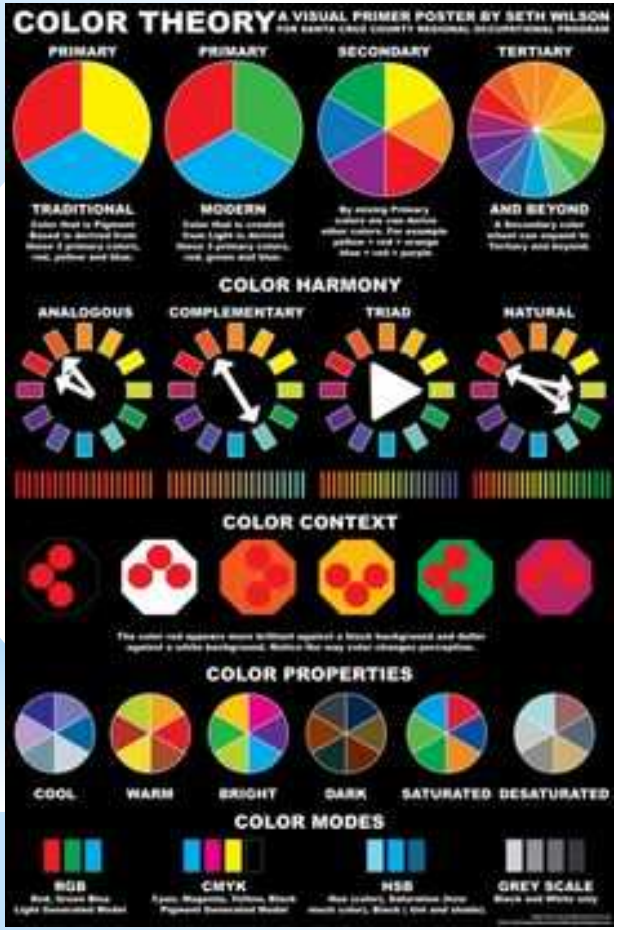
NEAR VISION CHART 200

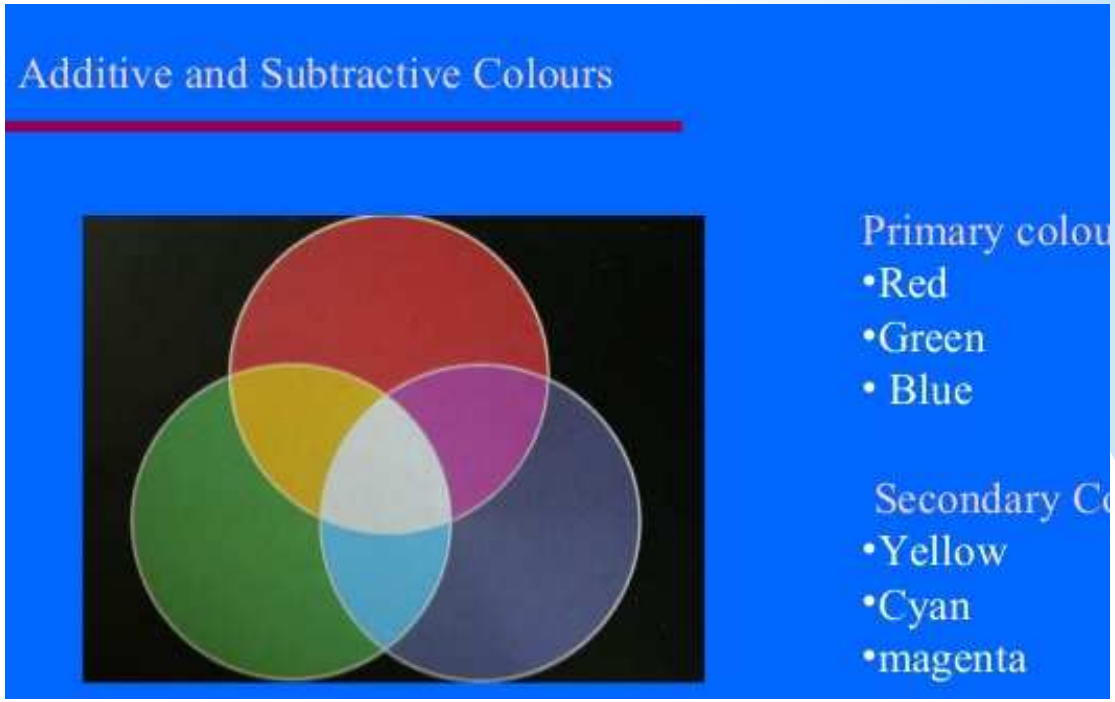
	DISTANCE CORRELATION	JAEGER	POINT SIZE	VISUAL EFFICIENCY %
D T 4	20/800		72	5%
L E S 3	20/400		42	10%
R F X B N	20/250	18	30	15%
P O 5 7 A	20/200	16	26	20%
9 V M C L	20/100	10	14	50%
K S 3 Z 7	20/70	7	10	65%
N R E T X	20/50	5	8	75%
O R D F M P	20/40	3	6	85%
V J F X G H	20/30	2	5	90%
P 3 S E A R	20/20	1	4	100%

This card has been specially designed for the vision care practitioner to aid in standardized measurements of near point acuity. This card should be held at approximately 16 inches away from the patients face under standard room illumination.

Human eye

Color vision





Human eye

Color vision

Trichromats
Dichromats
monochromates

Optical instruments

A **magnifier** or **magnifying glass** is any converging lens whose focal distance is smaller or equal to 25 cm, i.e. dioptric power equal or greater than 4 dpt.

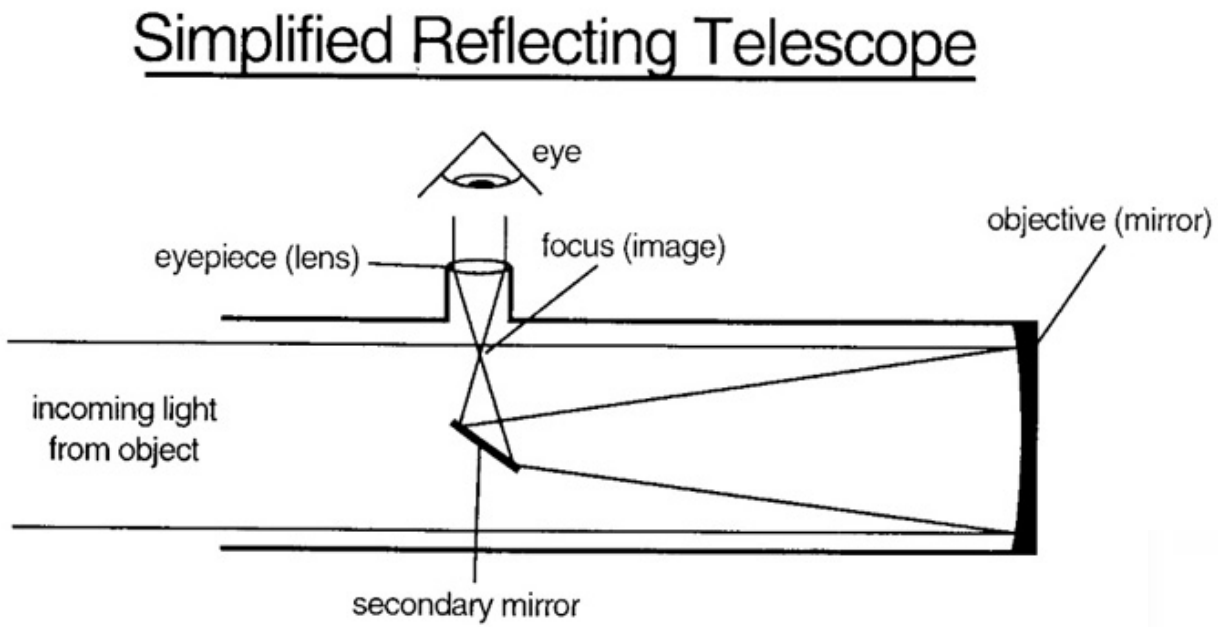
The image formed by the magnifier is virtual, magnified and erect. (See – Hyperopia corrected by a converging lens).

Suppose that the observed object is placed within the focal distance of the magnifier. Then:

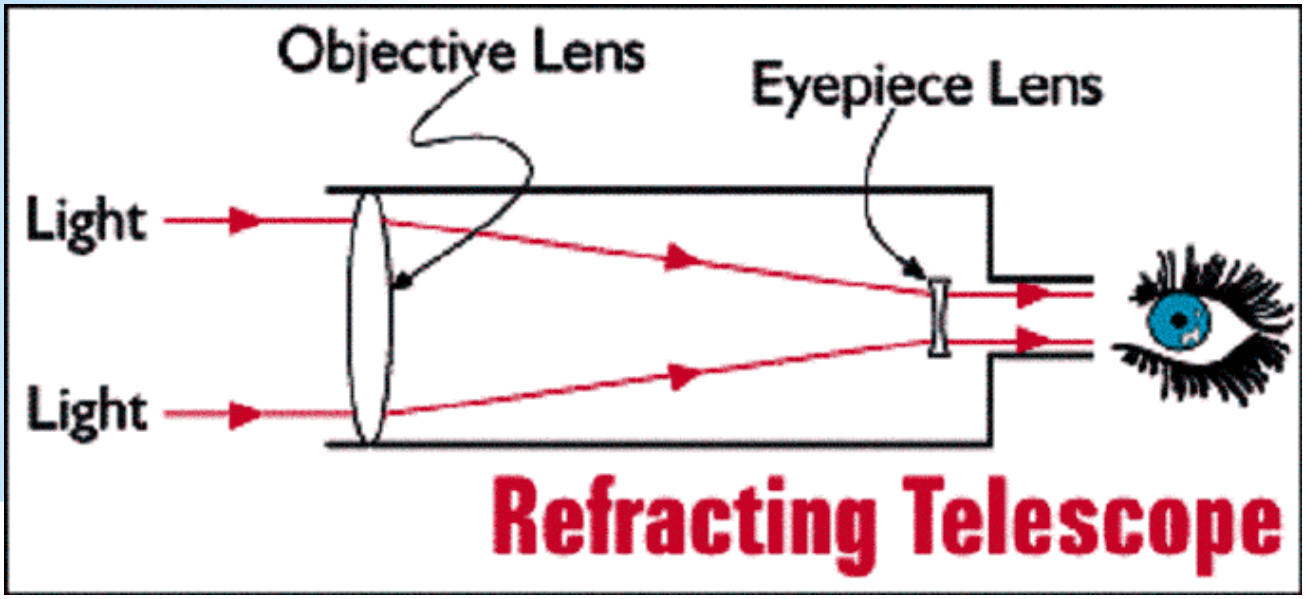
$$\gamma = \frac{d}{a}$$

where γ (gamma) is the angular magnification ($= \frac{\tau'}{\tau}$), τ' (tau-prime) is the virtual angle of vision, τ (tau) is the real angle of vision, d (25 cm) is the distance of the most distinct vision, and a is the object distance ($\approx f$).

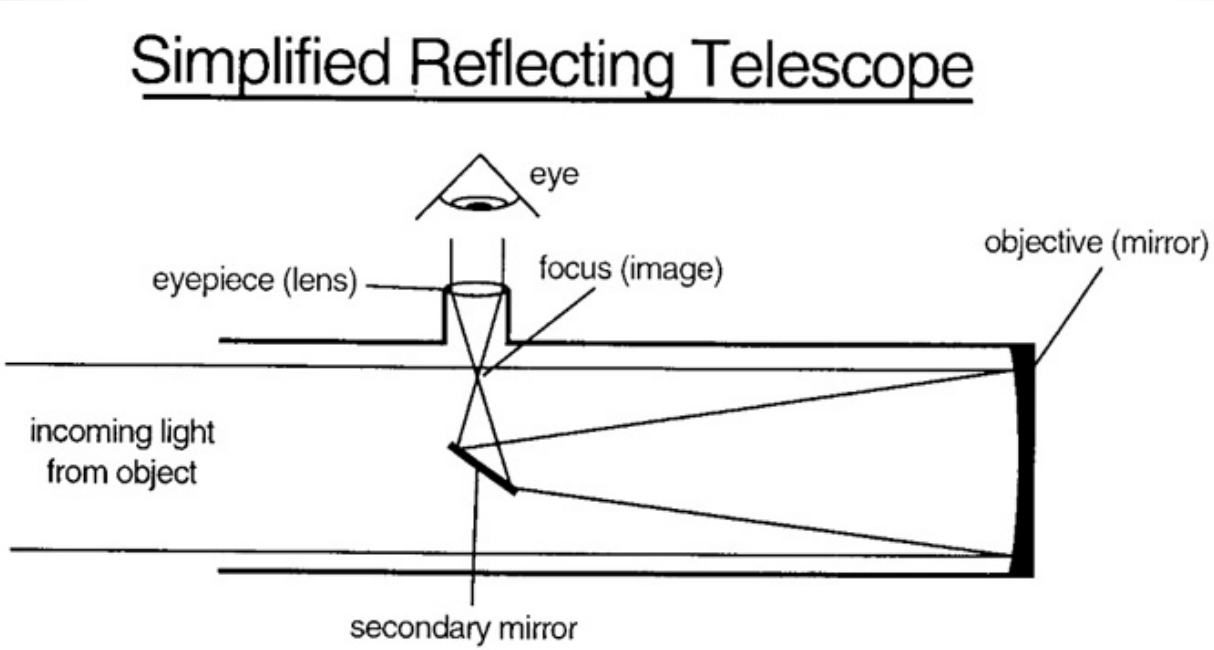
Telescopes


Simplified Reflecting Telescope
eye
eyepiece (lens)
focus (image)
objective (mirror)
incoming light
from object
secondary mirror

Telescopes


Objective Lens
Eyepiece Lens
Light
Light
Refracting Telescope

Telescopes


Simplified Reflecting Telescope
eye
eyepiece (lens)
focus (image)
objective (mirror)
incoming light
from object
secondary mirror

Microscope

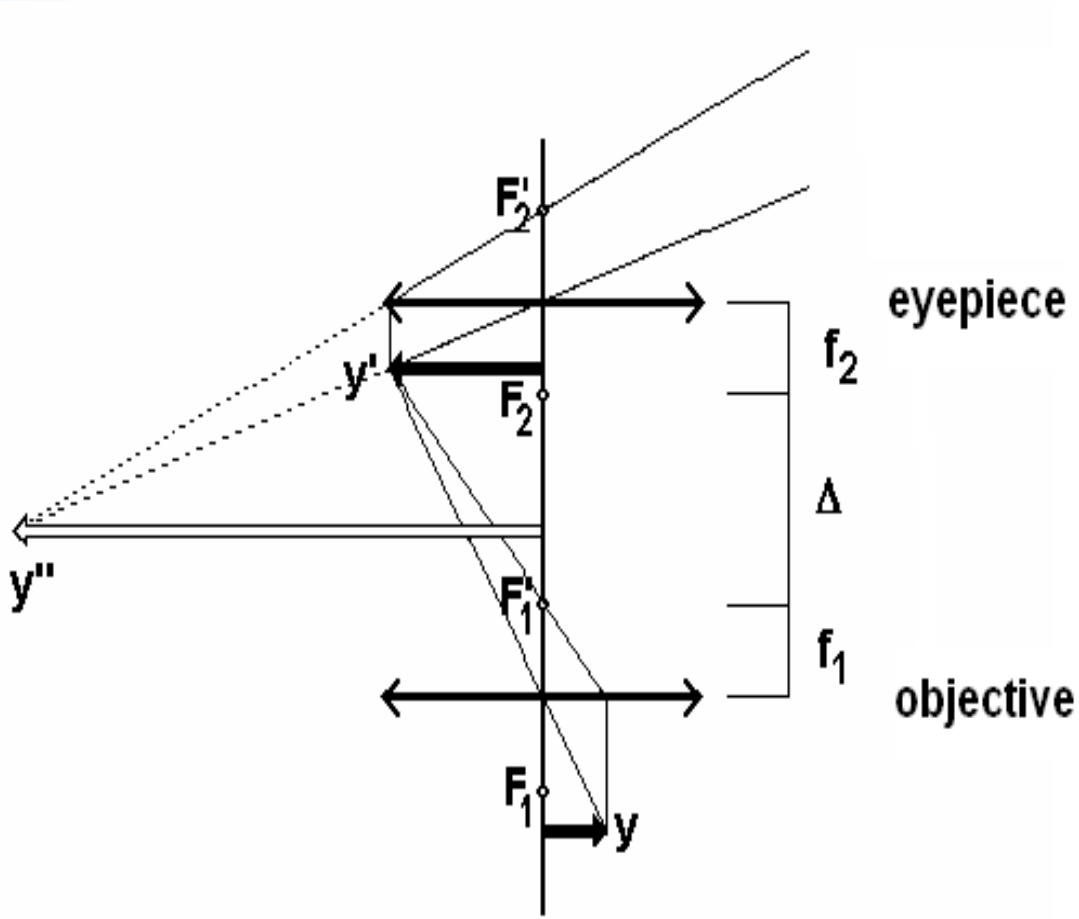
Apart of the mechanical movable and supporting parts, the microscope is formed by an objective and an eyepiece. The simplest **objective** is a converging lens that forms a real, magnified and inverted image. The **eyepiece** is a converging lens used as a magnifying glass for observation of the image formed by the objective. Therefore, the resulting image is magnified, virtual and inverted.

The total magnification of an optical microscope (in practice max. about 2000-times) is given by the product of the objective and eyepiece magnification:

$$M = M_{obj} M_{ep},$$

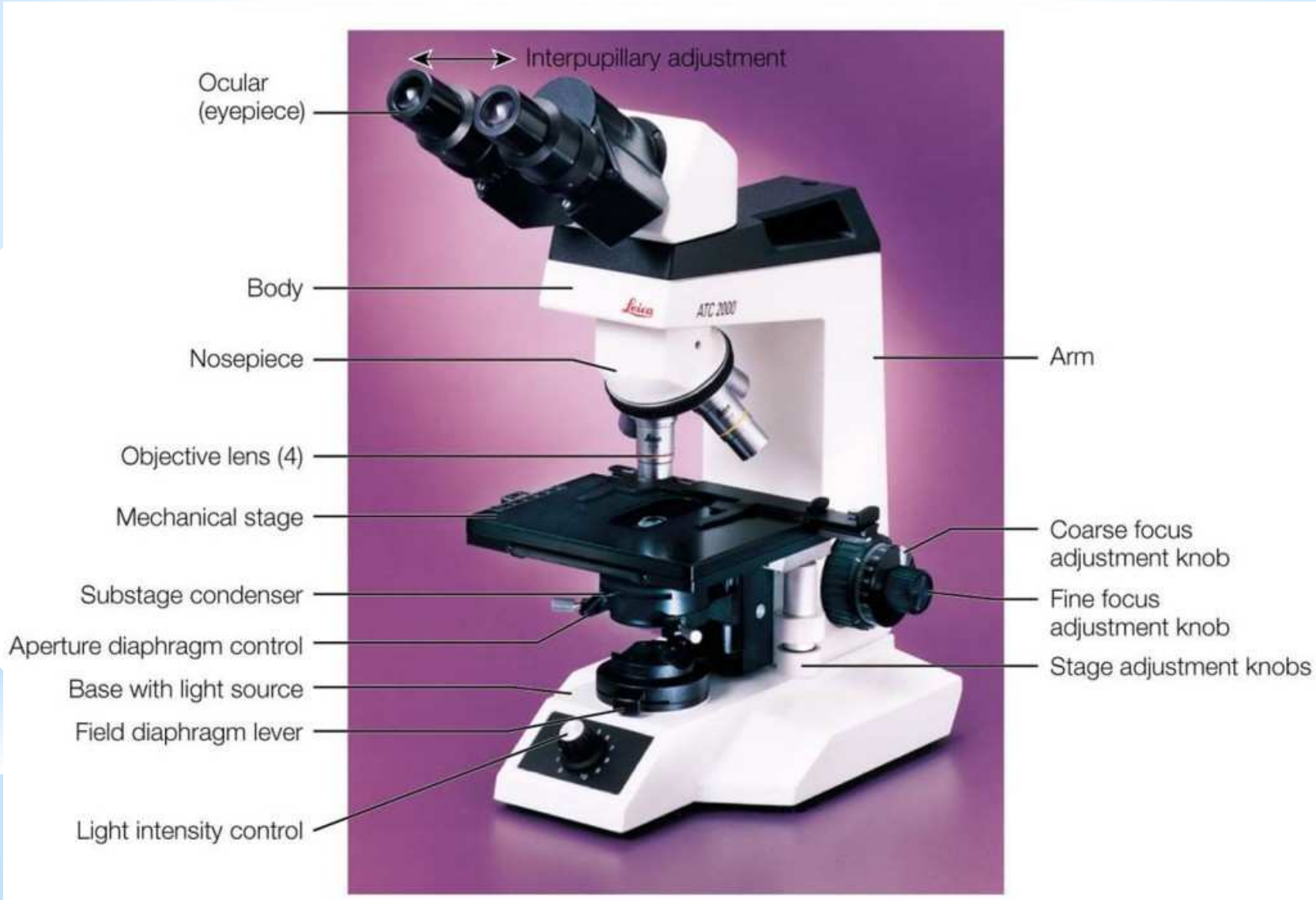
where M_{obj} is the magnification of the objective, and M_{ep} is the magnification of the eyepiece.

Microscope

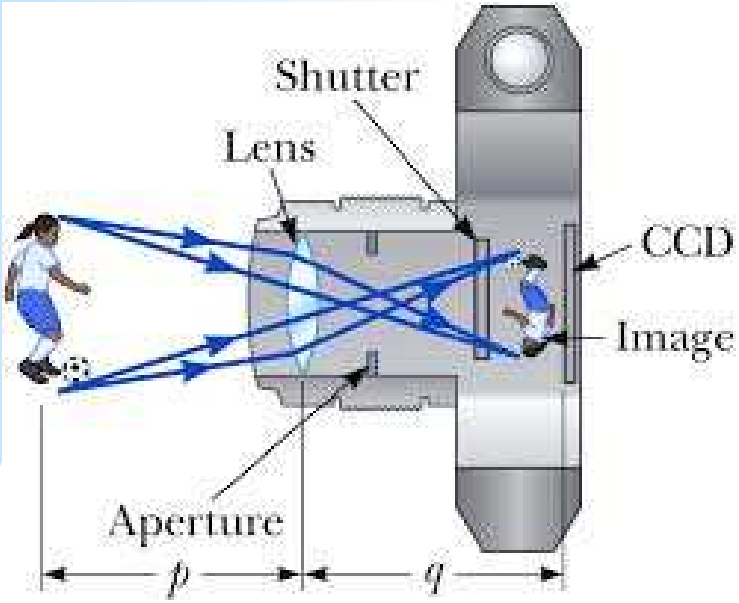


F – focal points, *f* – focal distances, y - object, y' – real image of the object formed by the objective, y'' – virtual image seen in the eyepiece, D – optical interval of the microscope.

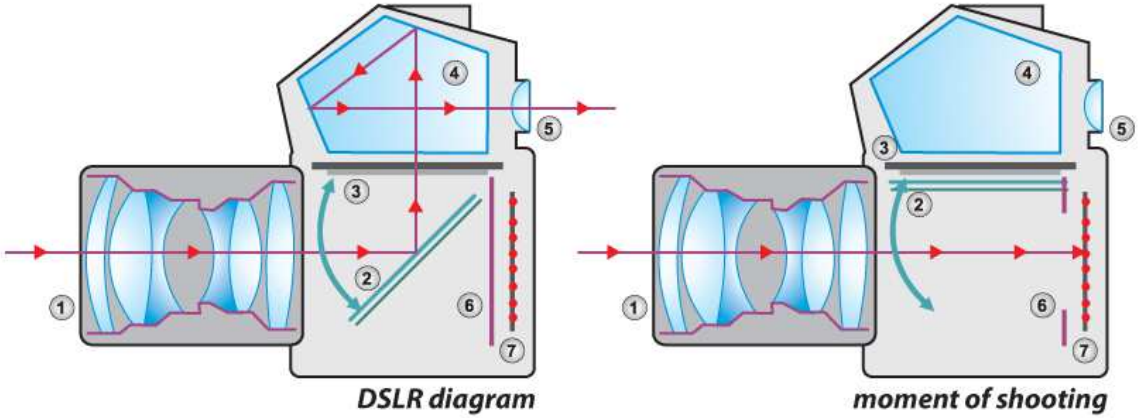
Microscope


Interpupillary adjustment
Ocular (eyepiece)
Body
Nosepiece
Objective lens (4)
Mechanical stage
Substage condenser
Aperture diaphragm control
Base with light source
Field diaphragm lever
Light intensity control
Arm
Coarse focus adjustment knob
Fine focus adjustment knob
Stage adjustment knobs

Camera



Single lens reflex camera



1. Lens
2. Reflex mirror
3. Matte focusing screen
4. Pentaprism
5. Eyepiece
6. Focal-plane shutter
7. Sensor

light