The Neurological Examination
Special Senses
Assessing Vision and hearing

Dr. Tamara Alqudah

THE OPTICS OF VISION

Refraction of Light

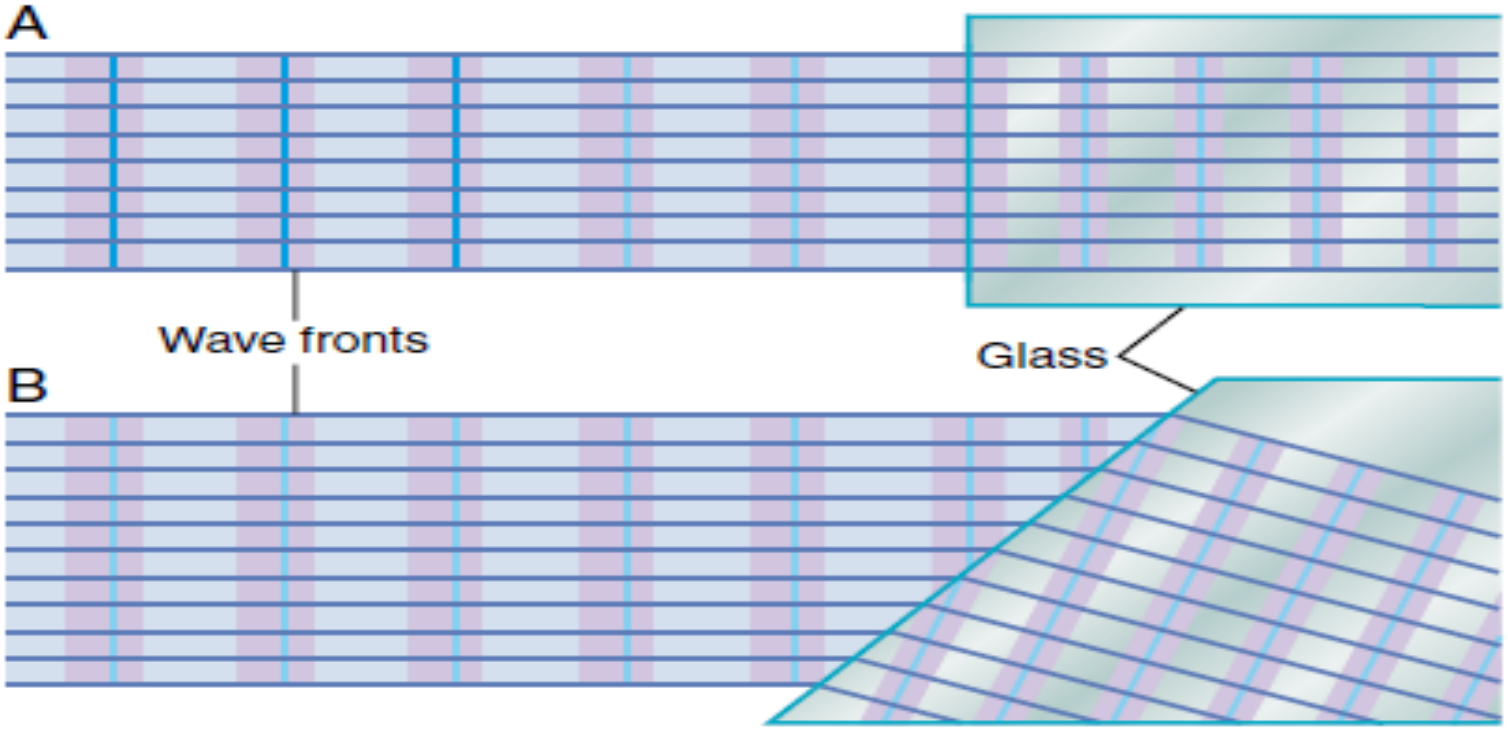


Figure 49-1 Light rays entering a glass surface perpendicular to the light rays (*A*) and a glass surface angulated to the light rays (*B*). This figure demonstrates that the distance between waves after they enter the glass is shortened to about two-thirds that in air. It also shows that light rays striking an angulated glass surface are bent.

The refractive index of a transparent substance is the *ratio* of the velocity of light in air to the velocity in the substance

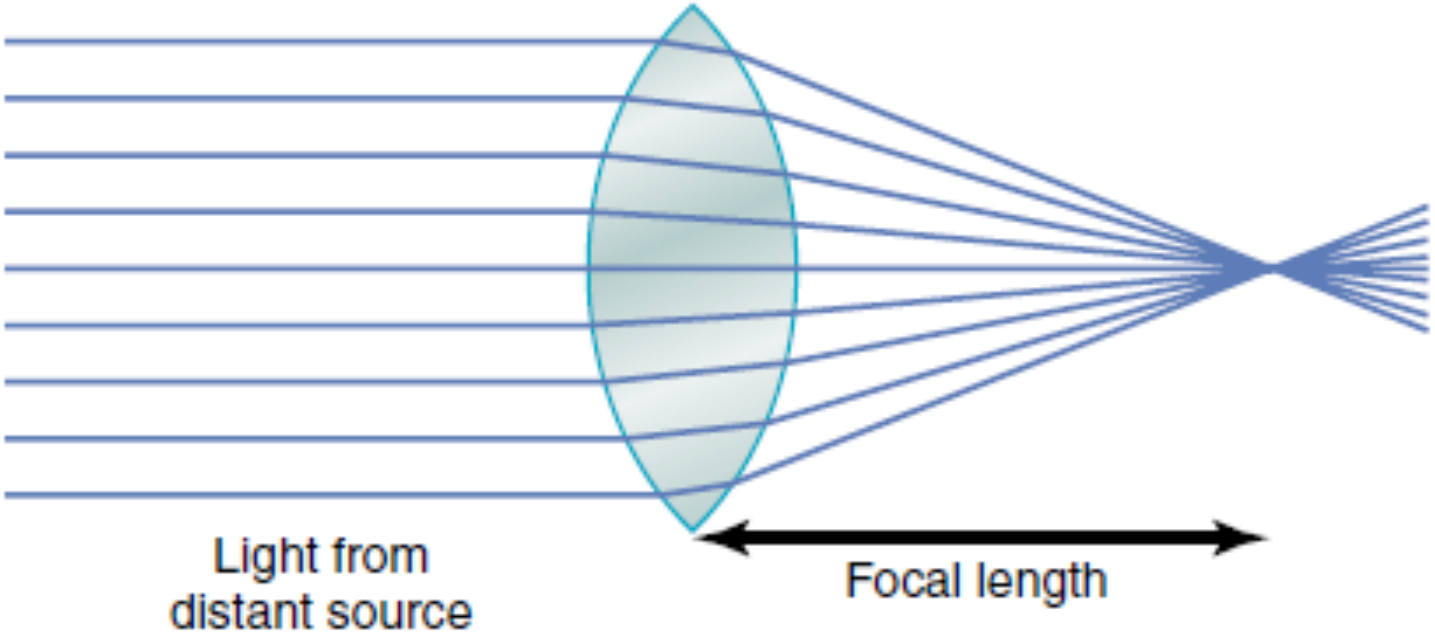
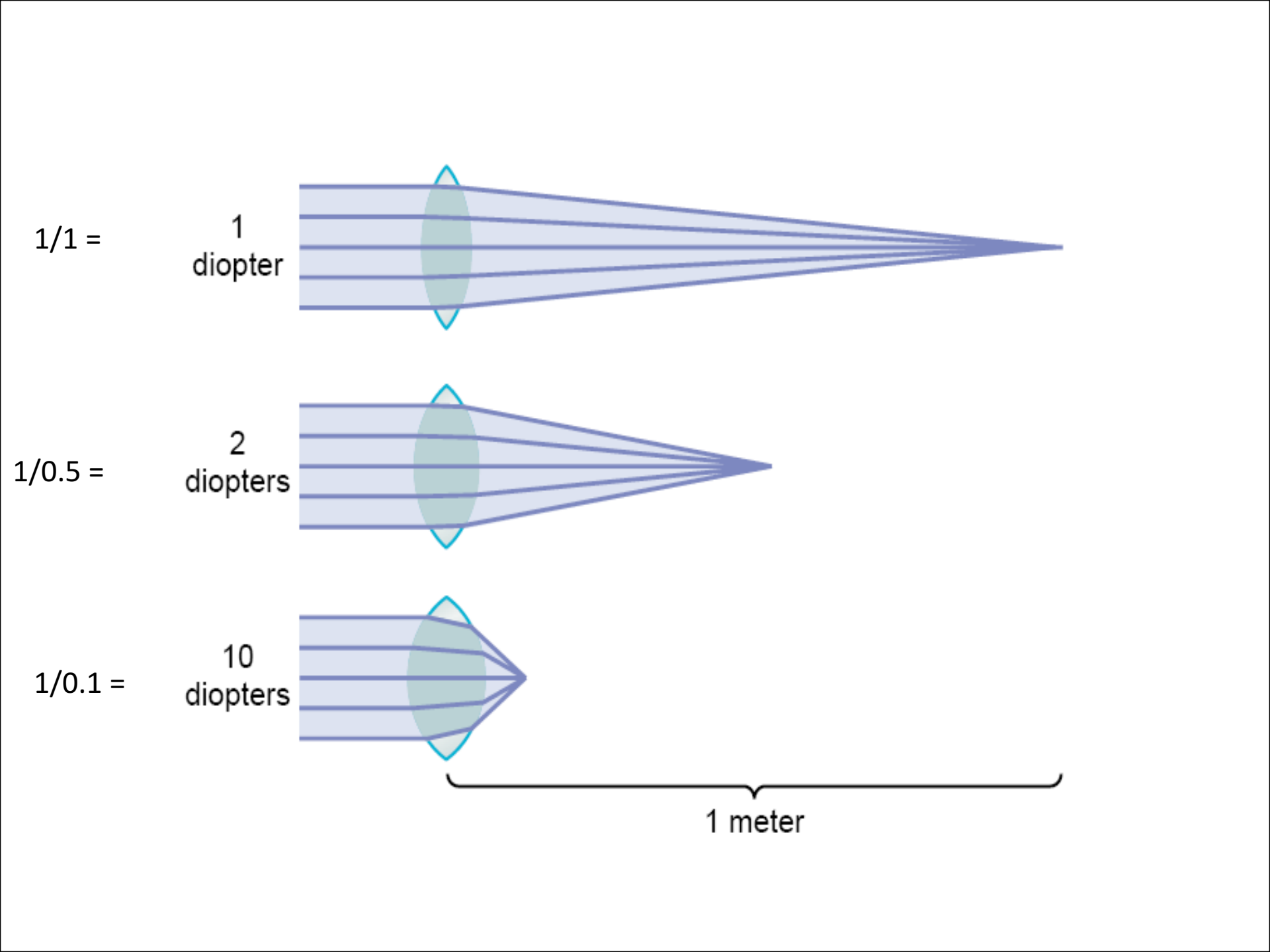


Figure 49-2 Bending of light rays at each surface of a convex spherical lens, showing that parallel light rays are focused to a *focal point*.

The more a lens bends light rays, the greater is its “refractive power.” This refractive power is measured in terms of diopters. The refractive power in diopters of a convex lens is equal to 1 meter divided by its focal length


1/1 =
1
diopter
1/0.5 =
2
diopters
1/0.1 =
10
diopters
1 meter

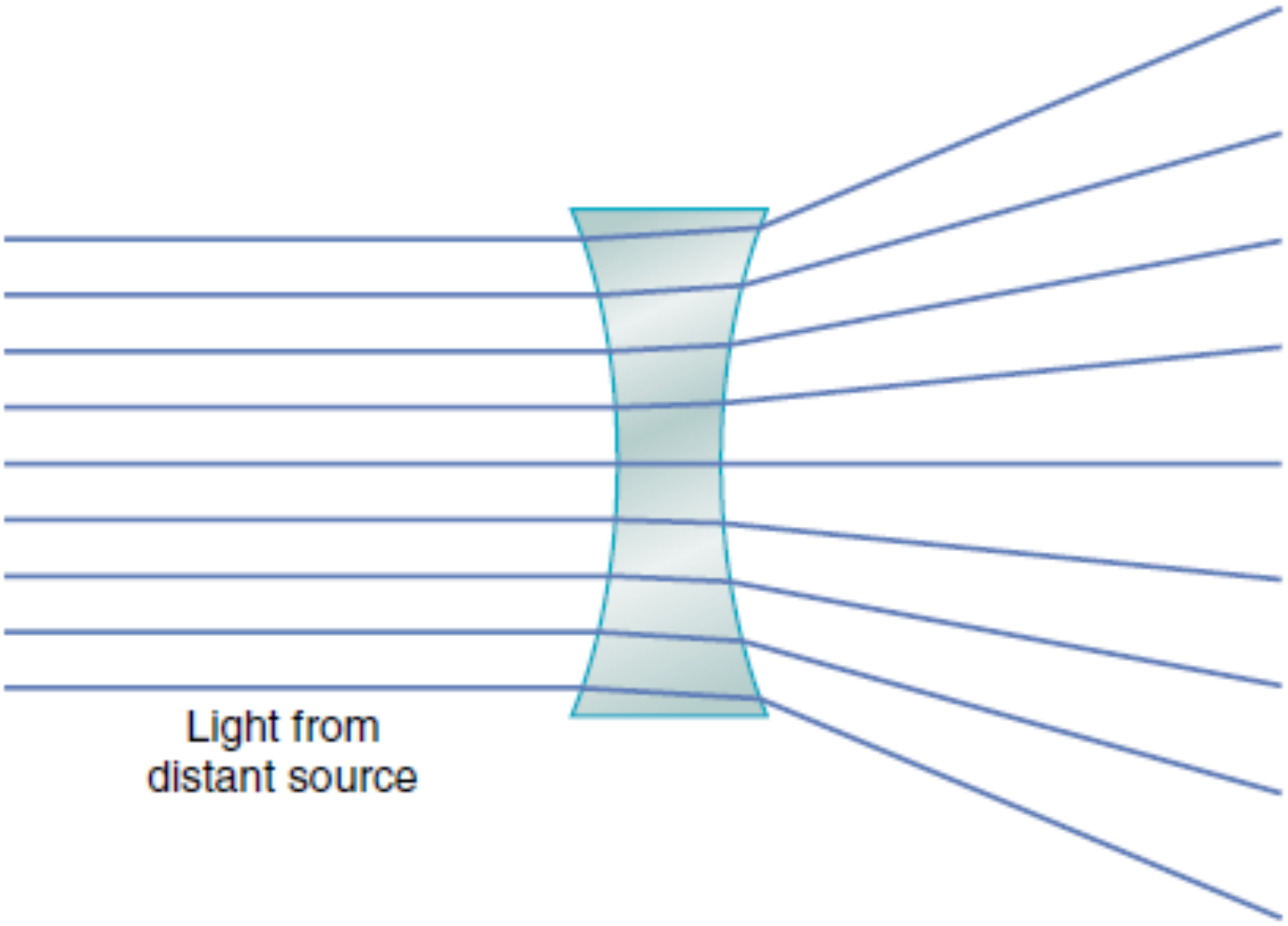


Figure 49-3 Bending of light rays at each surface of a concave spherical lens, showing that parallel light rays are *diverged*.

Vision

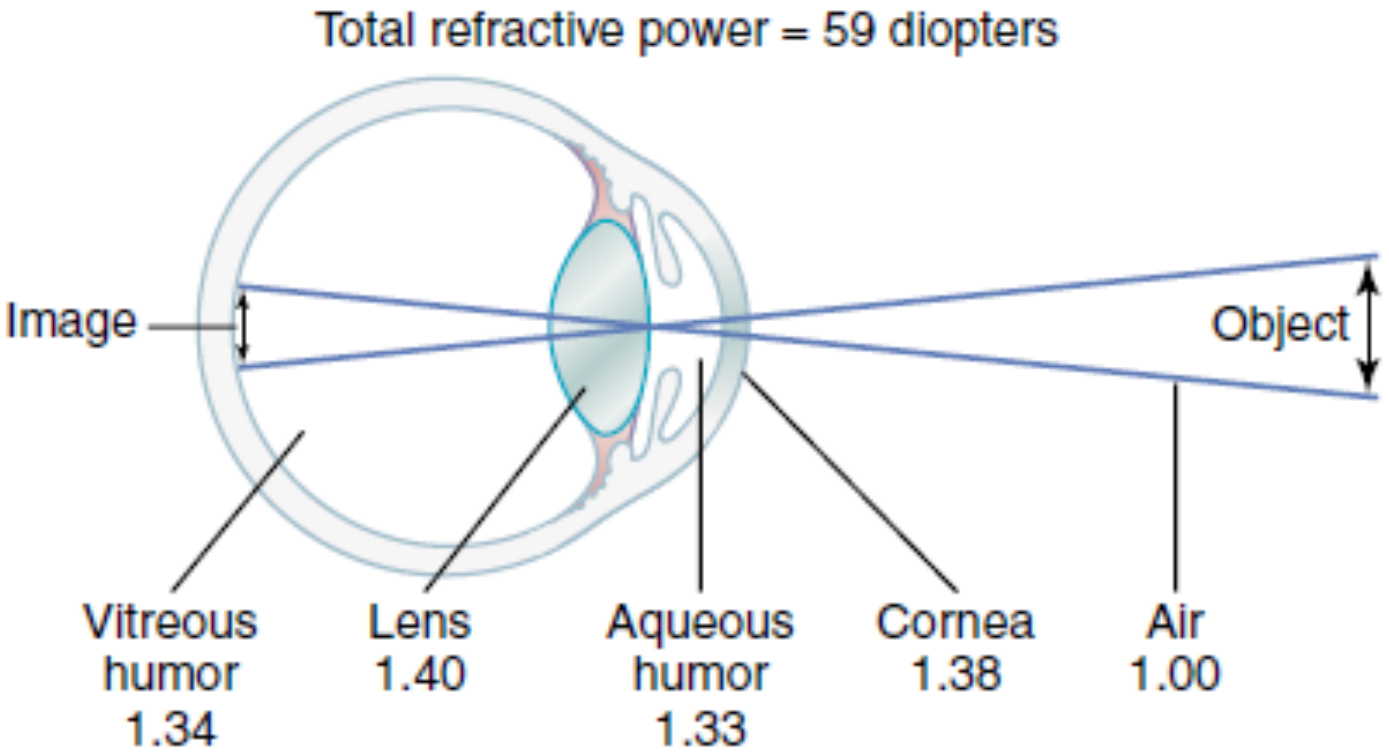
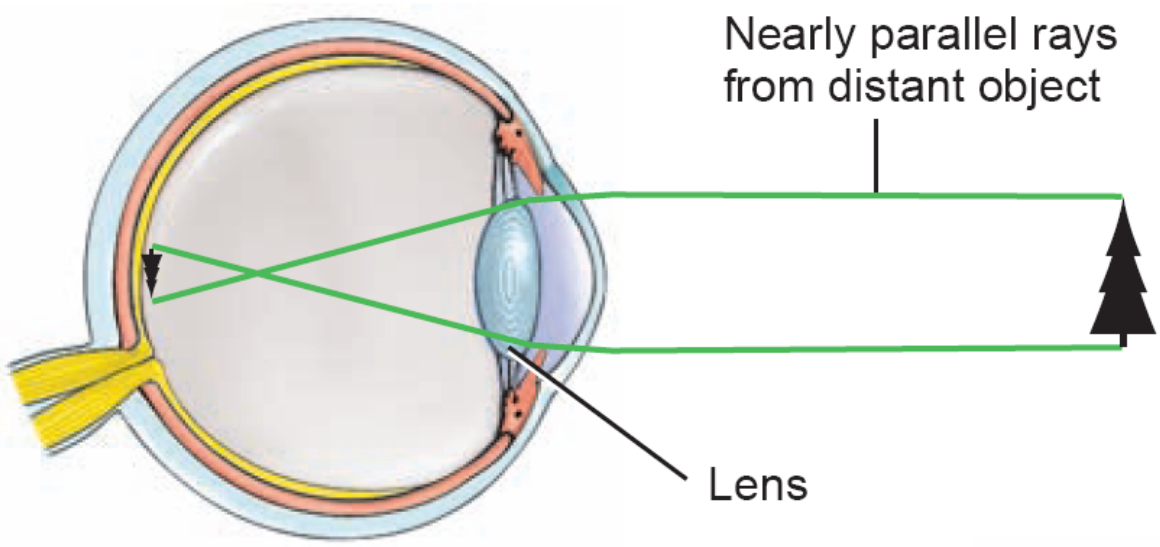
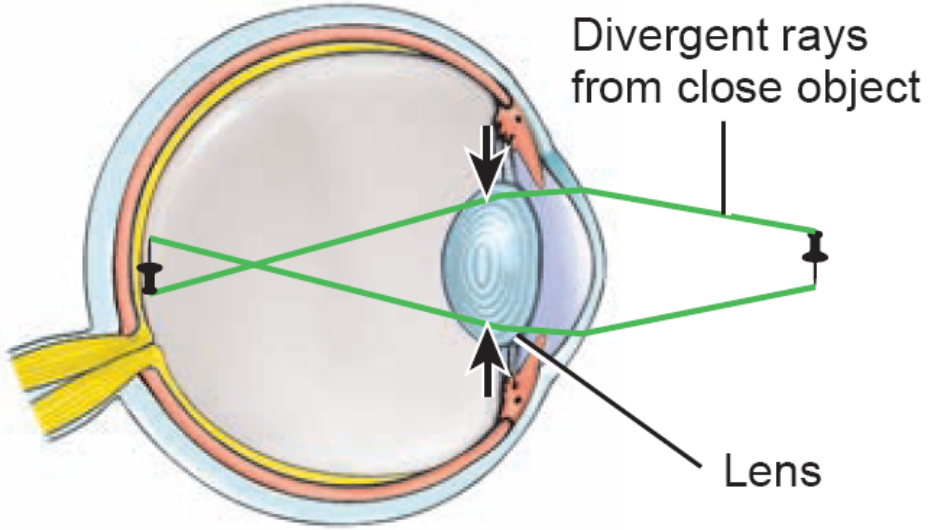


Figure 49-9 The eye as a camera. The numbers are the refractive indices.

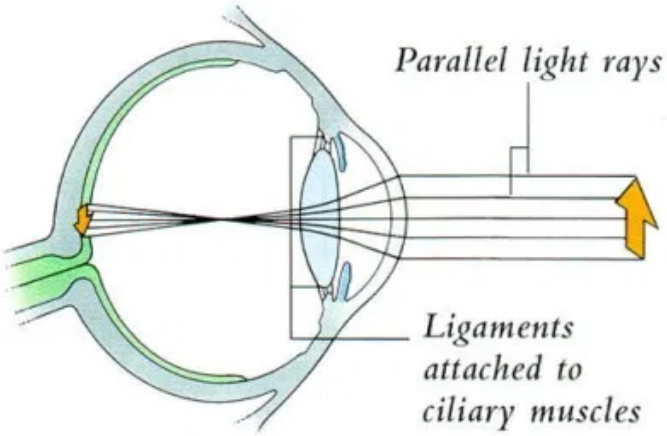
About two thirds of the 59 diopters of refractive power of the eye is provided by the anterior surface of the cornea


Nearly parallel rays
from distant object
Lens

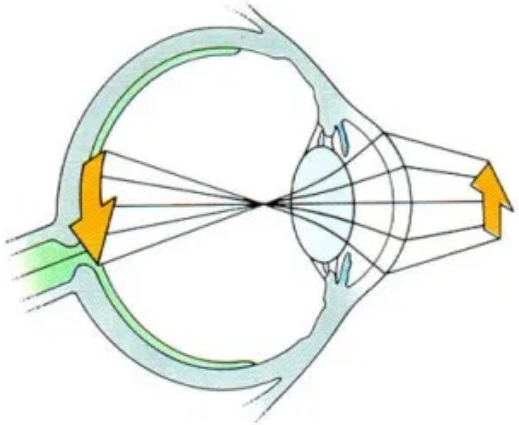

Divergent rays
from close object
Lens

Accommodation

- The ability of the eye to change its focus from distant to near objects and vice versa. This process is achieved by the lens changing its shape.



Distant objects
To focus on objects in the distance, the ciliary muscles relax and the lens flattens and thins. Light rays are slightly refracted (bent) by the lens.



Nearby objects
To view objects that are nearby, the ciliary muscles contract and the lens becomes more rounded. The point at which the image of a close object becomes blurred is called the near point of vision; it occurs when the lens reaches its maximum curvature.

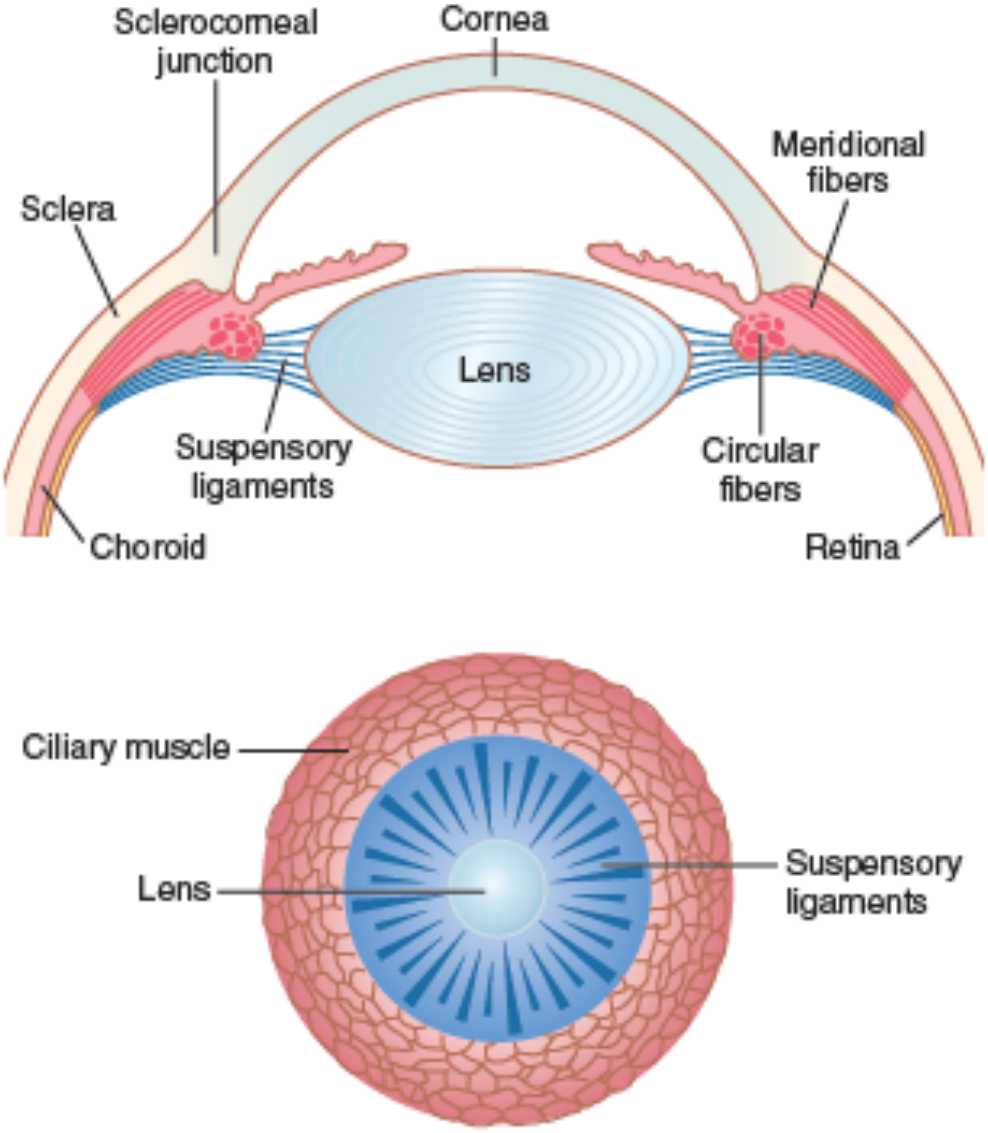
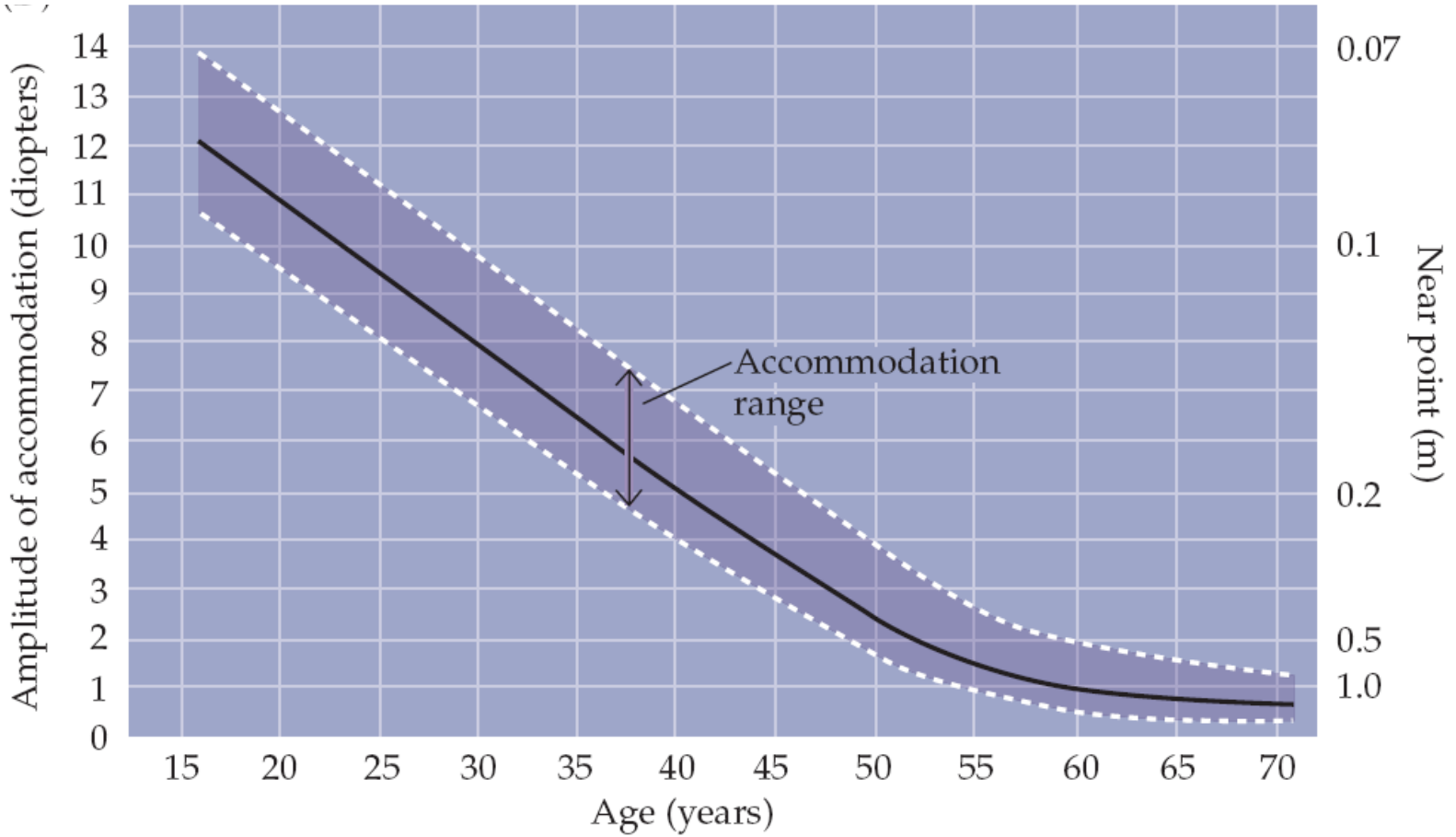


Figure 50-10. Mechanism of accommodation (focusing).

Accommodation



Presbyopia: Loss of accommodation by the lens

Errors of refraction

In hyperopia the eyeball is too short or the lens system is too weak.

In myopia the eyeball is too long an eyeball or the lens system is too active.

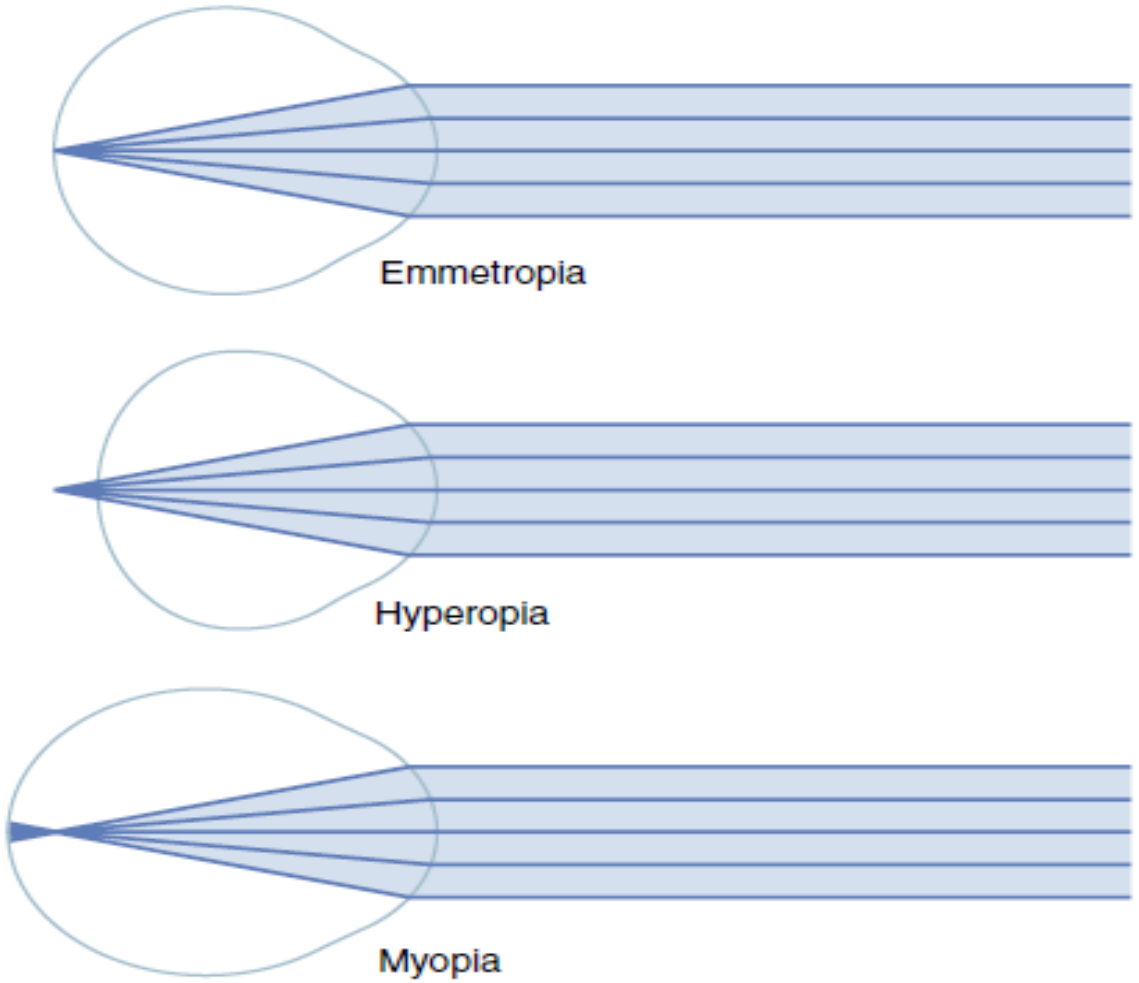


Figure 49-12 Parallel light rays focus on the retina in emmetropia, behind the retina in hyperopia, and in front of the retina in myopia.

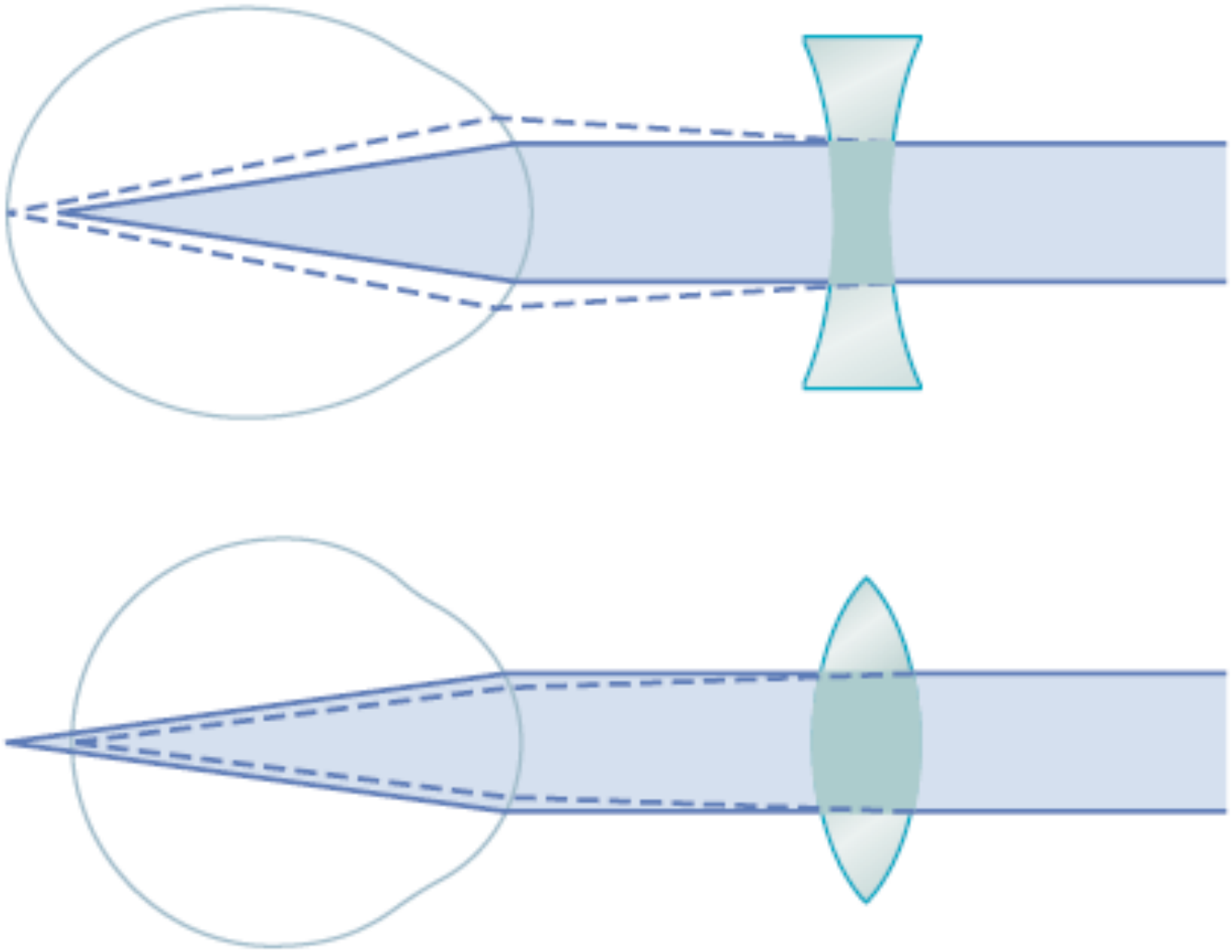


Figure 49-13 Correction of myopia with a concave lens, and correction of hyperopia with a convex lens.

Visual Acuity

- Visual acuity refers to the ability of the eye to appreciate two points 1.75 mm apart as two distinct points (clarity of vision).
- Assessment of visual acuity is mandatory in all ophthalmic patients. Each eye must be tested separately. The most commonly used method of testing is using a Snellen chart, which displays a random selection of letters at diminishing font size in successive lines.
- Each line is marked with a number (60,36,24,18,12,9 & 6). This represents the distance in meters at which a normally sighted person could read that line.

Top line is 6/60

6/12 – at this level of vision, many social activities are possible

(UK driving test standard)

6/6 – 'normal' eyesight, also known as '20/20 vision'

- Place patient 6 meters away from the chart
- Each eye needs to be tested separately
- Use an occluder to cover the eye that is not being tested
- Ask patient to read from the top letter
- Keep going until they cannot read the line clearly or they make 2 or more errors in a line.
- The previous line is the line you document
- The result is expressed as a ratio X / Y, where X is the testing distance and Y refers to the line containing the smallest letter that the patient identifies.

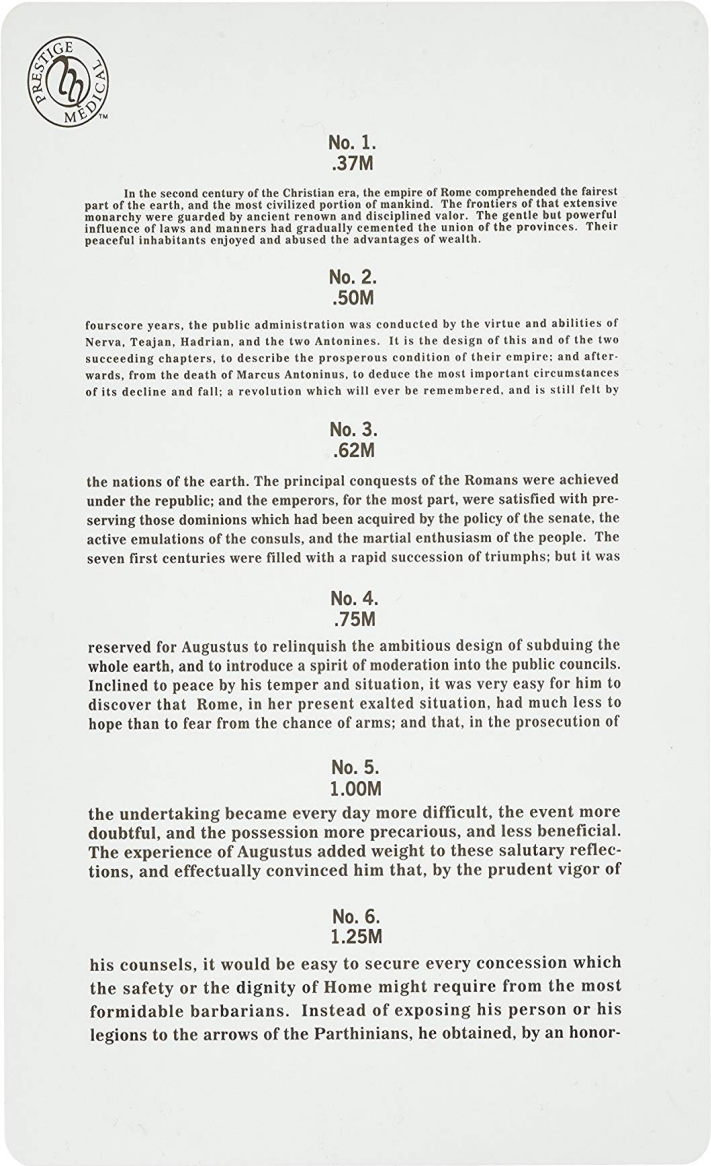
- If the patient cannot read down to line 6 (6/6), place a pinhole directly in front of the eye to correct any residual refractive error.
- If the visual acuity is not improved with a pinhole, this indicates the presence of eye disease not related to the refractive apparatus alone, such as retinal or optic nerve pathology.
- If the patient cannot see the largest font letter, reduce the test distance to 3 meters, then to 1 meter if necessary.
- If they still cannot see the largest font letter, document instead whether they can count fingers, see hand movement or just perceive the difference between light and dark.

- The power of the lens needed to correct the visual acuity problem is determined by trial and error

Jaegar eye chart

•The Jaeger eye chart (or Jaeger card) is used to test and document near visual acuity at a normal reading distance. It has print samples of different sizes (No. 1-No.11). Anyone with normal vision should be able to read the smallest print in good lighting, at a comfortable reading distance.

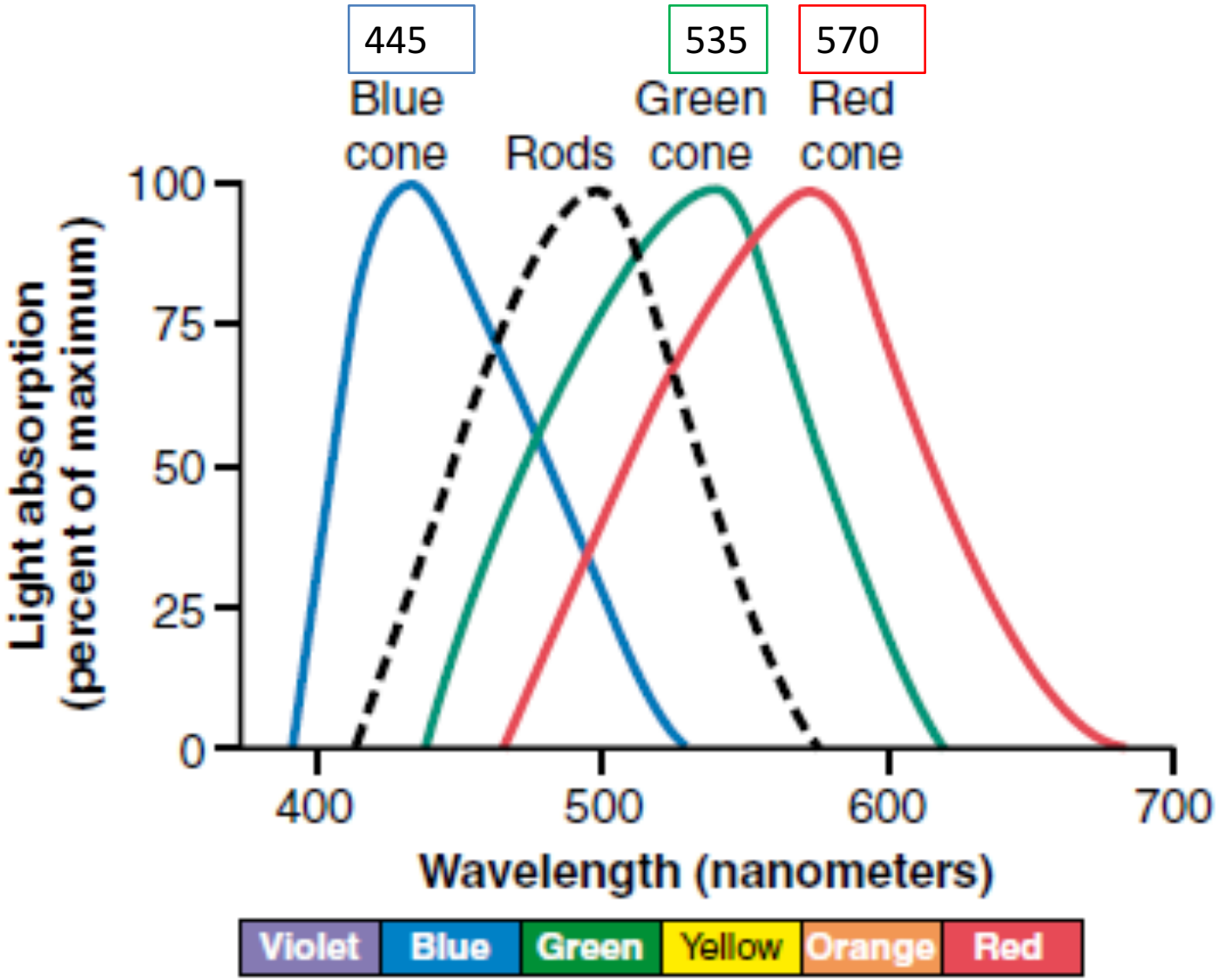
1. Ask the patient to hold the test card 37 cm away from the eyes.
2. Test each eye alone.
3. Ask the patient to go to the smallest block of text they feel can see without squinting, and read that passage aloud.
4. Ask the patient to continue reading successively smaller blocks of print until he reaches a size that is not readable.
5. Record the “J” value of the smallest block of text he can read

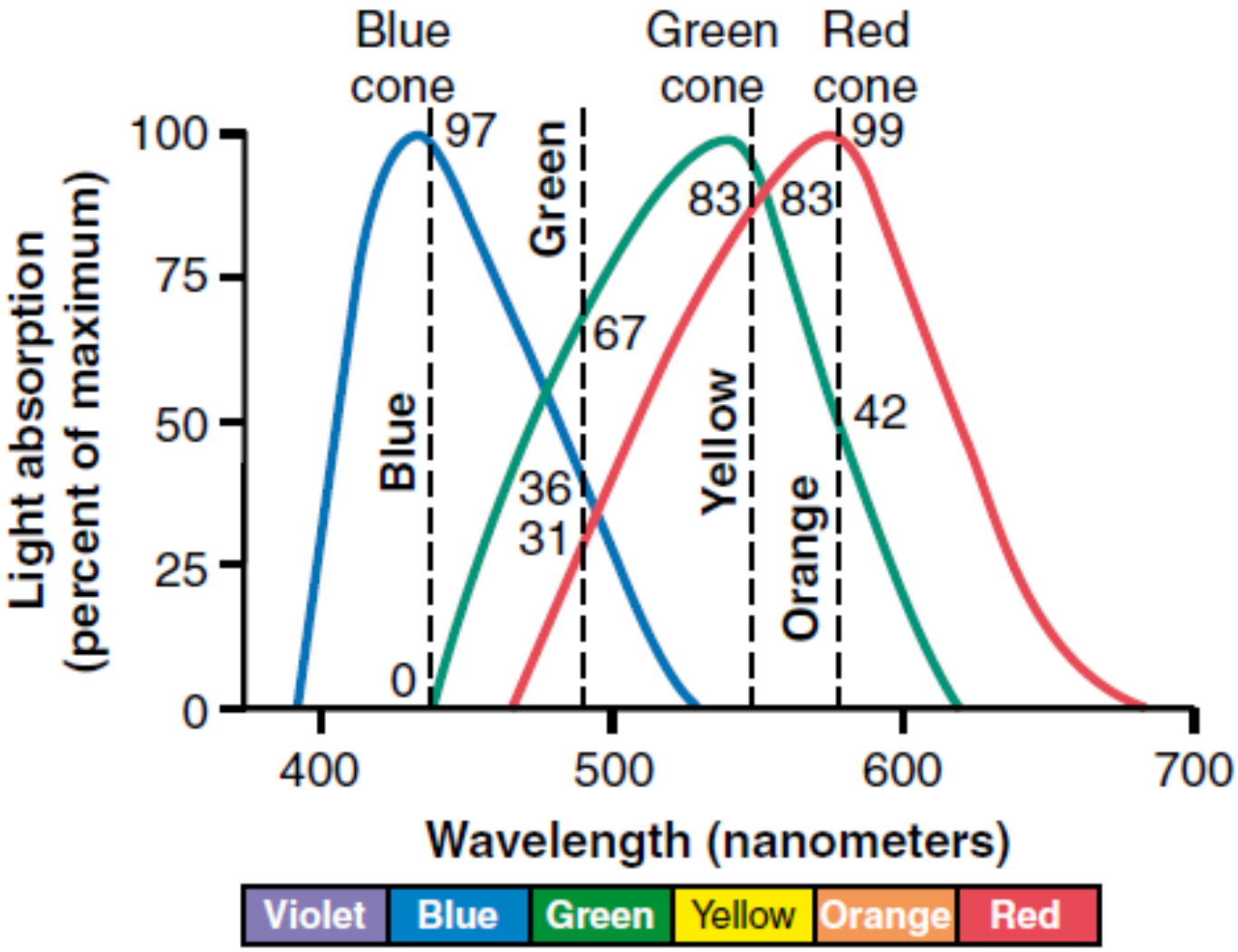


Color vision

- The retina contains two types of photoreceptors; the rods and cones.
- Cones are responsible for color vision.
- There are three types of cones, each containing a specific photopigment called an opsin that is most sensitive to particular wavelengths of light (blue, green and red).

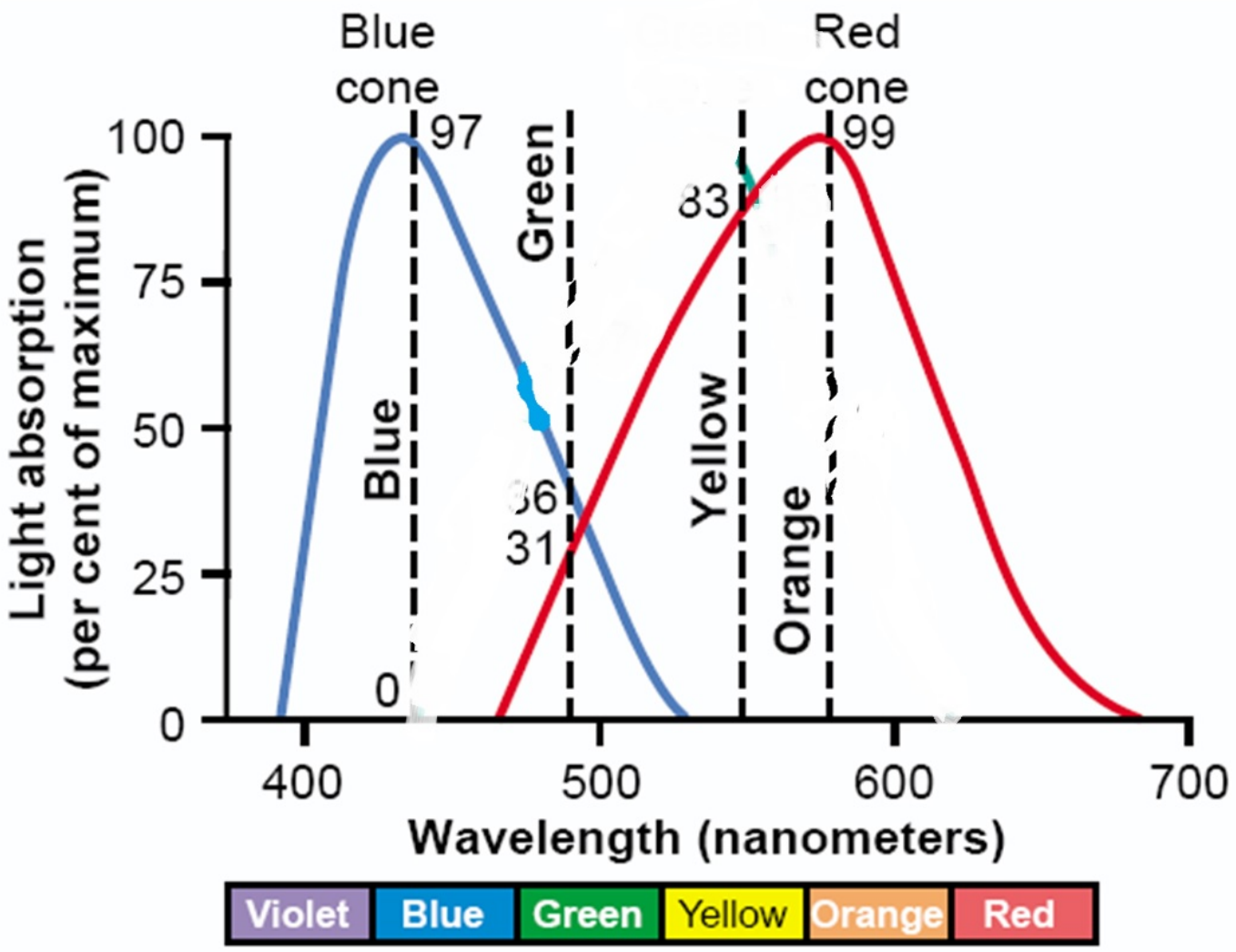
- The brain combines input from all three types of cones to produce normal color vision.


445
535
570
Blue cone
Rods
Green cone
Red cone
100
75
50
25
0
Light absorption (percent of maximum)
400
500
600
700
Wavelength (nanometers)
Violet
Blue
Green
Yellow
Orange
Red


Blue cone
Green cone
Red cone
100
75
50
25
0
Light absorption (percent of maximum)
97
99
83
83
67
42
36
31
0
Blue
Green
Yellow
Orange
400
500
600
700
Wavelength (nanometers)
Violet
Blue
Green
Yellow
Orange
Red

Color Vision Deficiency

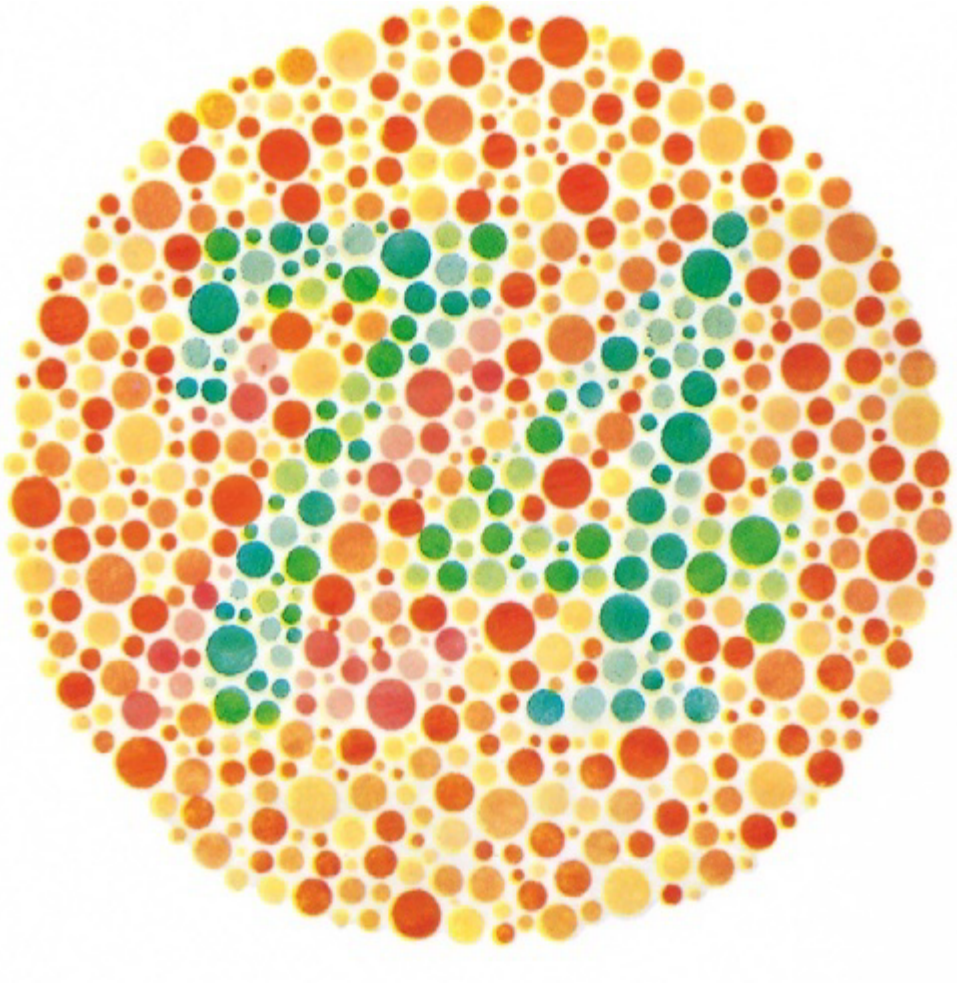
- Color vision deficiency (color blindness) represents a group of conditions that affect the perception of color.
- Red-green color vision defects are the most common form of color vision deficiency. Affected individuals have trouble distinguishing between some shades of red, yellow, and green. It is an X-linked genetic disorder.
- A person with loss of red cones is called a *protanope*
- A person who lacks green cones is called a *deuteranope*


Blue cone
Red cone
100
75
50
25
0
Light absorption (per cent of maximum)
97
99
83
Green
Blue
Yellow
Orange
31
0
400
500
600
700
Wavelength (nanometers)
Violet
Blue
Green
Yellow
Orange
Red

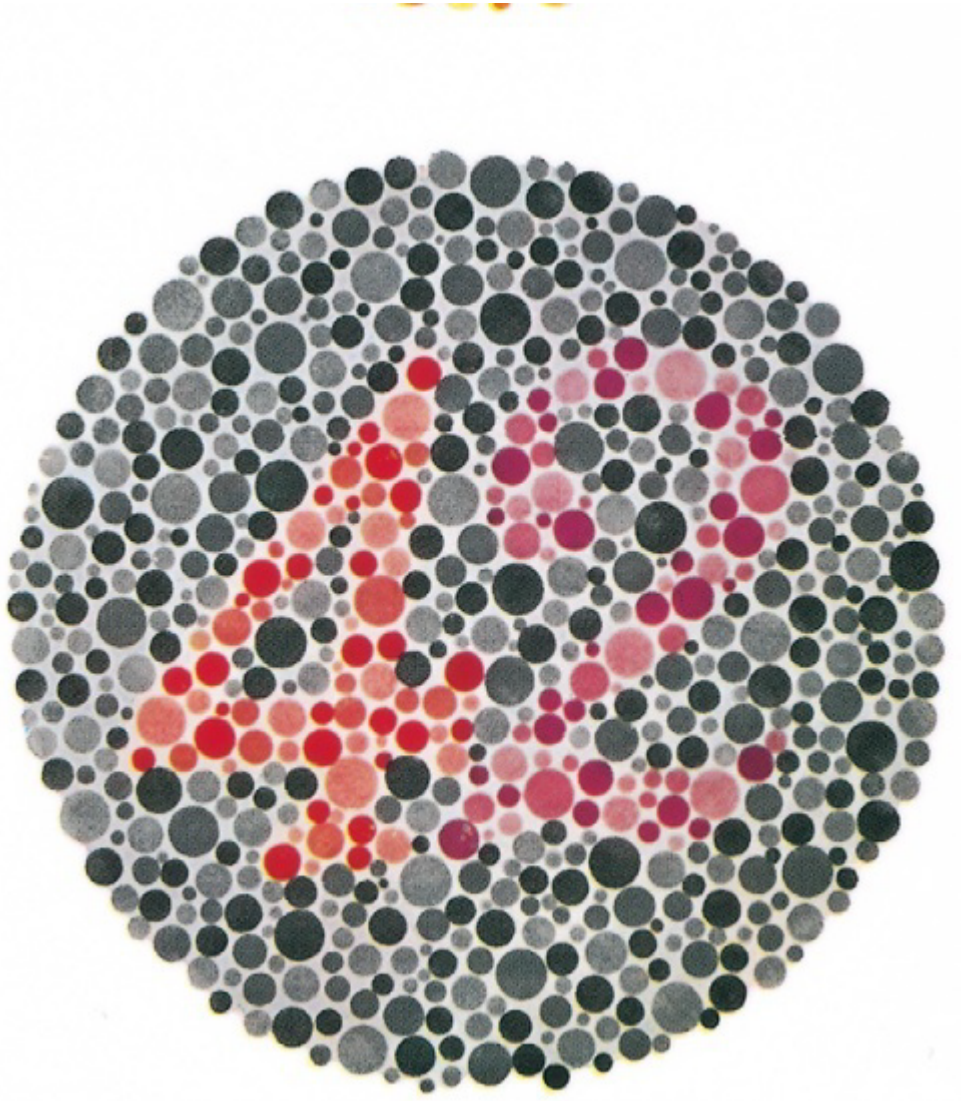
- Blue color vision defects(tritanopia) , which are rarer, cause problems with differentiating shades of blue and green. Defect in Chromosome 7
- Usually, color deficiency is an inherited condition. But disease or injury that damages the optic nerve or retina can also cause loss of color recognition in such case the condition might affect one eye only.

How to test for color blindness

- The patient is shown a series of specially designed pictures composed of colored dots, called pseudoisochromatic plates. Most commonly used is Ishihara test.
- The patient is asked to look for numbers among the various colored dots. Individuals with normal color vision see a number, while those with a deficiency see a different number or see nothing at all.
- Test each eye individually and ensure there is enough sunlight in the room.



74 vs 21



42 VS 4 “green” / 2 “red”

Assessing hearing

- Types of Deafness:

1. Conductive deafness: impairment of ear structures that conduct sound waves to the cochlea.
2. Nerve deafness: impairment of the cochlea, the VIII nerve or the CNS circuits from the ear.

- Hearing can be assed by subjective methods such as Rinne and Weber tests, or by objective methods such as an audiometry test

Weber Test

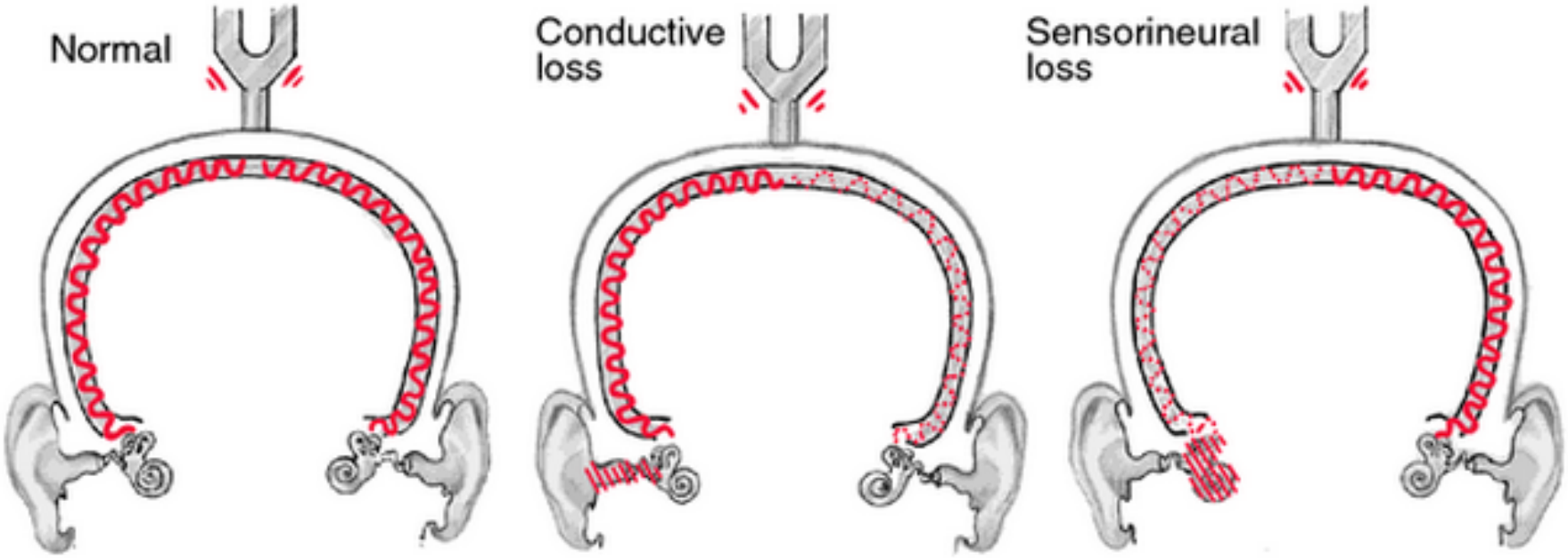
- The tuning fork is placed on the vertex of the skull in the midline, and the patient is asked to report the side where the tone sounds louder.
- Normally, the tone sounds equal on both sides.
- In conductive hearing loss, the tone is louder on the affected side.
- In sensorineural hearing loss, the tone is louder on the normal side.

Rinne Test

- This test is designed to evaluate hearing
- We use a 256 Hz tuning fork for this test

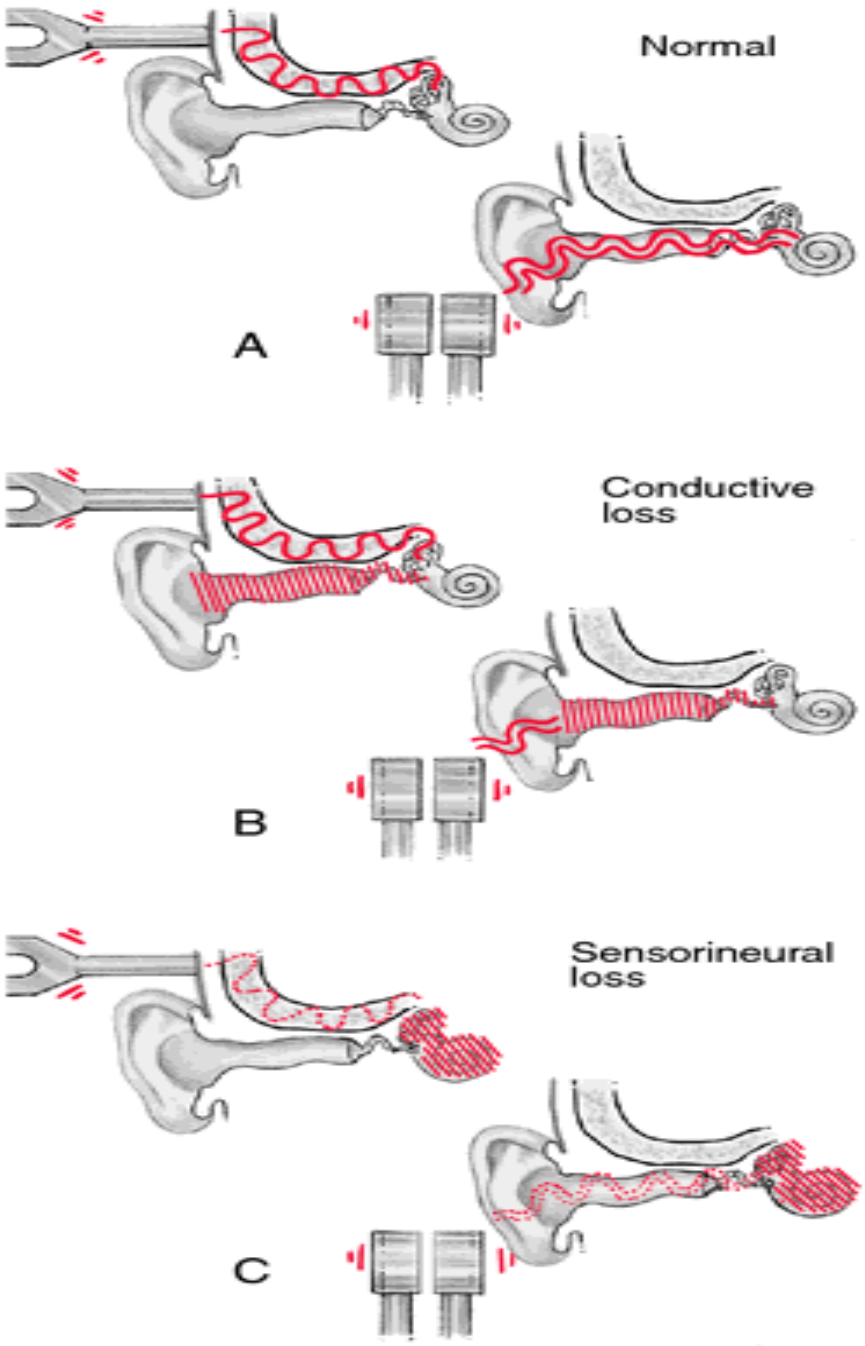
- We put a vibrating fork 1-2 cm away from the ear (air conduction) then we put the base of the fork on the mastoid bone(bone conduction), and ask the patient to compare between the two sounds. Repeat for the other ear.
- Normal individuals will hear the tone better by air conduction.
- In conductive hearing loss, bone conduction is greater than air conduction, because bone conduction bypasses problems in the external or middle ear.
- In sensorineural hearing loss, air conduction is greater than bone conduction (as in normal hearing), however, hearing is decreased in the affected ear.

Weber Test



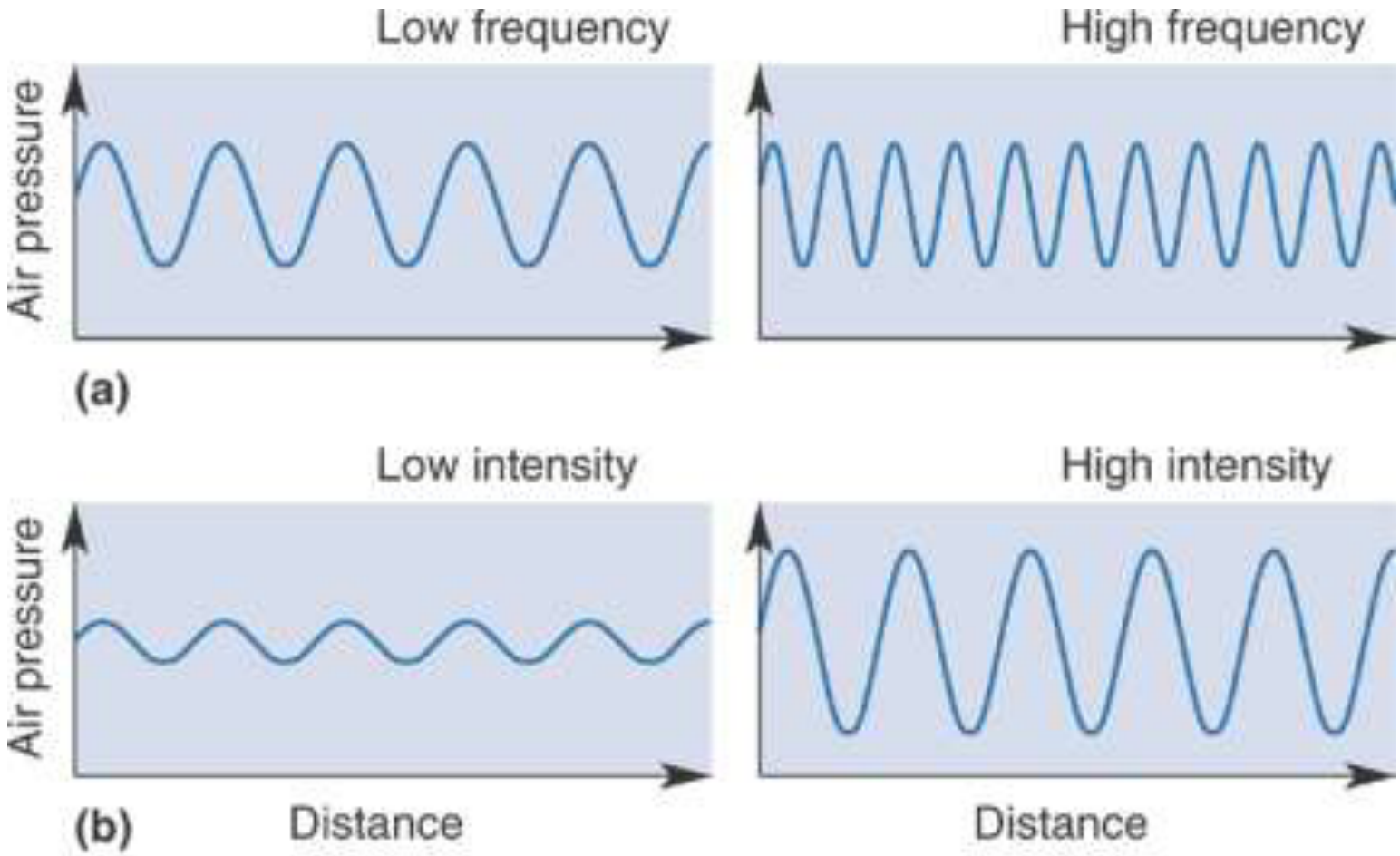
Sound louder in diseased ear because masking effect of environmental noise is absent on diseased side.

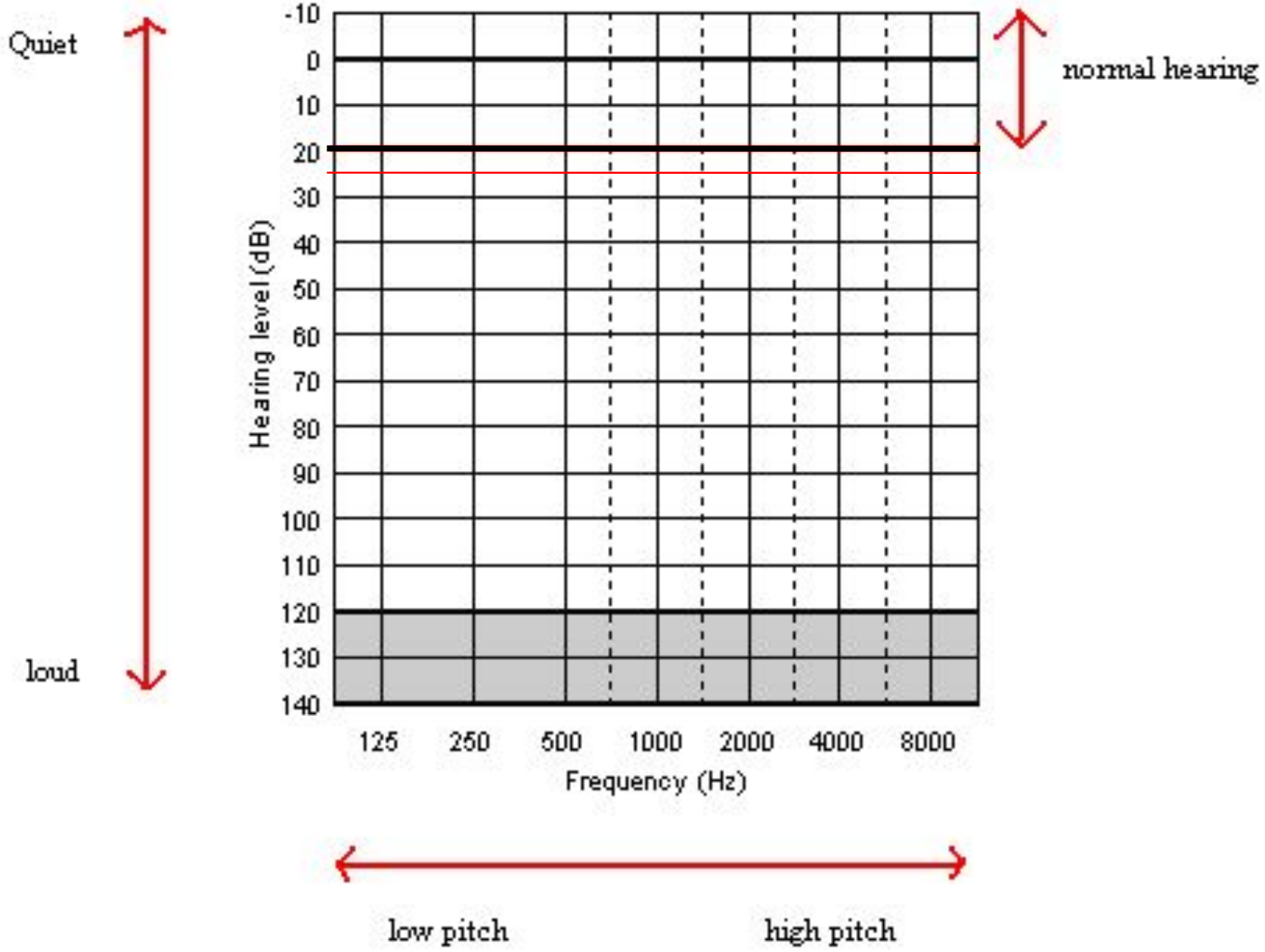
Rinne Test

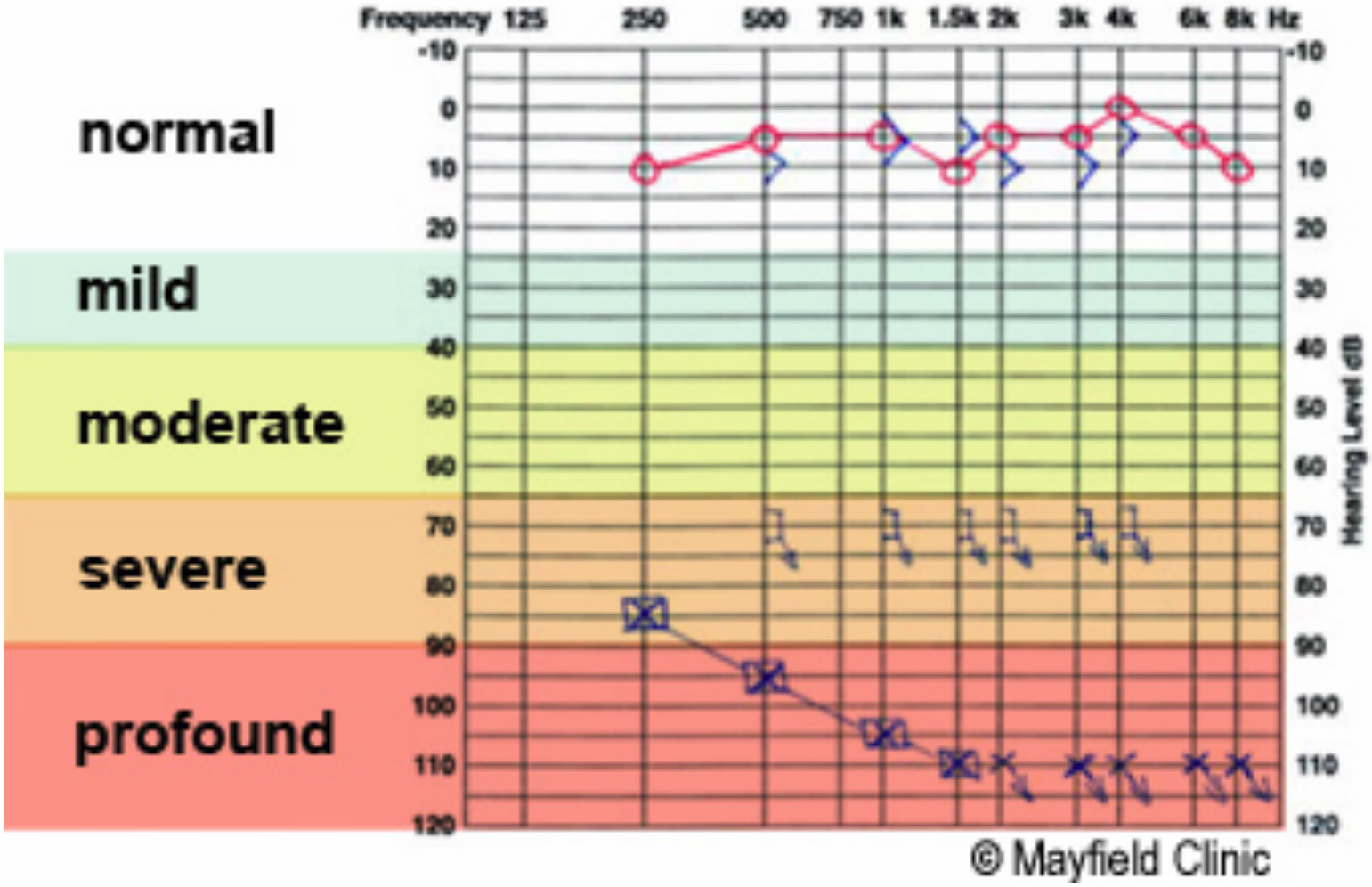


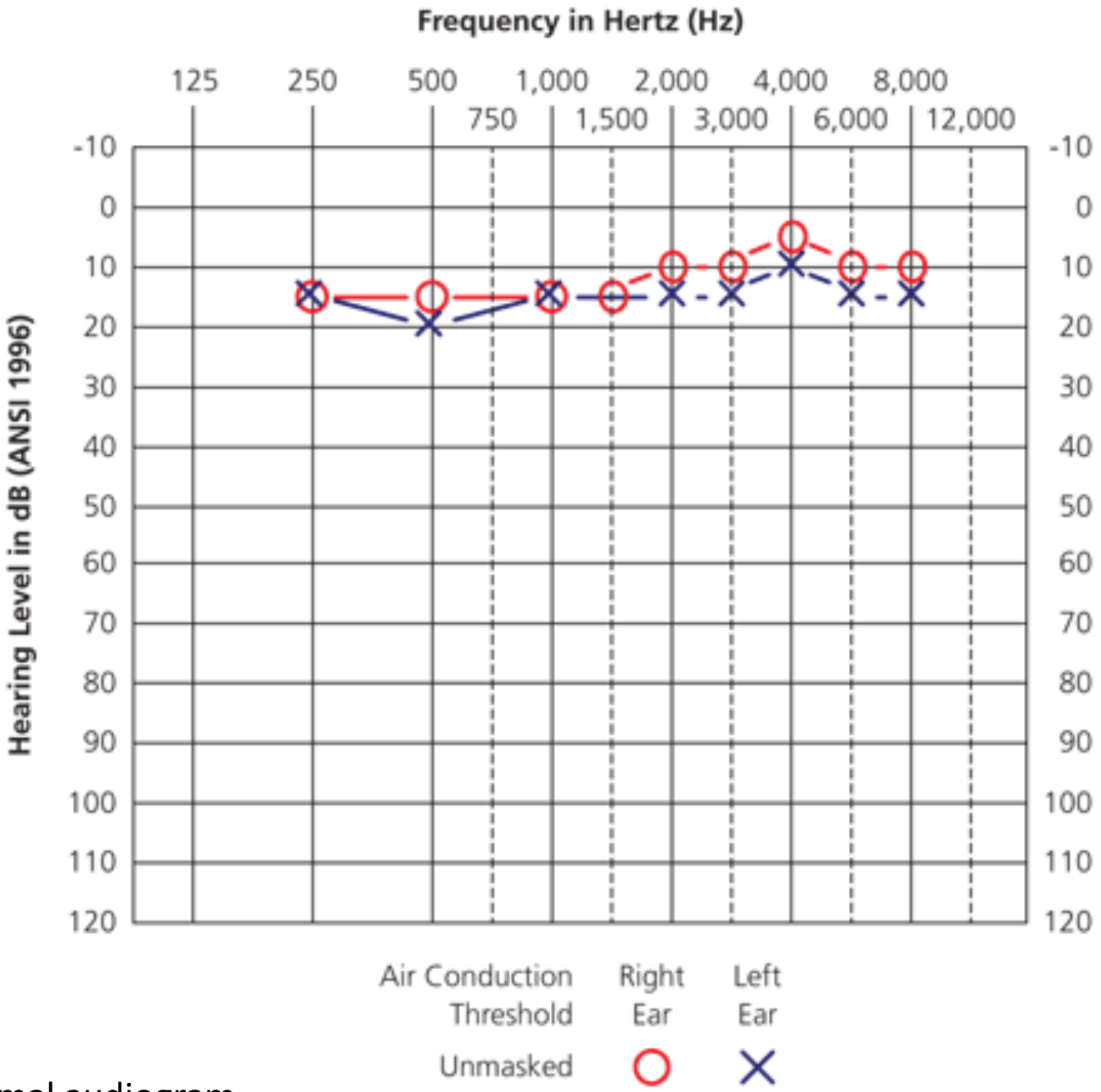
Audiogram

- An audiometry tests hearing acuity. It tests both the intensity and the tone of sounds.
- Sound intensity is measured in decibel (dB). A healthy human ear can hear quiet sounds such as whispers, these are about 20 dB.
- The tone of a sound is measured in cycles per second. The unit of measurement is Hertz.
- **Normal hearing range is 250-8,000 Hz at 25 dB or lower**.
- The test is designed to test air conduction.
- If air conduction is abnormal then bone conduction is tested.
- The results of the test are shown on an audiogram.

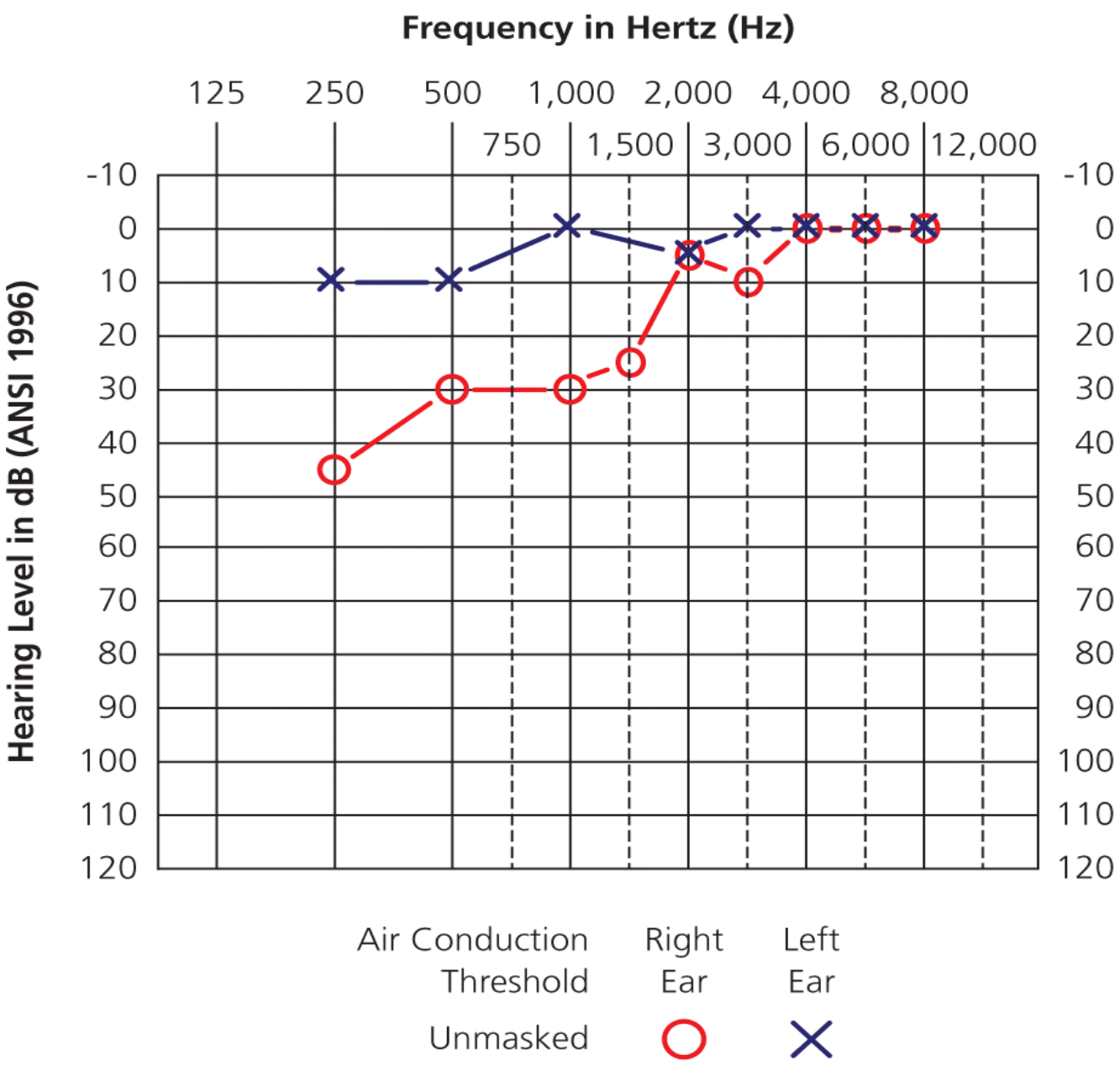



Quiet
loud
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Hearing level (dB)
125
250
500
1000
2000
4000
8000
Frequency (Hz)
normal hearing
low pitch
high pitch

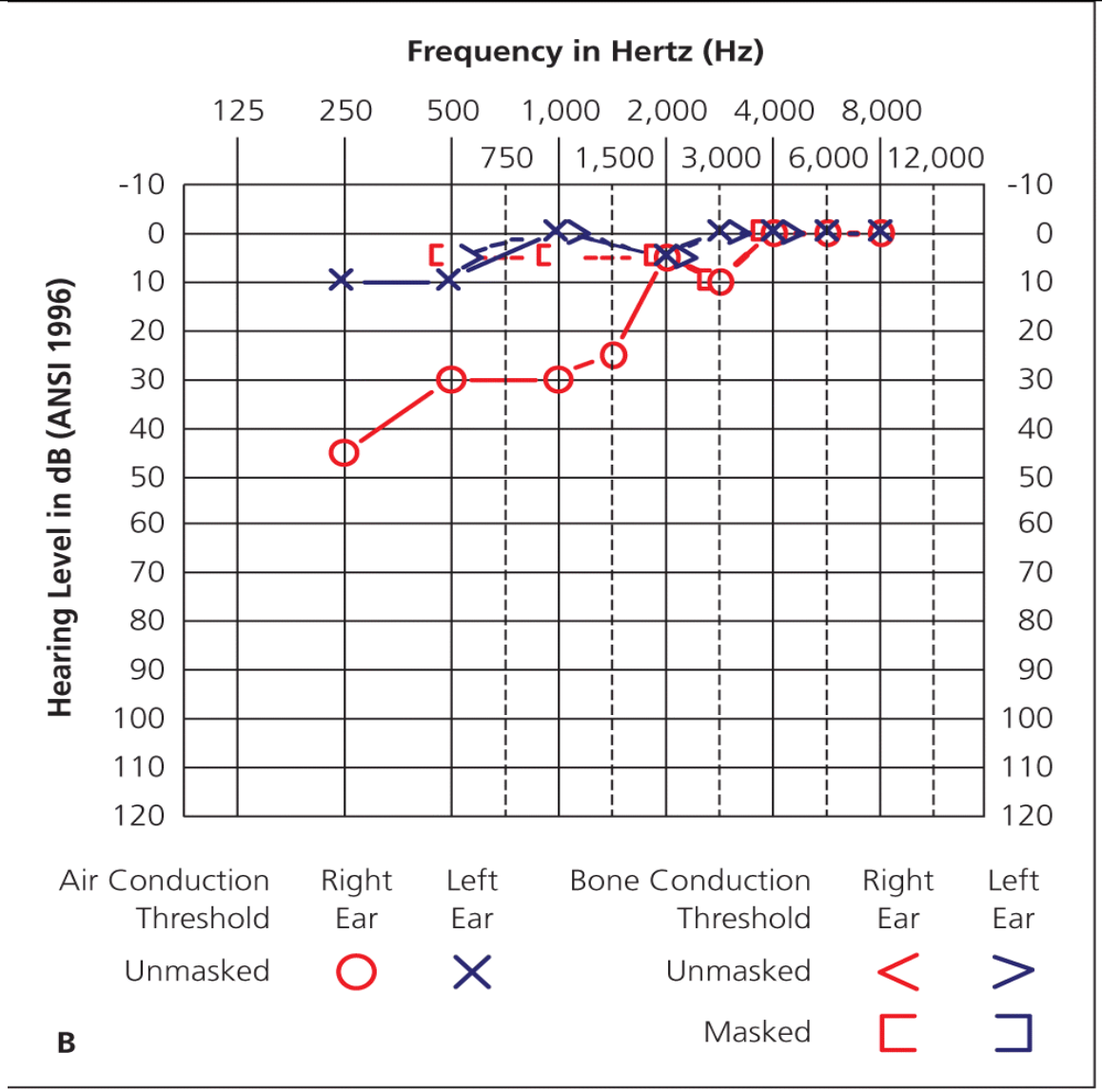

normal
mild
moderate
severe
profound
Frequency 125 250 500 750 1k 1.5k 2k 3k 4k 6k 8k Hz
-10 0 10 20 30 40 50 60 70 80 90 100 110 120
Hearing Level dB
© Mayfield Clinic



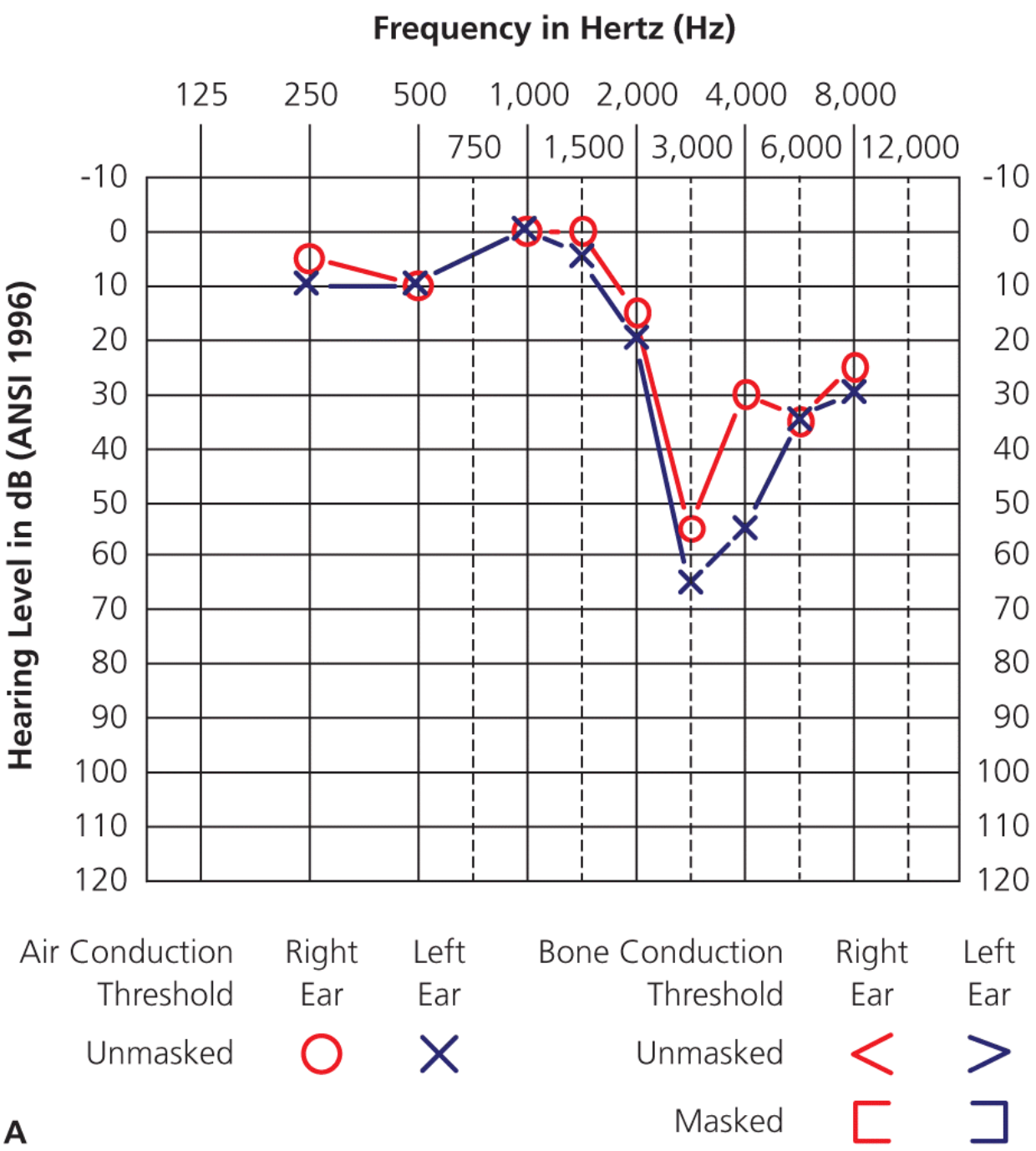
Normal audiogram


Frequency in Hertz (Hz)
125
250
500
750
1,000
1,500
2,000
3,000
4,000
6,000
8,000
12,000
Hearing Level in dB (ANSI 1996)
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
Air Conduction Threshold
Right Ear
Left Ear
Unmasked

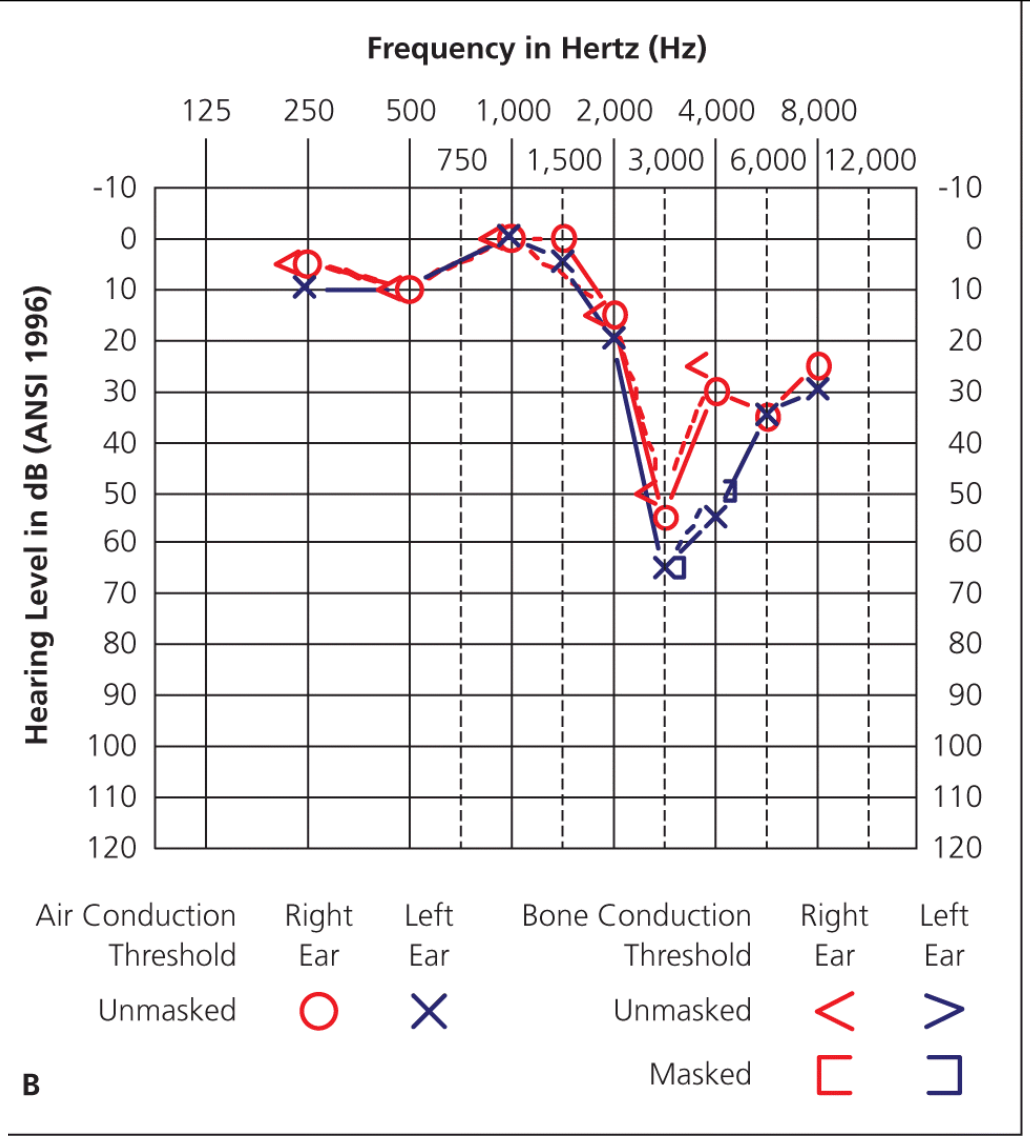
A



Right ear. Bone conduction is better than air conduction. The patient has low- to mid-frequency conductive hearing loss due to tympanic membrane perforation.


Frequency in Hertz (Hz)
125
250
500
750
1,000
1,500
2,000
3,000
4,000
6,000
8,000
12,000
Hearing Level in dB (ANSI 1996)
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
Air Conduction Threshold
Right Ear
Left Ear
Unmasked
Bone Conduction Threshold
Right Ear
Left Ear
Unmasked
Masked

A



Bilateral, noise-induced sensorineural hearing loss.

Best of luck