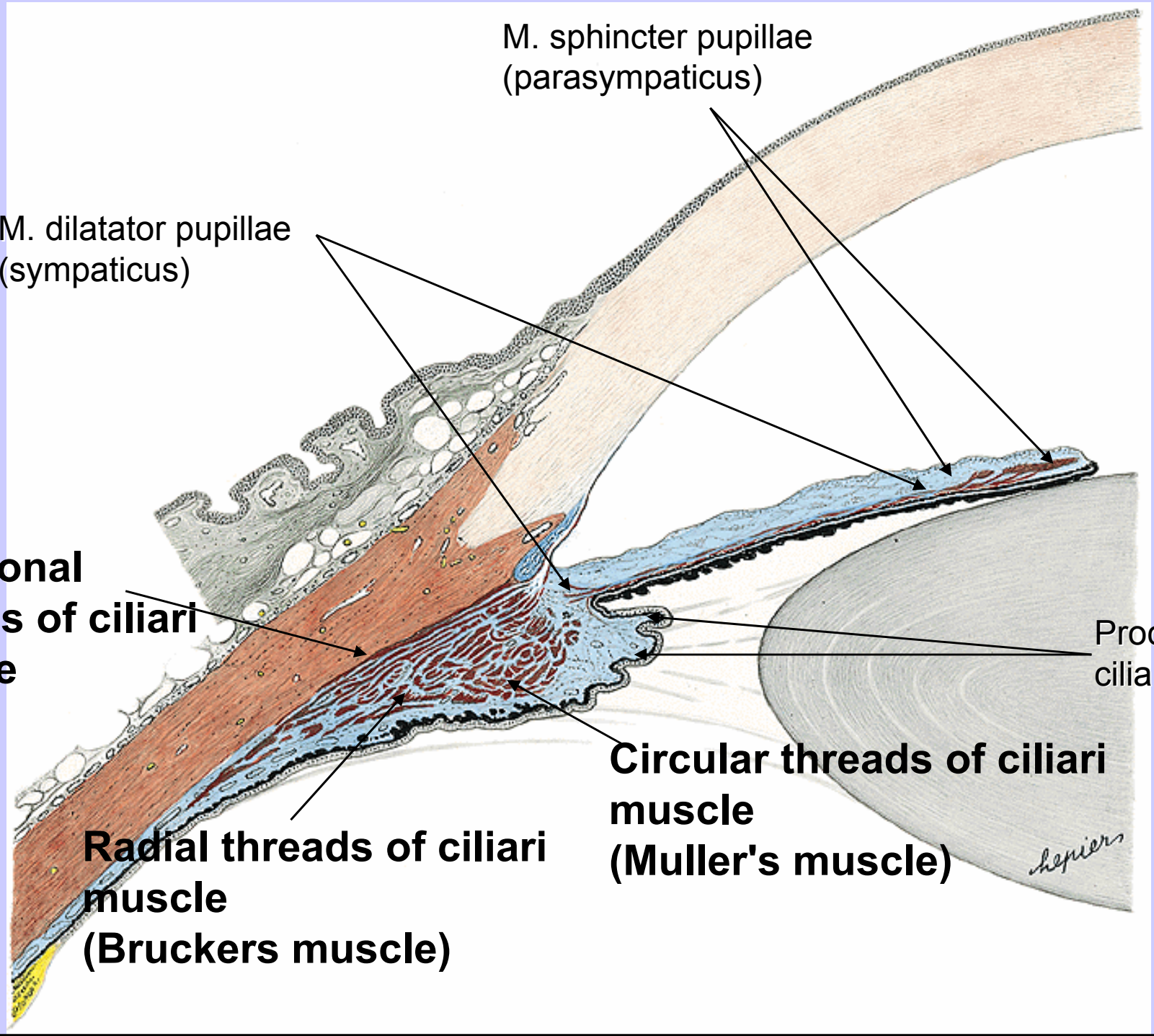
Physiology of an eye

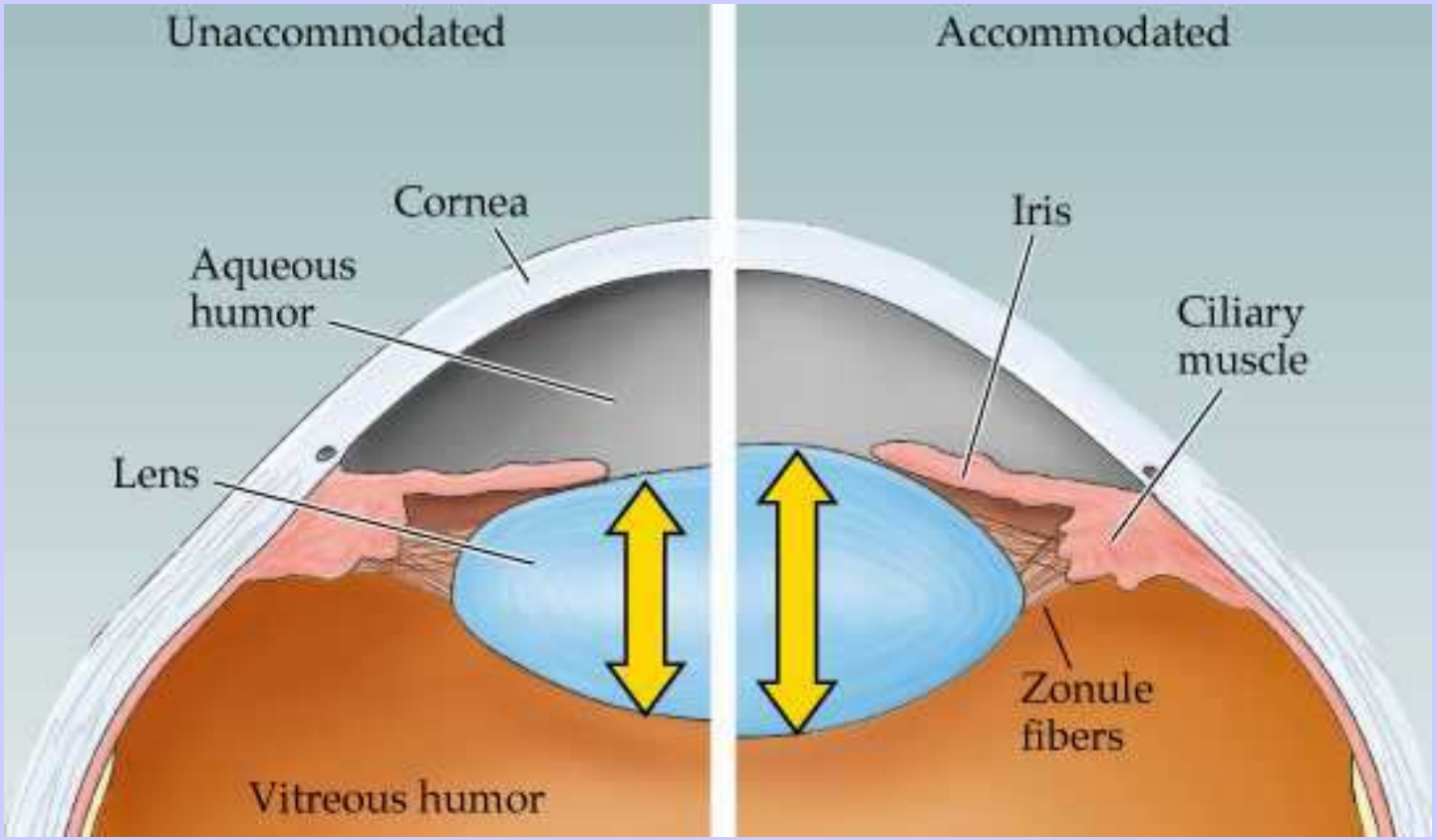
Table of contents

Accommodation

Accommodation

- Ability of an eye to see things in different distances
- Contraction of circular muscle (Muller's muscle; parasympaticus) $\Rightarrow$ lens is arched thanks its elasticity and plasticity


M. sphincter pupillae
(parasympaticus)
M. dilatator pupillae
(sympaticus)
Meridional threads of ciliari muscle
Processus ciliares
Circular threads of ciliari muscle
(Muller's muscle)
Radial threads of ciliari muscle
(Bruckers muscle)

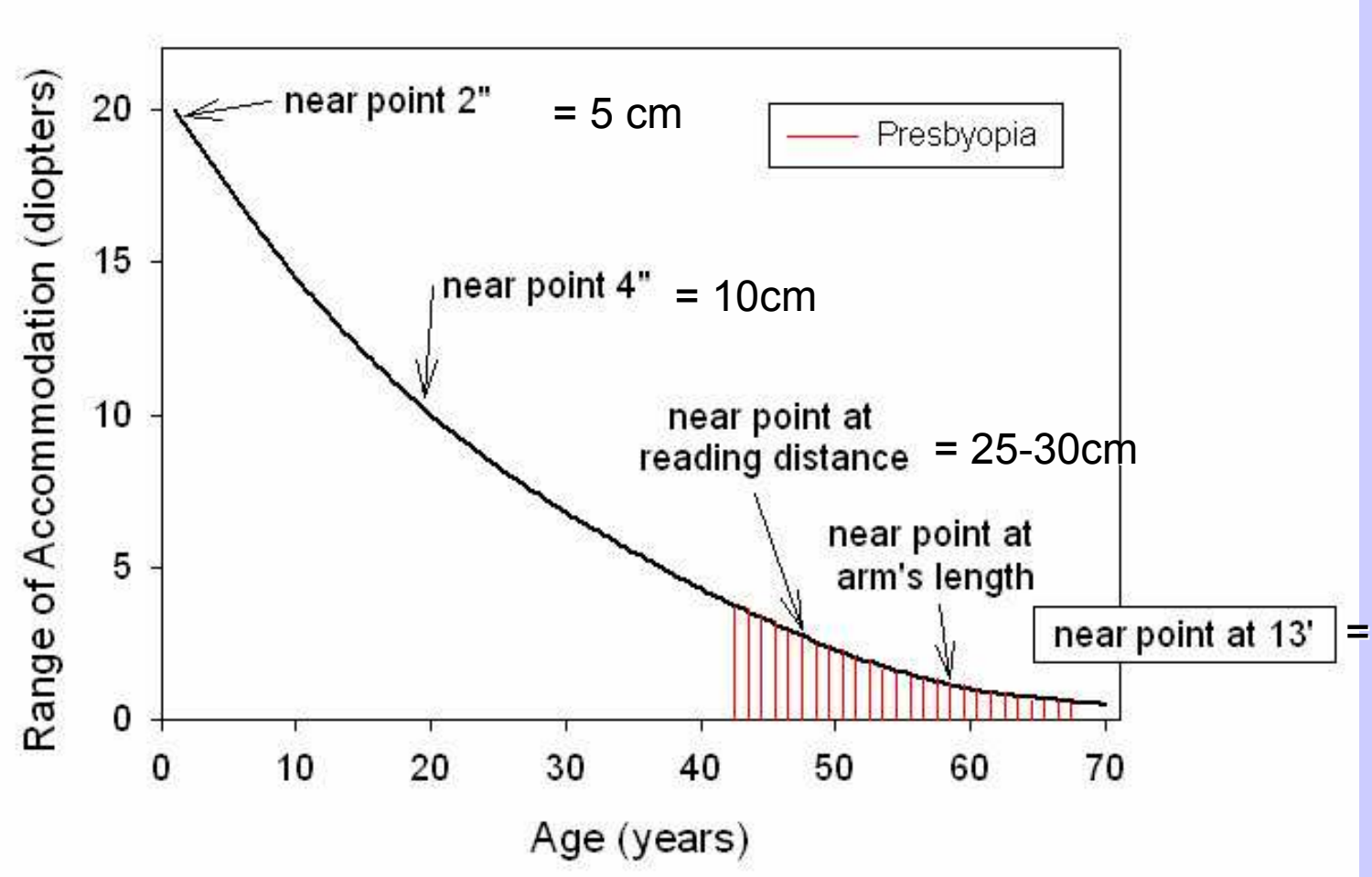

Unaccommodated
Accommodated
Cornea
Aqueous humor
Lens
Iris
Ciliary muscle
Zonule fibers
Vitreous humor

- **Accommodation for distance vision:** active process – contraction of ciliary muscle (Bruckers muscle; *sympaticus*)
- **Physical accommodation:** provided by elasticity of the lens (physical deformation of the lens) – measured in Dpt. After age 65 lens is not plastic – physical accommodation stops
- **Physiological accommodation:** provided by activity of ciliary muscle - measured in myoDpt. (contraction of the muscle necessary to lift refraction +1 Dpt)

- **Far point (*punctum remotum*):** furthermost point which you can clearly see with relaxed eye (emetrope in the infinite)
- **Near point (*punctum proximum*):** nearest point which you can clearly see with maximal accommodation
- **Accommodating area:** distance between far point and near point. Space, in which you can see points sharp (rate of accommodation affectivity)

- **Static refraction:** fragility of an eye without accommodation
- **Dynamic refraction:** fragility of an eye with maximal accommodation
- **Range of Accommodation:** measure of eye ability to accommodate. Difference maximal Dynamic refraction and Static refraction. It is difference 1/ Near point – 1/ Far point [meters]

Range of Accommodation and age



- **Presbyopia:** (at old people) physiological decrease of Range of Accommodation with incoming old age (decreasing of elasticity and plasticity of the lens and ability of ciliary muscle to contract). Near point is further (in face of emetrope – normal eye)
- **Accommodating astenopia:** headache, lacrimation, eye burning during accommodating to near points. (Without acc. as. when is used 2/3 maximal accommodation and 1/3 of accommodation is as reserve.)

- **Insufficiency of accommodation:** not effective accommodation
- **Paralysis of accommodation:** caused by injury of an eye, trauma or infection of CNS (e.g. Paralysis of *parasympaticus, nevus III – Oculomotorius)*

Eye movement

Eye movement

- Movement of eyes during fixation (eye is never 100% calm)

Small eye movement

- **Microsacads:**
  - Irregular very quick eye movements.
  - Deviation is 2´ do 40-50´ from subject of fixation.
  - Time of duration is 10-20ms.
  - Binocularly symmetric, with will uncontrollable.
  - Function is to get visual axis back on a watched objective (deviation after drifts)

- **Slipping eye movement = drift:**
  - Slow eye movement (200ms)
  - Axis is yawed maximal 6´ $\rightarrow$ vision on retina is moved about 10-15 cones and is not moved from fovea. (Moved back by microsacads)
  - Irregular movement – each eye is independent on movement of the other

- **Eye shake = tremor:**
  - Deviation is smallest (20 - 30´´).
  - Frequency is high (70 – 90 Hz, sometimes higher than 100 Hz).
  - Function is not known.

Large eye movement

- **Sacads:**
  - To scan visual field
  - Binocularly symmetric
  - Speed of each sacad is around 800°s^{-1}
  - Latention is 150 – 200 ms.
  - Time between two sacads is always minimal150 ms

- **Smooth pursuit movements:**
  - Only if a moving subject is in the optic field
  - With one´s own will uncontrollable.
- **Disjoint eye movement:**
  - Convergence, divergence
  - They start while an image of an object falls on disparate places of the retina (points on the retina which do not correspond together).
  - Slow, duration to 800 ms.

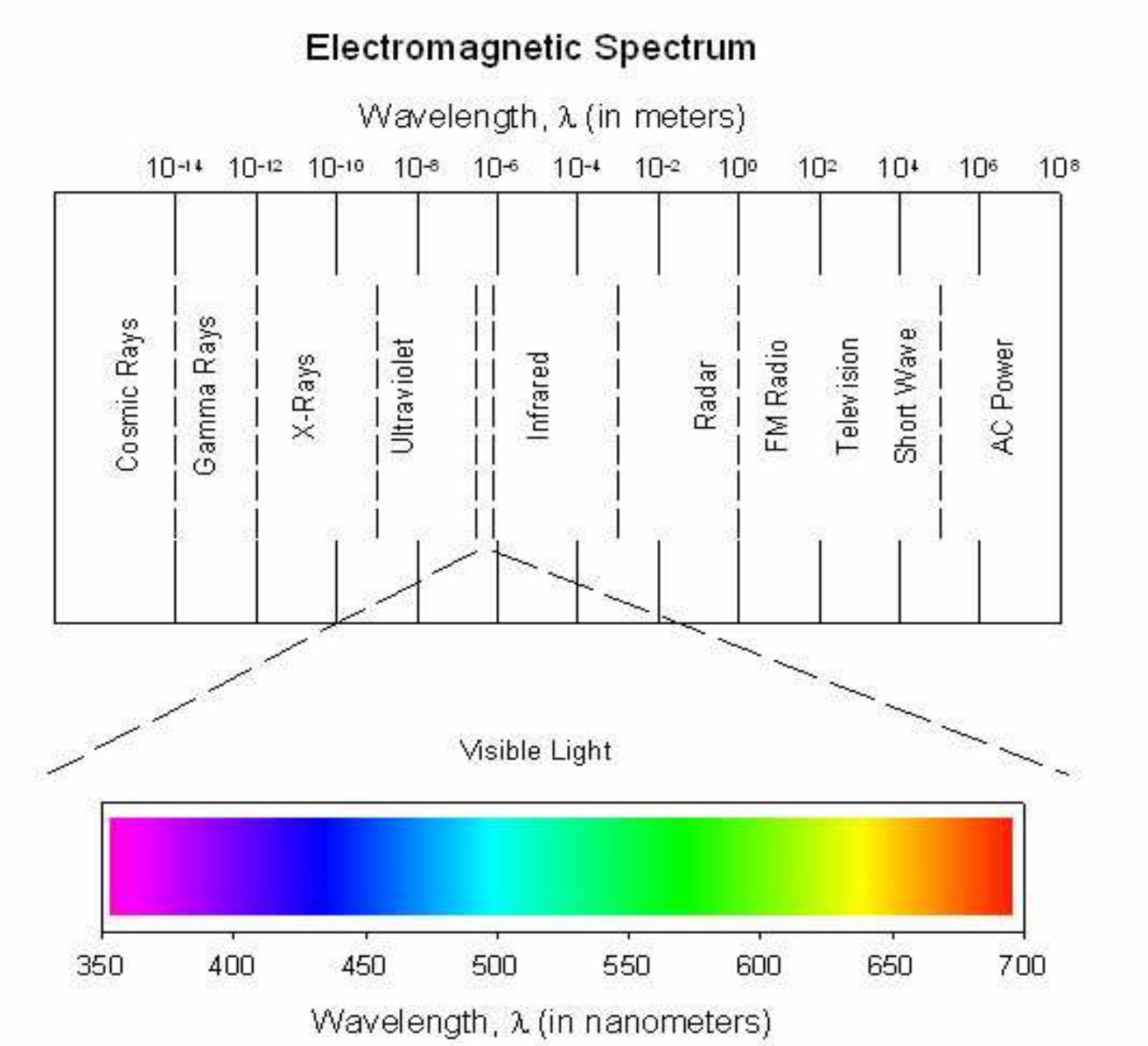
Coloursence

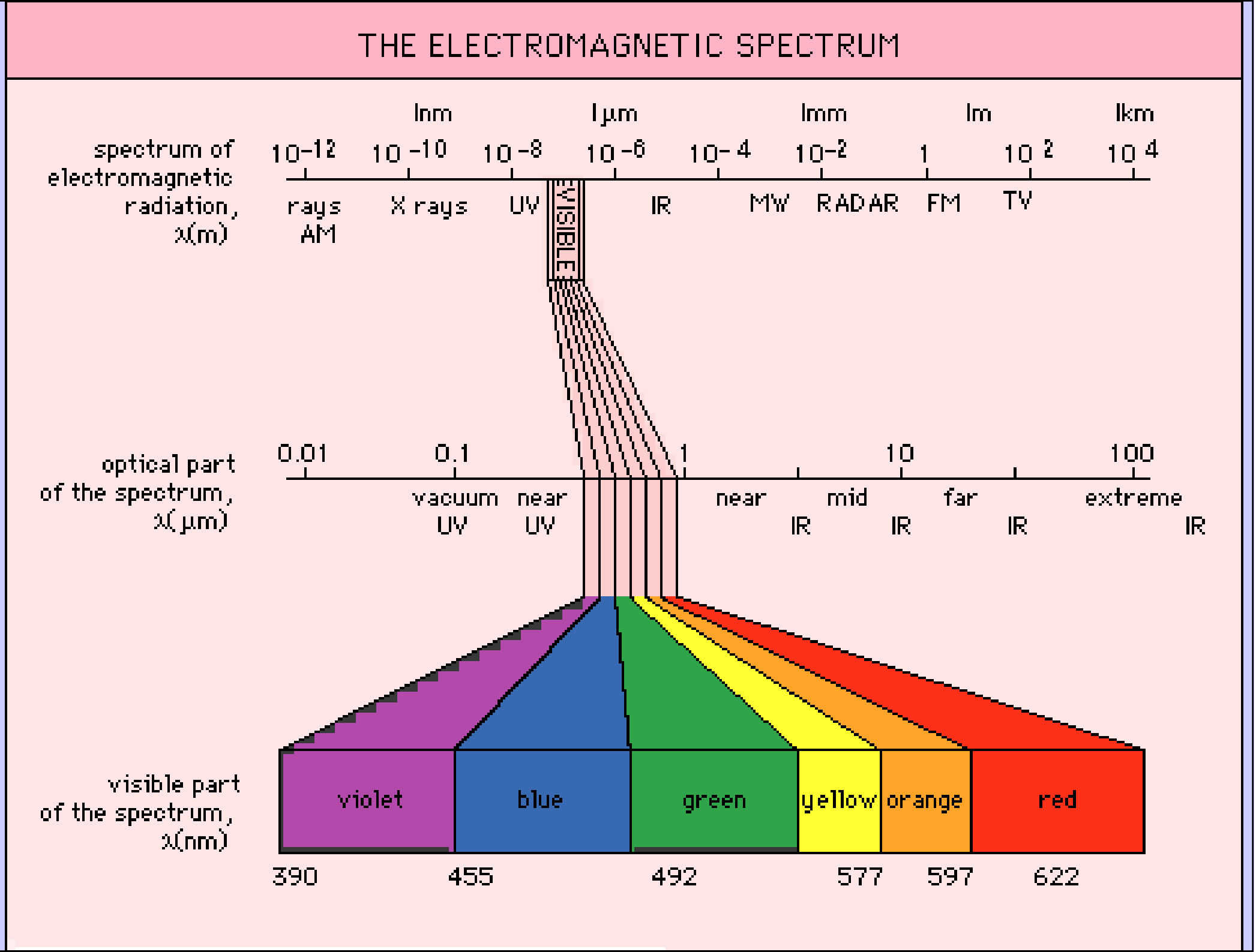
Coloursence

- Sence of colours is ability to differntiate a colour some watched object..
- Eye is sensitive for this wave length :

  380 - 780nm
- Eye is most sensitive for yellowish – green colour (555nm wave length)
- Receptors of colour vision are cones
- Receptors of piedbald vision are rods

Elektromagnetic spectrum of coloursence




THE ELECTROMAGNETIC SPECTRUM
spectrum of electromagnetic radiation, λ(m)
1nm
1μm
1mm
1m
1km
10-12
10-10
10-8
10-6
10-4
10-2
1
10 2
10 4
rays
AM
X rays
UV
VISIBLE
IR
MW
RADAR
FM
TV
optical part of the spectrum, λ(μm)
0.01
0.1
1
10
100
vacuum UV
near UV
near IR
mid IR
far IR
extreme IR
visible part of the spectrum, λ(nm)
violet
blue
green
yellow
orange
red
390
455
492
577
597
622

Receptors - Cones

- Cones are receptors of colour vision
- Cones are situated on retina
- We have 3 types of cones: red,green and blue. From this basic colours, the brain can compound all image.

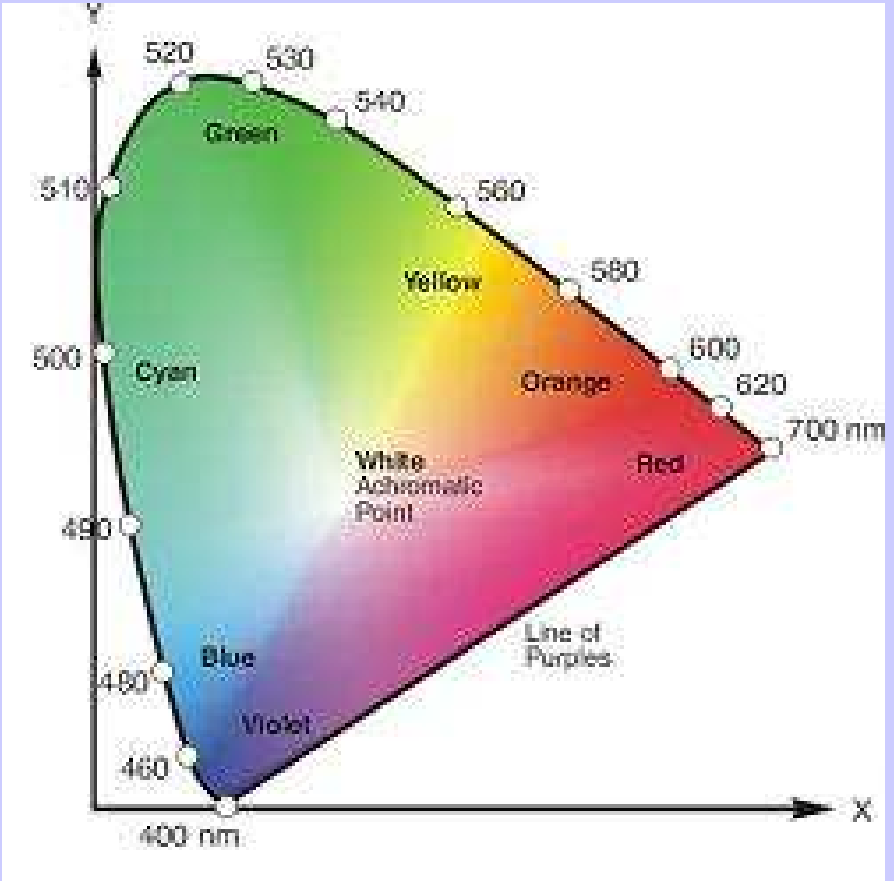
  This is also principle of all Tv, cameras and lot of others machines

Receptors - Cones

- The number of this cones isn´t same.
- Rate 1:16:32.
- The most numerous cones are red cone (Long-wavelength–sensitive cone

Theory of mixing colours

- **Anyone chromatic tinge we can get by mixing of three basic : red, green and blue (RGB).**
- **White light is mixture of this three colour in the same rate**

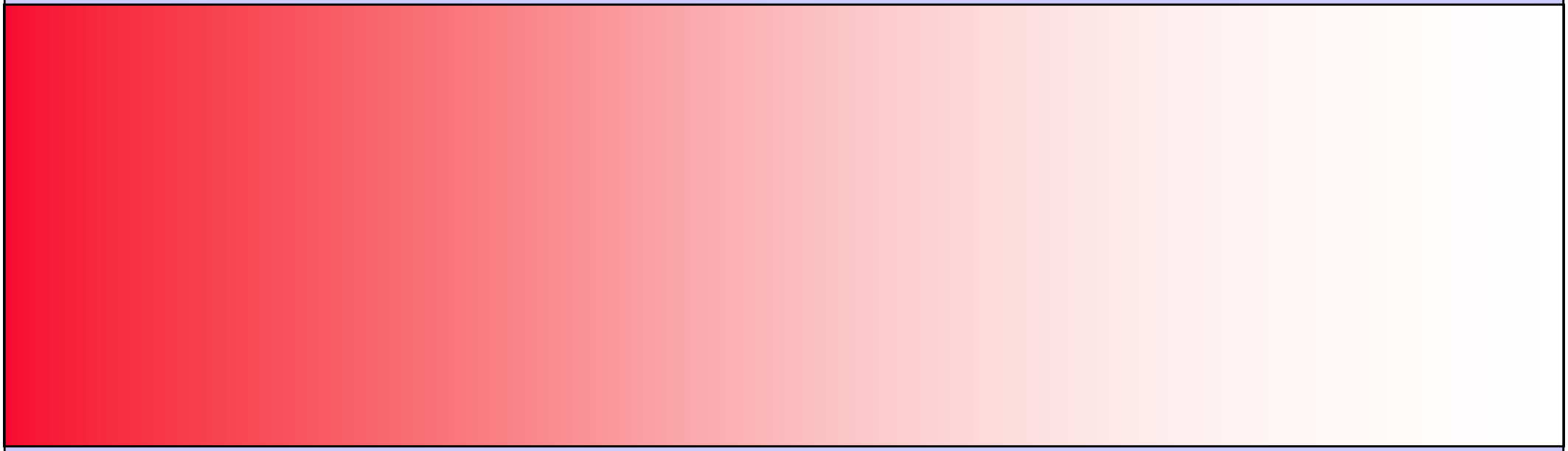


Chroma

Chroma *it means amount of white colour*

100% red, 0% white

100% white, 0% red



Coloursence diseases

- **Inborn coloursence diseases** - dichromasia,monochromasia
- 8% ♂ 0,5% ♀
- 3 types of cones,but in other rate
- **Acquired coloursence diseases**
  - **Cataract**
  - **Disease of optical nerve**
  - **Disease of retina**

Inborn coloursence disease

- **Dichromasia**

  The most frequently disease of coloursence disease.

  Patient sens only 2 colours – 2 types of recptors

  He sense only brigthness of third colour
- **Monochromasia**

Dichromasia

normal

Protanopia (eyeless for red colour)

Deuteranopia (eyeless for green colour)

Tritanopia (eyeless for blue colour)

Monochromazia

Patients don´t sense any colour. They sense only brightness

normal

Monochromazia

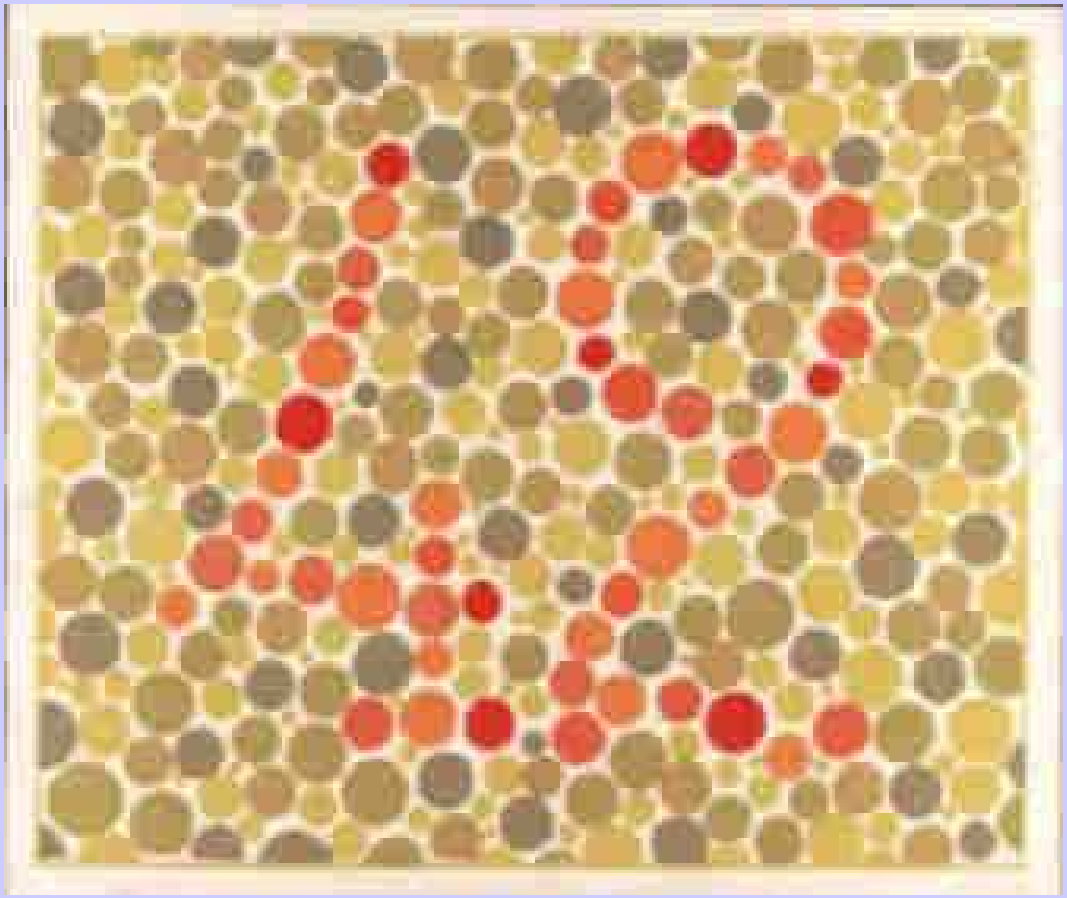
Examination of coloursence

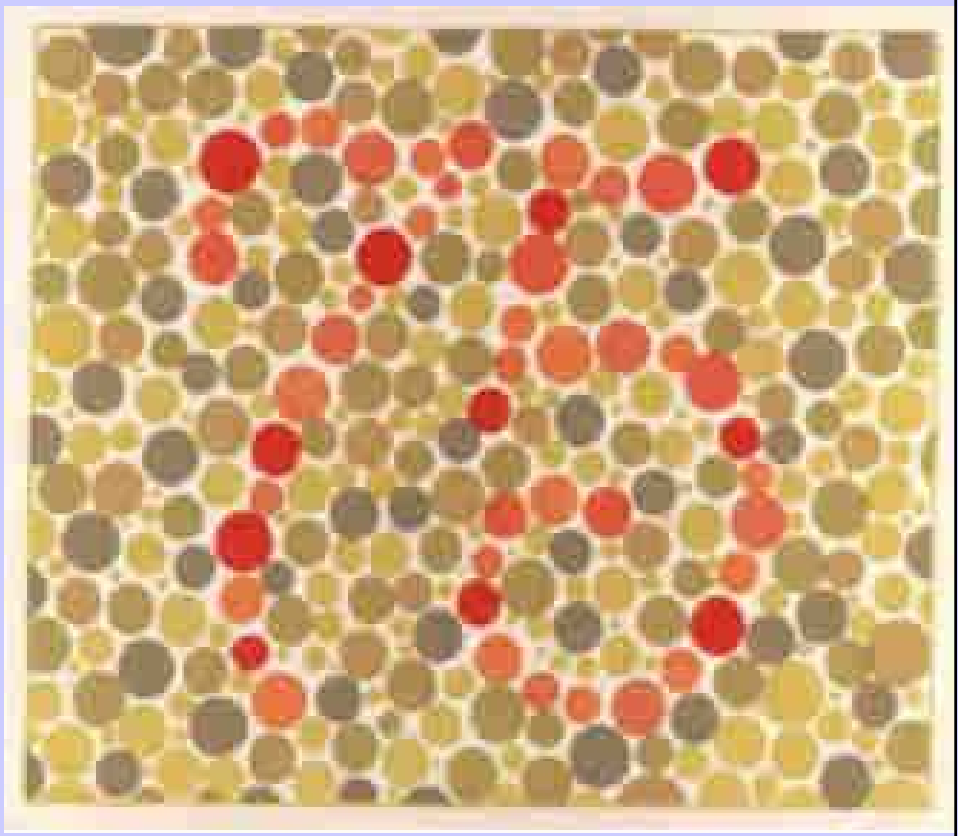
- **Pseudoisochromatic tabels:**

  Symbols or numbers in tables has ***different colour tinge, but same brightness.***
- **Lanthony panel –** Chromatic disc has ***same brightness and chroma.They have different tinge.***

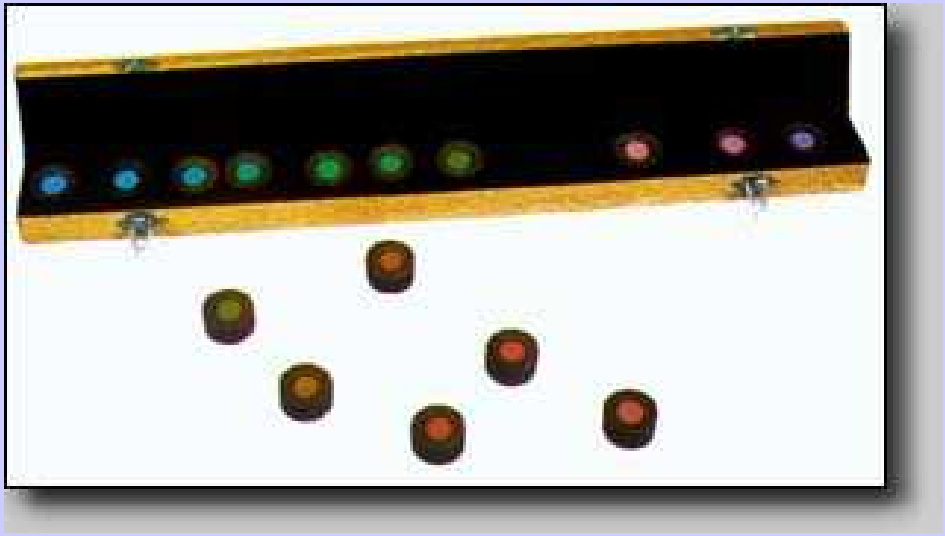
  Patient have to collect in colour sentence of spectrum

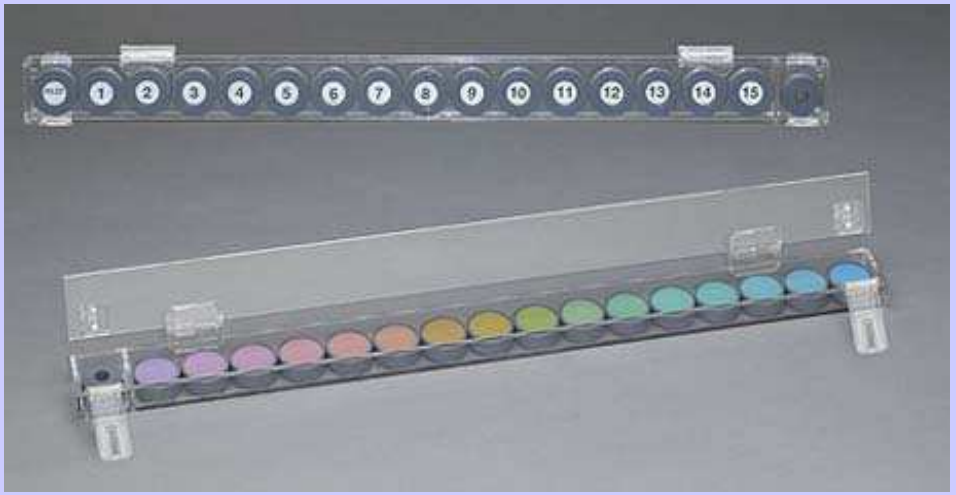
Pseudoisochromatic tabels:





Lanthony test





Vocabulary

- Furthermost – nejvzdálenější
- Infinite – nekonečno
- Accommodating area – akomodační interval
- Fragility – lomivost
- Range of Accommodation – akomodační šíře
- Lacrimation – slzení
- Deviation – odchylka
- Yaw – odchýlit
- Cone – čípek
- Smooth pursuit movements – Sledovací oční pohyby

Vocabulary

- Coloursence – barvocit
- Wave length – vlnová délka
- Cones – čípky
- Rods – tyčinky
- Chroma – sytost
- Brightness – jas
- Tinge – odstín
- Cataract – šedý zákal