

Physics of light in medicine

Practical Physics
the first lecturer

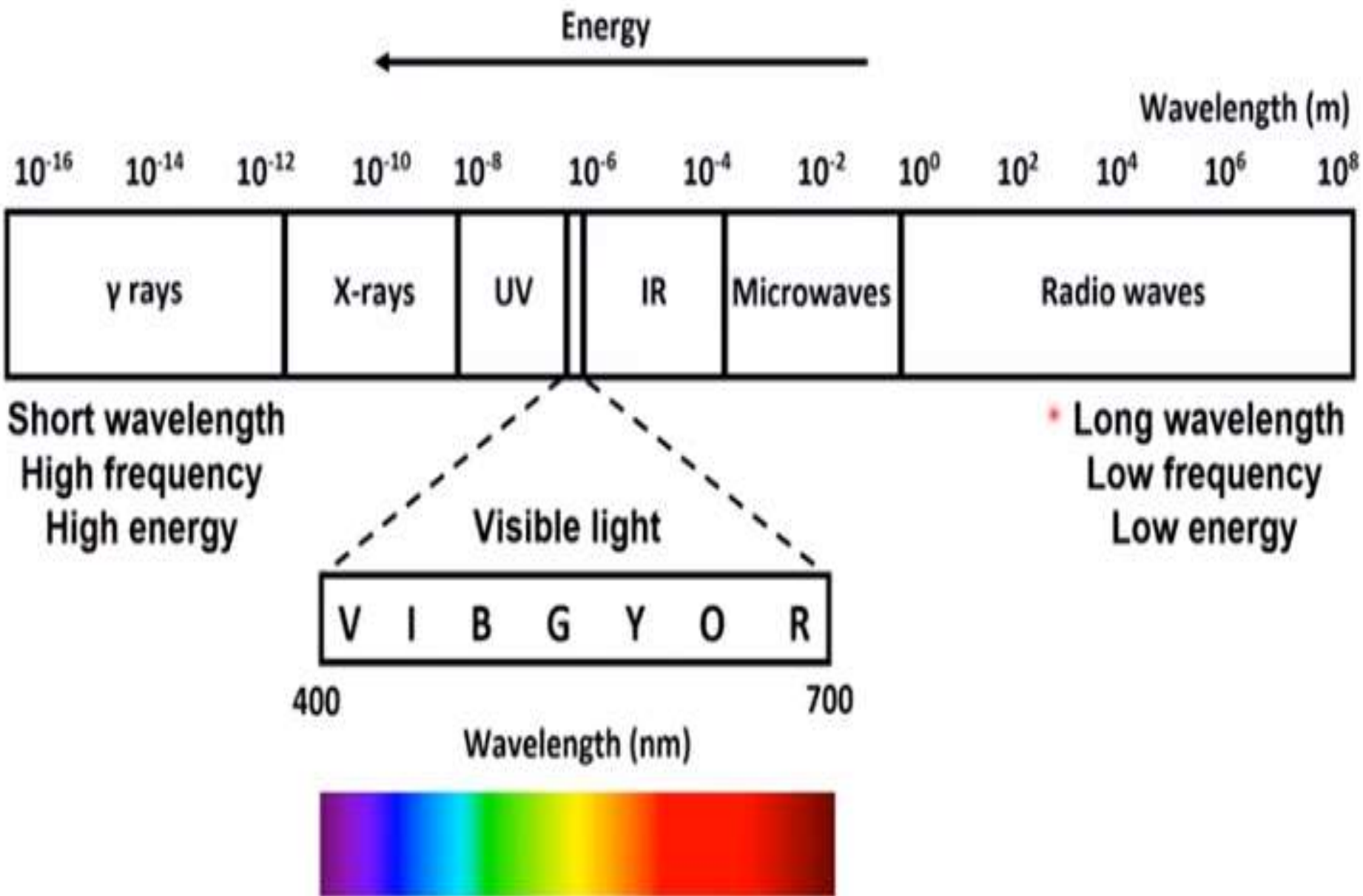


Definition:

Light or visible light is electromagnetic radiation within the portion of the electromagnetic spectrum.

1. Travel at the speed of light
2. Have no electric charge

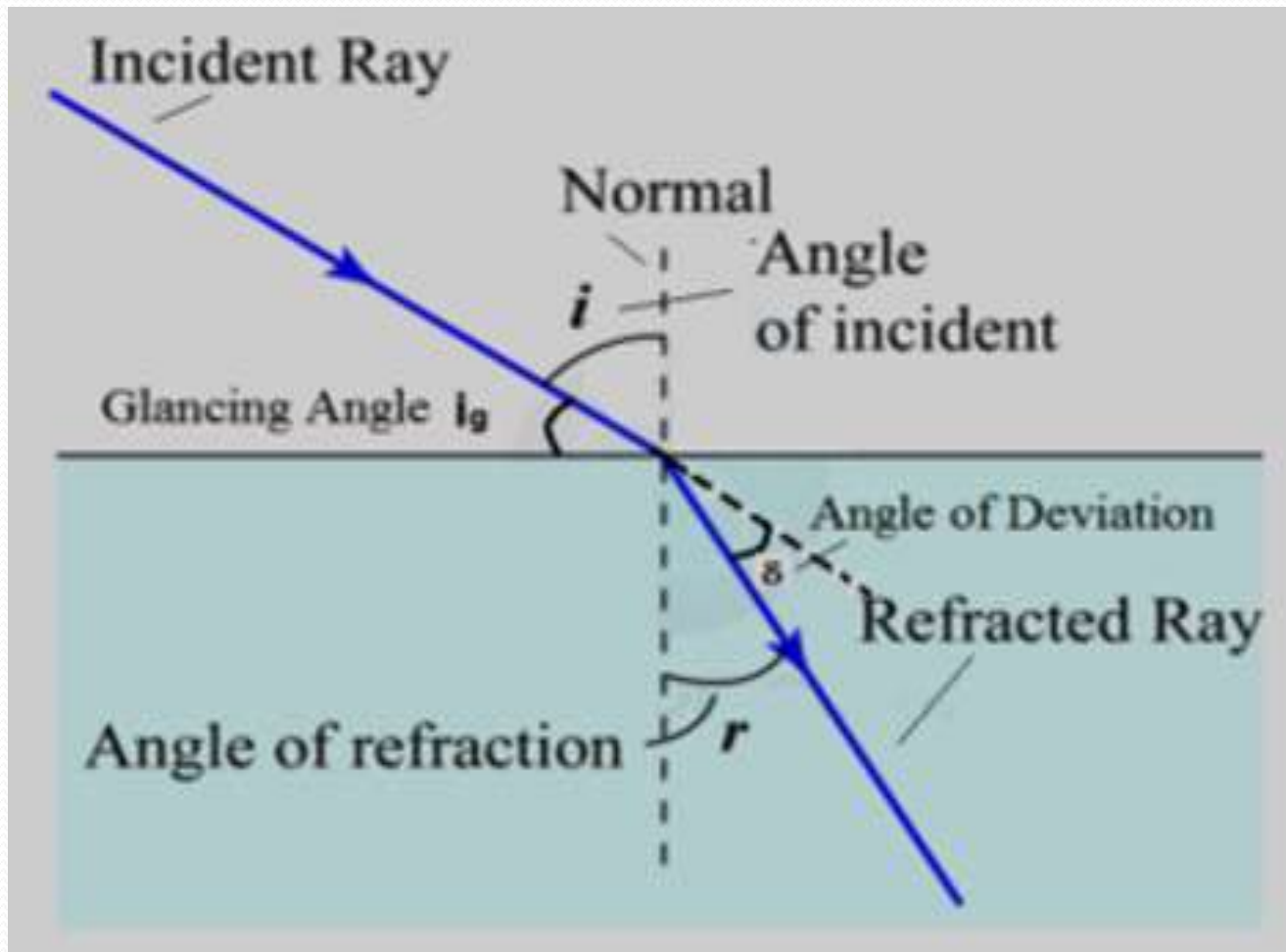
We will study light in three categories (visible & ultraviolet & infrared)



Light properties

1) Refraction

- due to the change in speed of light .
- index of refraction is the ratio of the speed of the light in a vacuum to its speed in a given material .
- this property permits light to be focused as in the eye.



2-Dual behavior

- Light behaves both as a wave and as a particle .
- As a wave when it produces interference and diffraction.
- As a particle when it can cause a chemical change in the molecule that in turn can cause an electrical change as in the retina of the eye.

3-Heat production

- When light is absorbed, its energy generally appears as heat
- IR light used to heat tissues and to coagulate small blood vessels in the retina.

4-Fluorescence

- Sometimes when a light photon is absorbed, a lower energy light photon is emitted.

5-Reflection

Light is reflected to some extent from all surfaces. There are two types of reflection. Diffuse reflection occurs when a rough surface scatters the light in many directions. Specular reflection is a more useful type of reflection; it is obtained from very smooth, shiny surfaces such as mirrors, where the light is reflected at an angle that is equal to the angle at which it strikes the surface. Mirrors are used in many medical instruments.



Application of visible light(400-700)nm in medicine

- 1- A simple instrument consists of concave mirror with a hole in the middle of it.(ophthalmoscope,otoscope).
- 2- Endoscopes: are used for viewing internal body cavities.

Special purpose endoscopes are often given names indicating their purpose. For example:

A- Cystoscopes: are used to examine the bladder.

B-Proctoscopes: are used for examining the rectum.

C-Bronchoscopes: are used for examining the air passages into the lungs

Some endoscopes are rigid tubes with a light source to illuminate the area of interest. Many of them are equipped with optical attachments to magnify the tissues being studied.

The development of fiber optic techniques permitted the construction of flexible endoscopes. Flexible endoscopes can be used to obtain information from regions of the body that cannot be examined with rigid endoscopes, such as the small intestine and much of the large intestine.

Some flexible endoscopes are over a meter in length . The image obtained with a flexible endoscope is not as good as that obtained with a rigid endoscope, but often the only alternative to a flexible endoscopic examination is exploratory surgery.

Flexible endoscopes usually have an opening or channel that permits the physician to take samples of the tissues (biopsies) for later microscopic examination.


3- Transillumination it is the transmission of light through the tissue of the body. It used clinically in the detection of:

1- hydrocephalus(water-head).

2- pneumothorax(collapsed lunge).

3- fracture lines in teeth.

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* Phototherapy visible light has an important therapeutic use . Since light is a form of energy and is selective absorbed in certain molecules ,it should not be surprising that it can cause important

Physiological effects. Many premature infants have Jaundice, a condition in which an excess of Bilirubin is excreted by the liver into the blood. It was discovered that most premature infants recover from jaundice if their bodies are exposed to visible light

Application of UV (100-400)nm light in medicine

- 1- to sterilize medical instruments(290)nm
- 2- converts some of molecular products in the skin into vitamin D.
- 3- Affects the melanin in skin to cause tanning.
- 4- UV light can produce sunburn , and cataracts in the lens of the eye.

Application of IR (700-1000)nm light in medicine

- 1- IR photons of 1000-2000nm are often used for physical therapy purposes.
- 2- Two types of IR photography are used in medicine :-
 - * Emissive IR photography , this is called thermography .
 - * Reflective IR photography (700 to 900nm) to show the patterns of veins just below the skin.