Ing. Anna Horňáková, Ph.D.

Institute of Hygiene and Epidemiology of the 1st Faculty of Medicine

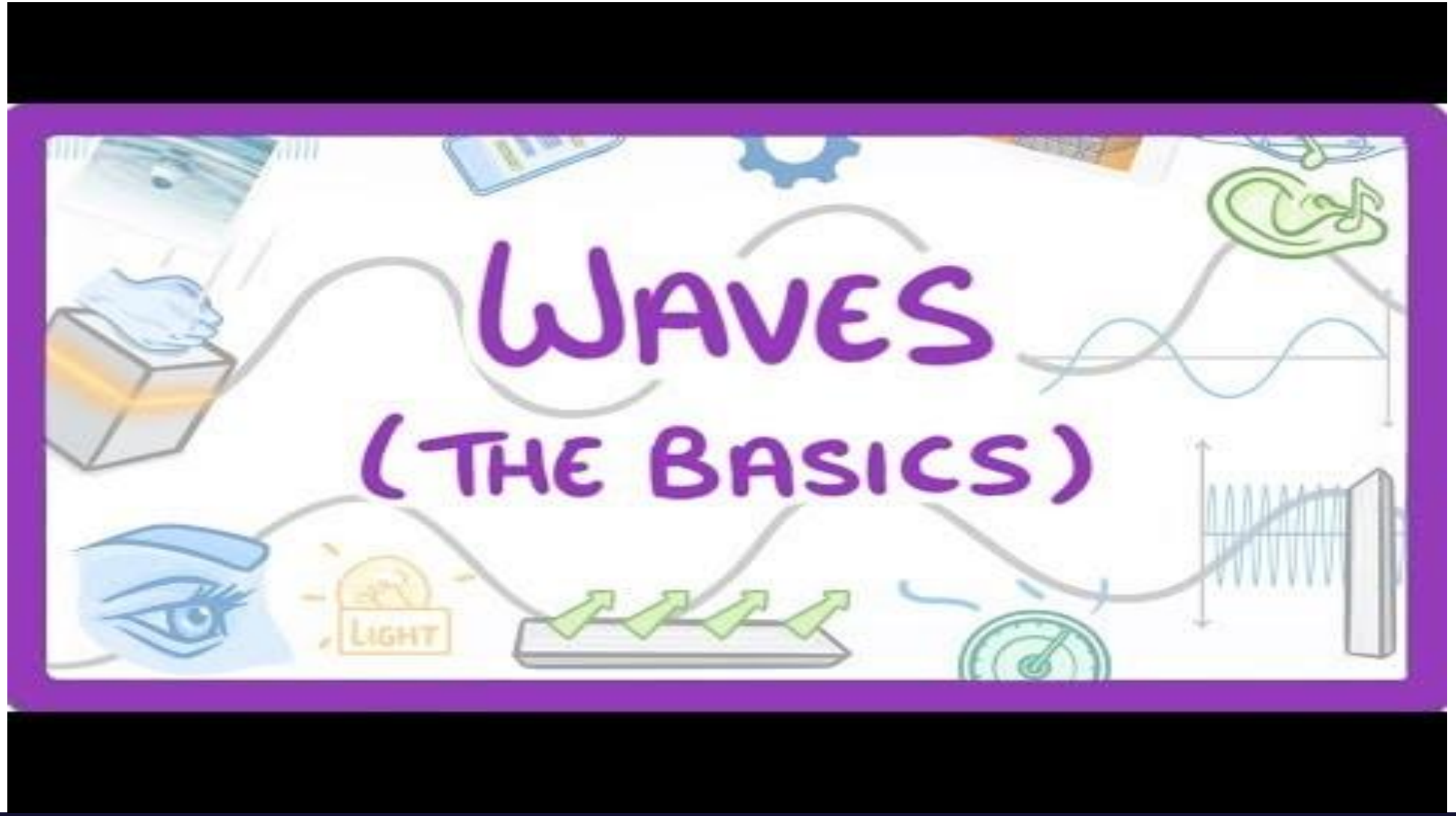
FIRST FACULTY OF MEDICINE
Charles University

PHYSICAL FACTORS IN ENVIRONMENT

Distribution of physical factors

Waves	Mechanical waves	Noise	
		Vibrations	
	Electro-magnetic waves	Non-ionizing radiation	Radio waves, Microwaves, Radar waves, Infrared radiation, Visible light, Ultraviolet radiation
		Ionizing radiation	alpha, beta, gamma, X-rays
Thermal comfort	Climatic factors	Air temperature, Air humidity, Speed of air flow, Intensity of heat radiation	
	Individual factors	Activity, Thermal resistance of clothes	

Waves



Sound waves

Noise

- **Noise = Any sound having disturbing or troubling character, or having damaging effects**
- The range of usual noise level values is 0-140 dB.
- The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect.
- Frequencies that may be perceived by the human ear vary from 20 to 20 000 Hz.
- The range of frequencies below than 20 Hz is called infrasound, the range above 20 kHz, is called ultrasound.

Types of noise

- **Steady state** – noise the level of which does not change more than 5 dB at given place and during given time period, such as the sound of a waterfall.
- **Fluctuating noise** – noise the level of which changes by more than 5 dB at given place and during given time period.
- **High-frequency noise** – noise with expressive components in frequencies higher than 8 kHz.
- **Noise with tone components** – noise, the spectrum of which contains tone (discrete) components with levels of acoustic pressure higher by more than 5 dB than surrounding frequency areas.
- **Impulsive noise** – noise produced by individual sound impulses in duration up to 200 ms or by series of such impulses following each other in intervals longer than 10 ms.

Noise – influence on humans

- Some sounds are noises only at certain times, in certain places, to certain people, e.g. some types of music.
- An important factor of disturbance is also the informative content of the sound. Usually, the conversation is more disturbing that an indifferent sound (music, humming).
- On the contrary, indifferent sounds are used in many cases to mask sounds with disturbing information.

Noise – influence on humans

The damaging effect of noise:

- a direct damage to hearing;
- acoustic trauma caused by levels of noise over than 140 dB;
- a rustle in ears;
- system changes or symptoms as an increase of blood pressure or some immunological changes;
- permanent functional changes, changes in work effectiveness, the extent of fatigue after working hours or the quality of sleep.

Noise – influence on humans

- The severity of damaging effects is given by the dose of energy received.
- Strong intermittent sounds with tone components and/or with impulses are biologically more effective than soft and steady sounds. The intensity of noise:
  - above 120 dB can damage cells and tissues;
  - above 90 dB are dangerous for the organ of hearing;
  - above 60-65 dB for the vegetative system;
  - above 30 dB for nervous system and psychic state.

Noise – influence on humans

- Repeated exposure to excessive noise levels results in a noise-induced hearing loss.
- Its effects on the hearing apparatus appear usually after a long period of time (for levels about 80 dB even after 10 – 15 and more years) when the damage is usually irreversible.
- Another important thing is that a man is usually unable to find out the changes in his hearing because here the objective comparison is missing.
- We don’t know what we have to hear, and what we don’t have.

Examples of noise levels

Source of a noise	Noise level [dB]
Leaf noise in low wind	10
Whisper (a very quiet apartment and a very quiet street)	30
Muffled speech	40
Loud speech	60
Heavily busy street	70
Subway tunnel	80
Train (moving)	90
Pneumatic hammer	100
Airplane (at start)	120
Petards	170

Noise – measuring and evaluation

- For the steady-state noise, we measure the **average noise level** L_A.
- This means that we measure repeatedly the noise level using the weight filter A (The weight filter A respects different audibility for the different frequencies).
- From results we count the arithmetical average.
- When measured noise contains high frequencies, the usage of the weight filter A is not suitable because this filter will undervalue dangerous effects of higher frequencies. In this case, we have to use a special zone (octave) filter.

Noise – measuring and evaluation

- For the variable noise, we use the **equivalent noise level**, which means that we measure repeatedly the noise level using the weight filter A which is suitable for a long time, so we measure all of the incident noise levels.
- From results, we count an energy average of noise levels.
- An energy average is not an arithmetical average of dB values, but an average of p/p_0 value subsequently expressed in dB.
- *As an example, we can count an arithmetic average from values 40 dB and 80 dB which gives 60 dB. But the energetic average is 74 dB which means a mistake of 14 dB. In fact, this means more than 4 times higher noise energy.*

Noise – evaluation

- For **evaluation** of noise, we use the limit value L_L which is given as a sum of the basic value L_B and correction K_i.
- The correction K_i increase or decrease the resulting limit value L_L according to the existing situation, e.g. the type of room or time.
- The limit value <u>for the occupational environment</u> is given in accordance with the complicacy of work, type of noise, a period of noise etc.
- The basic value L_B of noise <u>for inside protected rooms</u> (apartment houses and civil constructions) is 40 dB and 50 dB in outdoor space.

Noise – prevention and protection

- Hearing damage can be prevented in following three steps:

1) <u>by technical arrangement</u>:
   - Remove the source of noise or lower it substantially. Innovation of noise equipment by the less noisy one is the best way.
   - Encase the source of noise in a suitable covering, e.g. bricks wall around a compressor, constructing a partition etc.

Noise – prevention and protection

2) by organizational arrangement:

- Separate exposed workers from the source of noise, e.g. by establishment of a control room.
- Limit the time of exposure to noise by arranging breaks rest in environment without noise or alternation of workers in noise and calm environment.
- Increase the distance of noise sources as the energy of noise decreases with a square of distance.

Noise – prevention and protection

3) by using the personal protection aids:

- Use of suitable personal protection aids, e.g. glass wool, cotton wool safeguards, resonance safeguards, earphone safeguards, masks and helmets against noise.
- The entrance into an environment with maximum noise level above 140 dB (A) should be not allowed even with use of personal protective aids.

Vibrations

- **Vibrations = A mechanical phenomenon whereby oscillations occur about an equilibrium point.**
- Any vibration has two measurable quantities: How far (amplitude or intensity), and how fast (frequency) the object moves helps determine its vibrational characteristics.
- The terms used to describe this movement are frequency, amplitude and acceleration.

Influence of vibrations on humans

- The effects of vibration on the body manifest themselves both mechanically and psychologically. The overall effect of vibration depends on:
  1) the characteristics of the vibration: amplitude and acceleration of vibrations, magnitude, frequency, direction;
  2) the exposure type: whole-body or hand-transmitted;
  3) the factors related to the worker, including his/her exposure duration, the posture used during the exposure, location of the body contacts, applied forces, and the amount of training with the tool.

Whole-body vibration exposure

- **When a worker sits or stands on a vibrating floor or seat, the vibration exposure affects almost the entire body.**
- The typical general effect of vibrations is caused by total horizontal or vertical vibrations usually associated with driving the vehicles and mobile machinery.
- Vibrations cause mostly the general effects as tiredness and worsening of reactions to outside stimuli after a long-term exposure.
- Another risk is the combination of forced operating position and exposure to whole-body vibration – the most vulnerable segment in the case of a vertical direction of vibration is the lumbar spine.

Hand-arm vibration exposure

- **When a worker operates hand-held equipment, vibration affects hands and arms.**
- Hand-arm vibration causes damage to hands and fingers.
- The main risk here is vascular disease or nerve and musculoskeletal disease of the upper limb. Mostly it appears as damage to blood vessels and nerves in the fingers.
- The resulting condition is known as white finger disease, Raynaud's phenomenon and is caused by vibrations transmitted to hands at frequency 20 – 40 Hz.

Influence of vibrations on humans

- The sensoric effects: e.g. the vision is affected by whole-body vibration, which may lead to motion sickness.
- In buildings we can find a small vibration from external (e.g. trains, subways or industrial facilities) or internal sources (elevator systems or exercise rooms).
- Beside the human annoyance these vibrations can also disturb sensitive medical and industrial equipment.

Vibrations – measuring and evaluation

- The physical quantities typically measured in the case of evaluating the influence of vibration to the human body is acceleration effective value expressed in [ms^{-2}] and acceleration level in decibels [dB] relative to the reference acceleration.

Vibrations – measuring and evaluation

1) Vibrations at working places.
   - The setting up of the highest admissible limit is done in a similar way as for noise.
2) Vibrations in dwellings and other buildings for activities not related to work.
   - The highest admissible level of acceleration of vibrations in building structure is set up as a sum total of the basic level of acceleration, of vibrations, and corrections for the utilization of premises, daytime and character of vibrations.
3) Vibrations of the frequency lower than 1 Hz.
   - The limitation of incidence of kinetosis should be taken into consideration when setting up admissible values for vibrations with the frequency lower than 1 Hz.

Vibrations – prevention and protection

- There are a number of ways that exposure to vibration can be minimized, we can divide them into following three categories:

1) <u>technical/engineering solution:</u>
   - Anti-vibration handle or grip of tools and maintenance of the tool.
   - Special operator's seat with elastic construction.

Vibrations – prevention and protection

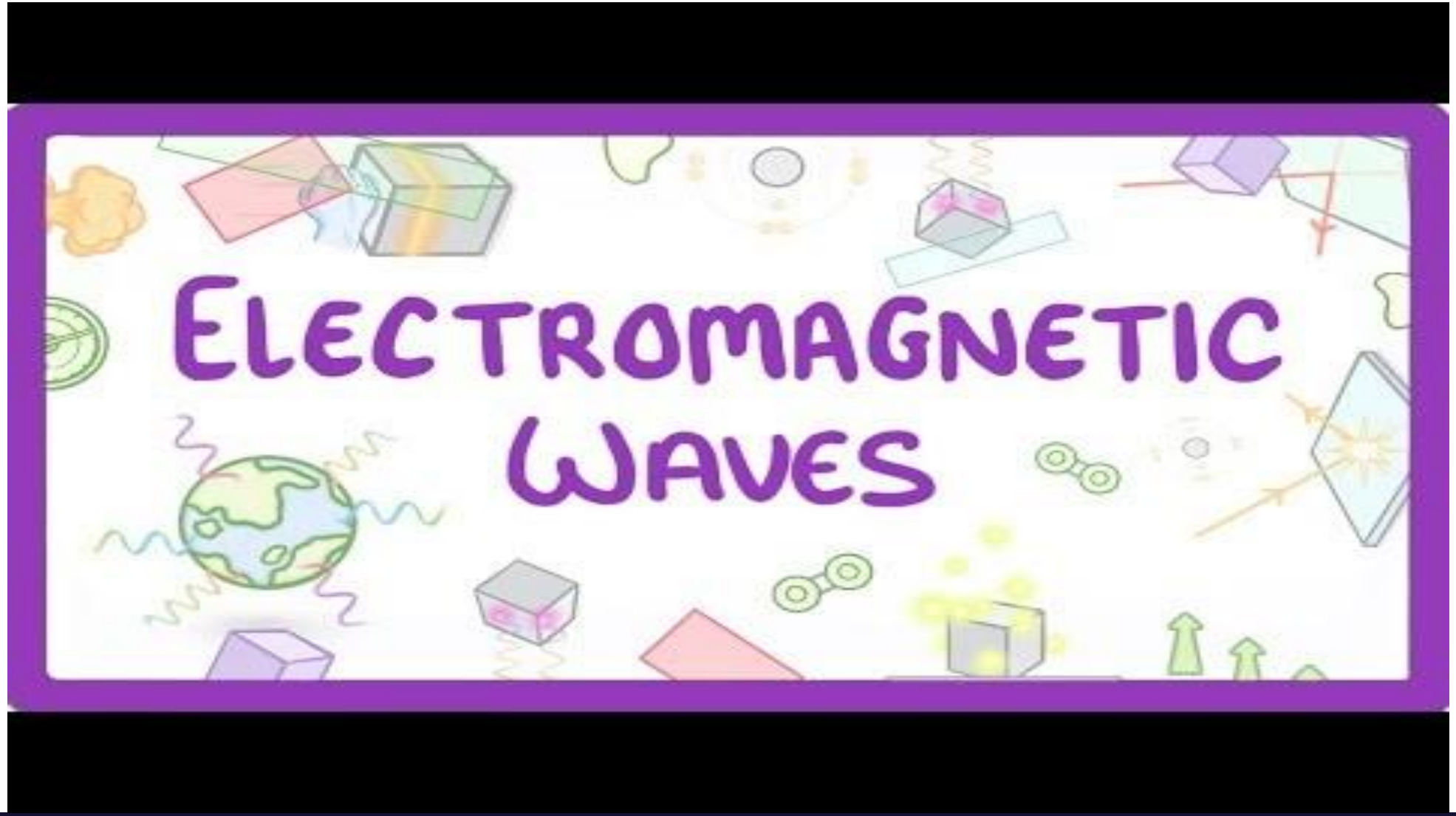
2) <u>organizational arrangement:</u>
   - A reduction in exposure time e.g. by using job rotation schedule and providing adequate rest (e.g. working with certain types of vibrating tools is limited to two hours per work shift).
   - Informing the workers about early symptoms and how to avoid factors enhancing the risk of disease caused by vibrations (drinking coffee or smoking).

Vibrations – prevention and protection

3) <u>using the personal protection equipment</u>:
   - “Anti-vibrating” gloves help to some extent by impeding some vibration.
   - However, with the gloves, it is often necessary to exert more force than would be exerted without a glove.
   - It is important to keep warm the worker or his/her hands exposed to the detrimental effects of vibrations, they must be also protected against cold and dampness (warm working clothing and footwear, gloves with the limited transmission of vibrations, heated machine cabins, warming rooms).

Time for a break

Electromagnetic waves



Non-ionizing radiation

- Non-ionizing radiation is characterized by the inability to induce ionization of the material in which it is absorbed.

- According to the wavelength or type of source, non-ionizing radiation is divided into following categories: radio waves, microwaves, infrared radiation, visible light and ultraviolet radiation.

Non-ionizing radiation - Influence on humans

- The changes induced by this radiation are mostly reversible.
- At high intensities even **thermal phenomena** are possible but **non-thermal phenomena** occur more frequently.
- In general, the **biological effects** are the bigger the greater is the field intensity, and therefore induced tension.
- Different intensities of non-ionizing radiation can produce three different responses of the exposed organism:
  - indifferent response (functional changes do not exceed physiological norms),
  - active adaptation (non-specific but observable effects),
  - extreme effect (cumulative of various types).

Principles of health protection

- The principles of health protection against adverse effects of non-ionizing radiation are:

1) time protection,
2) protection by distance,
3) the protection by screening (e.g. the Faradays cage for screening HF field).

Radio waves

Radio waves

- Radio waves are the longest and contain the least energy of any electromagnetic waves.
- Radio waves are used for transmission of data, television, mobile phones, wireless networking or amateur radio.
- Naturally occurring radio waves are made by lightning or by astronomical objects.
- Artificially generated radio waves are used for fixed and mobile radio communication, broadcasting, navigation systems, communications satellites, computer networks and innumerable other applications.

Microwaves

- Microwaves fall between radio waves and infra-red waves with wavelengths from about 30 cm to 1 mm.
- Microwaves are used for high-bandwidth communications, radar and as a heat source for microwave ovens and industrial applications.
- Low-intensity microwave radiation is used in Wi-Fi, at intensity levels unable to cause thermal heating.
- Radar uses microwave radiation to detect the range, speed, and other characteristics of remote objects and can be used for air traffic control, weather forecasting, navigation of ships or speed limit measurement.
- Radar waves can be also used in astronomy or spectroscopy.

Microwaves and Infrared waves

Infrared waves

- The infrared part of the electromagnetic spectrum covers the range from 1 mm to 750 nm.
- The infrared radiation can be divided into the near-infrared radiation (IR-A), the short-wavelength infrared radiation (IR-B), the mid-infrared and long-wavelength infrared radiation (IR-C) and far-infrared (FIR) radiation.
- We cannot see these infrared waves with our eyes, however, instruments that can sense infrared energy, such as night vision goggles or infrared camera allows us to see these infrared waves from warm objects like humans and animals.
- Some objects (such as a fire) are so hot, that they emit also a visible light.

Visible light

- Visible light is an only part of the electromagnetic spectrum that humans see with wavelengths ranging from violet at 380 nm to red at 700 nm.
- Objects appear to have a colour because EM waves interact with their molecules.
- Some wavelengths in the visible spectrum are reflected and other wavelengths are absorbed.

- Lighting is usually divided into the **daylight**, **artificial lighting** and **mixed lighting**.

Visible light

Daylight

- **The biggest advantage of the natural daylight is its dynamic component, i.e. the variable intensity and variable color.**
- The daylight is the direct sunlight and the sky light (reflected light).
- The daylight coming from the side (usually from windows) is called a lateral/side lighting and is mostly used in living and administrative spaces.
- The daylight coming from above is called the top/upper lighting and is mostly used in factories, halls, studios, etc.
- Sometimes we can also use the combined daylight which means that light is coming to the room both from the side and from above.

Daylight

- For measuring and evaluating the lighting we use the following quantities and units:
  - The luminous intensity (I) is defined as a power emitted from a small light source, in a particular direction. The unit of luminous intensity is the candela (cd).
  - The luminous flux (Ø) is the quantity of the energy of the light emitted per second in all directions. The unit of luminous flux is lumen (lm).
  - The luminosity (E) is the intensity of lighting or illumination. The unit of illumination is lux (lx) which is the amount of illumination provided when 1 lumen is evenly distributed over an area of 1 m^2.
  - The brightness (B) is an attribute of visual perception in which a source appears to be radiating or reflecting the light.

Daylight

- Because of this permanent variability of daylight, the intensity of daylight is expressed as a relative unit called **factor of day illumination**, which is defined as a ratio of daylight illumination at the given point of the given level to simultaneous comparative illumination of the outer not screened level at the estimated or known distribution of sky brightness.
- For evaluation of the room illuminance, we also need to take into account:
  - shape of the room (the relation of depth of the room and its height),
  - light coefficient (the ratio of the area of glass in the windows to the floor area)
  - reflections or barriers outside the building (shading by neighboring buildings, vegetation, terrain, etc.).

Artificial Lightning

- The artificial lighting, even the best one, is not a natural component of the living environment and is not quite in conformity with physiological needs of a human sight.
- Despite the technical progress, an artificial lighting mostly misses the dynamism of daylight and its spectral composition is usually less favorable for a man than the natural lighting.
- Simultaneous local and general artificial lighting is called a combined artificial lighting. The intensity of local lighting should be in a suitable proportion to the intensity of the general lighting.

Mixed Lightning

- Mixed lighting is **simultaneous lighting by daylight and a supplementary artificial light source**.
- A mixed/joint lighting cannot fully replace a good natural daylight, however, it can to some extent, join the advantages of daylight (spectral composition, variability) and an artificial lighting (suitable intensity).

Disturbing glare/dazzle

- A disturbing glare/dazzle can be caused directly by a light source or by its reflections on surfaces with a high reflection factor.
  - **absolute glare – dazzle by critical brightness**: occurs when the brightness in the field of sight is so high (critical) that the sight is not able to adapt itself (direct sunshine, electric arch etc.)
  - **transitory glare**: is caused by a sudden change of brightness in the sight field when the difference of brightness is greater than 1:100 and the sight adaptation takes longer than the change of brightness (a light is switched on suddenly, the transition from a dark space to a lighted one etc.)
  - **relative glare – dazzle by contrast**: occurs when there are surfaces of various brightness in a ratio higher than 1:100 in the sight field of the observer simultaneously (e.g. bulb filament and surrounding wall, glare from the oncoming vehicle).

Visible light and ultraviolet waves

Ultraviolet waves

- The light behind the visible violet, the ultraviolet waves (UV radiation), are in wavelengths from 400 nm to 10 nm and can be subdivided to the three regions, UV-A (320 – 400 nm), UV-B (280 – 320 nm) and UV-C (280 - 10 nm).
  - **UV-A**, the long wave ultraviolet, is the closest to the visible light, most UV-A also reaches the Earth's surface.
  - Shorter wavelengths, called **UV-B**, are the harmful waves that cause the sunburn. Fortunately, about 95% of UV-B is absorbed by ozone in the atmosphere.
  - **UV-C** waves are the shortest and most harmful and are almost completely absorbed by our atmosphere. The atmospheric protection from harmful UV-radiation is good for humans because if all the UV-radiation would have reached the Earth's surface, it would have deadly effects on life on the Earth.

Effects of UV radiation

- clinical findings - headaches, decrease of blood pressure, fever
- histopathological changes - reduction of LC in epidermis
- biochemical changes - release of histamine from histidine
- effects on DNA - dimerization of pyrimidine and thymine: UVB
- immunological changes - selective immunosuppression
- carcinogenic effect, melanoma - by increased UVB exposition
- germicidal effects - disinfection of air by use UVC radiation 254 nm
- curative effects - psoriasis: UVA radiation + psoralens
- production of D provitamin

UV prevention and protection

- The main **protection** against excessive UV radiation of the sun is limiting the time of exposure, especially at noon.
- When it is not possible to limit the sun exposure e.g. for professional reasons (farmers, sailors, lifeguards at swimming pools etc.), it is necessary to apply lotions with effective sun filters to unprotected areas and to use eyes protection (dark glasses).
- Staying outdoors, however, positively influences physical and psychical regeneration and also leads to the above-mentioned production of D vitamin.

Time for a break

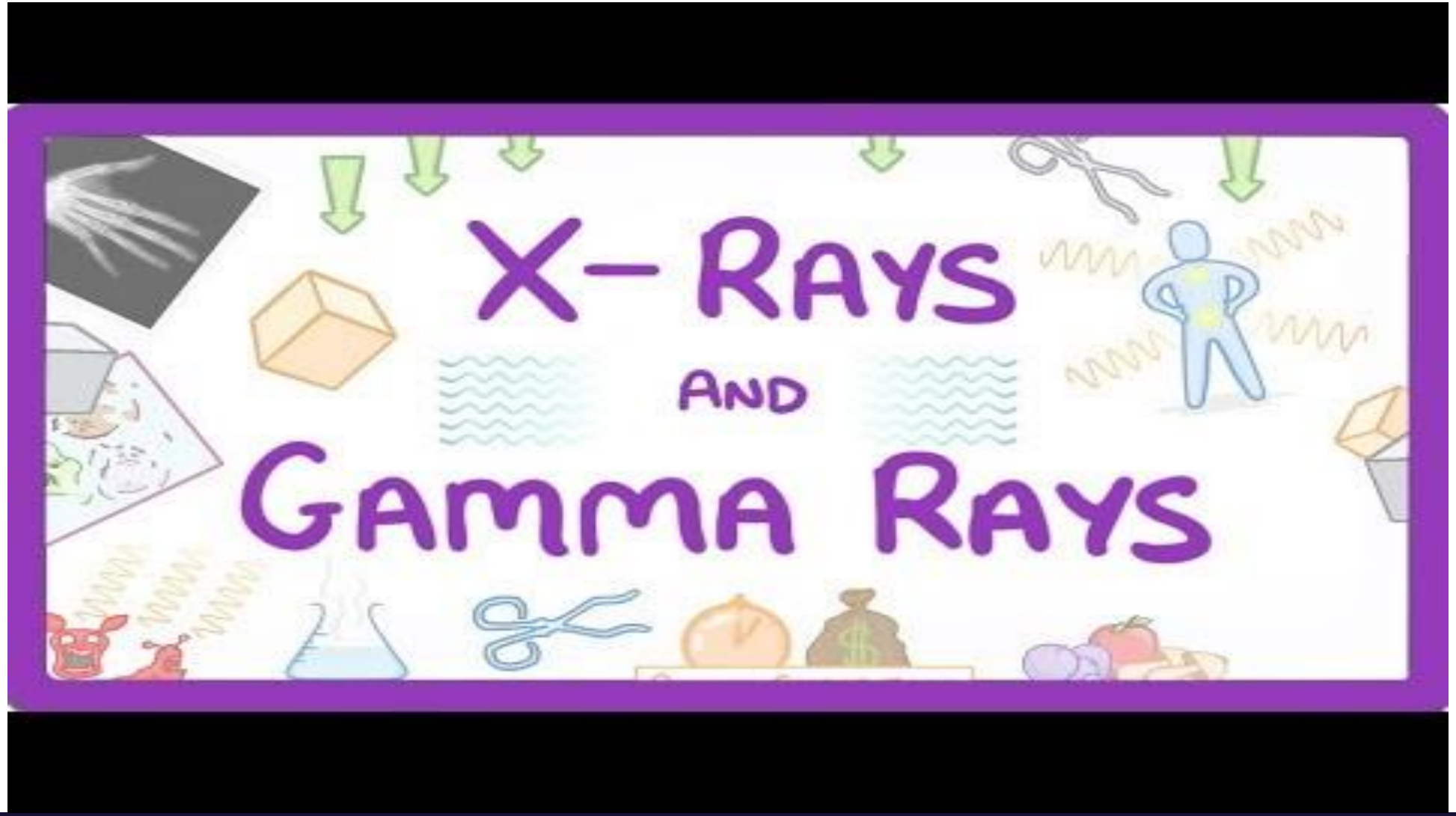
Ionizing radiation

- **The ionizing radiation causes, when passing through a matter, its ionization.**

- We distinguish three types of ionizing radiation: alpha, beta and gamma radiations.

Ionizing radiation

Ionizing radiation



Ionizing radiation

- We distinguish two main types of radionuclides:
  - **sealed source of ionizing radiation**, which is a type of radio-nuclide, whose arrangement eliminates a possibility of elusion of radioactive materials for anticipated conditions.
  - **opened radio-nuclide**, which is a type of radio-nuclide, which don’t answer to the qualification of a sealed source of ionizing radiation, e.g. various radioisotopes (radiopharmaceutical materials).

Influence on humans

- Two types of effects in mammals are recognized:

1) **Deterministic**: acute post-irradiation syndrome or acute skin injury
2) **Stochastic**: malignant tumors and genetic disorders

Measuring and evaluation

- **Absorbed dose** (D) = Energy absorbed per unit mass.
  - Its unit is the joule per kilogram, which is given a special name Gray: (Gy = J/kg)
- **Equivalent dose** (H) = Absorbed dose (D) correct by special factor according to relative biological effectiveness of radiation.
  - The unit is also joule per kilogram, with a special name Sievert: (Sv = J/kg)
- **Activity** = Mean number of radioactive decays per unit time.
  - The unit s^{-1} has a special denotation Becquerel: (1Bq = s^{-1})

Measuring and evaluation

- For individual monitoring of persons in **external irradiation risk**, we use the personal dosimeters or the finger thermo-luminous dosimeter for the work with opened radio-nuclides in hoods.
- The monitoring of persons in **inner contamination risk** we can divided to direct by external measuring by whole-body computer and indirect monitoring by excretion analysis (blood picture, hematocrit, chromosomal aberrations of lymphocytes or immunological indicators).
- The last possibility can occur in the case of so-called **"radio-active" patient**, which received radio-nuclide mostly for the diagnostic purposes.

Principles of radiation protection

- **Principle of justification** – the practice should be justified on the grounds that it produces sufficient benefit to the exposed individual and to society to outweigh the radiation detriment it may cause.
- **Principle of non-exceeding the limits** – for justified practice, other than those involving medical exposures, dose limits are required in order to ensure that no person be subject to an unacceptable risk attributable to radiation.
- **Principle of optimization** – the number of people exposed and the likelihood of incurring exposures all be kept as low as reasonably achievable.
- **Principle of source protection** – physical protection of the source against misuse by other people, and safeguarding the technical safety to enhance the operational safety and to prevent radiation accidents.

Principles of radiation protection

- The effect of the ionizing radiation from sealed source can be minimalized:

1) by technical solution:
   - Protection by shielding: The installation of shielding by building material, shielding layers (e.g. plasters with barium carbonate) or providing the remote control.
2) by organizational arrangement:
   - Protection by distance: With the square of the distance the absorbed energy of radiation is lowering.
   - Time protection: The control areas are delineated with limited staff access. An appropriate working regime is here established and carefully watched there to shorten of exposure time.
3) by using the personal protection (shielding) equipment:
   - lead-containing gloves and aprons for radiologists.

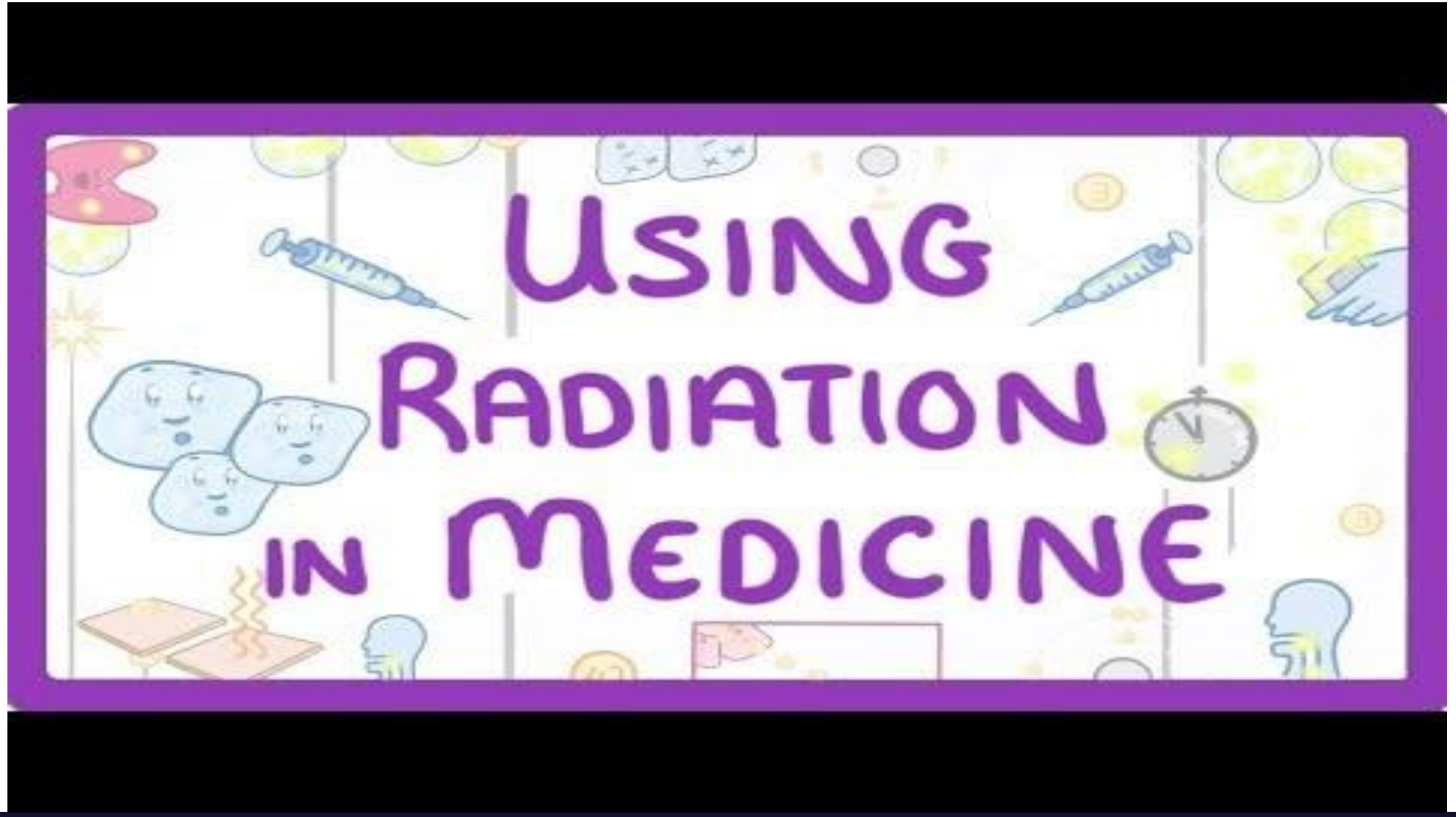
Principles of radiation protection

- The radioactivity contamination risk from opened radio-nuclides can be prevented:

1) by the technical solution:
   - ventilation and isolation systems (e.g. hoods, glove boxes, hot cells);
2) by organizational arrangement:
   - work with a minimum necessary quantity of substance;
   - work with liquid substances, no with powder materials (danger of inhaling or spilling);
3) by using the the appropriate personal protective tools for the work with unsealed radionuclides (overalls, gloves, masks).

Electromagnetic radiation

Using radiation in medicine



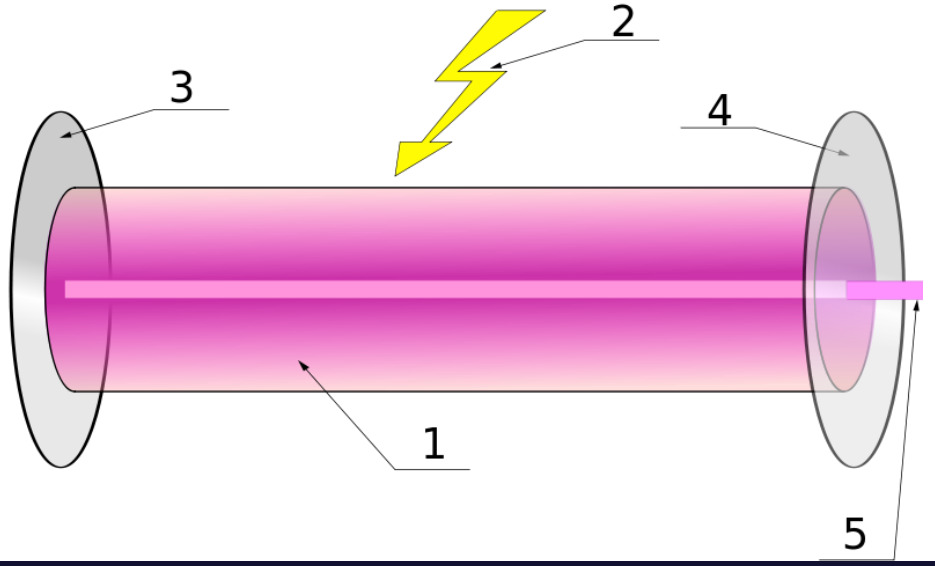
Lasers

- LASER = Light Amplification by Stimulated Emission of Radiation.

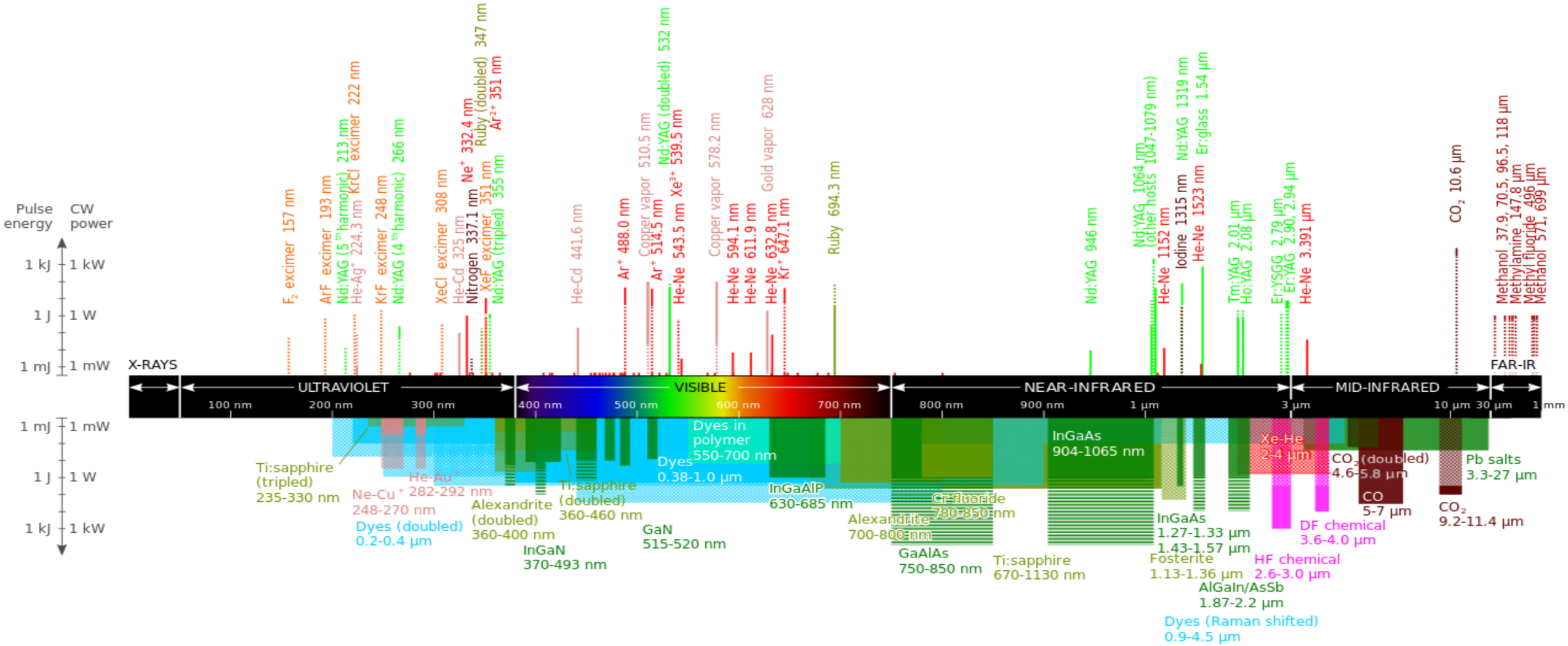
- Laser light is: **monochromatic** (unicolour), **coherent** (orderly) and it has a **small divergence** (diverging beam).
- Parameters: wave length; operating time; an angle by which exposed worker sees source of radiation

Laser construction

1) Gain medium [a material with properties that allow to amplify light by way of stimulated emission]
2) Laser pumping energy [a mechanism to energize the gain medium; e.g. electric current or light at a different wavelength.]
3) High reflector [feedback from an optical cavity - a pair of mirrors on either end of the gain medium.]
4) Output coupler [partially transparent mirror]
5) Laser beam



Laser types

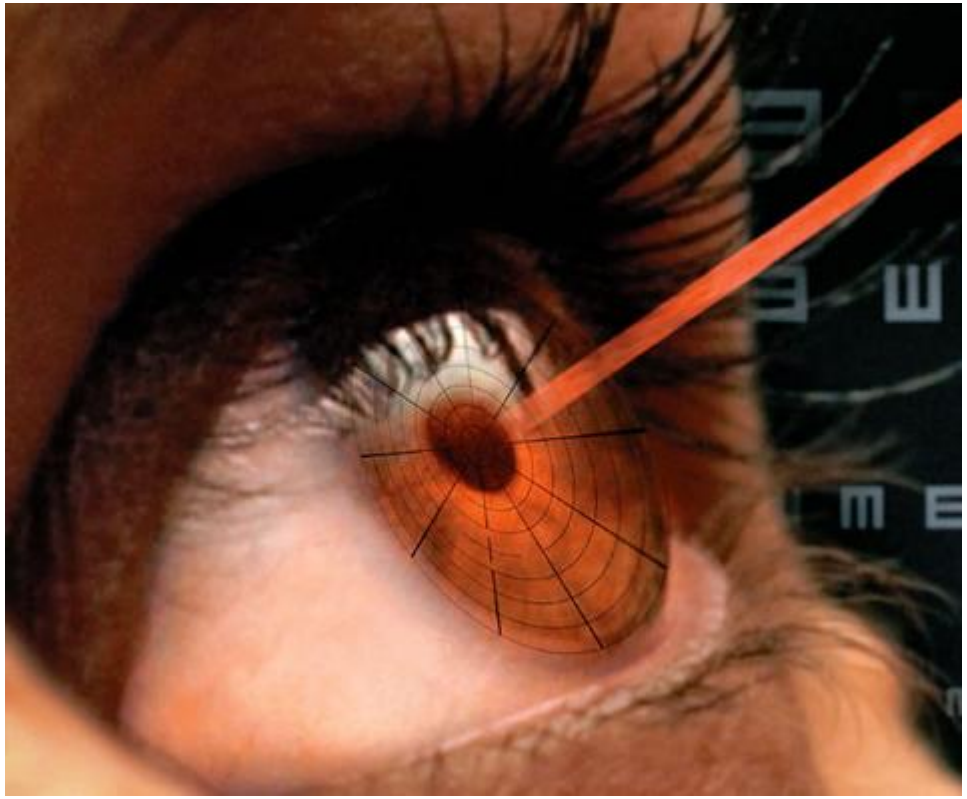

Pulse energy
CW power
1 kJ
1 kW
1 J
1 W
1 mJ
1 mW
X-RAYS
ULTRAVIOLET
VISIBLE
NEAR-INFRARED
MID-INFRARED
FAR-IR
100 nm
200 nm
300 nm
400 nm
500 nm
600 nm
700 nm
800 nm
900 nm
1 µm
3 µm
10 µm
30 µm
1 mm
F2 excimer 157 nm
ArF excimer 193 nm
Nd:YAG (5th harmonic) 213 nm
He-Ag+ 224.3 nm
KrCl excimer 222 nm
KrF excimer 248 nm
Nd:YAG (4th harmonic) 266 nm
XeCl excimer 308 nm
He-Cd 325 nm
Nitrogen 337.1 nm
Ne+ 332.4 nm
Ruby (doubled) 347 nm
XeF excimer 351 nm
Ar2+ 351 nm
Nd:YAG (tripled) 355 nm
He-Cd 441.6 nm
Ar+ 488.0 nm
Copper vapor 510.5 nm
Ar+ 514.5 nm
Nd:YAG (doubled) 532 nm
He-Ne 543.5 nm
Xe3+ 539.5 nm
Copper vapor 578.2 nm
He-Ne 594.1 nm
He-Ne 611.9 nm
He-Ne 632.8 nm
Kr+ 647.1 nm
Gold vapor 628 nm
Ruby 694.3 nm
Nd:YAG 946 nm
Nd:YAG 1064 nm (other hosts 1047-1079 nm)
He-Ne 1152 nm
Iodine 1315 nm
Nd:YAG 1319 nm
He-Ne 1523 nm
Er:glass 1.54 µm
Tm:YAG 2.01 µm
Ho:YAG 2.08 µm
Er:YSGG 2.79 µm
Er:YAG 2.90, 2.94 µm
He-Ne 3.391 µm
CO2 10.6 µm
Methanol 37.9, 70.5, 96.5, 118 µm
Methylamine 147.8 µm
Methyl fluoride 496 µm
Methanol 571, 699 µm
Ti:sapphire (tripled) 235-330 nm
He-Au+
Ne-Cu+ 282-292 nm
248-270 nm
Dyes (doubled) 0.2-0.4 µm
Alexandrite (doubled) 360-400 nm
InGaN 370-493 nm
Ti:sapphire (doubled) 360-460 nm
GaN 515-520 nm
Dyes 0.38-1.0 µm
Dyes in polymer 550-700 nm
InGaAlP 630-685 nm
Alexandrite 700-800 nm
GaAlAs 750-850 nm
Cr fluoride 780-850 nm
Ti:sapphire 670-1130 nm
InGaAs 904-1065 nm
InGaAs 1.27-1.33 µm
1.43-1.57 µm
Fosterite 1.13-1.36 µm
AlGaIn/AsSb 1.87-2.2 µm
Dyes (Raman shifted) 0.9-4.5 µm
Xe-He 2-4 µm
HF chemical 2.6-3.0 µm
DF chemical 3.6-4.0 µm
CO2 (doubled) 4.6-5.8 µm
CO 5-7 µm
CO2 9.2-11.4 µm
Pb salts 3.3-27 µm

Laser types

- Ruby and argon laser – ophthalmology (eye retinae surgery), dermatology (pigmentary taches removal)
- Nd:YAG pulse laser – secondary cataract
- Excimery laser (ArF, KrCl, KrF, XeCl, XeF) – myopia, hyperopia
- GaAs laser – laser display cursor, laser printer
- GaAlAs laser – CD players, display units
- AlGaInP laser – DVD players
- InGaN laser – Blue-ray disks

Lasers in Medicine

- Ophthalmology:
  - Retinal surgery
  - Treating diabetic retinopathy
  - Removal of secondary cataract
  - Treatment of glaucoma: treatment by cleaning the tear ducts, reducing the ciliary body or creating a hole in the iris
  - Elimination of myopia or hyperopia - photoablation - the use of excimer laser



Lasers in Medicine

- Dermatology
  - Removal of naevi
  - Removing color tattoos
  - Treatment of red spots or small veins
  - Cosmetic purposes: wrinkle removal, hair removal, hair implantation, laser lipolysis

Lasers in Medicine

- Surgery
  - Nd: YAG or CO_2 laser operating in a continuous or pulse mode
  - Advantages of Laser Surgery:

  1) precision without touch,
  2) sharply demarcated cut,
  3) work in a dry surgical field.

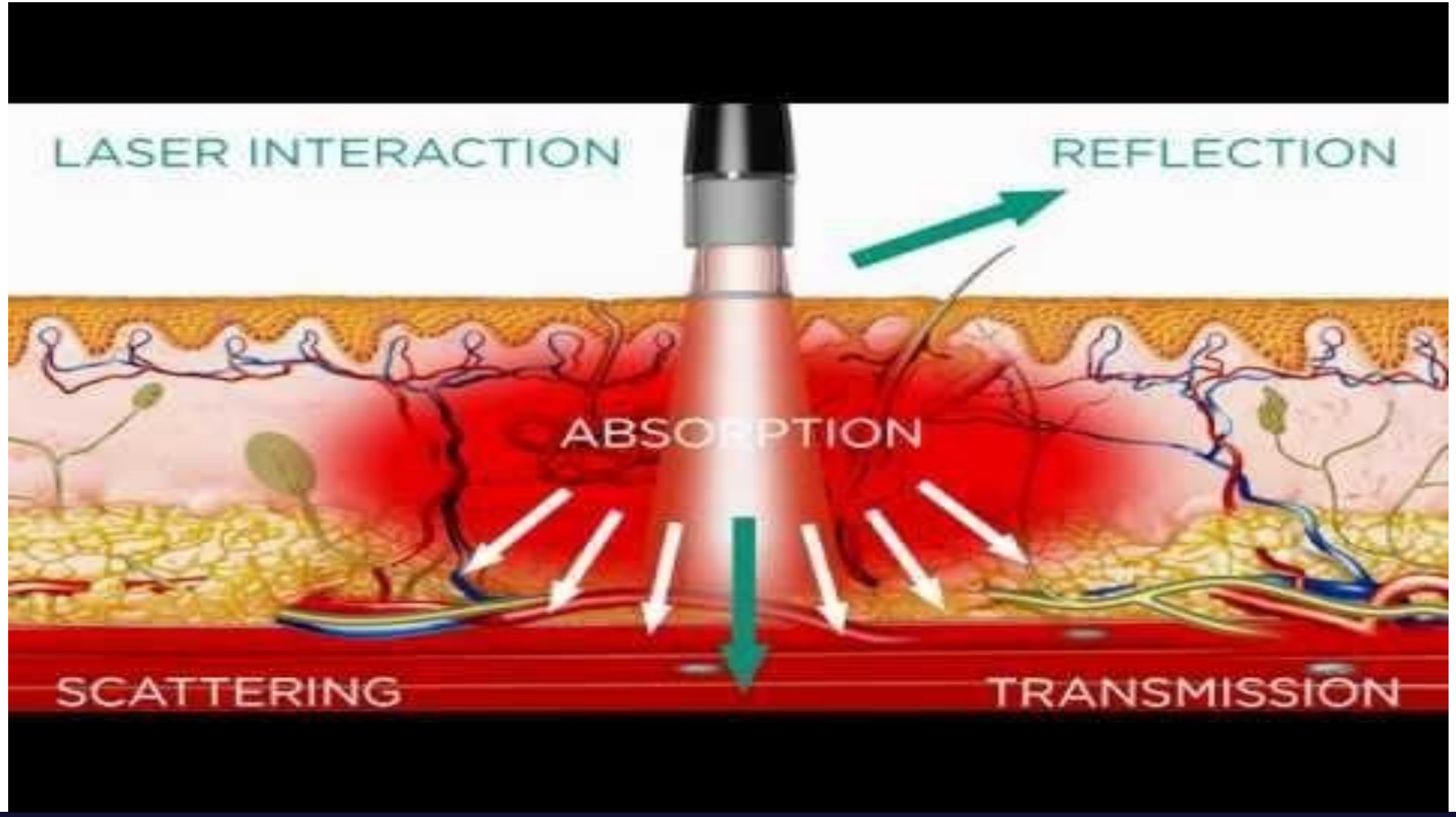
  - Disadvantages:

  1) poorer tissue adhesion

- Cardiology

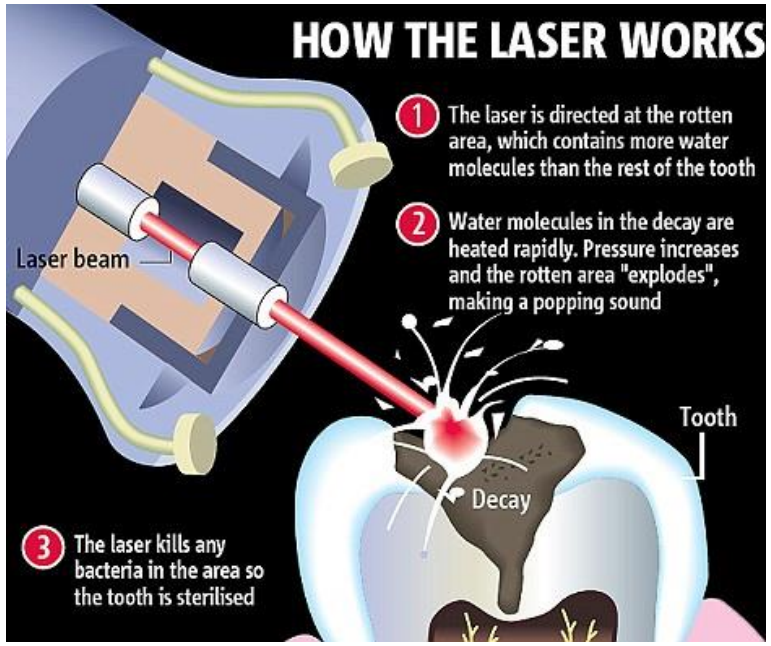
  1) Heart Surgery: CO_2 laser
  2) Angioplasty
     - Shaping plaque: Laser - Argon or Nd: YAG
     - Removal plaque (ablation): Laser - Ho: YAG or excimer laser

Lasers in Medicine



Lasers in Medicine

- Dentistry
  - Biostimulation treatment
  - Laser painless dental drills (Er: YAG laser)



- Photodynamic Therapy (PDT)
  - Non-invasive methods of phototherapy
  1) Applying photosensitive substance (the photosensitizer) that accumulates selectively in the fastest proliferating cells (particularly cancer cells)
  2) A subsequent irradiation of the tissue with light of such a wavelength that can be absorbed by the photosensitizer.

Laser classes

- **Class I** is inherently safe, usually because the light is contained in an enclosure, for example in CD players.
- **Class II** is safe during normal use; usually up to 1 mW power, for example laser pointers.
- **Class IIIa** lasers are usually up to 5 mW and involve a small risk of eye damage within the time of the blink reflex. Staring into such a beam for several seconds is likely to cause damage to a spot on the retina.
- **Class IIIb** can cause immediate eye damage upon exposure.
- **Class IV** lasers can burn skin, and in some cases, even scattered light can cause eye and/or skin damage. Many industrial and scientific lasers are in this class.

Safety risks

- Even low-power lasers (class I, II) with only a few milliwatts of output power can be hazardous to human eyesight when the beam hits the eye directly or after reflection from a shiny surface.
- Powerful lasers (class IV) are cause burn, lacerated or incised wound; eventually cause fire. People working with class IIIb and class IV lasers can protect their eyes with safety goggles which are designed to absorb light of a particular wavelength.
- Series of lasers emit dangerous materials or work with a high electric tension in order tenfold kilovolts.

Prevention and protection

1) Technical solution
   - Laboratory/Room without windows
   - Room without glass or reflective surfaces and objects (mirrors, metal objects etc.)
2) Organizational measures
   - secure entrance
   - instructed personnel
3) Use of personal protective equipment
   - Goggles, gloves

Time for a break

Thermal Comfort

- **Thermal comfort is the condition of mind, which expresses the satisfaction with the thermal environment.**

- **Environmental (climatic) factors**: air temperature, air humidity, the speed of air flow and the intensity of heat radiation.

Thermal comfort factors

Thermal Comfort

- **Objective individual factors**: activity (transformation of chemical energy into thermal energy, e.g. intensity of work) and thermal resistance of clothes (clothing insulation between an organism and environment).
- **Subjective individual factors**: adaptation and thermoregulation mechanisms (sensitive resistant), health state (healthy sick), mental condition (comfort stress), conditions of an organism (rested exhausted, satiety hunger).

Climatic factors

- **Air temperature** is one of the important parameters to evaluate the thermal comfort.
  - The recommended range for internal air temperature in apartment houses is between 19 °C and 23 °C (grades of Celsius) in winter, and less than 27 °C (grades of Celsius) in summer.
  - But, for example, 21 °C may be considered too warm for housework or exercising, but perhaps a bit cold for a sedentary work. Comfortable air temperature requirements also vary from day to day for the same person.
  - For the air temperature measuring, we use any type of thermometers.

Climatic factors

- **Absolute air humidity** is the concentration of water vapours in air at a given temperature expressed in gram per cubic meter (g/m^3).
- **Relative air humidity** is a ratio of the partial pressure of water vapour to the equilibrium vapour pressure of water at a given temperature. Relative air humidity is usually expressed as a percentage.
  - For humans, the comfortable relative humidity range is between 30 % and 60 %.
  - For the measuring of the relative air humidity, we use different types of hygrometers or psychrometers.

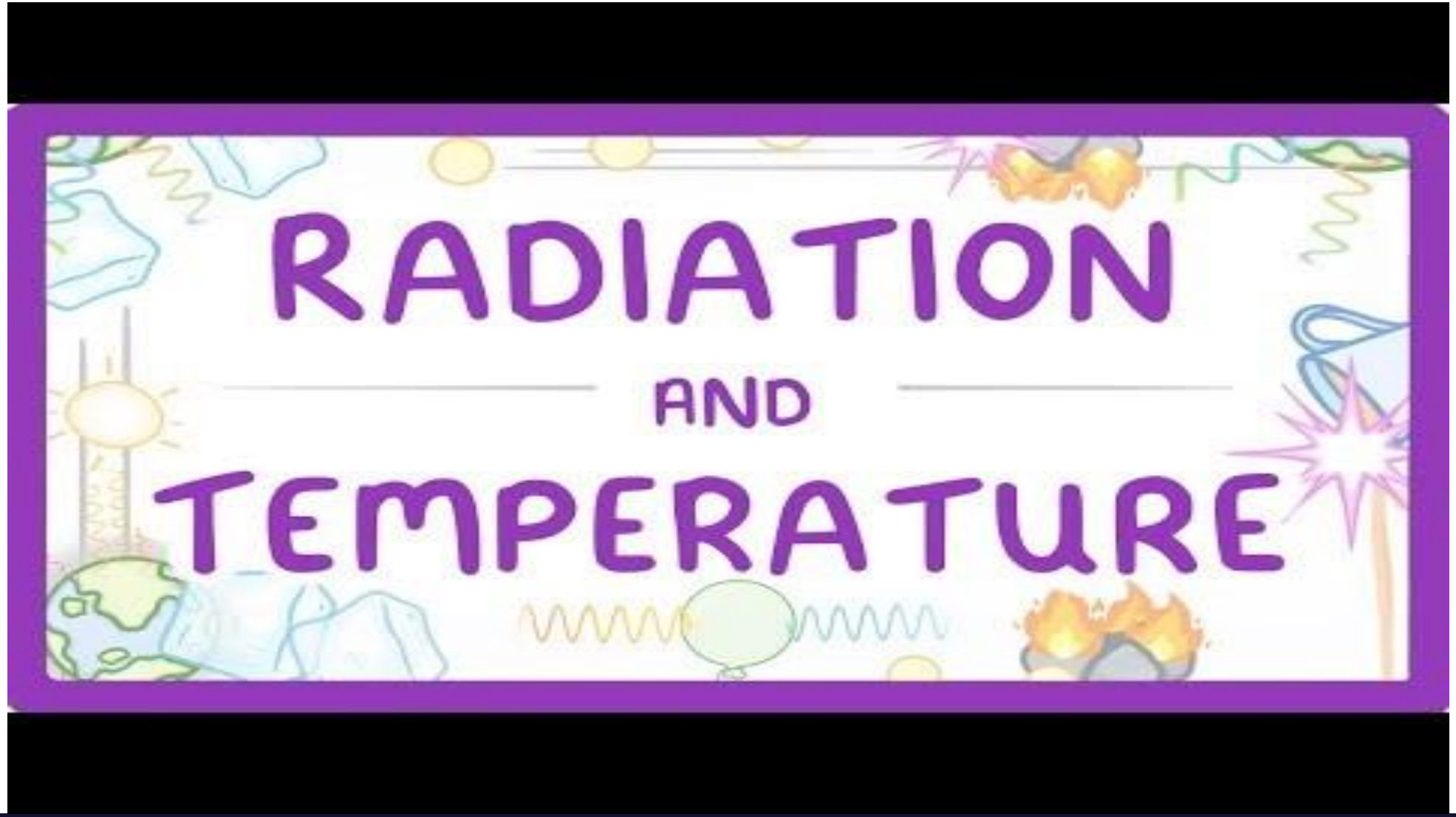
Climatic factors

- The **speed of air flow** is a measure of the movement of air in a space.
  - The recommended values for the work environment are 0.1-0.3 ms^{-1}, for administrative buildings depending on the type of activity and the used clothing it is for winter period of maximum 0.15 ms^{-1} and for the summer period, not more than 0.25 ms^{-1}.
  - For the measuring the speed of air flow, we usually use different types of anemometers or the kata-thermometer for the low velocity of the air flow.

Climatic factors

- The principle of **heat radiation** is infrared energy exchange between a human body and surrounding surfaces.
  - Thermal load of an organism is an issue mainly at hot workplaces (glassworks, blasts furnaces).
  - For measuring the heat radiation we use a globe thermometer.

Thermal comfort factors



Objective individual factors

- The **activity** is usually measured as the energy output of an individual.
  - The total (gross) energy output we count as the sum of nett (clear) energy output and the basal metabolism.
  - The net energy issue is measured as the heart activity by Holter apparatus or we use the orientation estimate done by pulse rate or by spreadsheet method.
  - An energetic value of the basal metabolism depends on the sex and falls with the age. For measuring, we can use the direct calorimetry or – what is more used – the graphic findings.

Objective individual factors

- The **thermal resistance of clothes** depends on the number of clothes layers and the speed of air flow.
  - The higher is the number of cloth layers, the higher is the number of thermal insulation layers among these layers.
  - The graphical findings show a strongly decreasing of protective ability of clothes against the cold by an increase of air streaming speed.

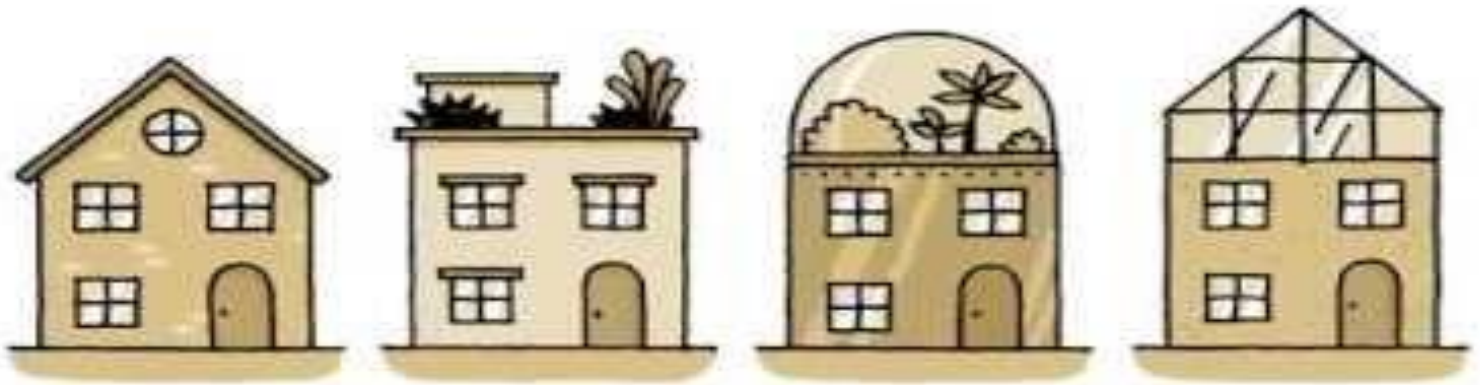
Subjective individual factors

- From **subjective individual factors**, the most important are the adaptation and thermoregulation mechanisms of an organism, the health state, the mental condition and current state of the organism.

- The thermoregulation mechanisms of the human body are:
  - the direct heat loss – convection, conduction, heat radiation and
  - the indirect heat loss – evaporation and respiration.

Thermal Comfort factors

These changes, as well as a new approach to energy use, will require buildings to be capable of evolving over time in order to be both comfortable and energy efficient.



Evaluation

- For **evaluation of thermal comfort**, the tables or graphs are used to determine the suitability of climatic factors combination according to the individual factors, e.g. the energy load.
  - The optimal thermal load is used in apartment houses or in workplaces where only moderately heavy work is performed.
  - The long-term feasible thermal load is used in workplaces where heavier work is performed (energy load, temperature).
  - The short-term feasible thermal load is used in workplaces with the heaviest work (high energy load, high temperature).

Atmospheric pressure

- The sudden shift to an environment of lower ambient pressure, as occurs with the rapid ascension to the surface from deep-sea diving or with loss of cabin pressure while flying at high altitudes, causes **decompression sickness**.
  - divers, unterwater workers, pilots
- **Compression sickness** can also occur following movement to an environment of higher ambient pressure, but the only common example of this is barotitis.
  - descent of an aircraft from a high altitude, under water during diving descent, or during hyperbaric oxygen therapy

Atmospheric pressure

- **Decompression sickness** is a disorder in which nitrogen dissolved in the blood and tissues by high-pressure forms bubbles as pressure decreases.
  - Symptoms can include fatigue and pain in muscles and joints.
  - In the more severe type, symptoms may be similar to those of stroke or can include numbness, tingling, arm or leg weakness, unsteadiness, vertigo (spinning), difficulty breathing, and chest pain.
  - People are treated with oxygen and recompression (high-pressure, or hyperbaric, oxygen) therapy.
  - Limiting the depth and duration of dives and the speed of ascent can help with prevention.

Local muscular load

- Burden on small muscle groups while working limbs.
- When evaluating local muscular load are detected and assessed:
  - expended muscle strength,
  - number of movements of assessed movement structures,
  - working positions depending on the extent of static and dynamic work.

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Local muscular load

- Measuring and evaluation
- Integrated electromyography (IEMG) is currently the most accurate method available, in which we monitor the response of the neuromuscular system function to the workload.

Ing. Anna Horňáková, Ph.D.

Institute of Hygiene and Epidemiology of the 1st Faculty of Medicine

FIRST FACULTY OF MEDICINE
Charles University

THANK YOU FOR YOUR ATTENTION

QUESTIONS?

CONTACT ME:
ANNA.HORNAKOVA@LF1.CUNI.CZ