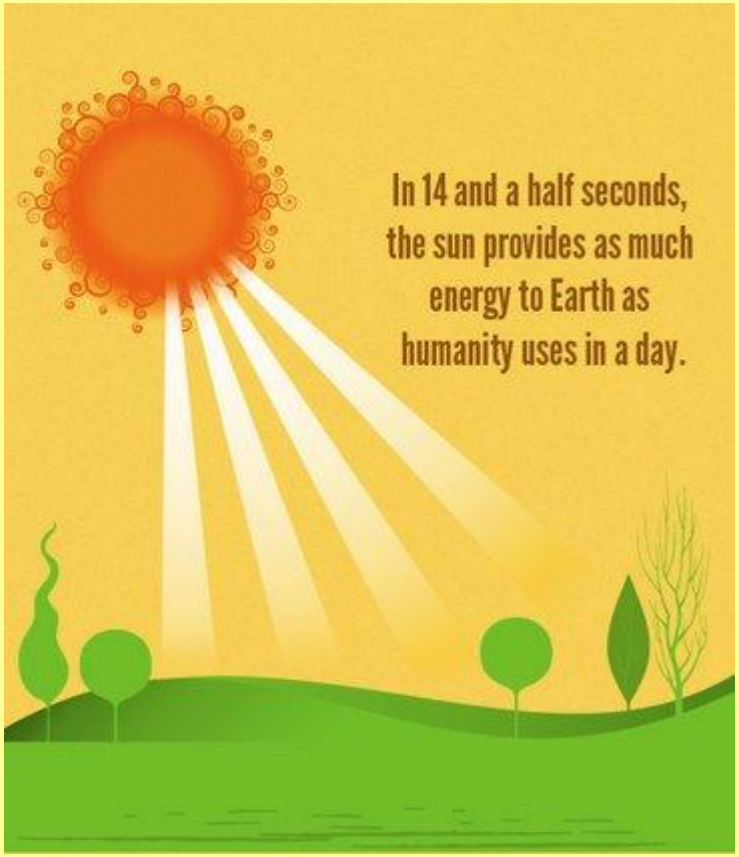
**Volgograd State Medical University**
**The Chair of general hygiene and ecology**

**LECTURE № 5**

# Solar radiation, hygienic value

Solar radiation is the integral flux of energy released by the Sun.



**Physically** the energy from the Sun is released in the form of **electromagnetic and corpuscular radiation.**

The electromagnetic radiation extends from gamma-rays to radio waves of very long wavelength.

The corpuscular constant of the solar radiation consists mainly of protons and electrons.

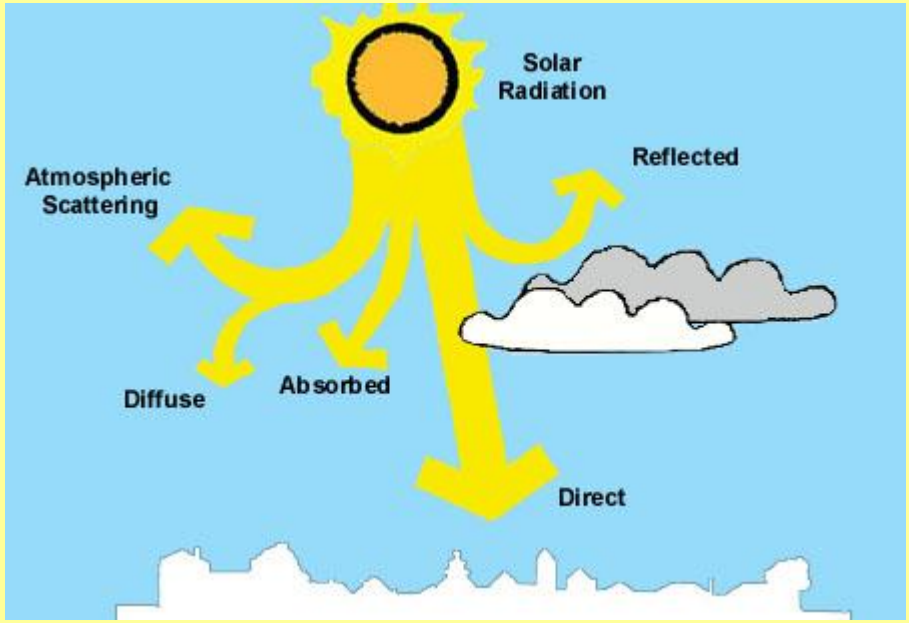
# The solar radiation is classified as:

**Direct solar radiation** is the radiation which is produced by the Sun.

**Diffused solar radiation** is the radiation which originates from the firmament.

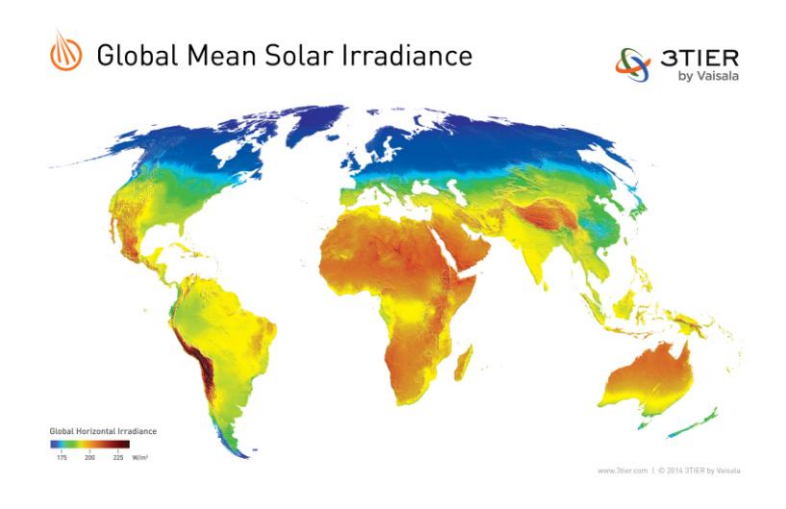
**Reflected solar radiation** is the radiation which is produced by the surfaces of various objects.

**The sum of all types** of radiation falling on the horizontal surface, is called **the total solar radiation.**



# One can distinguish three types of the sunny territory:

1) sunny summer and sunny winter – the number of days without the Sun is less than 60 per year, less than 1 day in July, and less than 10 days in January;
2) sunny summer and mild cloudy winter – the number of days without the Sun amounts to 60-100;
3) mild cloudy summer and cloudy winter – consequently the number of days without the Sun is more than 100 per year.



Under the influence of the solar radiation a number of photobiological processes take place in the human body (for example, different biochemical and physiological reactions).

**All photobiological processes which take place in the human body can be divided into three main groups:**

1) The first includes the reactions which provide **the synthesis of biologically important compounds** (for example, vitamins, pigments, etc.)

2) The second group includes photobiological processes which enable **to receive the information and to orientate in the environment** (for example, eyesight, phototaxis, etc.).

3) The third group includes the processes which are **accompanied by harmful complications** (for example, destruction of proteins, vitamins, enzymes, emergence of unhealthy mutations, carcinogenic effect).

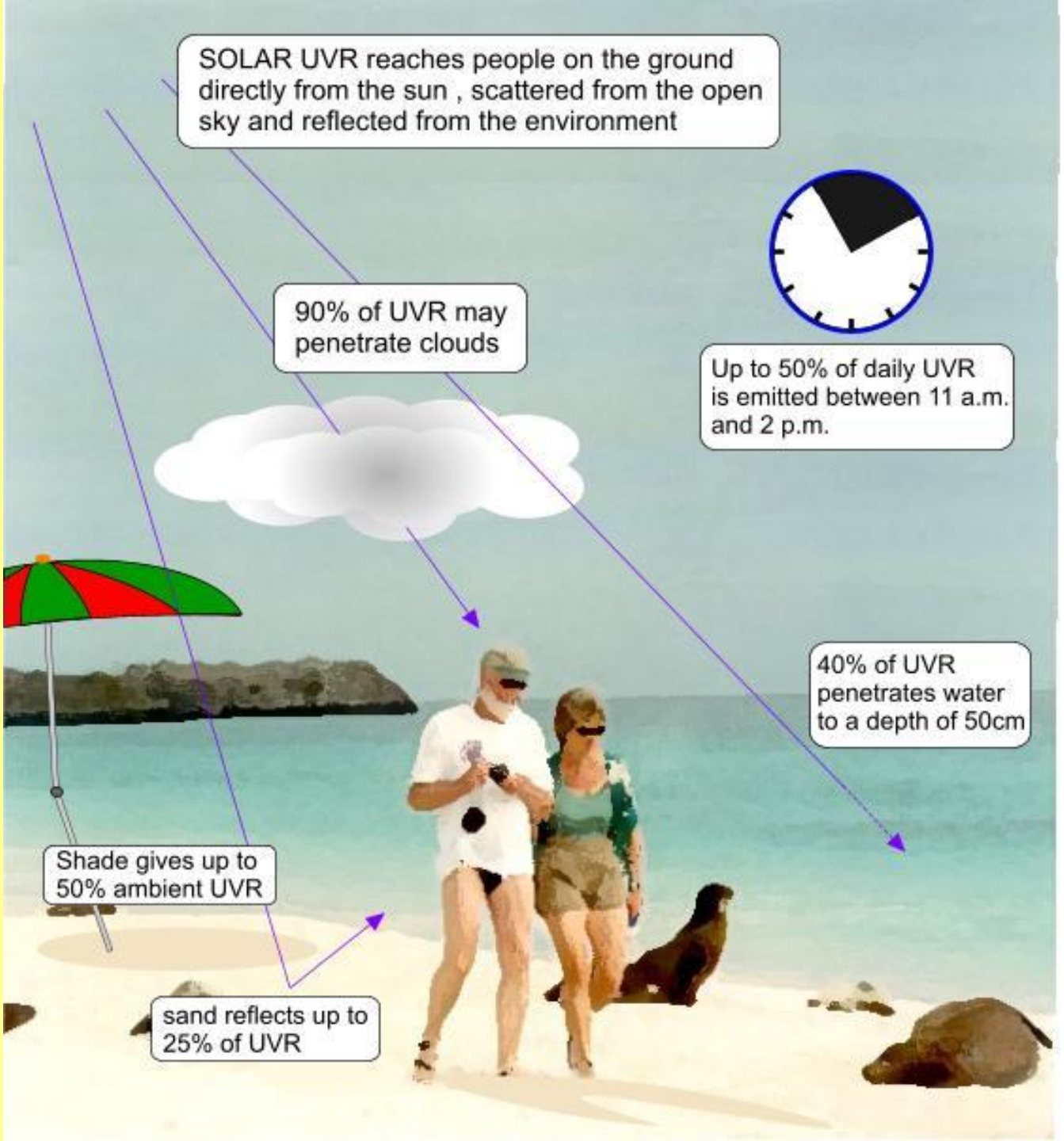
**In terms of hygiene the optic part of the solar spectrum, which falls within three bands of the solar radiation, is of great importance:**

- the waves of the infrared part of the solar spectrum are between 2800 nm to 760nm;
- the waves of the visible part of the solar spectrum are between 760 nm and 400 nm;
- the waves of the ultraviolet part of the solar spectrum are between 400 nm and 280 nm.

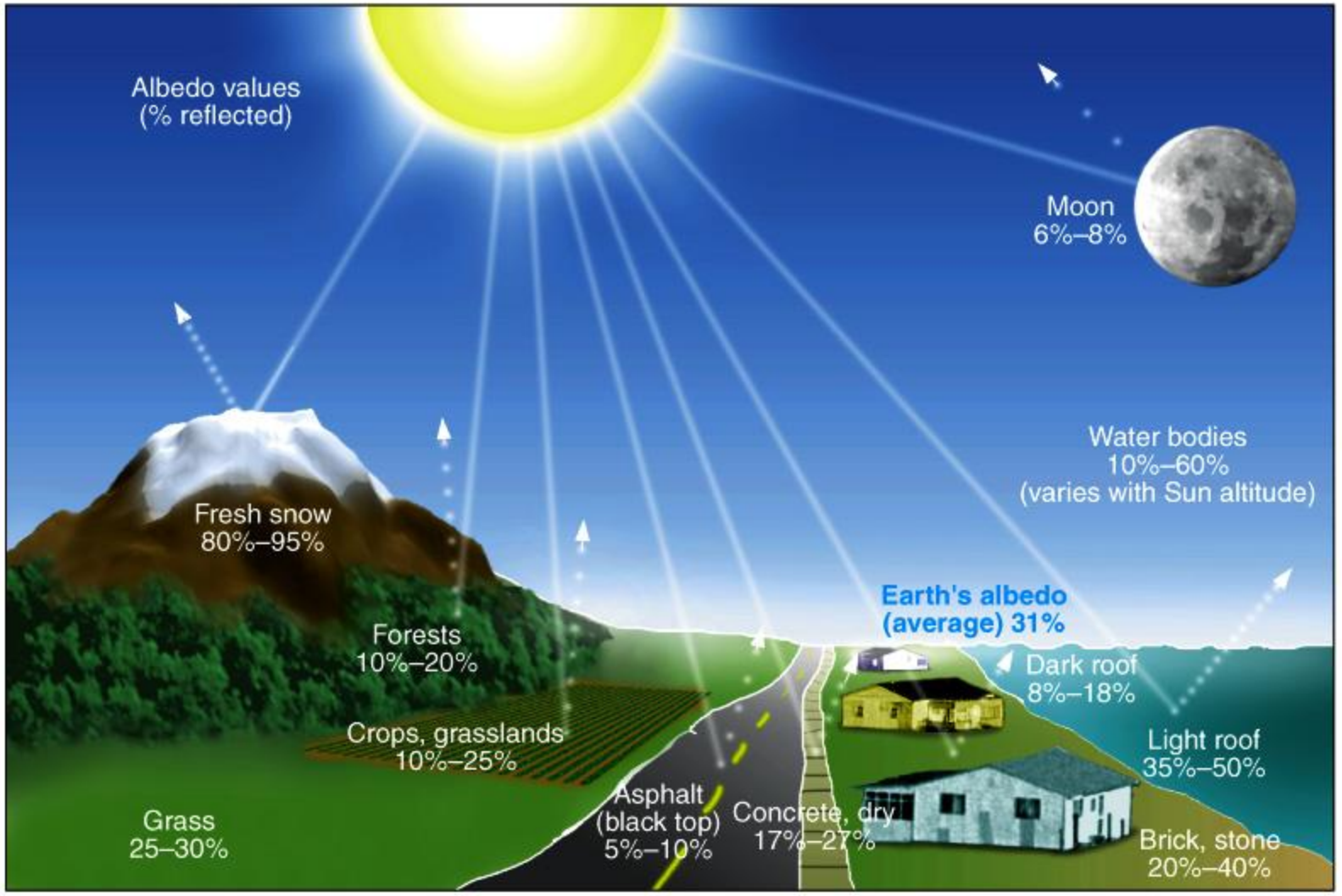
# The parts of the solar spectrum

## 1.The ultra-violet radiation (UV).

Biologically the most active part of the solar radiation is the ultra-violet band of the solar spectrum, which is presented in the form of the waves between 290 nm and 400 nm on the Earth.


SOLAR UVR reaches people on the ground directly from the sun , scattered from the open sky and reflected from the environment
90% of UVR may penetrate clouds
Up to 50% of daily UVR is emitted between 11 a.m. and 2 p.m.
40% of UVR penetrates water to a depth of 50cm
Shade gives up to 50% ambient UVR
sand reflects up to 25% of UVR

# Albedo: a measure of how well a surface reflects insolation



**The intensity of the UV radiation may depend on the following:**

1) **geographic latitude**

   UV intensity is greater at high altitudes. Skiers need to take extra care.

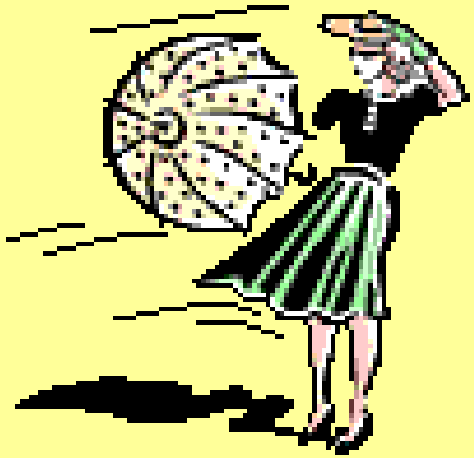
2) **season and climate, degree of the transparency of the atmosphere**

in winter the UV radiation is lower than in summer

Clouds and pollution don’t filter out UV rays, and can give a false sense of protection.

Even on cloudy, cool, or overcast days, UV rays travel through the clouds and reflect off sand, water, snow, and even concrete.

This “invisible sun” can cause unexpected sunburn and skin damage.



# Solar radiation is a great medical and prophylactic factor

**It influences on all physiological processes in the organism, changing metabolism, general tone and efficiency**

# Reactions of organisms depend on:

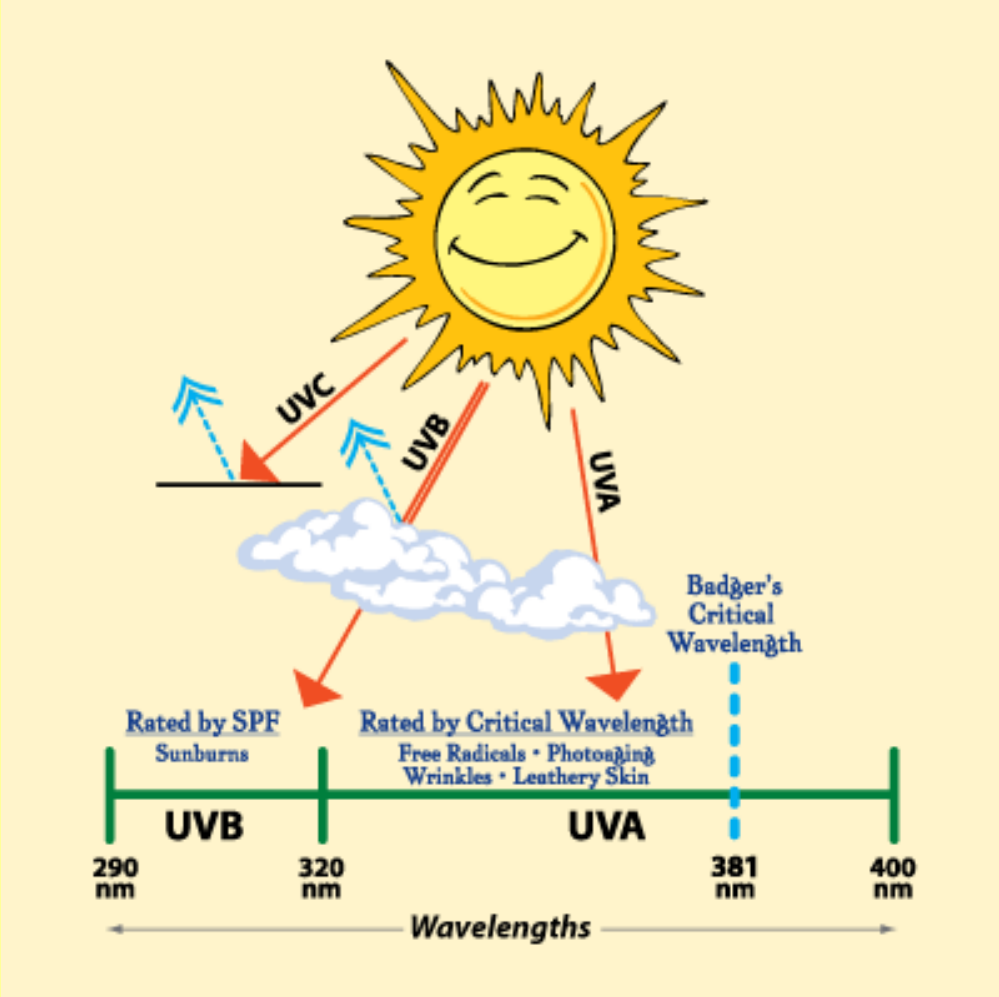
- the type of radiation
- the length of electromagnetic waves
- the absorption of these waves by tissues

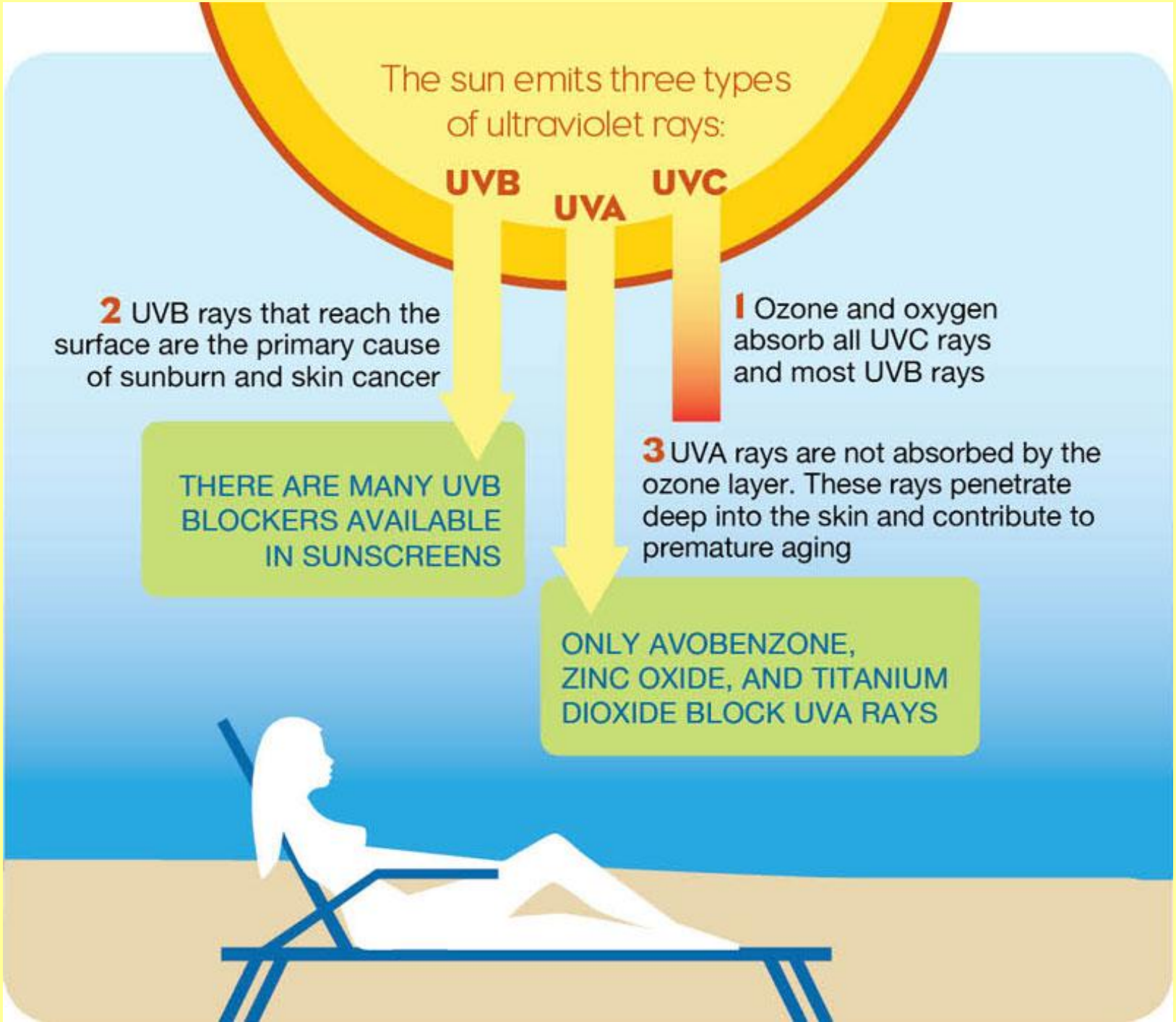
**Depending upon biological activity, the ultraviolet part of the solar spectrum falls within the three bands:**

**A –** the ultraviolet radiation with the waves between 400 nm and 280 nm, that is **sun-tan effect.**

**B –** the ultraviolet radiation with the waves between 320 nm and 280 nm, **vitamin D.**

**C –** the ultraviolet radiation with the waves between 280 nm and 210 nm, that is **bactericidal action.**




The sun emits three types of ultraviolet rays:
UVB
UVA
UVC
2 UVB rays that reach the surface are the primary cause of sunburn and skin cancer
1 Ozone and oxygen absorb all UVC rays and most UVB rays
THERE ARE MANY UVB BLOCKERS AVAILABLE IN SUNSCREENS
3 UVA rays are not absorbed by the ozone layer. These rays penetrate deep into the skin and contribute to premature aging
ONLY AVOBENZONE, ZINC OXIDE, AND TITANIUM DIOXIDE BLOCK UVA RAYS

# Specific biological influence of ultra-violet rays typical of a certain wave range

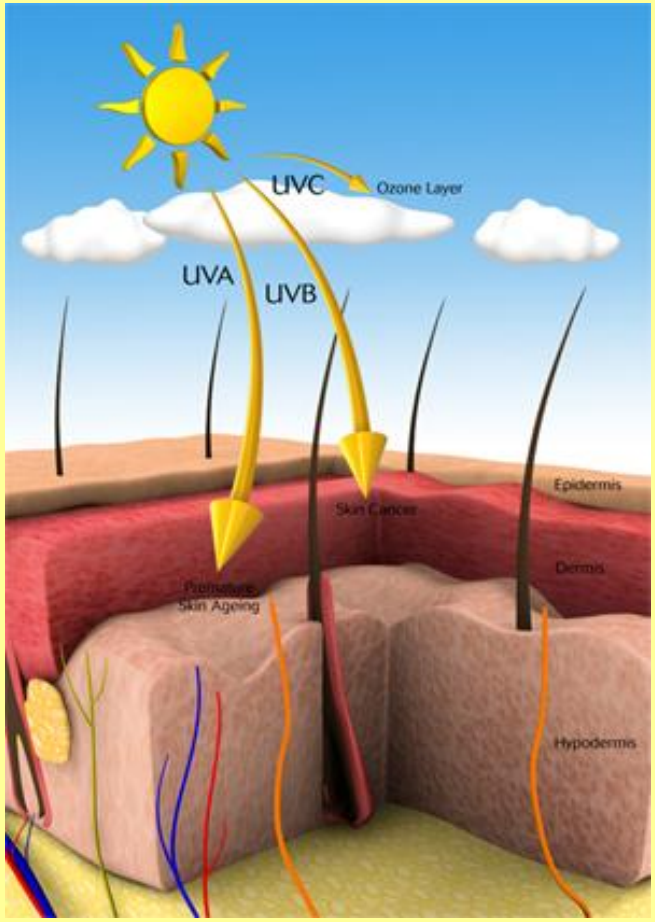
- **range A, UV-A – leads to erythematous-suntan influence**
- **range B, UV-B – antirachitic and low bactericidal influence**
- **range C, UV-C – causes a damaging influence on a biological tissue, skin, eyes**

# UVA:

The waves of the solar spectrum between 400 nm and 320 nm have an erythematous effect. Under the influence of the UV rays on the human body, a special pigment **melanin** is formed on the skin which is characterized by the darkening of the skin.

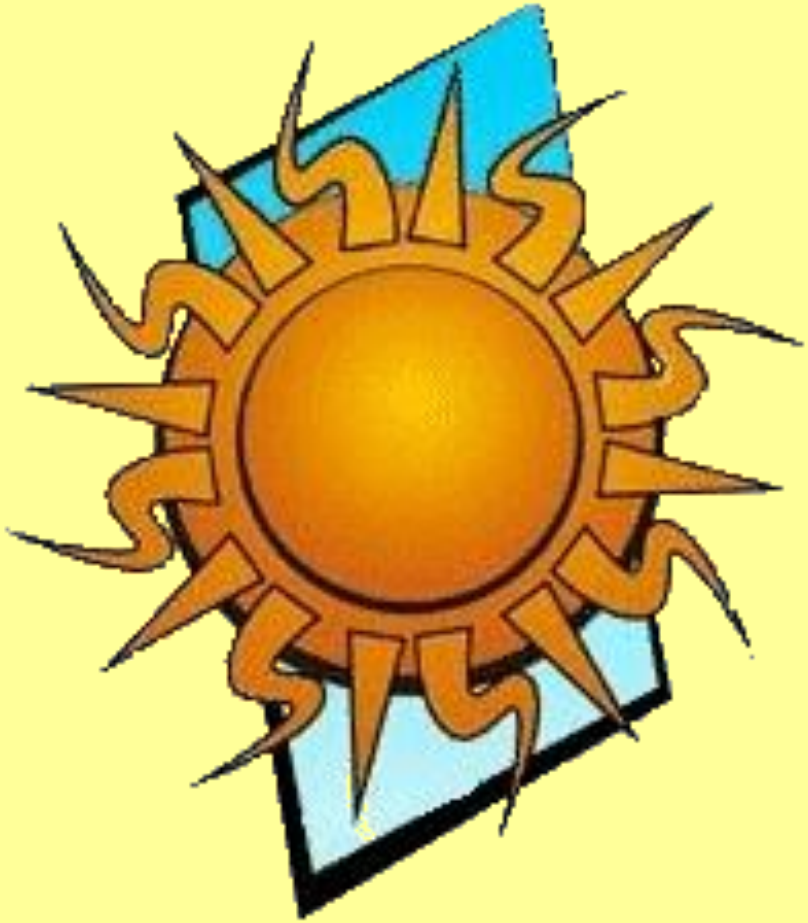
The mechanism of origination of ultra-violet erythema is connected with the vasodilating effect of histamine and the histamine-like substances formed under ultra-violet radiation.

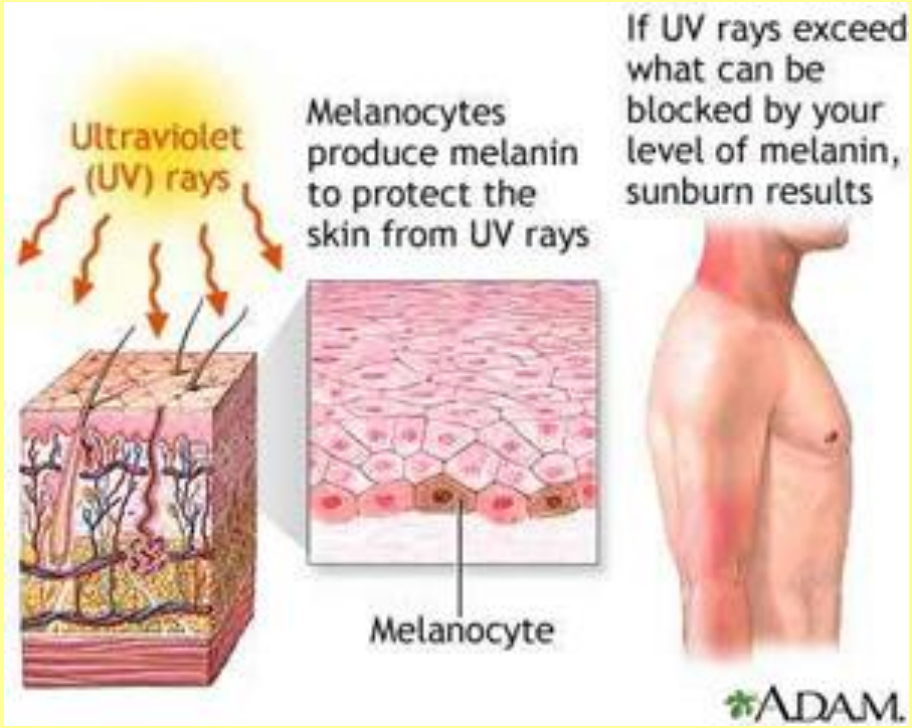
- **UVA**—causes skin aging & wrinkles. Used in tanning beds. Colors skin and gives false sense of protection from the sun. UVA rays pass effortlessly through the ozone layer.



# Effects of UV Exposure

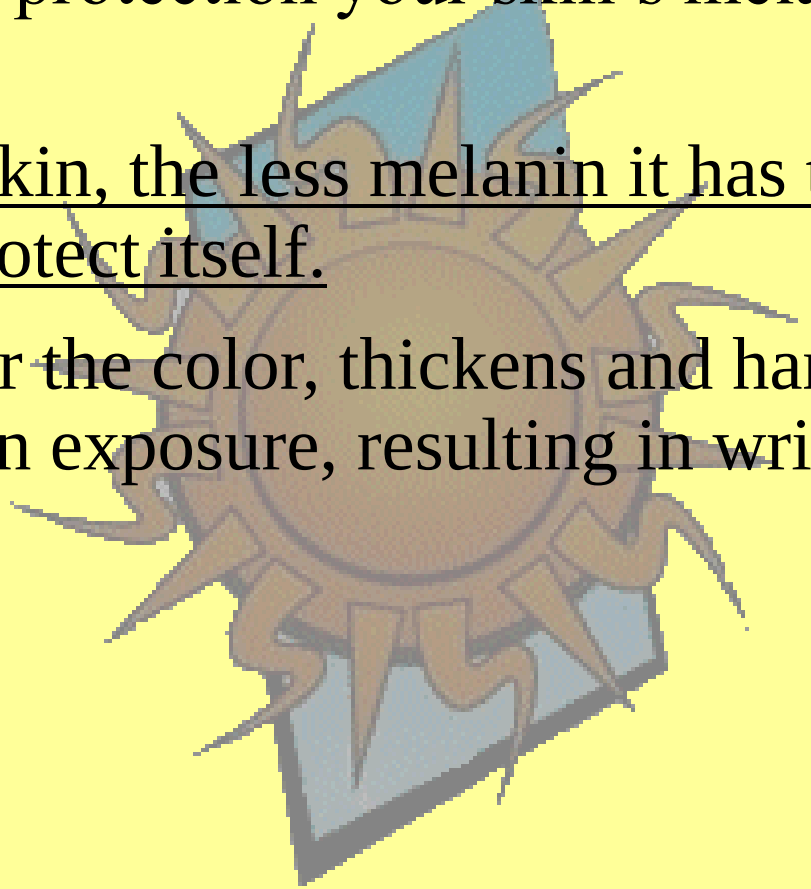
## Sunburn





# Effects of UV Exposure

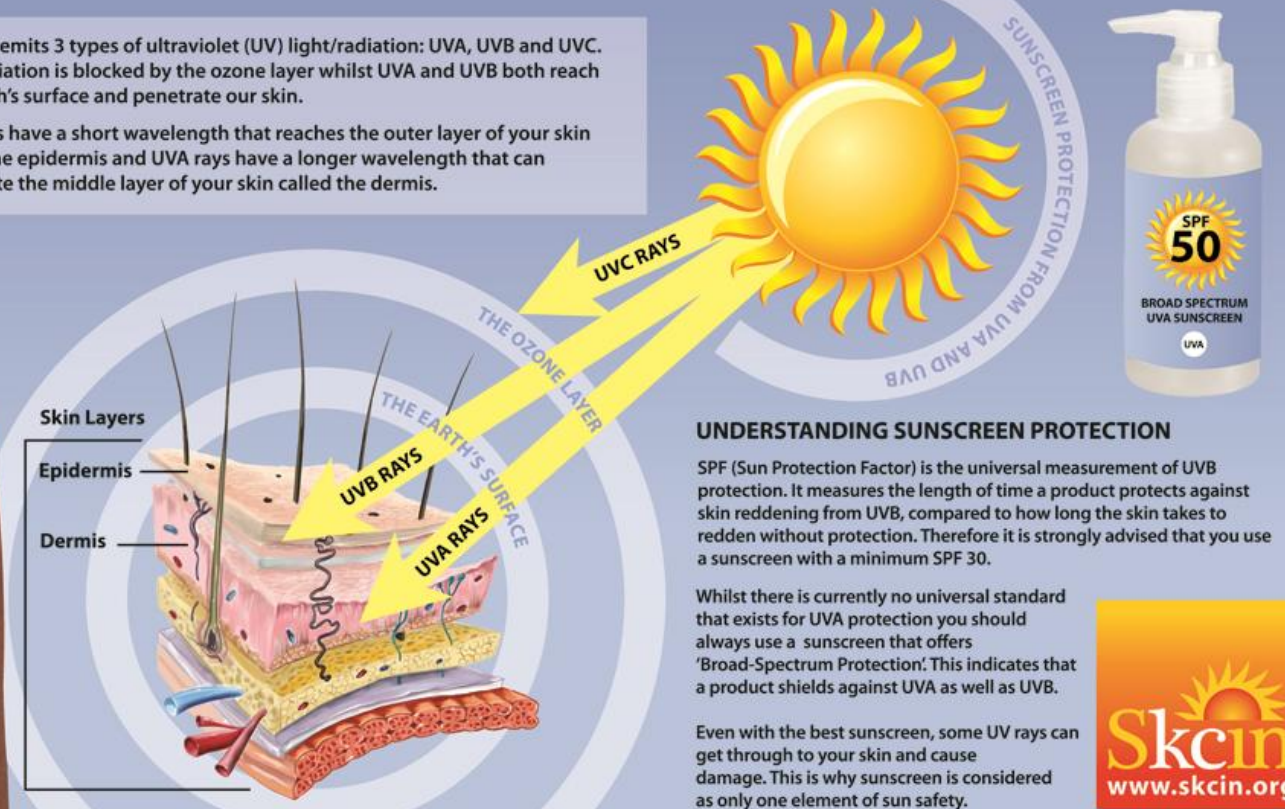
- Sunburn develops when the amount of UV exposure is greater than the protection your skin's melanin can provide.
- The lighter your skin, the less melanin it has to absorb UV and protect itself.
- All skin, no matter the color, thickens and hardens with continued sun exposure, resulting in wrinkles later in life.



# UNDERSTANDING ULTRAVIOLET (UV) RADIATION AND OUR SKIN

The sun emits 3 types of ultraviolet (UV) light/radiation: UVA, UVB and UVC. UVC radiation is blocked by the ozone layer whilst UVA and UVB both reach the earth's surface and penetrate our skin.

UVB rays have a short wavelength that reaches the outer layer of your skin called the epidermis and UVA rays have a longer wavelength that can penetrate the middle layer of your skin called the dermis.




## HOW UV RAYS CAN AFFECT OUR SKIN

UVB rays are burning rays and are the primary cause of sunburns and skin cancer.

UVA rays are able to penetrate deeper into the dermis or the base layer of the skin. UVA rays also contribute to skin burning, skin cancer and wrinkling/ premature aging.

Both UVA and UVB rays can suppress the immune system, which helps protect against the development and spread of skin cancer.

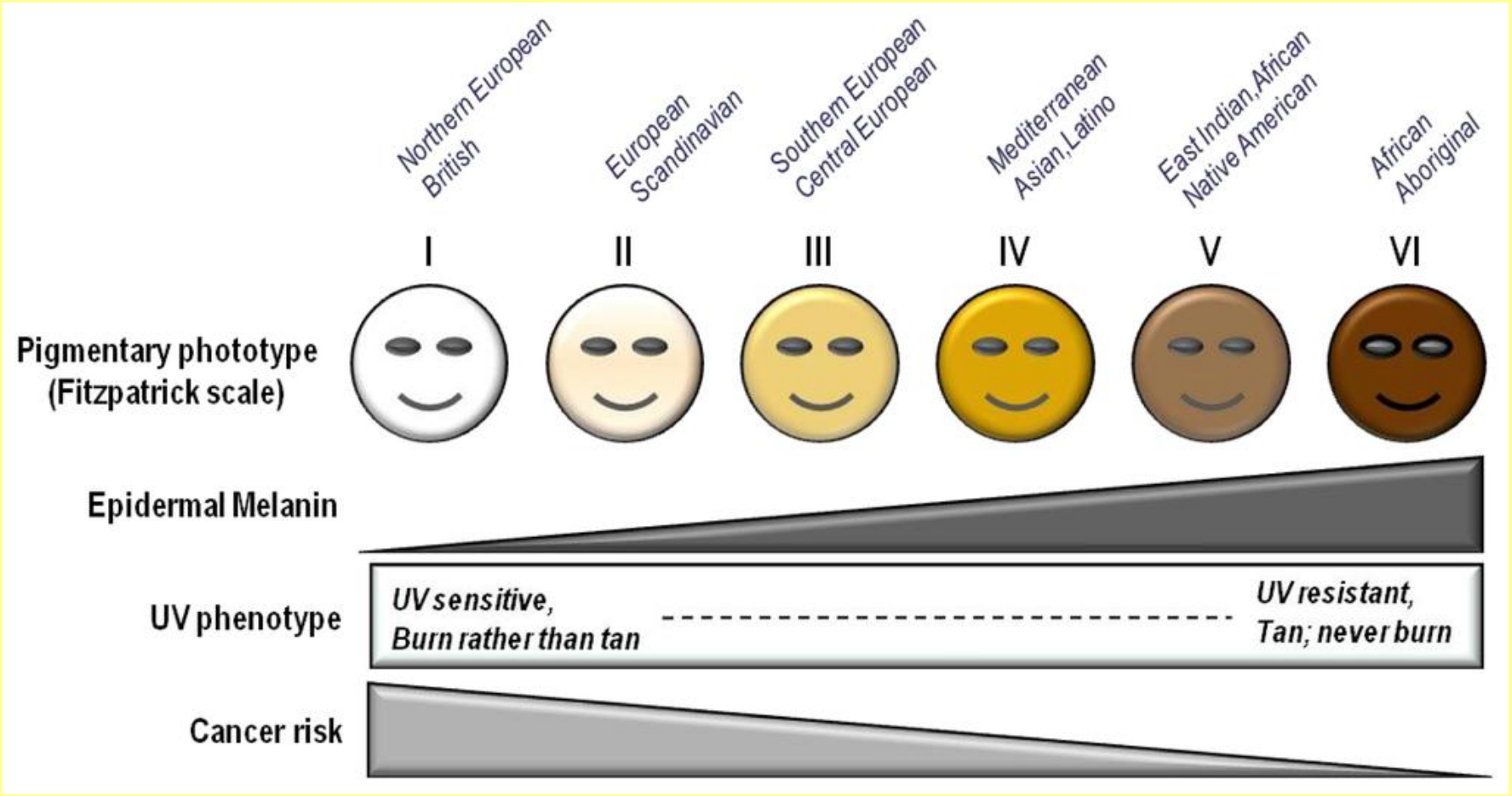
## UNDERSTANDING SUNSCREEN PROTECTION

SPF (Sun Protection Factor) is the universal measurement of UVB protection. It measures the length of time a product protects against skin reddening from UVB, compared to how long the skin takes to redden without protection. Therefore it is strongly advised that you use a sunscreen with a minimum SPF 30.

Whilst there is currently no universal standard that exists for UVA protection you should always use a sunscreen that offers 'Broad-Spectrum Protection'. This indicates that a product shields against UVA as well as UVB.

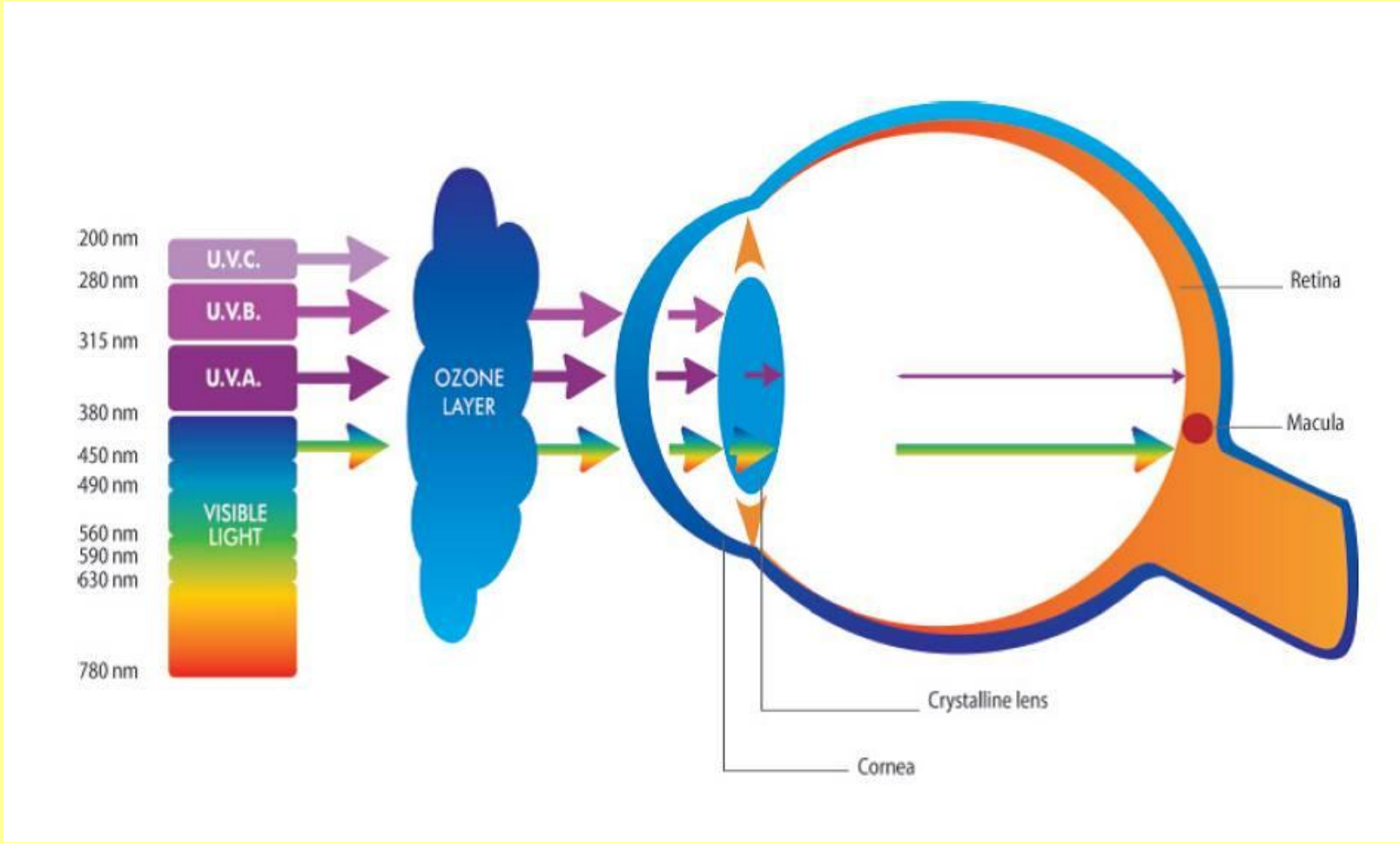
Even with the best sunscreen, some UV rays can get through to your skin and cause damage. This is why sunscreen is considered as only one element of sun safety.

Skcin
www.skcin.org


Northern European
British
European
Scandinavian
Southern European
Central European
Mediterranean
Asian, Latino
East Indian, African
Native American
African
Aboriginal
I
II
III
IV
V
VI
Pigmentary phototype
(Fitzpatrick scale)
Epidermal Melanin
UV phenotype
UV sensitive,
Burn rather than tan
UV resistant,
Tan; never burn
Cancer risk

# Effects of UV Exposure

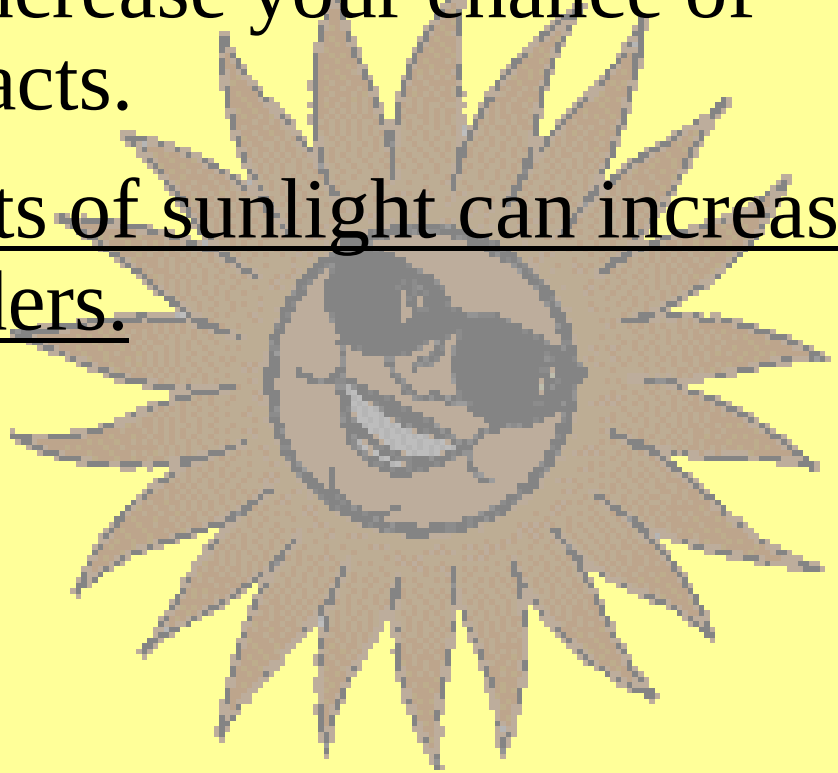
## Eye Damage



- UV exposure of the eye depends on many factors: ground reflection, the degree of brightness in the sky leading to activation of the squint reflex, the amount of atmospheric refection, and the use of eyewear

# Effects of UV Exposure

- Spending long hours in the sun with no eye protection may increase your chance of developing cataracts.
- Even low amounts of sunlight can increase the risk of eye disorders.



# How UV Radiation can Damage Your Eyes

Eyelids
- Skin Cancer

Retina -
Macular
Degeneration

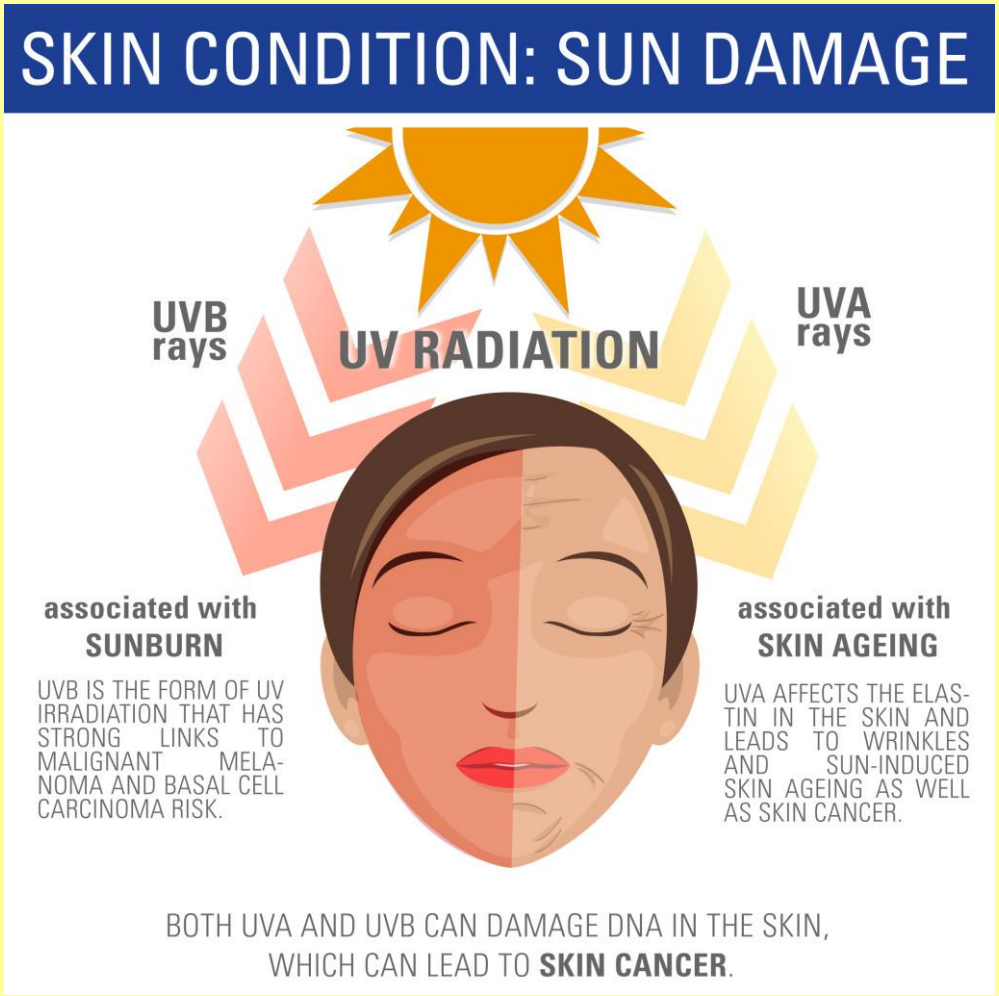
Ptervgia -
Growths on
whites of eyes

Lens -
Cataracts

Cornea and
Conjuctiva -
Carneal Burn - Photokeratitis

# Effects of UV Exposure

## Skin Damage




Melanoma

is one type of skin cancer.

# UVB:

The waves of the solar spectrum between 320 nm and 275 nm. The formation of provitamin D in the skin.

Under the influence of the ultraviolet radiation of the solar spectrum, **provitamin ergosterol and cholecalciferol are converted into vitamin D3**.

# Sufficient Supply of Vitamin D

- The most notable benefit of exposure to sunlight is its ability to boost your body's vitamin D supply.
- A healthy supply of vitamin D promotes bone growth and prevent illnesses such as breast and colon cancer, inflammation, multiple sclerosis, seasonal disorders, and depression.

# Actually Protects From Melanoma

- In a study, indoor workers were found to have increased rates of melanoma because they were only exposed to UVA light, which is associated with skin damage and skin cancer. These workers were found to get three to nine times less solar UV exposure than outdoor workers and therefore had lower levels of vitamin D. It was reported that the indoor UV breaks down vitamin D3 formed after outdoor UVB exposure, which can result in a vitamin D deficiency and increase the risk of melanoma.

# There are some cases when a person may suffer from the deficiency of the UV rays.

**The natural deficit of the UV rays** may occur in the Far North, where we can see the polar night.

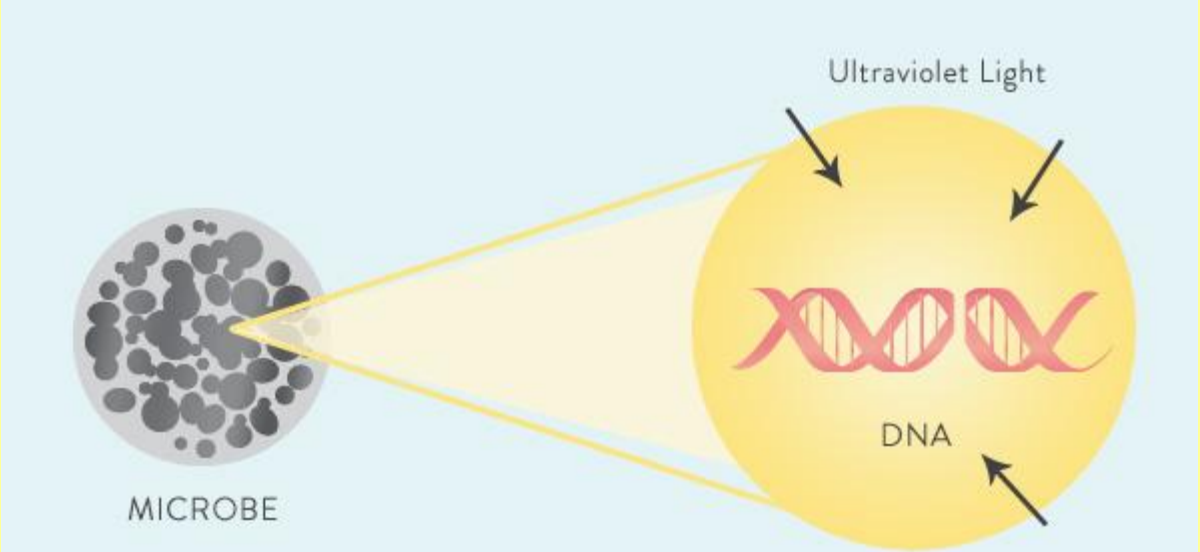
**The anthropogenic deficit of the UV rays** is related to the pollution of the air. In this relation people who live in the cities may suffer from the UV starvation. If this UV starvation occurs in a child, the child may develop the deficit of vitamin D which causes rickets, called in this particular case **anthropogenous rickets**. If the UV starvation occurs in the adult, it may cause **osteoporosis of the bone tissue.**

# UVC:

- —these rays are the most dangerous. Fortunately, these rays are blocked by the ozone layer and don’t reach the earth.

- The waves of the solar spectrum between 275 nm and 180 nm have a harmful effect on the biological tissues. On the Earth´s surface living organisms don’t suffer from these waves of very short wavelength, because they are diffused in the upper layers of the atmosphere and, thus they do not reach the Earth´s surface.

- However, this bactericidal effect is widely used in biology and medicine for sanation of various objects. They are used for the irradiation of operating rooms, microbiological boxes, rooms where  sterile medications are produced.




UV-C light breaks down the molecular structure of a microbe's DNA. This disrupts vital cellular functions, effectively killing it.

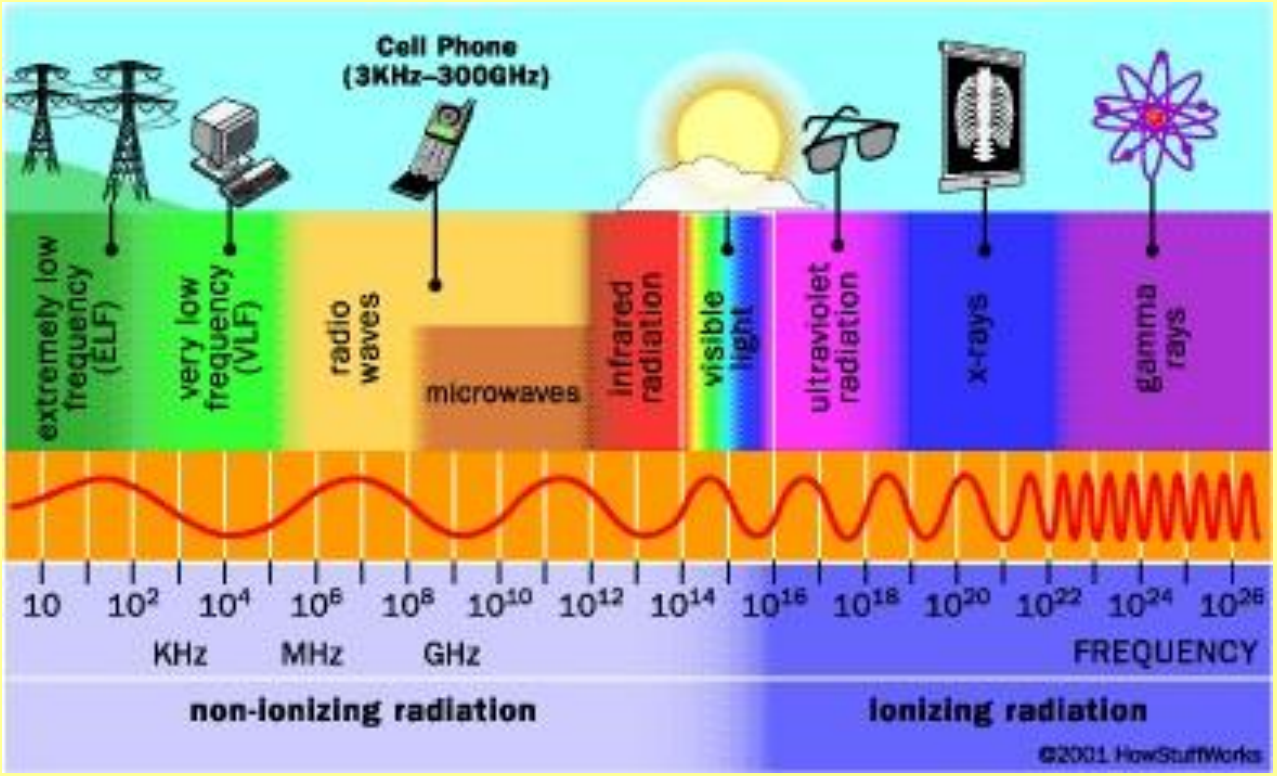
The influence of the UV rays on the human body and the environment is not only positive.

**Excessive irradiation** can cause skin burns, eye affection which is called **photoelectric ophthalmia**. One can even observe the **photosensitizing effect** (that is sun allergy) in some people who are sensitive to the sun rays.

There is also evidence that **high risk factors of cancer** includes excessive UV radiation.

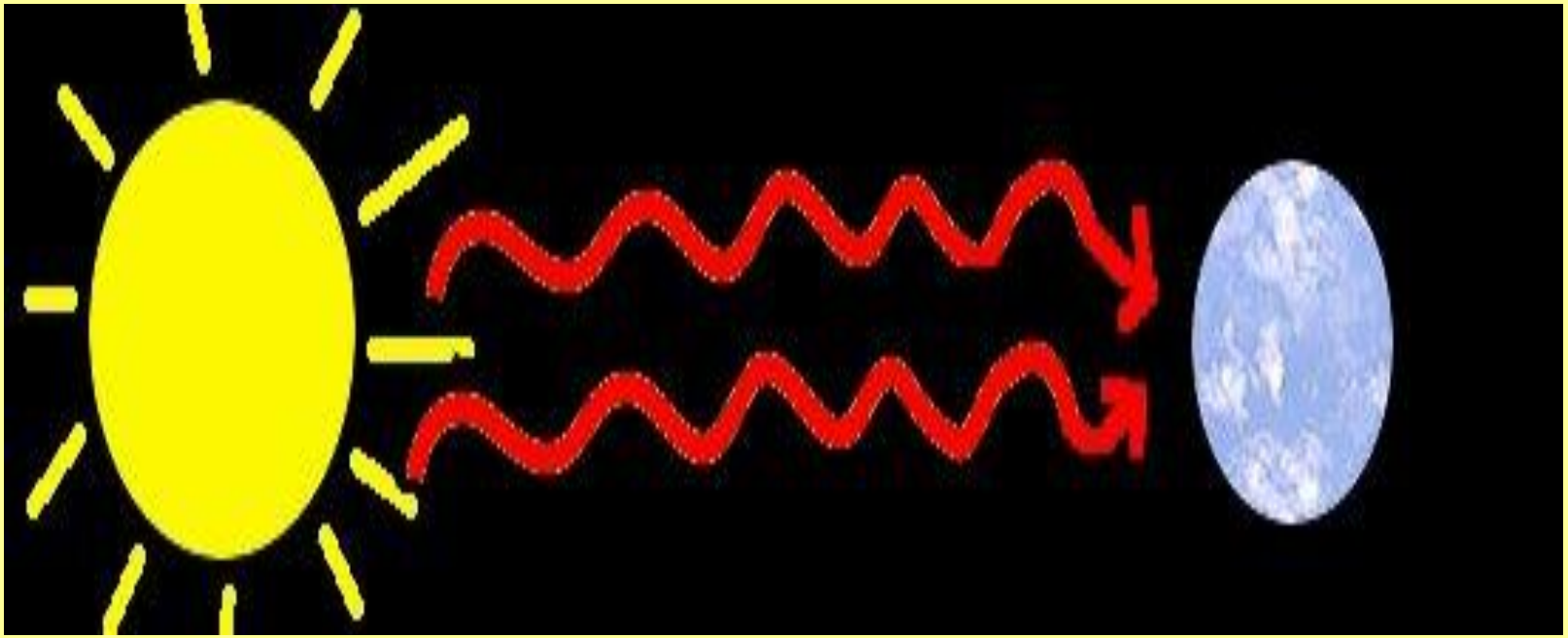
# 2. The infrared radiation (IR) Heat energy waves (or rays)

The infrared radiation includes the waves of very long wavelength of the solar spectrum. Biologically the infrared rays are classified into the waves of short wavelength of the solar spectrum between 760 nm and 1400 nm and waves of long wavelength between 1500 nm and 25 000 nm.



**The infrared radiation produces a thermal effect on the human body** which is determined by the degree of the absorption of the rays in the skin fold thickness.

The feelings of warmth or burning are less expressed at that.



# Infrared Radiation pictures


- This is a  infrared image of a child’s hand holding a lizard.
- Lizards are reptiles and are cold blooded.
- Notice how the child`s hand is warm compared to the lizard.

# Infrared Radiation pictures


- This  is a infrared image of a dear in the dark.
- Since infrared cameras detect heat radiation they can  see the heat from  warm blooded animals in the dark.

# Infrared Radiation pictures


- This infrared medical scan shows an injured and healthy leg.
- The bright white region shows the location of the injury, which is warmer due to the increased blood flow to the injured area.

# 3. The visible part of the solar radiation.

The visible part of the solar spectrum is between 400 nm and 760 nm.

These waves determine the lighting of a certain area. The day light on the open area depends on weather and the solstice. Lighting in the open space in Russia extends from 60 000 lx in August to 1 000 and even less in January.

The visible light is of a specific importance, as it is connected with the functioning of the visual analyzer. At the same time it has a nonspecific importance which is determined through the influence on the central nervous system and via it on all organs and systems of the human body.

It is widely known that in sunny weather the general condition of people is much better than in dull weather

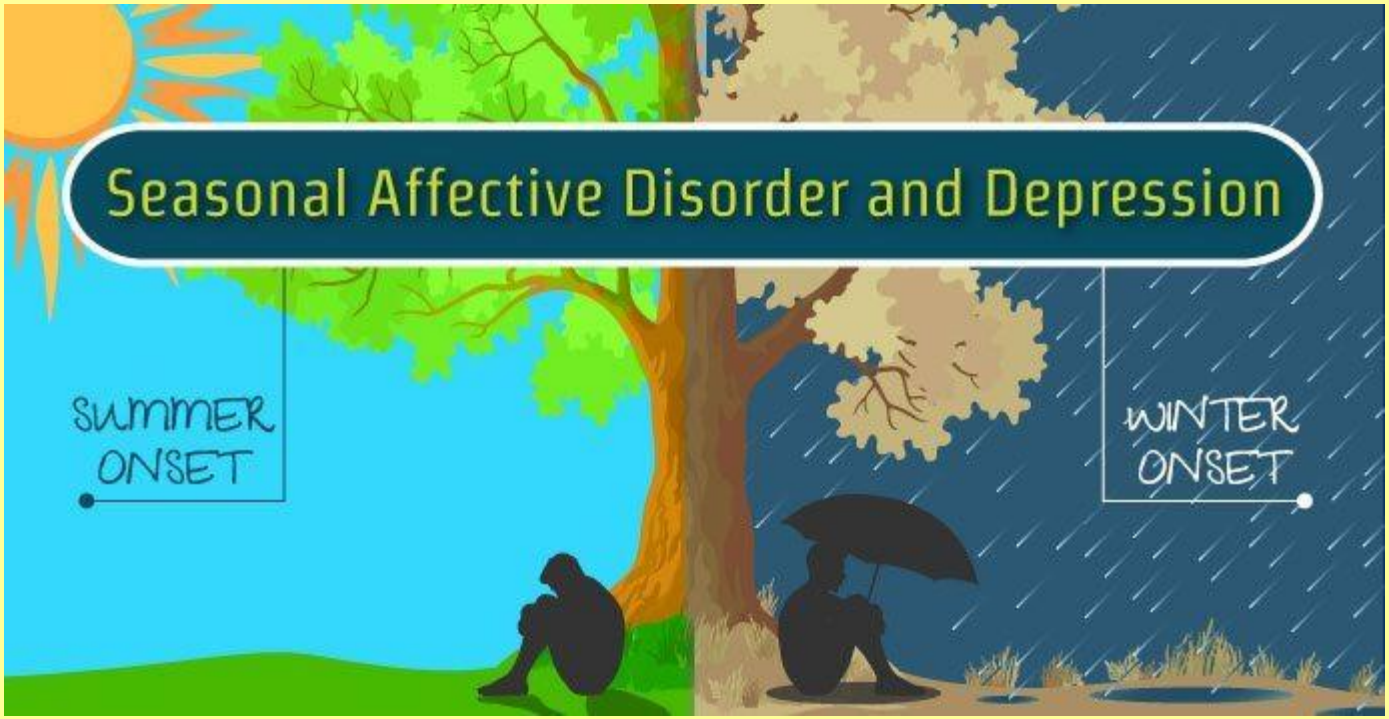
# A Better Night's Sleep

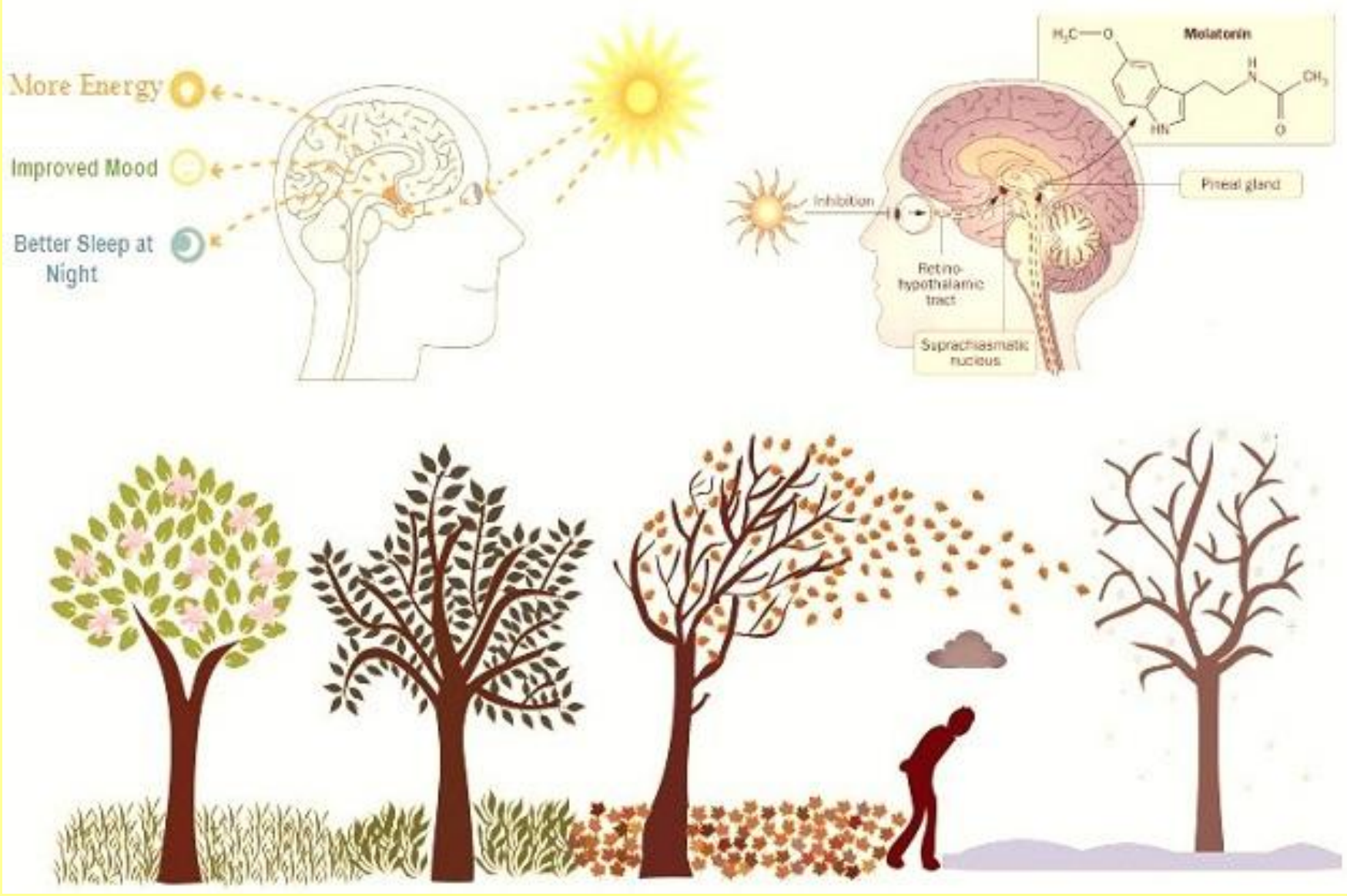
- Your amount of daylight exposure is vital in maintaining a normal circadian rhythm.
- To avoid confusing your circadian rhythm, try not to sit in dim settings during the day because your body will associate the bright light with night.

# Enhances Your Mood

- Regular sunlight exposure can naturally increase the serotonin levels in your body, making you more active and alert.
- The positive correlation between the development of serotonin and the hours of sunlight during the day was seen in healthy volunteers.
- In a sample size of 100 healthy men, researchers found that turnover of serotonin in the brain was lowest during the winter whereas the production rate of serotonin was highest when the subjects stayed in the sunlight longer.

- Seasonal affective disorder (SAD), seasonal depression, and mood variation has been linked to sunlight exposure.




More Energy
Improved Mood
Better Sleep at Night
Melatonin
Pineal gland
Inhibition
Retino-hypothalamic tract
Suprachiasmatic nucleus

# Lowers Blood Pressure

- Skin that is exposed to ultraviolet (UV) rays release a compound, **nitric oxide**, that lowers blood pressure. In a recent study conducted at Edinburgh University, dermatologists studied the blood pressure of 34 volunteers under UV and heat lamps. In one session, the volunteers were exposed to both light sources and in the other session, the UV rays were blocked so only the heat affected the skin. The results of the study showed a significant drop in blood pressure after exposure to UV rays for an hour but not after the heat-only sessions. It is important to note that the volunteers' vitamin D levels were unaffected in both sessions.

If the lighting is insufficient, a person may develop rapid eye fatigue as well as the reduction in work capacity & productivity. It may result, after all, in the pathology of the organ of vision, and first of all, the myopia (that is shortsightedness).

It is interesting that the human body responses not only to this or that degree of lighting but also to the colour spectrum of the Sun.

**The optimum conditions for the work** of the visual analyzer create the **yellow and green** waves of long wavelength. **Blue visible waves** contribute to pain relief and they **have a sedative action** on the central nervous system.

The physiological research of the scientists proved **a depressing effect of the blue and violet** parts of the spectrum or **a stimulating effect of the red and yellow** parts of spectrum on the human body.


Thank you for attention