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ENGINEER OF LIGHT.

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LIGHT SOURCES FOR PHOTOTHERAPY

ADMISSIBLE EXCERPT OF THE CORRESPONDENT PHILIPS-INFORMATION BROCHURE





## THE HUMAN BEING AND SUNLIGHT IN HISTORY.

Far back in history, sun was considered a source of life. Indeed, it was often elevated to the status of a god and men believed in the healing powers of its rays. All over the world evidence has been found of cults worshipping sun-gods.

In ancient history the sun worship of the Pharaoh Akhenaton (1350 B.C.) was very important. He built temples dedicated to the light god, Aton. These temples were very unusual for the time as they had no roof, so the sunlight could freely fill the space inside. As an example to their co-religionists, Akhenaton and his family took off their clothes to benefit from the healing effects of the rays of the sun. The priests remained rather skeptical about this "enlightened" religion of Akhenaton. It flourished at the expense of their mystical and darker cults.

After the death of Akhenaton, the sun temples were soon pulled down. However "sunbathing" continued to exist through the centuries in Egypt.

The historian Herodotus (5th century B.C.) found this so remarkable that he described it in his chronicles: "The health-promoting properties of sunlight have been recognized from the beginning of civilization as a natural intuitive desire which causes humans, when in poor health, to be attracted by our largest optical radiation source: the sun". In these early times, phototherapy (heliotherapy) was born and guided by experience rather than any scientific basis for the treatment of certain ailments.

The Greek doctor and "father" of medical science Hippocrates (born in 460 B.C. on the Island of Cos) had, on his many travels in Egypt, studied the sunlight treatment which was practiced there. On his return to Greece, he set up a clinic and medical school on the island of his birth thus breaking away from the medicine as practiced at the time by the priests. He was practicing medicine for the first time as a real empirical science. He wrote books on the surgery of fractures, hygiene and diets.

In his sanatorium with its open gallery facing south he treated patients on a scientific basis. He is, with good reason, considered to be the father of light therapy.

Later the Greeks and Romans continued this light therapy, otherwise known as heliotherapy. In the Roman baths (therms), famous throughout history, it was also possible to sunbathe in a solarium.

With the decline of the Roman Empire, heliotherapy disappeared. In the Dark Ages and with the spread of Christianity, medicine and hygiene declined, creating a situation where epidemics of cholera, plague and smallpox could easily break out. Also with the rise of Christianity, attention to the body and display of nakedness was considered sinful. All baths disappeared from houses and public bath houses were closed. The Swiss Arnold Rikli (1823-1906) reintroduced the positive effects of sunlight forgotten for many centuries, and used these effects as the basis of successful natural healing methods. He practiced for more than 50 years. He was responsible for developing therapeutic guidelines and ideas which are still valid today. His motto "Water is good, air is better and light is best of all" is at the core of heliotherapy. The Danish doctor Niels Ryberg Finsen (1860-1904) initiated an emphatic rebirth of light therapy in 1898. In that year he established a sun garden in Copenhagen (attached to the Finsen Institute) for his patients, where they could sunbathe completely naked. At the start, only natural sunlight was used, but because sunlight at this latitude (55°N) is not so plentiful, he soon changed over to the use of artificial light sources. Consequently he discovered that the ultraviolet part of the sunlight spectrum had a beneficial influence of the

human body. In 1893 he demonstrated that red light was beneficial for healing skin of smallpox patients. With artificially generated ultraviolet rays he could cure patients suffering from skin tuberculosis. In 1903, one year before his death, he received the Nobel Prize for Medicine.



## LIGHT IN PREVENTION, THERAPY AND REHABILITATION.

Modern photomedicine started about 100 years ago with already mentioned publication (1899) of Niels Finsen in which he described the treatment of lupus vulgaris by ultraviolet radiation.

The past 30 years has seen an increase of publications concerning photobiological research and photomedicine; this reflects the expanding potential of optical radiation for prevention and therapy.

Of course, adequate knowledge and experience with handling optical radiation are essential if full advantage is to be taken of all potential uses. The aim is always to maximize the benefit whilst minimizing the level of risk. The correct dosage is the most important step. This means that **phototherapy must always be carried out under the supervision of a doctor.**

### **PUVA photochemotherapy**

A new era in therapeutic photomedicine was initiated at the start of the 1970's when, on the basis of research work carried out in USA and Austria, the systemic treatment of psoriasis by psoralens and irradiation with UVA, so-called PUVA therapy was described. At this time the concept of photochemotherapy was introduced. In photochemotherapy, the combination of a photosensitizing chemical compound and optical radiation is used to bring about a therapeutically beneficial result not produced by either the radiation or a drug alone. The drug may be applied topically or orally to reach the skin by blood circulation and is subsequently activated by irradiation with UVA. In practice, PUVA photochemotherapy is not only used for the treatment of psoriasis but for many other skin diseases as well (being in common use for more than 20 indications at present). It is applied by using a UV-sensitizing medicine and combining it with UVA lamps.

Recently it has been found that chronic and high dosage use of PUVA chemotherapy in the treatment of psoriasis has serious negative side effects. Under the conditions indicated, the application of PUVA increases the risk of obtaining skin cancers. As a consequence there is a shift in preferred treatment protocols in favor of UVB narrowband phototherapy



### **Broadband UVB/Narrowband UVB phototherapy**

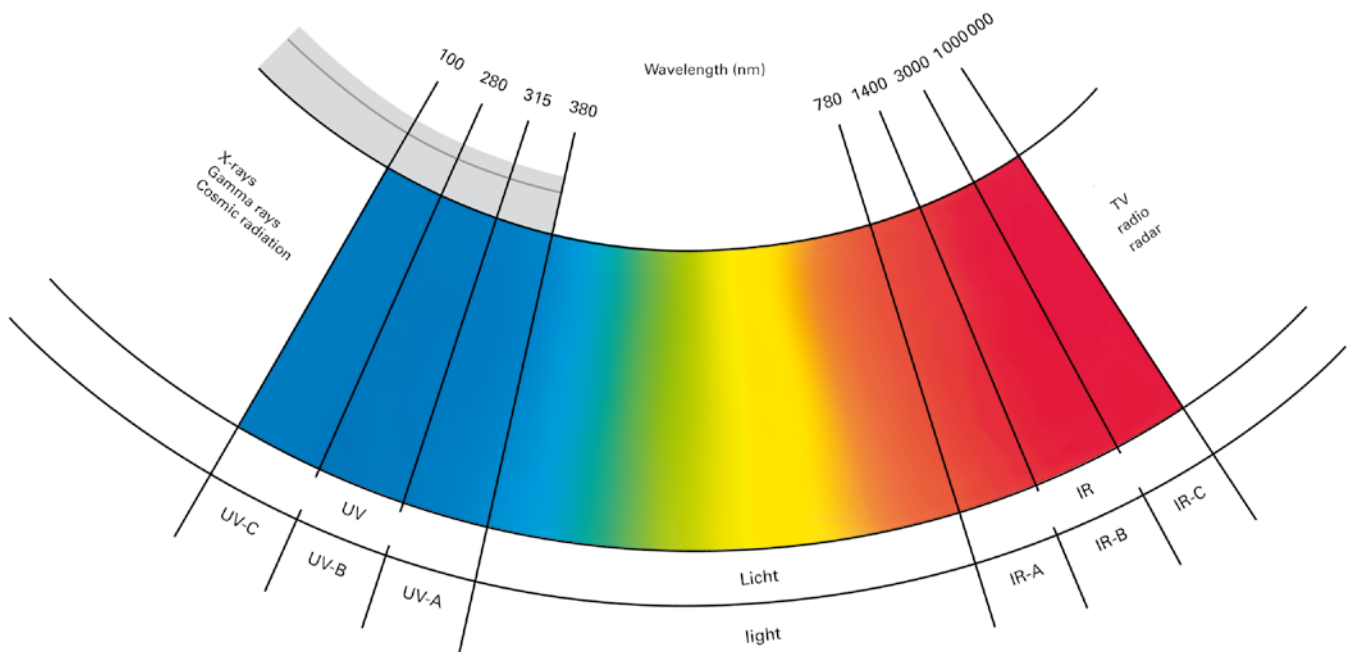
Phototherapy of psoriasis or other diseases of the skin is a type of therapy without any photo-sensitizing agent. It is the oldest form of treatment, and it is based on the experience with the favorable effects of sunlight on the general appearance of the skin. Numerous investigations show that phototherapy with UVB is just as effective as PUVA therapy if the right doses are maintained. Another critical parameter is the UVB wavelength applied. Investigations imply that the most favorable range for the effective UVB treatment of psoriasis is in the long-wave part of the UVB spectrum (between 305 and 315nm). This warrants a high (therapeutical) efficiency on the one hand and minimum (acute and chronic) risks on the other. There are mainly two types of fluorescent lamps of different spectral distribution – the UVB narrowband and the UVB broadband lamp – available for the therapy of psoriasis. The erythematous effect of the radiation from the UVB narrowband lamps is much smaller than from the UVB lamp so that – with the aim of being able to irradiate as much UVB as possible without producing erythema (reddening of the skin) – the UVB is a better proposition. Moreover, recent investigations show that for successful therapy, radiation can be dosed far below the

erythematous threshold. This makes the period of exposure shorter, reducing overall dosages and thus any acute or chronic side-effects. UVB narrowband lamps have been tested world-wide in extensive clinical tests and are universally in practice. Irradiation equipment involving UVB narrowband lamps supply good means of home therapy as the dosage can be easily controlled. The therapy schedule is drawn up by the doctor (adjustment of the individual sensitivity of the patient to the irradiation quality and quantity of the equipment) who will verify its success at regular intervals. Once the patient shows no symptoms any more a low-interval maintenance treatment is sometimes started to prevent early exacerbations.

### **Balneo-phototherapy**

Balneo-phototherapy the positive experience with the treatment of psoriasis at the Dead Sea is being increasingly transferred to the clinic. Brine baths, with a simultaneous or subsequent exposure to UVB narrowband provide better results at a generally lower dosage than in UVB broadband phototherapy. This is mainly attributed to the greater transparency of wet skin. Balneo-phototherapy of psoriasis is successfully applied for in-patients in numerous spas: it is also applied for out-patients in therapeutic centers.

## CHARACTERISTICS OF OPTICAL RADIATION.



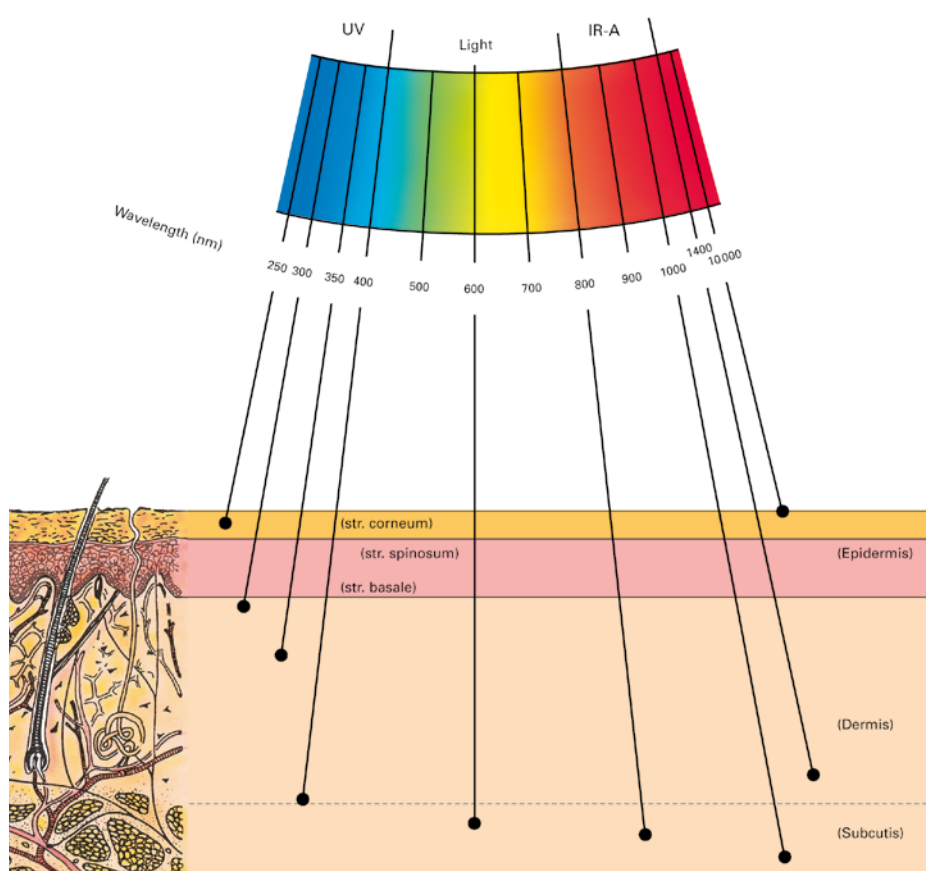
Spectrum of electromagnetic radiation according to DIN 5031-7

The spectrum of optical radiation (Fig. I) lies between 100 nm (in the UV range) and 1 mm (in the IR range). For practical purposes, this wavelength range is subdivided into seven bands in accordance with CIE (International Commission on Illumination): UVC from 100 to 280 nm (short-wave UV), UVB from 280 to 315 nm (medium-wave UV), UVA from 315 to 380 (400) nm (long-wave UV), Light (visible radiation) from 380 (400) to 780 nm, IRA from 780 to 1400 nm (short-wave infrared radiation), IRB from 1.4 to 3  $\mu$ m (medium-wave infrared radiation), IRC from 3  $\mu$ m to 1 mm (long-wave infrared radiation).

Not only ultraviolet "light" but also visible and infrared "light" have many possible applications in photobiology and photomedicine. Ultraviolet, visible and infrared radiation has distinctive physical, photobiological and photochemical features. Going from the infrared towards the ultraviolet region, the energy content (photon energy) of the "light" increases.

Most photobiological effects in the ultraviolet and visible region are due to photochemical reactions, whereas effects in the infrared region are mostly due to heat dissipation.

## OPTICAL PROPERTIES OF THE SKIN.



Knowledge of the optical properties of the skin is indispensable for understanding the effects of optical radiation. Optically, the skin can be regarded as an inhomogeneous medium consisting of four layers:

- Stratum corneum
  - Stratum spinosum
- } Epidermis  
(50-150  $\mu\text{m}$  thick, incl. stratum basale)
- Dermis (0,8 – 1 mm)
  - Subcutis (1 – 3 mm)

These layers have different refractive indices and distributions of chromophores, which will bring about different reflecting, transmission and scattering characteristics depending on the wavelength. Figure 2 gives a schematic representation of the skin layers and the depth of penetration as a function of the wavelength.

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