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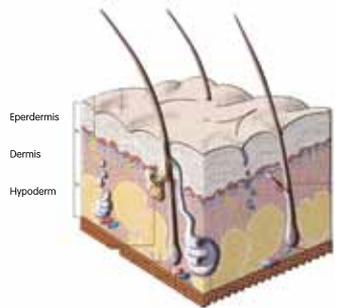


Protect Your Skin!

— A window onto your skin

Look at your nails. They are windows onto your skin. They are made of cornified cells i.e., dead cells filled with keratin. This cornified layer is so dense that it is transparent. The white half moon at the base of the nail is the basal layer that makes new cells to replace the ones you remove by cutting or chewing. Your skin is organized in the same way. The surface is covered by fine strips of cornified cells that are thinner and less dense than the cornified cells of nails. Under this layer lies the basal layer, but you can't see it as you can under your nails. This is the **epidermis**.

Just under the nail, you see tissue that is more or less pink. This is **dermis**. It is made of cells and white fibers that are criss-crossed by blood vessels and nerves. Press the tip of your nail. The blood stops circulating in the cutaneous capillaries and you can only see the white connective tissue. Lift your nail and you will immediately feel the pain nerves located there.



Under the dermis is another layer of cells and white fibers but they are more loosely woven together so that they are able to capture fatty cells. This is the **hypodermis**.

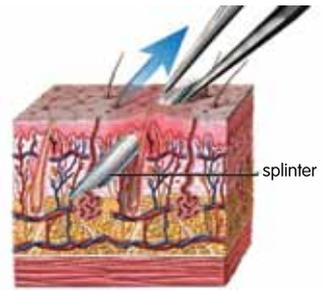
Simply looking at your skin, you wouldn't think it does anything. To the contrary, it is far from inactive. It is constantly fighting off countless external agents and is highly successful in this task. On the other hand, sometimes aggression can be too strong, happen too often or last too long. Skin is injured or diseased. You use methods to eliminate, to substitute or to reduce aggression but sometimes they are not enough to reduce the risk of injury or disease. You no longer have a choice. You must protect your skin with the appropriate gear.

— Overcoming mechanical agents

The mechanical agents that only affect skin are micro-traumatism, incrustations, friction and pressure.

Micro-traumatism are small superficial linear cuts. They are usually caused by abrasive particles (cement, salt, glass fibers), plants (sharp stalks and leaves, thorns) or sharp instruments. Skin defends itself by manufacturing thick scar tissue. On drying, this tissue cracks and forms very painful crevices.

When agents enter the skin, **incrustation** or **tattooing** may occur. This may be caused by compressed air, liquid under pressure, wood splinters, metal shavings, or tiny glass or cactus fibers. Skin reacts by thickening the outer layer, by retaining them indefinitely (tattooing) or by rejecting them after infection. Sometimes warts will form around a permanent incrustation (fiberglass, hair, flint).



To protect itself from **friction**, skin only has resistance and hair. If the friction is harsher than a caress, it begins to rip off layers of the epidermis. When friction is very harsh, it causes painful abrasions, because it exposes nerves of the dermis to air, or may cause blisters, if the epidermis pulls away from the dermis and the space in between fills with liquid. You have all experienced this kind of problem with ill-fitting shoes.

If you subject your skin to repeated **pressure**, it will react by manufacturing epidermis. The thickness of the epidermis ranges from 0.06 to 0.12 mm over the entire body, but where pressure exists, it may range up to several millimetres. Look at your heels, your elbows, the palm of your hand or the fingers you use to hold a pencil. There is callused skin there.

You can wear all kinds of clothing to protect yourself against mechanical agents. When handling heavy, rough or angular materials, you must wear

gloves, arm protectors, bibs, aprons, jackets, overalls or suits. If you work on your knees, you must wear lined knee pads. Leg guards, leg straps and trousers protect the lower limbs.

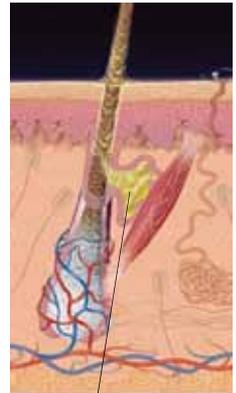
When the risk is low, a cotton or polyester-cotton fabric is adequate. In the most serious cases, use clothing or linings made of canvas, leather, reinforced plastic or fiberglass. Metal mesh protective clothing also exists.



— Dangerous properties of chemical products

Countless chemical products may attack your skin. They include acid, caustic and irritating substances, fatty oils, allergens and metal compounds. The skin's main defence mechanism against all these products is *sebum* manufactured by some glands of the dermis. Sebum is a kind of oil that prevents the water of cornified skin cells from evaporating, and that allows the skin to retain impermeability, flexibility and resistance.

Sebum can do virtually nothing against acidic and caustic substances. **Acid** provokes dry burns that take a long time to heal. Usually, only the cells of the epidermis are destroyed. If exposure is regular, the epidermis thickens. If the capillaries and the cells of the dermis are destroyed, premature wrinkling will occur. **Caustic substances** are much more dangerous. They dissolve the cells of the epidermis and the dermis. Burns are deep and humid, and sometimes difficult to heal (ulcers).



The most common **irritants** are detergents, cleansers and solvents. Some do no more than remove the sebum covering the skin. If the dermis does not have time to regenerate sebum, the epidermis dries and falls off in the form of large flakes. If the cells of the epidermis are damaged, redness and blisters will occur.

Skin repels nearly all oils. However, some **fatty oils** are difficult to remove even after thorough cleansing. They accumulate around hairs, and in pores, producing blackheads. Bacteria can grow on this abundant food, and cause pimples or furuncles if the dermis is affected.

The most insidious chemicals are **allergens**. Fortunately there are not many allergens. Cement, epoxy resins, acrylates, diisocyanates, amines and chromium salts, cobalt and nickel force some cells in the epidermis to manufacture antigens so that eczema plaques and dermatitis may later appear. You have probably heard of people who are allergic to latex gloves because of the additives they contain. Some substances can even induce a cutaneous allergy only when the skin is exposed to the sun.

Finally, certain **metallic compounds** containing antimony, silver, arsenic, chrome, cobalt and copper may cause interior skin irritation. They accumulate in the skin which begins to thicken. Others react with cells and cause them to turn yellow (nitric acid, sulfuric acid), grey (silver), blue (chrome) or green (copper).

Impermeable clothing

Manufacturers lack no imagination in inventing impermeable clothing against chemical products. You can find impermeable hats, shirts, jackets, sleeves, arm protectors and gloves, trousers, coveralls, aprons, leg protectors and shoe rubbers. You can even find waterproof hoods and frog suits that cover the body from head to foot and that are equipped with their own source of air supply. The choice of clothing is simple: you try to cover a surface of the skin a bit larger than the places that can be exposed to chemical products.

The choice of material is more complicated because several products can react to fabrics. For example, most synthetic fabrics that you wear at home do not resist acids or caustic substances. Even the good old rubber raincoat

does not resist oils, greases, several solvents and chemical products. Always consult the manufacturer’s manual to find out which chemical products are compatible with the clothing that you buy.

Contamination of clothing and skin

Despite all the precautions you may take, your clothing may be contaminated by chemical products. Learn the correct way of removing it. As a general rule, in order, remove boots, coat, apron, hat and gloves and wash your hands before removing eyeglasses, face shield and respiratory protective equipment. Inspect your clothing and immediately replace any clothing that is deteriorated or worn out.



In case of contact with the skin, immediately flush with water and take a shower if necessary. To facilitate cleansing the skin, you can apply a protective cream before working. Some creams are silicone-based (to protect against solvents, paints and greases) others are petroleum-based (to protect against aqueous solutions). Apply a moisturizing lotion or cream at the first sign of irritation and drying. If the drying persists, use creams containing lactic acid or urea (Caution! These may irritate). In extreme cases, only ointments containing lanolin or vaseline or zinc or titanium pastes may work.

Absorption through the skin

Many chemical products may penetrate the skin, enter the blood and produce toxic effects in your organs and internal systems. In the regulations, these substances are identified with the notation “skin.” You must avoid any contact with these substances in liquid form especially if the exposure standard is low. Wear protective clothing when necessary.

— Invasive microbes

The most common occupational infections are mainly caused by the bacteria that live naturally on your skin. As soon as the epidermis is exposed, they

can multiply and cause pimples, impetigo, folliculitis, furuncles (boils) or oozing or crusty spots. However there are many other microbes that can cause serious health problems. Less innocuous bacteria such as anthrax, syphilis, tuberculosis and tularemia can attack the skin in dangerous ways. Certain microscopic fungi, such as dermatophytes, yeast (*Candida sp.*) and herpes, certain viruses such as man pox, certain parasites, such as scabies acari, certain plants, such as poison ivy, and certain insects, such as mosquitoes, can also affect your skin.

To fight off microbes, the skin adds substances to sebum that are toxic for bacteria, and glands in the dermis manufacture slightly acidic perspiration (pH from 4.0 to 6.8) that moistens all the skin and that is able to kill several micro-organisms. For other biological agents, the skin has no means of defence.

To protect against microbes use clothing that is sealed with latex, polychloroprene, nitrile rubber, polyvinylchloride, polypropylene or polyethylene, regardless of whether or not it is disposable. In many cases, ordinary polyester or cotton clothing may suffice if they are regularly disinfected.

There are anti-microbial soaps and detergents containing an active agent (chlorhexidine, PCMX, triclosan, povidone-iodine) with or without alcohol or glycol for washing your hands and skin after exposure, but you must not use them unless it is necessary because they also destroy the skin's natural bacteria. Do not use creams containing an antibiotic (penicillin, erythromycin, cephalosporin). They are only useful for the treatment of infections.

— Physical agents

Heat and infrared

The skin has virtually no mechanisms to protect itself from heat and infrared radiation. The brain has to intervene. When the body's internal

temperature rises, the brain orders the blood vessels of the dermis to dilate and orders the body to produce perspiration. Dilating the capillaries (the dermis turns pink) causes more blood to circulate at the surface of the skin and throws heat out to the air. As you know, water needs heat to evaporate, like a kettle heating on a burner. This is what causes perspiration. It draws heat from your skin, which automatically refreshes itself. When these mechanisms no longer work, the temperature of the skin continues to rise and burns, rash, redness and rosacea (permanent dilation of blood capillaries) occur.

Up to 65°C, leather clothing provides good protection from heat. Beyond that, flame-retardant clothing must be worn if the exposure lasts no longer than three minutes. For longer periods of exposure, clothing must contain a cooling system.

There are two types of flame-retardant clothing: fabrics that have been treated or covered and flame-retardant synthetic fibers. Cottons treated with organophosphorous may resist 50 washings or more. Cottons treated with ammonia salts or covered with paraffin or antimony are less resistant. Nearly all wools treated with antimony or zirconium lose their treatment after several dry cleanings. Polyesters and polyamides that are treated are highly durable. On the other hand, the most resistant fabrics are those actually made of flame-retardant fibers (Trevira, Velicren, Sandoflam, Saran). Among these, polyaramides (Nomex, Conex, Kevlar), polyaramidarimides (Kermel) and polybenzimidazoles (PBI) withstand very high temperatures. When heat emanates mainly from infrared radiation, wear aluminized clothing to reflect radiation.

Cold

The only cutaneous protective mechanism against cold is the thickness of the hypodermis. In normal people, the layer of fat is greater in certain places, particularly in the buttocks and the abdomen. If you regularly work in the cold, fat will be evenly distributed over the entire body.

When it is cold, the skin can do nothing. The brain has to intervene once again. As soon as the skin's temperature drops, the brain dilates the blood vessels of the dermis to provide more internal heat to the skin, diminishes perspiration so there is no evaporation, orders muscles to shiver to produce more heat, and stands hair on end to capture a tepid layer of air close to the surface of the skin. When these mechanisms are inadequate, the skin's temperature continues to drop and cells begin to freeze. Blood no longer flows (the skin becomes white), the nerves send pain messages and underlying muscles become numb. The brain will then react by provoking muscle spasms. If the temperature continues to drop, the Raynaud syndrome appears (numbing and insensitivity of the skin), dryness (xerosis) and superficial or deep burns (blisters). In severe cases, skin necrosis may occur.

The principles of protection against cold are very simple. First of all, the more layers of clothing you add, the more layers of captured air you have. Air is a good insulator. Think of double windows in winter and thermal pane glass. Second, make sure that the layers of warm air at the surface of the skin do not escape. If the cold is not intense, a rib knit lining is adequate. For more intense cold, a quilted lining is required. For extreme cold, a lining quilted with down or fur is essential. Think of cats and dogs that prepare for winter by growing a layer of down.

Ionizing radiation

Skin has no protection against ionizing radiation. This radiation easily penetrates skin like X-rays. Its main effects on skin include photoreaction, burns and cancer. Radiation can transform many substances within cells and cause a variety of effects that are difficult to predict. Burns only appear after intense local radiation or prolonged exposure in the same place. Radiation can also cause melanoma and carcinoma if the basal layer of the epidermis is affected or epithelioma if the cancer is superficial.

When the level of exposure is low, clothing made of polymer or reinforced paper may be adequate to protect you. For X-rays and gamma rays you

must wear clothing made of leaded rubber, plastic or fiberglass or of fabric containing thin lead sheets. Caution! None of this clothing protects you against direct ionizing radiation.

Non-ionizing radiation

Skin possesses good protective mechanisms against the rays of the sun and intense lights (spotlights): **melamine**. This is a dark pigment produced by the epidermis to prevent the sun's rays from heating and burning your skin. The longer you are exposed to the sun, the more you have (sun tan). The more you have, the darker your skin is. If this mechanism is not enough, you can suffer sunburn and polymorphous light eruptions, which are essentially burns. There is always the risk of skin cancer caused by ultraviolet radiation.



Nearly all hats and urban clothing are suitable for preventing non-ionizing radiation from reaching your skin. For the parts of the body that are hard to cover, you can use sunscreen lotions with a sun protection factor (SPF) ranging from 1 to 32. Caution! If you perspire or bathe, these lotions lose half of their power over time.

Humidity

Excessive humidity may irritate your skin and macerate it, as when you stay in the bathtub for a long period. You can use the old reliable raincoat with an external water repellent covering, a vapour barrier (e.g. polychloroprene, PVC) and an internal lining (polyester, nylon, cotton). For exposed parts, a protective petroleum-based cream may suffice. For divers, good waterproof clothing that is more or less insulated against the cold is available.

— Cleansing the skin

All cleansers are irritants. Therefore you must find a balance between cleansing power and irritant potential especially if the cleansers you use are sold in concentrated form and you must dilute them.

Soaps and liquid lotions are made of animal fat or vegetable oil buffered with a base (NaOH or KOH). Many of these are irritating. The least irritating have a pH from 4 to 10. Sometimes abrasive particles are added to increase their cleansing power (borax, silica, pumice, nut shells, polystyrene), which increases irritation.



Liquid and powdered detergents are synthetic chemical products that dissolve fats by emulsifying them. They all dry out the skin because they also emulsify the skin's protective layer of sebum. Some contain an emollient (softener), such as glycerine, lanolin, lecithin and cholesterol, to combat drying and prevent irritation. However, you will often need to use a moisturizer at the end of the work day.

Heavy duty pastes, creams and waterless soaps are oil emulsions containing a solvent (kerosene or varsol). They are highly irritating. After using them, wash with soap and apply a moisturizing cream.



— Conclusion

All the protective gear that we have described is used to reinforce the skin's natural barrier. They each have functions and above all, their limits.

Remember that there is no magical protective gear, and no one can give a 100% guarantee for its effectiveness. If an instrument that could measure the level of risk to your skin existed, you might be able to certify that a given type of gear offered 40% protection, or another, 67%, or yet another, 82%. This is not the case. Even though we suggest a given type of protective gear for a given aggressive agent, you must never forget that the best protection is dictated by the judgment of a qualified person and by testing.

Notes

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