Skin in Science Fiction Films

By Mark C Glassy, Ph.D.

Submitted for your approval

We all know what skin is…that soft outer covering on vertebrates, including man. Other animals have a harder substance or an exoskeleton that covers their bodies. For humans the largest organ from our bodies is skin. Yes, skin is an organ and just so you know body organs aren't all internal like the brain or the heart. Skin is made up of multiple layers of ectodermal tissue and helps protect the internal organs, bones, muscles, ligaments, and everything else inside. Also, not all skin is the same and even on our same body there are areas of skin that are very different from each other. For example, the skin on our fingertips is quite different from the skin on our scalps. Furthermore, some areas of skin are thicker than others and this too can vary from location to location. The thinnest skin is the eyelids (0.5mm thick). Skin on the palms and soles of the feet are around 4mm thick and the thickest in the body. On animals some skins are very hard and thick, like on a rhinoceros, and others are smoother. Reptiles and fish have hard protective scales to protect skin, birds have feathers, and mammals have fur. It should be clear that not all skin is created equal so some skin areas are more important than others.

Gimme some skin

The study of skin, including hair, nails, and their diseases, is called dermatology, which is derived from the Greek *dermatos*, meaning skin (or at that time, "to flay" which provides an entirely different meaning). We all know that skin is what we wear on the outside of our bodies and adults carry some 8 pounds (3.6 kilograms) and 22 square feet (2 square meters) of it. An average square inch of skin (6.5cm^2) contains 650 sweat glands, 20 blood vessels, 60,000 melanocytes (pigment producing cells), and more than 1,000 nerve endings. All totaled, this fleshy covering does a lot more than make us look presentable. In fact, without it, we'd literally evaporate.

Skin and various visible alterations have been recognized since animals began to see and the skin surface has been the indicator of an overall sense of health. As a discipline, dermatology first came into being in Paris during the early 19th Century and the first textbooks dedicated to dermatology began to appear at this time too. Much of this study began when the microscope was invented and improved. Currently, to specialize in dermatology requires an additional 4 years of training beyond medical school. The field of dermatology can be divided into two specialities, namely medical and surgical. Various subspecialities include, immunodermatology (skin's immune response), phototherapy, laser medicine, dermatopathology (pathology of skin), and perhaps the most recognized of all,

cosmetic surgery, commonly known as plastic surgery.

Some examples of common therapies dermatologists use are: cosmetic fillers for plastic surgery; use of lasers to remove birth marks, tatoos, and skin disorders like vitiligo; use of ultraviolet light (called photodynamic therapy) to treat some forms of skin cancer as well as cosmetic resurfacing; cryosurgery to remove warts and skin cancers; use of radiation; and allergy testing or 'patch testing' for contact dermatitis. Last but not least are the numerous varieties of topical treatments ranging from oils, emoliants, and salts to hydrations.

Also, skin is considered a soft tissue that has mechanical behavior when stretched. When deep cuts are made on the skin this mechanical behavior causes the skin to retract and stretch which helps widen the slice. When skin is severely damaged then wound healing scar tissue forms which is often discolored and depigmented.

Skin covers it all

An important element of skin is hair. Though hair serves many functions one of the primary ones is as insulation for skin. As a general rule, thick skin tends to be hairless whereas thin skin tends to be hairy.

Human skin is similar to most other mammals except it is not covered by fur. While just about all human skin is covered with hair follicles it can appear hairless. Overall there are two general types of skin, hairy and glabrous, which contains no hair follicles such as the skin found on the palms of hands, lips, and mucous membranes. Skin pigmentation of hair in humans varies considerably among populations as does the range of dry to oily skin (see below).

Functions of skin

Skin serves many functions such as protection, touch, thermoregulation, control of evaporation, storage for fats, and allows small amounts of air diffusion to enter the body. As protection the skin is a barrier from the many microbes and pathogens that can damage internal organs and processes. Immunologically, the skin is a part of the body's adaptive immune system that can process and eliminate antigens and germs. Skin can sense heat, cold, touch, pressure, vibration, and tissue injury. The eccrine (sweat) glands in skin help thermoregulation with heat loss and retention by controlling the dilation (loss) and constriction (retention to conserve heat) of capillary blood vessels in the skin. As a relatively dry and semi-permeable barrier skin helps to control and reduce body fluid loss. Like a camel's hump that can store lipids and water, human skin also serves as a storage source of lipids and water. Oxygen, nitrogen, and carbon dioxide can readily diffuse through the skin in small amounts. Just so you gentle readers know the cells in the outermost layer of skin, about 0.25mm-0.4mm deep, get their oxygen just about exclusively by diffusion from air and not through the blood vessel system. Lastly, as a water-resistant barrier skin prevents essential nutrients from being washed out of the body. The outermost layer of skin, the epidermis, is covered with oils secreted by the sebum glands that helps

repel water. In one respect human skin allows us to say we are essentially walking bags of water in that the water resistant barrier of skin prevents essential body nutrients and fluids from washing out of the body.

Skin anatomy

Skin is primarily composed of three layers, the outermost layer, the epidermis, the middle layer, the dermis, and the innermost layer, the hypodermis. The epidermis provides the barrier to infection and water proofing and also helps the body regulate temperature, the dermis serves as the location for the appendages of skin, and the hypodermis is the subcutaneous adipose layer. Tissues below the fascia are not considered skin.

For the epidermis (from the Greek, epi, meaning, “over” or “upon”) about 95% of the cells in this outermost skin layer are called keratinocytes with most of the remaining cells called Merkel cells, melanocytes (pigment bearing cells) and Langerhans cells. The epidermis itself is composed of a stratified squamous epithelium of at least 4 layers of cells. It is the keratinocytes in the epidermis that secrete keratin proteins and lipids that give skin its mechanical strength. When humans shed dead skin from the surface, called desquamation, it is these keratinocytes that are shed. The epidermis contains no blood vessels so these cells receive nourishment from blood capillaries that extend into the upper layers of the dermis and oxygen diffuses in from the atmosphere. Keratinocytes form several layers that constantly grow outward as the exterior cells die and flake off. It takes roughly five weeks for newly created cells to work their way to the surface. The outermost layer of the epidermis consists of 25 to 30 layers of dead cells.

Layer after layer

The epidermis and the dermis are separated by a thin layer of fibers called the basement membrane that acts like a gatekeeper in that it controls the traffic of cells and molecules between the two skin layers. The dermis primarily consists of connective tissues and helps cushion the body from stress and strain in that it provides tensile strength and elasticity to the skin. This elasticity is due to a variety of collagen fibrils and elastic fibers embedded in the dermis layer. The dermis also serves as a reservoir of biomolecules that are important for some skin repair processes such as seen with cuts and bruises. Furthermore, the dermis contains nerve endings (mechanoreceptors) that provide the sense of touch and heat, hair follicles, various glands like the sweat glands and sebaceous glands as well as blood vessels and lymphatic vessels. These vessels provide nutrients and remove waste products for itself but also the epidermis.

The dermis itself is structurally divided into two areas, the superficial area adjacent to the epidermis called the papillary region and a deeper, thicker area called the reticular region. The papillary region got its name because of the fingerlike projections, called papillae, that extend into the dermis. The papillae

provide a sort of bumpy surface that interdigitates within the epidermis providing connecting strength between the two layers of skin. In fingers, palms, soles of the feet, and toes it is these papillae projecting into the epidermis that forms contours on the skin's surface called epidermal ridges. These ridges, such as those seen with fingerprints, are unique to each individual and are a means of identification.

The reticular area of the dermis lies deeper and is typically much thicker because it is primarily composed of dense irregular connective tissue, collagenous material, elastic and reticular fibers. These protein fibers provide strength and elasticity to skin. Also within the reticular area are hair roots, the sebaceous and sweat glands, nails, and blood vessels. Tatoo ink stays within the dermis and pregnancy stretch marks are also located in the dermis layer.

The hypodermis lies below the dermis and is technically not part of the skin. Another name for hypodermis is subcutaneous tissue. Its main purpose is to attach the skin to the underlying muscle and bone as well as supplying other nerves and blood vessels. The hypodermis is primarily composed of connective tissues and elastin with the main cell types being fibroblasts, macrophages (scavengers of the immune system), and fat cells called adipocytes (the hypodermis contains about 50% of body fat). The hypodermis fat serves as padding and insulation for the body.

Touch

The tiny ridges on our fingertips can aid in improving our grip on slippery objects (like treads on a tire). Fingerprints enhance the perception of texture by increasing vibrations in the skin (via Pacinian corpuscles that act as tiny mechano-receptors) as fingers rub across a textured surface. Texture information plays a major role in ability to identify objects by touch. It's the design of the fingerprint "hardware" that allows such sensitive identification instead of the neural "sorfware" to interpret the signal/stimulus. Merkel cells on our fingertips sense very minor differences in touch which is why humans can readily distinguish a large variety of shapes, sizes, and textures. Pacinian corpuscles are mechano-receptors tuned to detect high-frequency, low-amplitude signals. Found in human palm and fingertips, they are useful for discrimination of rough and smooth textures, a sensitivity seemingly amplified by the ridges of fingerprints.

Skin pigmentation

The variety of human skin color varies from a light pinkish-white hue to a dark brown and is more of a variety that any other mammalian species. This color range was no doubt a natural evolutionary adaptation to regulate the amount of ultraviolet (UV) radiation that penetrates the skin. Skin color variation is due to all the pigments within. Human pigmentation varies considerably within and among populations and is a function of both variation in exposure to UV radiation and the type and quantity of pigments produced in some specialized skin cells.

Mammals develop most of their coloration through a system comprised of two types of cells, referred to as pigment donors, which are melanocytes, and pigment recipients, which are epithelial cells that acquire and hold the pigment (melanin). Through this system of donors and recipients the melanin pigment is placed in precise locations, which can often differ among or within species. In humans, pigment is targeted to the skin epidermis and hair follicles. In other animals the hair coat may receive most of the pigment leaving the underlying skin unpigmented. All of this can be regulated at the genetic level. Specifically, a single gene, called Foxn1, which is a gene essential for the development of epithelial tissues including those with melanin pigment. Altering this single gene can give rise to a total loss of hair, a symptom called alopecia.

There are several different types of pigments in human skin that help determine skin color. What brings out major variations is when these pigments are present at different concentrations and at different places on the body. As mentioned, one of the most common pigments is melanin which is brown in color and is restricted to a narrow band in the epidermis layer. Melanin also has the ability to absorb some of the potentially dangerous UV radiation in sunlight. In addition, melanocytes, the cells that produce melanin, have enzymes that can repair UV-damaged DNA and those lacking these enzymes are prone to high rates of skin cancer such as melanoma, which can be deadly. Melanoid, also brown in color, resembles melanin but is spread throughout the epidermis and not confined to one band. Carotene is a yellow to orange pigment and is primarily present in the dermis layer as well as the superficial fascia. For hemoglobin and oxyhemoglobin, though not pigments per se, they do indeed contribute to the overall color of skin by providing a red tone. For those people with light pigmented skin the color is primarily determined by the bluish-white connective tissue under the dermis layer along with the circulating hemoglobin in the blood vessels of the dermis. Those completely lacking in pigment are called albinos and have an almost milky cream skin color.

It should be noted that there is a correlation between the amount of exposure to UV radiation and the pigmentation of human skin. Those in geographic areas with high UV radiation, near the equator, tend to have more melanin whereas those in geographic areas with less UV radiation exposure, such as those located in higher latitudes, have lighter skin colors. Furthermore, females in the same populations tend to have lighter skin pigmentation than males. During pregnancy females need more calcium (fetal bone growth) and vitamin D (for lactation). Vitamin D, which is synthesized from sunlight, helps in absorbing calcium so females have evolved to have lighter skin colors so their bodies can absorb more calcium.

Depending upon the person's skin color, exposure to the sun's UV radiation can cause neglible to severe changes. Those who have pale, fair, or freckled skin almost always get a skin burn, and never tan, when exposed to the sun's rays for

prolonged periods of time without proper protection. Those with light brown skin may burn but usually tan and those with olive brown skin rarely burn but always tan. Those with darker skin rarely burn.

Oily skin

Within the dermis layer are sebaceous glands that are associated with hair follicles. These glands produce a natural, healthy skin lubricant called sebum and when over-active can cause oily skin. A buildup of sebum results in a heavy and thick texture to the skin that typically looks shiny. However, this is not necessarily a bad thing because oily skin tends not to wrinkle as much as dry skin. The oil layer helps to keep surface skin moisture trapped or locked into the outermost epidermis skin layer. The down side to oily skin is that it is prone to clogging pores resulting in the buildup of dead skin cells on the surface.

Aged skin

Old skin typically is thinner and more easily damaged making the ability to heal itself harder to do. Aged skin also is not as elastic. There are many causes to skin aging, both internal and external. Old skin receives less blood and the skin glands are not as active. Various clinical descriptions have been given to aged skin such as laxity (sagging), rhytids (wrinkles), photoaging (redness), dyspigmentation (brown discoloration), solar elastosis (yellowing), keratoses (abnormal growths), and overall poor texture. Those of you who take cortisol treatments should know that cortisol degrades collagen, a prime component of skin, which accelerates skin aging. Younger skin can heal faster since the cells in the epidermis layer grow faster whereas in older skin, which is thinner, the cells in the epidermis layer grow slower so repairing damaged skin is slower. The cosmetic industry is chok-a-block full of anti-aging formulas, some more useful than others.

Wrinkles

Skin changes with age and over time wrinkes, age spots, and on overall dryness appears. Most of these changes are due to prolonged exposure to sunlight. Cigarette smoking contributes to wrinkles and the wrinkles are proportional to the number of cigarettes and years spent smoking. Most of the commercial products that claim to revitalize aged skin and reduce wrinkles generally do not live up to their claims. Moisturizing skin does help reduce some age effects and some treatments can reduce the appearance of age spots.

Skin bacteria

As scary as it sounds there is an entire ecosystem of microbes that lives on the skin and no amount of cleaning will remove all of them. There are around 1000 different species of bacteria from 19 bacterial phyla that live on human skin. Just on one square inch ($6.5cm^2$) of human skin contains about 50 million individual bacteria, though this does vary greatly depending upon the skin area, and oily skin may contain over 500 million individual bacteria per square inch. Most of these bacteria species come from only 4 different phyla: Actinobacter (about

52%), Firmicutes (24%), Proteobacteria (16%), and Bacteroidetes (6%). In sebaceous glands Propionibacteria and Staphylococci are the main species of bacteria.

In total there are three main ecosystems on skin: moist, dry, and sebaceous (oily). In moist areas Corynebacteria and Staphylococci are the dominant species whereas in dry areas mostly Proteobacteria and Flavobacteriales dominate. The sebaceous areas have the greatest diversity of species of all types. As one skin researcher said, “hairy, moist underarms lie a short distance from smooth dry forearms, but these two niches are likely as ecologically dissimilar as rainforests are to deserts.” Though they all have strange sounding scientific names these microbes are essential for life and are a part of healthy skin and its when their natural balance is altered that disease and excessive microbe growth occurs.

Those who use cosmetics on skin know that some may cause allergic reactions which are irritations of the skin layers and care should be used in using the right cosmetics. Some of the cosmetics are used for exfoliation by removing the top outermost layer of dead skin cells exposing the newer (and presumably healthier) underlying cells. Also, different clothes are required for each season to help with the evaporation of sweat. In all, sunlight, water, and air all play an important role in keeping skin healthy.

Also, when skin is breached or disrupted as in a cut it can lead to invasive bacterial disease. When this does happen many of the cells in the skin layers help to control bacterial growth. Recently, it was shown that the skin’s fat cells (adipocytes) directly participate in focusing an immune response to the invading bacteria, especially, *Staphylococcus aureus*, (the culprit of MRSA infections). Epidermal keratinocytes produce antimicrobial peptides that help to destroy the invading bacteria.

Skin nutrition

To maintain proper skin nutrition several vitamins are essential. Vitamin A, also known as retinoids, helps skin by keeping the formation of keratin in balance, keep sebum production in balance, and helps treat photodamage caused by the sun’s UV radiation. Vitamin D helps in the use of calcium in bone formation in addition to providing skin immune benefits. Vitamin C is an antioxidant that also regulates collagen synthesis and provides some photoprotection. Vitamin E is also an antioxidant that provides protection against harmful UV radiation. When the vitamin levels go below baseline then this does affect skin condition.

Skin permeability

Due to the nature of skin it has low permeability so most foreign substances can not penetrate nor diffuse through normal skin. The skin’s outermost layer, the stratum corneum, does provide an effective barrier to non-organic substances, so such things as toxins do not readily enter the body. However, since the skin is

semi-permeable some substances can enter the body via the skin. This has obvious medical applications so much effort has been put into areas that can enhance delivery of a variety of substances. For example, the transdermal patch is capable of delivering a drug dose (limited by permeability of the skin) with minimal toxicity, very few side effects, and is a painless application.

An entire branch of medicine called, nanomedicine, investigates ways to increase skin permeability for the delivery of substances (for example, anti-cancer treatments) called, nanoparticles, which are typically smaller than 40 nanometers in size. To enhance skin permeability the surface of the skin can be slightly damaged by UV radiation. The UV radiation causes a weakening of the boundary between the stratum corneum and the epidermal layer which increases skin permeability of various particles of different sizes and materials.

Another way to increase skin permeability is by using short pulses of an electric field, sometimes called electroporation. These high voltage pulses are just a few milliseconds long and when applied to the skin allow charged molecules to penetrate which normally would not.

Skin diseases

In total, there are more than 3,000 skin disorders and no doubt many of our favorite screen monsters have a condition or two. Examples of some of the most common skin diseases are acne, basal cell carcinoma (most common form of cancer), eczema (inflamed skin), herpes simplex, hirsutism, hives, impetigo, keloids, melanoma, psoriasis (thick red plaques covered with silvery scales), scabies, shingles, and vitiligo. Many of these result in itchy skin, a rash, perhaps oozing sores, and scaly skin. Some are temporary and others long lasting, some just a nuisance, and others debilitating with much pain. And deadly, like melamona, the most aggressive of skin cancers. Many of these skin diseases are chronic but can be managed by drugs and various treatments. Moles are growths on the skin. Lastly, as a separate discipline is pediatric dermatology since children have a different skin texture than adults.

Synthetic skin

Synthetic skin is an interesting concept and why not? The potential applications are extensive with the two most obvious being burn victims and those needing skin grafts. Interestingly, the concept of artificial skin dates back to at least the 17th Century when water lizard skin was applied to care for certain wounds. Since skin is composed of layers then which layers are needed to satisfy the requirements for synthetic skin? This is a bit of a moving target since it depends upon which layers of skin need replacing which would in turn depend upon the type of synthetic skin used. Synthetic skin is made by primarily culturing epidermal cells called keratinocytes into multiple layers often using artificial scaffolds to build the layers. Ideally these cells would come from a skin biopsy from the same patient.

Plastic surgery

Plastic surgery involves the correction or restoration of form and function. The best known type is known as cosmetic surgery. Those plastic surgery procedures not dealing with cosmetic issues are considered reconstructive surgery such as in the treatment of burns. Some elements of plastic surgery have become trendy. In plastic surgery the primary procedure is the transfer of skin tissue (skin grafting) from one area of the body to another. The types of skin grafts used are called, autografts (taken from the same person), allografts (taken from a donor of the same species), and xenografts (taken from a donor of a different species).

In most procedures, especially those involving the face, good results are expected so there must be careful planning of incisions that mimic and follow natural skin folds and lines. Appropriate wound closures require suture materials specific for that particular tissue and is some cases the wound is held closed by buried sutures.

Reconstructive plastic surgery is used to fix skin areas affected by burns, traumatic injuries (facial bone fractures), congenital abnormalities (like a cleft palate), infections, and disease including cancers. Most of this type of skin surgery is performed to improve function and not essentially appearance. The most common types of reconstructive plastic surgery are scar repair (especially from tumor removal), hand surgery, and breast reduction. Skin flaps as small as 1 to 2 millimeters have been used by plastic surgeons.

Cosmetic surgery is a totally voluntary procedure and its only purpose to improve one's appearance. In the US, the number of cosmetic surgery skin procedures has continued to increase year after year. Breast augmentation ("boob job"), liposuction, nasal surgery ("nose job"), eyelid surgery, fat grafting ("Brazilian butt lift") and abdominoplasty ("tummy tuck") are the most common cosmetic surgery procedures. Even botox treatment is considered cosmetic surgery since the skin is involved. In some cases a laser is used to re-surface the top layer of skin.

Fish and Amphibians

Unlike mammals the skin of fish and most amphibians consists almost entirely of live cells. Very little keratin is in the cells of the outermost layer of fish skin. Fish and amphibian skin is permeable and with some amphibians it may be a major respiratory organ. The dermis of mammals is composed primarily of connective tissues whereas in fish this is replaced by solid and protective bony scales. Reptile scales are small rigid plates made of keratin that grows out of the skin epidermis layer to primarily provide protection.

Reptiles have several types of scales such as cycloid, granular (bumpy), and keeled (have a center ridge like the keel of a boat) and all of these vary in size with larger scales covering the feet, tail, and head areas and smaller scales

covering joints for flexibility. All reptile scales have a dermal papilla under the epidermal layer.

Mammals have sweat and sebaceous glands that help keep skin hydrated. Fish and amphibians do not have these glands but instead have numerous mucus-secreting skin cells that help with insulation and protection. Also, most amphibians also have granular glands in their skin involved in secreting irritating and toxic molecules.

Unlike amphibians the epidermis of birds and reptiles is similar to that of mammals in that a layer of dead keratin-filled cells are at the surface that help reduce water loss. In reptiles the epidermis is not divided into distinct layers as seen with human skin. Birds and reptiles, such as an alligator, have relatively few skin glands.

Fish scales help to identify the species of fish and can vary considerably in size, shape, structure and can range from strong rigid armor-like plates (shrimp) to totally absent (eels). Fish scales are produced by the mesoderm layer of the dermis and most fish are covered with a protective layer of mucus slime. Fish skin serves many functions like maintaining an osmotic balance in a water environment, coloration, sensory receptors, and overall protectioin. In addition, fish skin has many nerve endings that help with tactile, thermal, and pain responses. Some fish even breathe in part through their skin by exchanging oxygen and carbon dioxide between the water and the fish skin surface. Fish are able to show an almost limitless range of colors through pigment cells in their skin that serve as defense, advertisement, and all in between.

The Films

DOCTOR X (1932)
Synthetic skin
Dr. Xavier (Lionel Atwil) is the head of the “Academy of Surgical Research” and bodies keep showing up at the academy. It is believed one of the academy members is the killer so an elaborate device was used to discover the real killer who developed a synthetic skin as a disguise.

While explaining synthetic flesh, Professor Wells comments, “For years I’ve been searching to find the secret of living, manufactured flesh. I went to Africa to get samples of the human flesh that the natives eat…living flesh from humans for my experiments.” As bizzare as it sounds, Wells reasoned that African cannibals must naturally have selected the best flesh, being experts, and he thought that if he used the same flesh area (as you know by now, not all flesh is created equal) then his own research would benefit.

Wells, who has an artificial left hand, is seen removing it and attaching another, which is composed of his synthetic flesh. He then places the synthetic hand in an electrical device and the current makes the hand come alive. For electricity to

affect a hand this way would require the presence of nerves and functional muscles otherwise there would be no effect. Perhaps the electricity stimulates blood vessel formation. Wells then takes the same paste/clay skin material and rubs it all over his face and head and does this while peering over a steaming vat. It should be noted that putty is not skin and synthetic skin grows in layers, not globs, and is certainly not applied like make-up. This type of application of synthetic skin is a non-sterile procedure and makes no sense.

(As a digression, in the film I thought the reference to the caged animals used for experiments by calling them, "mankind's benefactors" to be a wonderful tribute to the countless small animals who have helped advance biomedical science. I have used my fair share of mankind's benefactors in my own research.)

THE RAVEN (1935)
Plastic surgery to repair skin.
In a bit of blackmail, Edmond Bateman (Boris Karloff), a criminal on the run, must succumb to face-changing plastic surgery by Dr. Richard Vollin (Bela Lugosi). Bateman says, "I want you should change my face." Vollin responds, "But, I'm not a plastic surgeon…I can do it. I can change your face. It isn't plastic surgery but there is a way."

Vollin says, "The operation itself is very simple (a 10-min procedure). The nerves. The nerve endings. The 7th cranial nerve has its roots here (touches area at the base of Bateman's lower left neck). From this comes the nerves that control the muscles of the face. If something happens to these nerve ends, it alters your expression. Only I know what to do with these nerve ends and make you look any way I choose." The implication here is what is often seen with stroke victims in which there is some paralysis of facial muscles. Though in extreme the facial changes of Bateman do appear to be the result of a stroke.

If the procedure was only 10 min as Vollin described then why cover 3/4ths of Bateman's head with bandages? Since Bateman appears groggy when waken after the procedure an anaethesia may have been used for the brief surgery. Bateman says after the bandages have been removed, "Its hard to talk. Do I look different?" (by now he has shaved and has a haircut.) With Bateman's 'new look' his right side of his face has many wrinkles, an off-set eye, and a drooping right mouth; all as if he had a mild stroke, a form of peripheral facial palsy, called Bell's palsy. All in all this is an effective way to show that the underlying muscles, nerves, and tissues are important to maintain normal facial skin expressions. The elastic nature of skin covers the underlying support muscles and when the support is sufficiently altered the changes are reflected in surface skin shape. However, it should be noted that the off-set eye has nothing to do with skin.

Bell's palsy is a form of temporary facial paralysis resulting from trauma to the 7th cranial nerve. The 7th cranial nerve controls facial muscle movement and when

the nerve no longer functions then the surrounding facial muscles are no longer controlled so the surrounding affected skin areas sag. The appearance of Bateman is like one with Bell's palsy in that his eye does not close, the side of his mouth droops, and there is a dryness of the eye and mouth. There appears to be no facial movements on the involved side of his face. Facial expressions of smiling and frowning are difficult with Bell's palsy patients. What is interesting and never explored in the film is those with Bell's palsy also have a loss of taste. Recovery from Bell's palsy is possible but it takes time and not all fully recover.

THE FACE OF MARBLE (1946)
Hardening of the skin
In essence, this is a resuscitation plot where the scientists use forms of electricity to revive the dead. As a result the revived appear to have skin of marble. Even a revived dog appears to have such skin (with fur!).

Upon examining their first case a scientist says, "dead about a couple hours" (a body was washed ashore: "an ideal form of death for our purpose", says one of the scientists). Electrodes were placed on the dead body and electricity from a thunderstorm (a "full charge") was used to revive the body. A glass neon light device, like a basket that surrounds the head, provides precise light wavelength bursts. Depending upon the wavelength of the light there can be a variety of effects on the exposed skin (not sure if the wavelength can penetrate clothing), such as enhanced pigment production, metabolic changes, keratinization, and inflammation among others. After the experiment, one scientist says, "Look at that face. It's a face of marble." (what about the rest of his body that was covered with clothes?) The revived man opens his eyes first and looks around. Dr. Randolph (John Carradine) says, "We have conquered death!" The revived man gets off the table and receives another jolt of electricity before dying (again).

Randolph did the same resuscitation experiment on the great dane dog, Brutus. It should be noted the dog has an IV bag delivering fluids during the experiment. Though the dog appears to die, it too was revived and appears 'white' like marble (including fur so not sure if hair is white or underlying skin is also white).

Mrs. Randolph dies by smoke inhalation and is resuscitated by her husband with the same apparatus. After revival she appears to also have a face of marble. Dr. Randolph helps his wife by trying to "relax cranial nerves" but to minimal effect.

For skin to harden and appear like marble would require extensive keratinization of the skin surface and for the skin color to appear white would mean the pigmentation cells were destroyed or silenced with minimal blood flow. The destruction of pigment cells would be the same for the dog fur to also appear white.

MONOLITH MONSTERS (1957)

Hardening of the skin

A meteor from outer space lands in southeast California, near the fictitious town of 'San Angelo'. At the geology lab in town (District Office – Department of the Interior) a fragment of the meteor is examined. Later, water accidentally spills on the fragment thereby causing it to grow. During crystal growth much smoke and apparently heat is given off indicating an exothermic reaction. A geologist (Ben) is found dead and 'stone solid'. The body falls over but apparently does not break (like stone?). An autopsy was done later suggesting the coroner (Dr. Reynolds) was able to cut through the skin to examine the internal organs. Therefore, the skin could not have been that 'stone solid' or otherwise no knife would be able to cut it. From the autopsy, Dr. Reynolds says, "Scleroderma. Extreme hardening of the skin…but his entire body, organs, skin, muscle tissue, everything. He's been welded into a solid mass." Regarding the cause, Reynolds says, "nothing to go on." A reporter sarcastically suggested newspaper headlines, "Local geologist turns to rock" and "Autopsy fails to turn up reason".

[Scleroderma is also known as systemic sclerosis and is a chronic autoimmune disease characterized by a hardening (sclero) of the skin and in severe forms also affects internal organs. A mild case would involve the hands, arms, and face. In some more severe cases a deposition of calcium nodules occurs in the skin also contributing to the hardness, and there may be difficulty in swallowing.]

A local girl, Jenny, picks up a piece of the meteor and brings it home. She leaves the fragment in a tub of water. Later the entire house is destroyed, crystal fragments are everywhere, Jenny's parents are stone cold dead, and Jenny herself is inflicted with progressive skin hardening that starts with her hands and progresses to her entire body. A doctor gives Jenny an injection and the needle has no problem penetrating her skin. Jenny has a "sub-normal body temperature". Jenny is placed in an iron lung to help breathing while a cure is developed. We see her upper body x-ray and the doctor says, "Disease will affect her whole body unless we can slow it down." While looking at the x-ray the doctor says, "You can see how the pectoral muscles become paralyzed. The disease merely followed the disease arteries through the arms into the upper chest cavity." None of this is discernible from that normal x-ray.

[An iron lung, also called a negative pressure ventilator, is a medical ventilator that enables a person to breath normally when muscle control has been lost. Invented in the 17th Century iron lungs came into prominence during the 1940s and 1950s helping those suffering from polio. While in an iron lung pumps increase and decrease the pressure causing the chest to expand and contract to assist in breathing. Modern respiratory techniques have replaced the iron lung.]

Later in the film, a geologist experiments on a meteor crystal fragment and determines the fragment is primarily composed of silicates and states, "Incredible. As if someone tossed all silicates into a single basket." Silicate crystal fragments grow or are "fed" by absorbing all silicon derived molecules not

only from the soil and rock, but also from humans. The crystal fragments grew by absorption of silicon irreguardless of its source.

Silicon is a trace element in humans. As a doctor in the film states, “silicon is what makes the skin flexible.” And take silicon away and the implication is you get someone like Jenny. The sheriff says the “rock robbed entire body of silicon.” For a cure a doctor wants “to synthetically replenish that element in Jenny’s body and arrest its solidifying action.” A doctor makes a cure formula and describes it by saying, “I use a base of silicic acid, uncut, CMC, glucose db, and monochloroacetic acid. Suspend in normal saline solution.” Apparently, only a single injection is needed to affect a cure. Jenny’s skin returned to normal.

[Silicon is the 8th most common element in the universe and mostly found in dusts, sands, planetoids, and planets, mostly as silicon dioxide (silica) or silicates. Over 90% of the earth’s crust is composed of silicate minerals. The element silicon is not to be confused with the compound silicone. Silicon is also an essential element for biology though used in only trace amounts. Some sea sponges and diatoms secrete skeletal structures made of silica. Silicon is needed for synthesis of elastin and collagen, key components of skin, with the highest quantity found in the aorta of the heart.]

Later in the film it was determined at least a 3% salt solution (sodium chloride) was necessary to deactivate the growing silicate crystals. This then begs the question, what about the high level of natural salts (sodium and potassium) in the body and on skin? Wouldn’t these serve as a natural protectant?

THE MAN WHO TURNED TO STONE (1957)
Hardening of the skin
At the LaSalle Detention Home for Girls a group of scientists are using the girls in various experiments to extend life beyond normal limits. The scientists convert the bioelectrical energy of the young girls into life-extending energy for themselves. The scientists have been living for centuries and when their skin begins to harden and turn to stone they need an “energy boost” from another victim in order to prolong their own lives.

One scientist, Dr. Cooper, claimed he has lived for 230 years and if so then how did he extract the life force from previous victims before the invention of new technology like electrical machines? It was stated he needs one victim every 2 years so this would mean about 90 women sacrificed per person and since there are 5 scientists this could mean about 450 women were sacrificed over the many years by the group. In the 1800s, for the copper sulfate solution needed for the water baths, they would have to make the compound and when it became commercially available (100 years later) they could then buy it from a vendor.

At the end the ‘ancient’ scientist’s heart beat became louder most likely due to the extra strain of the heart pumping blood to the capillaries in hardening skin;

the harder the skin then harder pumping is needed to get blood to the hardening skin. Near the end the scientists' skin became whitish indicating loss of blood to the skin surface.

Dr. Rogers reads from Cooper's diary. "Dr. Compte de Saint Germaine, who was experimenting with animal magnetism was on the verge of a momentus discovery. How to prolong life indefinitely. It is well known in medicine that the cells of the body continually reproduce to replace themselves. What is not known is why this process doesn't go on forever [see the "Hayflick limit" comments below on DARKMAN]. It is the answer to this question that we learn from Saint Germaine." Later, Rogers continues to read, "We discovered that it is possible to transfer bioelectrical energy from one individual to another. Naturally, the person who is the donor dies. But the person who is the receiver of the energy get a new lease on life." Continuing, "In the course of time we learned the best source of energy is from women of child bearing age. The donor is placed in an electric conducting bath of copper sulfate solution. We have tried to analyze this current so that it could be synthesized so we wouldn't have to take one life to prolong another." Even more, "Eric…was a casualty of our first experiment. A peculiar side effect of the process is that as we used up our borrowed life energy there are dramatic changes in our bodies. Externally, we develop a petrified sheath, harder than stone. But for those last few hours before we require a transfer we are the same as other people." This petrified sheath would be a scleroderma-like condition in which excessive keratinazion of the skin surface occurs.

Victims (young girls) are placed in a tub of copper sulfate solution mixed in warm water up to their neck line. Electrodes are in the water (electrical current) and the victim wears headgear (pick up brainwaves?). To protect Rogers' love interest, Carol Adams, who is in the tub ready to have her life force transferred, he scatters a box of "sodium salts" (table salt?) in the tub to stop the reaction. The sodium chloride (NaCl) inhibits the copper sulfate reaction. Needless to say, as soon as the current was applied the girl would be electrocuted in the tub.

THE ALLIGATOR PEOPLE (1959)
Human to reptile skin transformation
The overall premise is the alteration of human skin to reptile (gator) skin. The American alligator (*Alligator mississippiensis*) is native to the Southeast US. Since this gator is the least bony of the 23 species of crocodile its skin is softer and has smoother scales than the other types crocodile skin. The gator exoskeleton on the back and sides of the trunk consists of protective dermal and epidermal layers and is in the form of oblong horny scales (armor), arranged in transverse rows, parallel to the body. On the sides of the head and trunk and on the legs these scales are much smaller and irregularly spaced. The first three digits of both the fore and hind feet have horny claws which belong to the epidermal part of the exoskeleton.

The dermal exoskeleton is made up of bony scutes (they act as a shield and are a bony external plate or scale overlaid with horn) under the epidermal scales. These scutes are nearly square in outline and joined together and are in two groups, one lies just back of the head (nuchal area) and the other is along the back (dorsal). Cells in the underlayers of gator skin become flattened and lose their nuclei as they become part of the horny layer. The cells of the uppermost superficial layers form ridges due to the pressure of the stacking cells. These cells eventually fuse together to form the bony plates. Around the jaw region of gators are small, scattered, wart-like elevations. Also skin pits form around the throat and other areas of their bodies suggesting specific skin differentiation. For their peculiar odor gators have musk glands that are derivations of their skin.

In the film, Paul Webster began to change into an alligator people. The skin areas affected first were his hands, face, neck, and upper chest; he also had a deeper, raspier voice. Skin areas that seemed to still mostly resemble human are hair, ears, nose, and lips. His truck and legs are unknown since they were covered with clothes; he had no gator tail. So, mostly we saw just skin restructuring and no bone restructuring. Later, after a massive dose of radiation he has a gator head, teeth, and reptile eyes though still with arms and an intact lower torso. On his back are two parallel rows of ridges. For this transformation his skin began to produce massive amounts of keratin to become bony scutes.

Dr. Sinclair says, “I isolated a protein chemical from the anterior pituitary gland” of a gator that he wants to use to help repair, “horribly mangled accident victims” and to make, “mangled limbs as good as new.” Unfortunately, there are symptoms and after effects from this treatment. Sinclair says, “Symptoms are after effects. There was an additional secretion beside the healing hormone (growth hormone) that I didn’t know about.” This “additional secretion” must have been gator DNA that got integrated into the humans. Joyce says, “Your patients are turning into alligators.” Apparently, excessive radiation exposure activated these gator genes and gator hormones making Paul more of an alligator man. Paul says, “Combining x-ray with gamma radiation from the cobalt 60 might cure me completely.” Well, actually, no.

HIDEOUS SUN DEMON (1959)
Human skin to scaly skin
Ernst Heinrich Philipp August Haeckel (1834-1919) was an eminent German biologist, naturalist, philosopher, physician, professor, and artist. A popular lecturer and supporter of Darwin’s evolution theories, he coined the terms “ontogeny” (the growth of an organism) and “phylogeny” (the interrelatedness of species) and famously dogmatized that “ontogeny recapitulates phylogeny”, meaning that a developing embryo goes through stages resembling or representing successive stages in the evolution of their remote ancestors. This now largely discredited biological hypothesis is dramatically shown in the film with a view of a biology textbook showing how early embryos from very divergent species look remarkably similar during the first few weeks of growth. As higher

organisms of embryos continue to grow they progress through all the early evolutionary stages of lower organisms until they become their own species and this is called, ontogeny recapitulates phylogeny, also known as the biogenic law. The concept here is that a man reverted back to an earlier stage of a developing embryo to become the hideous sun demon (see below).

At the Atomic Research, Inc. facility there is a radiation accident and Dr. Gilbert McKenna (Robert Clarke) was exposed for about 5-6 minutes to a radiation hazard from the sun, "far more deadly than cosmic rays". As someone described, "this guy's been soaked with radiation." After McKenna recovered from the initial shock he showed no signs of residual effects from radiation exposure. And there were no burns and no radiation effects which is what one would get from a mild radiation exposure.

While recovering, McKenna sat in the direct sun exposing his face and chest and after many minutes his skin was transformed. As a nearby woman shrieked, "Your face!" upon seeing him. It appears his face transformed first followed by his chest, arms, and hands. Apparently, his skin below the belt-line did not appear to be affected since they were covered with clothes.

To explain the transformation to reptilian form, a doctor says, "Each individual goes through this evolutionary process (ie., ontogeny recapitulates phylogeny) before he is born. And its not inconceivable that this process could be reversed." A scientist responds with, "you mean a human being could evolve backwards to some prehistoric creature?" To further explain the doctor says, "Biochemists did research on insects to see what effect radiation has on its cells." The doctor further adds, "The radiation from that isotope caused a peculiar and subtle change in the cells of Dr. McKenna's body…his whole appearance has changed into something scaly. Almost lizard like. A catalyst was needed to complete the reaction. Sunlight. He's alright as long as he stays out of the sun." Regarding indoor artificial light the good doctor says, "the radiation from tungsten is quite different from that of sunlight."

As a result of the sun's UV radiation exposure McKenna evolves backwards to the age of reptiles; half-human, half-lizard. His face changes first, his teeth are more pointed, and scales cover his upper body. It should be noted that an emotional outburst from a fight did not cause a transformation suggesting hormones are not directly involved. The second transformation came quicker than the first and explained as, "this is because the skin gets more sensitive as time goes on. It takes much longer to change back." After the fourth transformation McKenna becomes paranoid (his mind was affected) and after falling to his death he does not revert back to human form suggesting the transformation change is permanent.

Photosensitivity of skin is a well documented phenomenon and has to do with the amount of ultraviolet radiation absorbed by the skin cell's DNA. With too much

UV radiation, the DNA is broken up and the cells eventually die. Another possibility is McKenna got a form of shingles, caused by herpes zoster virus and is a painful rash, that changed his skin surface.

HAND OF DEATH (1962)
Blistering and swelling of skin
A paralyzing gas has been invented that as one victim says, “All of a sudden I can’t move, ain’t unconscious, but can’t move or even talk.” As the chief scientist, Alex Marsh, says, “Spray anesthesia. Vaporizing drugs that can be absorbed through the skin. I experimented at one point with a refinement of hydrocyatic acid (no such thing; though there is hydrocyanic acid) and pentathol sodium with various catalysts. I came up with a compound which paralyzed rather than anesthesized.” A colleague responds with, “A nerve gas?” Marsh says, “Exactly…a paralyzis nerve gas. I have a way to make it an even more fantastic weapon…a hypnotic drug such as scopalamine, in heavy strength, can be dispersed through the paralysis gas. Then you have a nerve gas that first paralyzes the enemy army. Even the entire population. And upon recovery from the paralysis the victims stay in a hypnotic state for days, maybe weeks. Subject to all orders and suggestions. So you eliminate all resistance…could banish all nuclear warfare.” At face value this is chemical warfare.

In the lab Marsh knocks over a flask containing the nerve gas solution and got a small amount on his hands. There may also have been some inhaled gas vapors. He immediately poured a solvent over his hands in an attempt to wash away the solution. Soon after he passes out and upon recovering some time later he is very groggy. As Marsh comments about his experience to a lab assistant, “I think it (gas exposure accident) would have been deadly but apparently I have a built in protection now…Well, I probably absorbed so much of it in my body in small doses over the past several weeks I have a certain immunity.” As a result of the exposure Marsh has a “tan” suggesting his skin pigment cells are overproducing melanin.

Regarding his condition, Marsh says, “I’m carrying it on my skin. Its in my whole body and its almost instantly lethal.” Anyone who comes in physical contact with Marsh gets an instant puffy, swolled, and cracked face with enlarged, also swollen hands. Understanding the problem, Marsh says to a colleague, “You got to find an antidote before this immunity wears off…I’m hot all over. My head’s bursting.” Being hot all over suggests his epidermis layer is producing much keratin which releases heat in the process. For skin to blister woud require excessive fluid buildup from the dermal layer meaning the tight junctions holding skin cells together would be disrupted and therefore become sieve-like in that they are leaky and allow fluid buildup.

As a result of being touched the victims skin turns black, which “may be a form of cyanosis. A diminished oxidation in the blood.” On Marsh, his skin has expanded, inflamed, blistered, swollen, and cracked and his overall skin color is

of a dark brown to black indicating excessive pigmentation. His neck is very swollen almost like a goiter patient with a swollen thyroid. Lips and eyelids were also swollen, though ears, scalp, ankles and feet were not (shoes still fit). While swollen Marsh drives a car, wears a hat, and manages to put on an overcoat over his bloated body. As stated, “face and hands swolled twice normal size. Skin is blackened and cracked like charcoal.” At the end, Marsh was shot and fell into the ocean; salt water did not revert his skin condition.

ATOM AGE VAMPIRE (1963)
Facial plastic surgery and skin regeneration.
Professor Levins develops a compound, “derma 28” (itself a derivative of derma 25), which regenerates and rebuilds abnormal cells and tissues. The motivation behind this is Levins’ desire to help those suffering from radiation-induced burns and tissue damage. As Levins says, “The destructive and degenerative effect of atomic explosions have driven scientists more than ever before into research involving methods and processes of regeneration, rebuilding abnormal or totally destroyed (skin) cells.”

After using all his supply Levins kills young women to get the “glands which produced derma 28.” Most likely, these glands are the pituitary, hypothalamus, and possibly the adrenals. (In this film, a young female is interpreted as post-puberty and pre-menopausal where “glands” would be more potent.) Nevertheless, a key ingredient would be estrogen with the supposition that female hormones would be better at returning scarred tissue to normal tissue in females. All in all, the radiation scarred cells and tissues would be destroyed and replaced with new cells and tissues brought about by the hormone treatment and this would take some time to occur. In essence Levins was using plastic surgery techniques combined with hormonal treatments to return scarred skin tissues back to normal.

INCREDIBLE MELTING MAN (1977)
Disruption of skin layers
Astronaut, Steve, was exposed to cosmic radiation in space and while his fellow asronauts all died, he survived because, “he was stronger than the others which is why he lasted so long.” Steve was in a hospital after landing and bandaged up and strapped to a bed with IV fluids (“get units of whole blood”). When Steve awoke he ripped off the bed straps and removed his head bandages revealing a pitted, scared, and oozing face. His hands were also pitted, scarred, and oozing. After analysis Steve was found to be radioactive and his ooze was also radioactive. To ooze radioactivity would mean you ingested radioactivity, something that Steve obviously did not do. Being exposed to radiation is quite different from ingesting radioactivity. You cannot “contract radioactivity” from someone who has been exposed to radioactivity.

When skin integrity is compromised (bruise, cut) then the underlying fluids can leak out and the amount of leaking depends upon the depth of the ruptured skin.

Throughout the film Steve has constant fluid loss, body part loss, and oozing skin and pores so his skin must have failed first followed by excessive fluid loss. His bare feet left radioactive ooze prints when he walked. In general, body fluids consist of blood, plasma, lymph, dissolved cells, and tissues. Though Steve was loosing so much fluids his clothes were surprisingly not that soaked, just stained. Also, Steve lost all of his hair.

As a result of all this melting one wonders if his internal organs work or how long did they work? Apparently, everything hemorraged in Steve like someone with hemorragic fever. To replace all the fluid loss does Steve eat and drink? During the film Steve gets progressively worse though not a steady melt but one puctuated by episodes of more melting than others. Overall, however the melting did increase. He even melts at night so sunlight is not related nor does cold night air stop the melting. With such extreme fluid loss Steve should have died much sooner. Near the end, Steve's left arm is cut off, he takes two shotgun blasts to the chest, and multiple bullets but keeps moving. He eventually completely melts into a pile of ooze and flesh.

HUMANOIDS FROM THE DEEP (1980)
Transformation of fish skin to humanoid skin
In an attempt to increase salmon production these fish were given a DNA growth promoting gene called, DNA5. In the film, DNA5 is a positive growth gene that was given to salmon in an attempt to increase their growth rate. From a storm, 3000 DNA5-treated salmon escaped into the ocean. As one scientist says, "It's my theory that feeding on the DNA5-treated salmon may have brought about evolution in more primitive fish, like coelecanth." Simply stated, when coelecanth fish fed on DNA5-treated salmon this "evolved them to become humanoid." The coelecanth started out as a fish but became humanoid in its final stages.

In describing the humanoids, an icthyologist says, "This species has only just appeared. There has to be a reason why a humanoid creature evolved so quickly. Note the gills on the side of the head…their natural habitat is clearly the water so I think they are in the process of becoming amphibious. And look at the size of the cranium. They have tremendous brain capacity…webbed hands." The humanoids have slimy, mucous skin with long strands of hair (seaweed?) and appendages like arms and legs which is quite a leap from coelecanth fish.

Coelecanth are cartilagenous fish and to evolve to a humanoid and be able to walk on land and use arms and hands the cartilage would have to be converted to harder bone to withstand the stress of walking on land. Furthermore, the coelecanth are salt water fish from the ocean and would be difficult for them to migrate to fresh water or even brine water. Coelecanth fish would have to loose their scales and their outer dermal layer would have to begin to produce keratin to provide protection of the outermost layer of skin.

DARKMAN (1990)

Synthetic skin

Dr. Peyton Westlake was doing research on synthetic skin. As a result of an explosion, Westlake was burnt over 40% of his body and subsequently taken to a burn unit and operated on. After he escaped Westlake established another lab to continue his research into synthetic skin, only this time with the purpose of making his own artificial skin to replace his burnt skin.

In his research, Westlake was able to make “synthetic skin” that routinely decomposes at 99 min. When observed under a microscope the individual cells were shown to disrupt at the 99 min mark and literally burst suggesting some sort of time limit for growth. In biology such a limit for growth is called the Hayflick limit.

The “Hayflick limit”, named after its discoverer, Leonard Hayflick (1928 -), is known in biology as the number of times a normal cell, such as a fibroblast or an epithelial cell, can divide until cell division stops which is typically no more than about 55 cell divisions. What this means in simple terms is individual normal cells have a limit on their growth and after a certain time will not grow further and die. Normal cells can not live forever. For normal cells to exceed their Hayflick limit they will need some sort of genetic modification, such as what is seen with cancer cells in that they lost their ability to die. Aged skin has cells that are near their Hayflick limit are not as robust as younger cells. As you alert readers now know not all skin cells are alike so even within the Hayflick limit parameters there are many variations of cells in skin, some with early doublings and some with late doublings.

The synthetic skin made by Dr. Westlake, his “liquid skin”, destabilizes after 99 minutes, sort of like a Hayflick limit, though one based on time and not biology cell doublings. The 3-D printing machine in the film (note: 25 years ago!) is not yet a reality though research is clearly heading in that direction. One major hurdle to overcome is lack of sterility in such procedures and machines. Using his machine it took Westlake 571 hours (3.4 weeks) to make a new face, a long time to wait but may actually be close to real culture time necessary to grow that many cells.

In one scene we get a point-of-view shot down a microscope at Westlake’s artificial skin cells and the individual cells shown appear to be oblong, rounded, single-celled protozoans (unciliated paramecia?). Typically, skin cells are tightly attached together, like a cobblestone street, and not as individual cells as shown here. Getting these protozoa cells to burst is an easy trick achieved by simply changing the osmolarity of the fluid (add more sodium ions).

Once the liquid skin is applied to Westlake’s face the cells would have to be sufficiently vascularized with blood vessels to receive nutrients but for only a 99 minute survival time blood vessels would not be necessary. Furthermore, the

numerous facial muscles would have to be adequately connected to the skin to display proper expressions.

Summary

These 12 films span 58 years of cinema skin history. And now you know that skin has such plasticity that it can be changed and altered in many ways and forms. Skin can be artificial, can harden, can be made youthful, can blister, become scaly, and can be altered by plastic surgery. Also, skin can be transformed to other species like reptiles and fish. Though much of our knowledge about skin has dramatically increased over these many years the way in which our cinema skin is portrayed from 1932 to 1990 is mostly unchanged. In other words, its the same ol' skin.

Thanks for reading. Its back to the lab for me. Stay healthy and eat right.