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COSMETIC APPLICATIONS OF STEM CELLS

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the beauty of science

NEW AGE-DEFYING CONCEPTS AND INGREDIENTS ARE constantly integrated into anti-aging cosmetic products. Stem cells are among the most recent anti-aging technologies investigated and developed by the cosmetics industry. This technology shows promise for rejuvenation of the skin.

Stem cells

Stem cells (SC) are undifferentiated cells characterized by self-renewal (they multiply to produce new SC) and differentiation (upon exposure to tissue-specific biochemical signals, they turn into specialized cells). They play a key role in tissue development and regeneration, and represent an ideal model for understanding tissue proliferation and differentiation. There are two major categories of SC: embryonic and adult.

Embryonic stem cells

Embryonic stem cells (ESC) have the extraordinary potential to form all tissues of the body. They can be found in early human embryos (aged up to five days old) and are also present in the umbilical cord blood collected at birth.

ESC are undifferentiated cells characterized by their combined capacity for self-renewal and differentiation. They can multiply to produce new identical SC and have a potentially unlimited proliferation capacity (figure 1). Furthermore, upon exposure to tissue-specific biochemical signals, ESC create specialized cells that may develop into different tissues.

Adult stem cells

Adult stem cells (ASC) have been found in most tissues and organs, including the skin of fetuses, children and adults. They contribute to tissue homeostasis and ensure tissue renewal.

ASC have a similar ability to proliferate as ESC, but they are already "pre-determined," which means they are engaged in a certain direction for differentiation. Their potential is thus more limited. For example, ASC cannot reproduce a whole organism. ASC are however involved in tissue renewal, regeneration and repair. The main role of ASC is indeed to regenerate tissue. In order for the human body to remain stable at a macroscopic level, SC are perpetually renewing it microscopically.

ASC are not randomly distributed but are concentrated in tiny regions called "niches." Each "niche" is composed of SC and differentiated cell types that secrete and organize a rich milieu of extracellular matrix and other factors that allow SC to conserve their properties. Inside the "niche," SC are often quiescent, but they interact constantly with their environment. For example, environmental changes might actively signal to the "niche" to mobilize the SC in response to injury. ➔

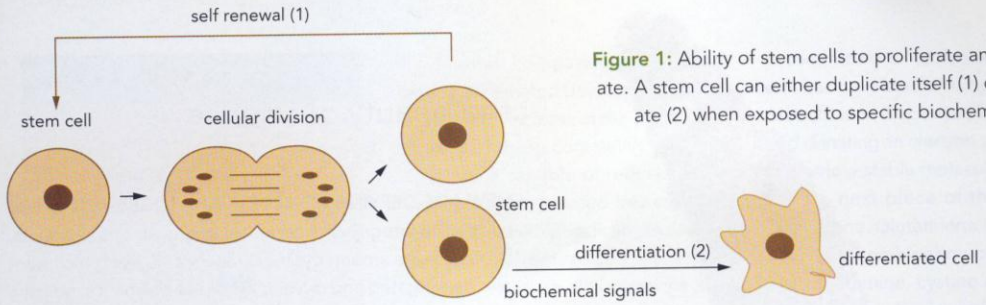

Figure 1: Ability of stem cells to proliferate and differentiate. A stem cell can either duplicate itself (1) or differentiate (2) when exposed to specific biochemical signals.

Skin stem cells

In the skin, "niches" are found in hair follicles that maintain skin stem cells (SSC) in a non-differentiated state (figure 2). The epidermis SC are essentially located in the erector muscle of hairs. SSC may migrate either toward the surface of the skin to replenish the epidermis or toward the base of the hair follicle to give rise to its constituents. SSC also continuously renew the skin.

Cellular therapy

Unlike conventional therapeutic methods based on the use of molecular chemical compounds (antioxidants) or physical approaches (laser), cellular therapy is based on the use of living cells. Cellular therapy is being considered in the treatment of diseases and conditions such as cancer, neurodegenerative diseases (Parkinson's and Alzheimer's disease), and tissue and organ lesions such as heart infarction or cirrhosis and aging.

Use for the skin

The cellular therapeutic approach is still in clinical trials and in early stages of development.

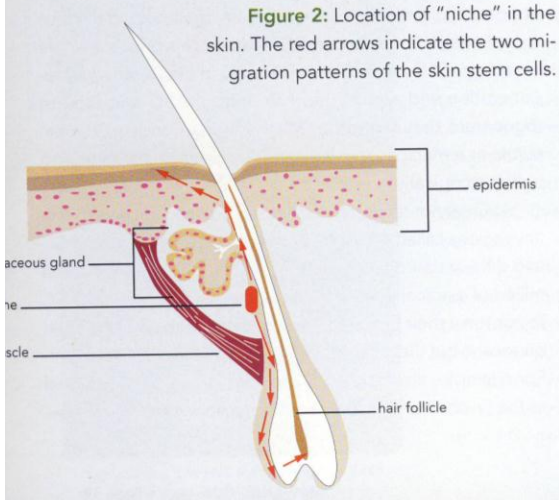

Figure 2: Location of "niche" in the skin. The red arrows indicate the two migration patterns of the skin stem cells.

Burns: The major skin condition SC are currently used to address is severe burns. Fragments of healthy skin may be taken from patients' skin unaffected from burns and cultured in vitro. Once amplified, the cells derived from the healthy tissue will recreate an epidermal tissue, which should be larger than the burned surface so that it can be easily grafted on the designated areas. Preliminary data has been published showing convincing results that include healing phenomena and disappearance of pain.

Esthetic medicine: Several centers of esthetic medicine offer an innovative skin rejuvenation treatment that uses the patient's own cells, multiplied millions of times. A tiny fragment of skin is removed from behind the ear, an area of the skin that has been minimally exposed to ultraviolet light. This fragment, containing fibroblasts (namely cells that produce collagen), hyaluronic acid and elastin will multiply. The cells are then injected into areas of facial skin that show significant signs of aging. The result is an improvement of skin quality and elasticity, and a decrease of fine lines.

Another highly regarded technique uses a similar principle: Plasma Rich in Platelets (PRP). PRP is a platelet concentrate derived from one's own blood, which is injected into the dermis to stimulate the subcutaneous tissue and restore the skin's homogeneity. This is not strictly speaking stem cell technology, but the concept involves using our own cells for rejuvenation.

Stem cells in cosmetology

SC also represent a very interesting tool for exploring aging theories. However, the link between SC senescence and skin aging is not yet clear. SC gradually lose their potential with aging, not because their numbers decrease, but because their activities change. SC interact physically and biologically with the "niche," but in time, the interactions' efficacy may decrease and molecular events may result in alterations in key signaling components controlling SC self-renewal and regenerative properties. SC may also lose their ability to fully express their regenerative power.

The cosmetic industry is also interested in actives that can maintain the regenerative capacities of SSC and restore the quality of the "niche." The objective is to select actives that

continues

sampling of sterilized tissues

callus induction in solid culture

new cell line

Figure 3: Process of obtaining stem cells from the meristem of a plant: *Buddleja davidii*. Only a tiny amount of plant tissue is required to obtain stem cell growth (Source: IRB, Italy).

preserve the "niche" in optimal conditions and thereby ensure that SC function at their best and are protected from aging. Molecular factors from plant stem cells (PSC) have been shown to have a positive effect on the "niche" located in the skin.

Plant stem cells

Plants are an extremely interesting source of SC. Similar to human skin, plants contain SC that are located at their apical and root meristem. The meristems are composed of totipotent SC capable of generating an entire organism. They are found in those regions of the plant where growth takes place. There are nearly inexhaustible reservoirs of undifferentiated cells capable of self-sustaining and of providing precursors for differentiated cells.

It is therefore possible, from only small fragments of a plant's meristem, to create multiple copies of the same plant, as well as to produce plant stem cells extract (PSCE) under sterile and standardized conditions (figure 3).

PSCE, like those obtained by IRB (Italy), contain selected factors that can restore the quality of the "niche." PSCE is currently being considered for cosmetic uses; indeed, while the exact mechanisms of action remain unknown, it appears these extracts may have a positive effect on human SC. Clinical studies have already demonstrated PSCE's anti-wrinkle effects (see PSCE clinical trials sidebar, data and study provided by IRB).

PSCE likely contains natural growth factors that should prove of utmost interest in future cosmetic developments, an interest that is confirmed by preliminary clinical results from various sources.

Continuing research

While stem cell technology for skin rejuvenation is still in its infancy and requires further clinical study, initial research suggests that there is significant potential. In the skin, stem cells are essentially used for reconstitution in the case of severe burns. The cosmetics industry is currently focusing its attention on plant stem cells. Indeed, it appears that plants, which have been hailed in recent years for their rejuvenating properties because of powerful antioxidants, have more to teach us about how to delay and prevent aging mechanisms.

Lasers and stem cells

Clinical experience indicates that a positive side effect of laser hair removal is an improvement in skin quality. Laser hair removal targets the hair follicle bulb SC and thus prevents hair re-growth. The link between the alteration of hair follicle bulb SC and the improvement of skin quality has not yet been explored. However, it has been established that lasers modulate cell migration and proliferation in the skin, and help stimulate the skin's healing and renewal. ■

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