Mr. Gunstenson
Health Science 20

Tattoos

It seems like everyone has a tattoo these days. Once sported only by sailors, outlaws, and biker gangs, tattoos are now popular body decorations for many people. And it's not just anchors, skulls, and battleships anymore — from school emblems to Celtic designs to personalized symbols, people have found many ways to express themselves with their tattoos.

Maybe you've thought about getting one. But before you head to the nearest tattoo shop and roll up your sleeve, there are a few things you need to know.

So What Exactly Is a Tattoo?

A tattoo is a puncture wound, made deep in your skin, that's filled with ink. It's made by penetrating your skin with a needle and injecting ink into the area, usually creating some sort of design. What makes tattoos so long-lasting is they're so deep — the ink isn't injected into the **epidermis** (the top layer of skin that you continue to produce and shed throughout your lifetime). Instead, the ink is injected into the **dermis**, which is the second, deeper layer of skin. Dermis cells are very stable, so the tattoo is practically permanent.

Tattoos used to be done manually — that is, the tattoo artist would puncture the skin with a needle and inject the ink by hand. Though this process is still used in some parts of the world, most tattoo shops use a tattoo machine these days. A tattoo machine is a handheld electric instrument that uses a tube and needle system. On one end is a sterilized needle, which is attached to tubes that contain ink. A foot switch is used to turn on the machine, which moves the needle in and out while driving the ink about 1/16 inch or less (about 1 millimeter) into your skin.

Most tattoo artists know how deep to drive the needle into your skin, but not going deep enough will produce a ragged tattoo, and going too deep can cause bleeding and intense pain. Getting a tattoo can take about 15 minutes to several hours, depending on the size and design chosen.

Tattoo Ink Placement

The tattooing process causes damage to the epidermis, epidermal-dermal junction, and the papillary layer (topmost layer) of the dermis. These layers appear homogenized (or in other words, like mush) right after the tattooing process. The ink itself is initially dispersed as fine granules in the upper dermis, but aggregate into more concentrated areas at 7-13 days.

Like any injury, the initial response is to stop bleeding, followed by tissue swelling, and the migration of non-resident immune cells into the area. The "automatic response" immune cells are mostly neutrophils, and macrophages later on. They are phagocytic cells that "swallow" debris to clean up the area and then leave via the lymphatics. This is the extent of an immune response unless an allergic reaction occurs or an infection sets in. The tissue is then repaired and/or regenerated by fibroblasts. Initially the tissue formed is known as granulation tissue (think fresh scar, pinkish and soft), which later matures into fibrous tissue (think old scar).

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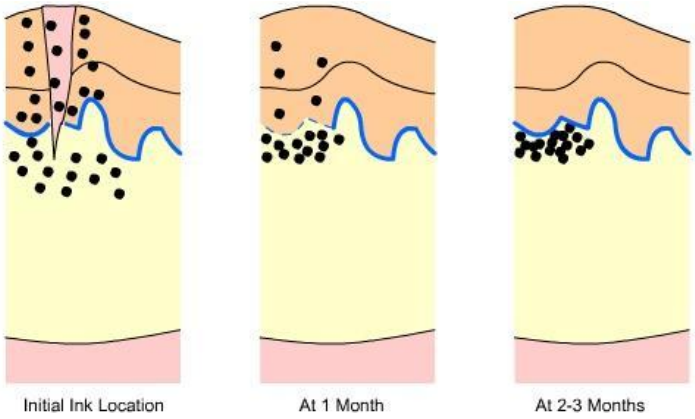
Stages of Ink Dispersal

Initially ink is taken up by keratinocytes, and phagocytic cells (including fibroblasts, macrophages and mast cells).

At **one month** the basement membrane of the epidermis (epidermal-dermal junction) is reforming and the basal cells contain ink. In the dermis, ink containing phagocytic cells are concentrated along the epidermal-dermal junction below a layer of granulation tissue that is surrounded by collagen. Ink is still being eliminated through the epidermis with ink present in keratinocytes, macrophages and fibroblasts.



At **two to three months** the basement membrane of the epidermis is fully reformed, preventing any further loss of ink through the epidermis. Ink is now present in dermal fibroblasts. Most of these ink-containing fibroblasts are located beneath a layer of fibrous tissue, which has replaced the granulation tissue. A network of connective tissue surrounds and effectively traps these fibroblasts. It is assumed that *these fibroblasts are the cells that give tattoos their lifespan*.

Then why does the tattoo fade over time?

It is debated whether all the ink particles are in fibroblasts, or if some remain as extracellular aggregations of ink. Also, the lifespan of the ink containing fibroblasts is not known. Presumably, ink particles are moved into the deeper dermis over time due to the action of mobile phagocytic cells (think immune cells), causing the tattoo to look bluish, faded and blurry. Examination of older tattoos (e.g. 40 years) show that the ink is in the deep dermis, and also found in local lymph nodes. Since some types of phagocytic immune cells migrate to lymph nodes to "present their goods", the discovery of ink in lymph nodes is consistent with the theory of phagocytic cells being the cause of ink movement.

What about the sun?

Sun exposure equals sun damage, whether you realize it or not. Langerhans cells, a type of dendritic cell, are present throughout the epidermis, but mostly located in the stratum spinosum. During sun exposure, many Langerhans cells will undergo apoptosis (a type of cell death where the cell breaks apart into many small fragments) while others migrate into the dermis and a minor inflammatory reaction occurs. The inflammatory reaction is not restricted to the epidermis, but also involves the dermis. Such a reaction causes the recruitment of more phagocytic immune cells to the area.

With the presence of larger than normal amounts of migrating phagocytic cells, the chances of ink movement increases, thus accelerating the fading of the tattoo.

Questions:

1. What makes the tattoo permanent? Which skin layer does the tattoo affect? Cite evidence.
2. Which skin layers are damaged during the tattoo ink placement? Cite evidence.
3. Which cells initially take up the ink?
4. Why do tattoos fade over time? Cite evidence.
5. What are Langerhans cells?
6. What effect does the sun have on tattoos? Cite evidence.