【Grant-in-Aid for Scientific Research (S)】

Skin Iontronic Biomedical Engineering

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Project Information	Project Number : 22H04956 Project Period (FY) : 2022-2026 Keywords : Skin Barrier, Skin Inflammation, Microneedle, Self-Medication

Purpose and Background of the Research

●Outline of the Research

About 7 years ago, PI was shocked to learn that "skin" is electrical (ionic) like brain and heart; then he has started research to develop electrical diagnosis and treatment techniques for skin. The skin is the interface between the artificial device and the living body, and the development of iontronics technology that mediates the physical difference (hard/dry ⇔ soft/wet) and the mechanism difference (electron-driven ⇔ ion/molecule-driven) is necessary. In this research, we will make full use of unique technologies that enable multi-transformation in the skin to clarify the mechanisms of skin functions and realize novel skin patches.

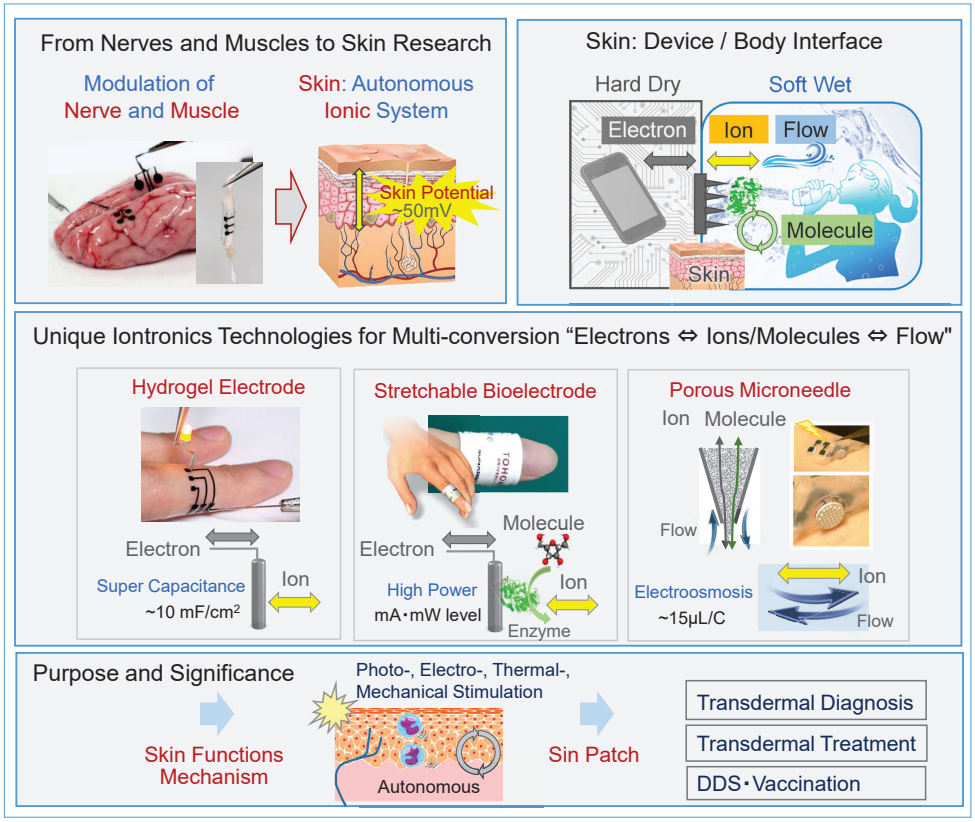

Figure 1. Research overview: background, unique iontronic technologies, purpose and significance.

●Exploring skin functions with pinpoint access

The PI created a microneedle with a porous material and coated its side surface to realize a "microneedle with an open tip" with an opening of 0.002 mm at the tip. By utilizing this, it is expected that pinpoint electrical stimulation and injection of molecules (pruritic molecules, allergens, etc.) to the surface layer of the skin (epidermis) will become possible. In addition, open-ended microneedles are also effective in tracking skin responses to these pinpoint stimuli by analyzing changes in epidermal potential and intradermal molecular species. This microneedle, which enables pinpoint access into the skin, is the core technology that supports the experimental plan of this research.

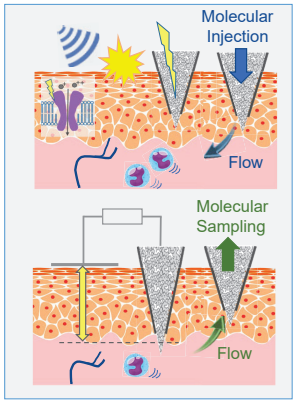

Figure 2. Intradermal Pinpoint Access

Expected Research Achievements

●From exploration of skin ionics to device development

In the first half of the research, we will explore the barrier function of the skin and the mechanisms of inflammation, pain, and itching, leading to the development of new treatment methods and self-care devices (Fig. 3 ① and ②). In the second half of the research, we will also explore the effectiveness of "local" stimulation of the skin against systemic dermatitis such as atopy (Fig. 3③). On the other hand, we will also promote the development of devices for transdermal medications and simple vaccines (Fig. 3 ④).

Figure 3. Research goal: Exploring skin functions with iontronics technology to create novel patch devices.

Homepage Address, etc.	http://www.biomems.mech.tohoku.ac.jp/index_e.html