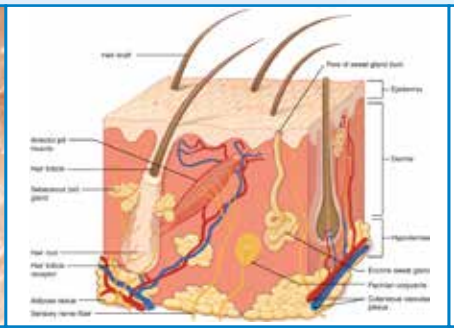
Measurement of Skin Surface pH

Human skin is covered with an acid mantle making it slightly acidic – pH 4.8 to 6.0. The apparent pH value of skin can be measured by applying 1 or 2 drops of DI water or physiological saline and placing a 6261-10C flat glass pH electrode or 0040-10D ISFET pH electrode on the moistened surface. The results may vary for test sites within an individual and between individuals.



Introduction

The skin is the outer covering of the body which serves primarily as protection against pathogens and excessive water loss. The other functions of skin include insulation, temperature regulation, sensation, synthesis of vitamin D, and the protection of vitamin B folates. The skin is composed of three primary layers: the epidermis (outermost), the dermis, and the hypodermis (innermost). The epidermis consists of five layers and the outermost layer is the stratum corneum. On top of the stratum corneum is a very fine, slightly acidic film called acid mantle that acts as barrier to bacteria, viruses, and other potential contaminants that might penetrate the skin.[1] The normal values of pH in intact skin range from 4.8 to 6.0 due to presence of the acid mantle, while the interstitial fluid is characterized by neutral values.[2]

The skin hydrogen potential (pH) is a measure of the hydrogen ion concentration [H^+] in the watery solution present on the surface. This solution is obtained by adding water to the skin surface, which is a hydrophobic layer comprising of lipids. Some of the lipids (the free fatty acid) are amphiphilic. These amphiphilic free fatty acids release their H^+ ions into the added water. The pH is therefore the measurement of their dissociation within the water applied on the skin surface.[3] Since the skin is not an aqueous solution, the measured skin surface pH values are referred to as apparent pH values due to the extraction of water-soluble components of the stratum corneum into the liquid interface between the skin and the pH measuring system.[4]

The skin surface pH can provide an indication of the skin condition and health. In the past, measurement of skin surface pH has been used to assess the barrier properties of the stratum corneum and also to evaluate the relationship between changes in superficial skin microflora and the development of skin irritation. Researchers have noted that a relationship exists between the acidity of the skin surface and its antimicrobial activity. Currently, skin pH measurements are used in assessing the effects of various materials such as acid or alkaline products and environmental factors on the skin surface and in assessing the state of acute or chronic cutaneous diseases.[2]

Flat pH electrodes, also called flat bottom pH electrodes, flat tip pH electrodes, and flat surface pH electrodes, were developed for measuring pH of surface skin. The use of flat pH electrode connected to a pH meter provides not only excellent contact with the skin but also measurement accuracy within ± 0.1 pH. This measurement is non-invasive and produces only small electric current causing no skin damage. Both the sensing membrane and reference junction of a flat pH electrode are constructed on the flat surface tip of the electrode body. This tip configuration is perfect for measuring pH of single drop or small volume of liquid samples as well as moist surfaces of soft solid or semi-solid samples such as meat, paper, skin, cloth, cheese, leaves, leather, bread dough, and culture media.

HORIBA offers two types of flat pH electrodes which are based on two different electrode technologies, the 6261-10C combination flat glass pH electrode and 0040-10D ion sensitive field effect transistor (ISFET) pH electrode. The pH sensitive part of the former is a glass membrane based on pH glass electrode technology while that of the latter is a miniature semiconductor-based sensor based on pH transistor technology. The 6261-10C is a refillable combination pH electrode with glass-body that is resistant to chemical attack and sleeve junction that prevents clogging because of its relatively high flowrate compared to conventional ceramic junction. The 0040-10D is designed with ISFET chip and non-glass body, which make it rugged, unbreakable, low maintenance, and waterproof. The advantages of 0040-10D over 6261-10C are as follows:

Features of 0040-10D ISFET pH electrode:

- The sensor is replaceable, easy to clean with soft toothbrush, and can be stored dry.
- The robust epoxy body is ideal for applications and environments where glass material is unacceptable.
- It is integrated with temperature sensor for automatic temperature compensation (ATC) and accurate pH reading.
- It has improved electrostatic protection circuit for reduction of static electricity effect.
- It gives fast response and reduces acidic or alkaline errors in extreme pH conditions.
- It shuts off automatically when not in use.

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Method

Meter Set-up and Calibration

Since pH is temperature-dependent, use a pH meter with ATC capability. If 6261-10C pH electrode is used, measure the temperature of pH buffers using a calibrated thermometer and enter the value into the pH meter. This will allow the pH meter to compensate the temperature effect in the calibration.

1. Prepare the pH electrode according to the instruction manual.
2. Set the pH buffer group (e.g. USA or NIST) and desired resolution (e.g. 0.1 pH) in the pH meter and connect the pH electrode.
3. Select at least two pH buffers (usually pH 4.01 and 7.00 buffers) that bracket the expected skin pH. Pour small amount of fresh pH buffers in beakers for calibration.
4. Rinse the tip of pH electrode with distilled or deionized water and blot dry with soft tissue.
5. Calibrate the pH electrode / meter system with pH buffers according to the manufacturer's instructions.

After calibration, slope should be within 95 – 105%. If slope is not within this range, change the pH buffers and clean, drain / refill (only applicable for 6261-10C), and condition the pH electrode according to the instruction manual.

Sample Preparation And Measurement

This method is based on the European Group on Efficacy Measurement of Cosmetics and Other Topical Products (EEMCO) guidance for the in vivo assessment of skin surface pH.[4]

During 24 hours before the measurement, sweating and washing the test site should be avoided. Practical considerations are as follows:

- Keep the room temperature under 23°C (e.g. 20 – 22°C) and the relative humidity between 40 and 60% to to minimize sweat production.
- Let the volunteers acclimatized to the measuring environment for at least 20 mins before measurements are performed.
- Avoid cleaning, even with pure water, as it can greatly affect pH measurements.
- Allow minimum period of time to elapse between the personal hygiene procedures of the volunteers and the measurements. For tap water, a period of 2 - 3 hours should be enough. After the use of synthetic cleansers and alkaline soaps, periods of 5 and 10 - 24 hours are recommended, respectively.
- Measurements should be made 12 hours after application of creams.[2]
- Remove cosmetic residues and excessive sebum on the skin by dry wiping.
- Refer to the instruction manual for the proper preparation, maintenance, cleaning, and storage of the pH electrode.
- To obtain accurate results, calibration and measurement should be carried out at the same temperature.

To measure pH on skin surface, perform the following:

1. Moisten the skin surface or pH electrode[3] by applying one or two drops of distilled / deionized water or physiological saline.
   - For comparative measurements, the volume of water used should be standardized (e.g. 20 µl) as the result of pH measurements could be affected by a surplus of water on the electrode.
2. Place the flat pH electrode on the moist skin surface with a slight pressure to measure pH. Make sure that the tip touches the skin surface and no gap between them.
   - Avoid excessive pressure on the electrode because this could influence the extraction of material from epidermis' stratum corneum and may exclude water between the skin and the pH electrode membrane.
3. Record the pH and temperature displayed on the meter once stable.
4. After measurement, rinse the tip of pH electrode with distilled or deionized water and blot dry with soft tissue.

The pH values of surface skin may vary for each test site within an individual and between one individual to another as a result of a number of factors. As such, report results of skin surface pH measurements as difference or percent change in pH values (rather than absolute values) using a measure of central tendency and variability (i.e., arithmetic mean and standard deviation).[5]

Model	 6261-10C	 0040-10D
Description	Combination Flat glass pH Electrode	Ion Sensitive Field Effect Transistor (ISFET) pH Electrode
pH Range	0 – 12	0 – 14
Temperature Range (°C)	0 – 50	0 – 60
Reference Junction	Sleeve	Porous sintered polyethylene
Reference Electrode	Ag/AgCl	Ag/AgCl
Temperature Sensor	—	Built-in
Replacement Sensor	—	0141
Material	Glass	Epoxy
Dimensions (mm)	150 x 12	190 x 10
Cable length	1m	1m
Connector(s)	BNC	BNC & phono jack
Fill Solution	3.33M KCl	—
Power	—	CR2032 x 2
Part No.	3014081807	3200367925
 Scan the QR code for more information		

References And Suggested Readings

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5. Stefaniac, A., du Plessis, J., John, S., Eloff, F., Agner, T., Chou, T-Z., Nixon, R., Steiner, M., Kudla, I., and Holness, D.L. International guidelines for the in vivo assessment of skin properties in non-clinical settings: part 1. pH. Skin Research Technology, 2013; 19: pp. 59-68.

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