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NOTAS DE APLICACIONES

MONITORES DE LA SALUD

Medición de sodio en sudor de atleta

LAQUAtwin es un rango de medidores de bolsillo de electroquímica. Los medidores de iones usan un electrodo selectivo, para medir el potasio, el calcio, los nitratos y el sodio este rango también incluye medidores de pH y de conductividad. Con tan solo una gota de muestra, el sensor plano LAQUAtwin mide rápidamente y con precisión las concentraciones de parámetros químicos en el campo o en laboratorio.

Introducción

Es importante de determinar la cantidad de sodio presente en el sudor porque el reemplazo de sodio (Na +) perdido en el sudor tiene un impacto importante en la prevención de los desequilibrios de líquidos y electrolitos. Conocer la cantidad de sodio perdida permite de entender como reemplazar efectivamente los electrolitos después del esfuerzo.

En general, el contenido de sodio en el sudor es medido por técnicas de laboratorio de análisis como cromatografía de iónica y el tiempo de entrega de resultado es 2 semanas. Pero la mayoría de los atletas no tienen fácil acceso a este tipo de instalaciones y necesitan conocer la perdida directamente después de esfuerzo. El medidor de iones HORIBA puede ser utilizado en lugar de la cromatografía iónica tradicional con el fin de determinar la cantidad de sodio en el sudor.

El medidor LAQUAtwin Na + se utiliza por realizar mediciones simple para determinar el contenido de iones de sodio en el sudor para poder reemplazar adecuadamente los electrolitos después de una actividad intensa. Este es un método fácil, rápido utilizado para comprobar la cantidad de sodio presente en el sudor.

Método

Cuando el deportista ha empezado a sudar, limpiar la píele con agua desionizada y se secarla y luego aplicar parches estériles sobre el muslo, la pantorrilla, los omoplatos, debajo de la espalda, los brazos y la frente. El deportista debería entonces proceder a su actividad física y luego al fin del entrenamiento tirar los parches.

Extraer el sudor del parche, exprimiéndolo en una jeringa. Colocar la pequeña cantidad de muestra de sudor extraída en el sensor del medidor LAQUAtwin Na + y medirla. Para repetir el muestreo, lavar el sensor con agua del grifo y secarlo con un pañuelo de papel.

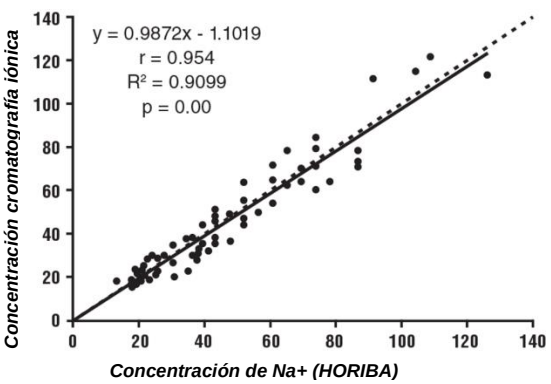
Resultado y Beneficios

Gracias a la prueba precisa de iones de sodio en el sudor de atletas, podemos determinar el desequilibrio de electrolitos y de esta manera los atletas pueden optimizar la recuperación de los electrolitos por el consumo de bebida enérgica durante y después la actividad física.

Aunque la cromatografía iónica es el laboratorio la técnica es considerada como referencia, los resultados obtenidos por método alternativo como los medidores de iones de HORIBA no sólo son más fáciles de adquirir y de usar pero también son muy preciso y rápido.

De acuerdo con un estudio realizado por Gatorade Sports Science Institute, hay una fuerte correlación entre los resultados de muestra medidas con los medidores LAQUAtwin y la cromatografía iónica.

El metro bolsillo LAQUAtwin Na + es pequeño y compacto; practico para llevar a todas partes para facilitar las pruebas en cualquier lugar. Su fácil de usar interfaz permite a cualquier persona de realizar mediciones precisa con medidor de bolsillo LAQUATwin Na +.



Medidor de bolsillo

LAQUAtwin

Características únicas

Realice calibraciones y mediciones con tan solo pulsar un botón; le indicará que ya puede leer el resultado.

La sencilla calibración automática con tan solo unas gotas de solución de calibración, le garantiza la exactitud de la medición. También se puede realizar la calibración en dos puntos y hasta 3 y 5 puntos con los modelos pH33 y EC33.

LAQUAtwin es totalmente a prueba de agua y polvo.

El medidor y el sensor son totalmente resistentes al agua y al polvo, por lo que puede llevarlo donde quiera.

1 IP67: no da errores al sumergirse en agua a una profundidad de un metro durante treinta minutos. Sin embargo, el producto no puede usarse bajo el agua

LAQUAtwin: Tecnología única de sensor plano ISE y pH

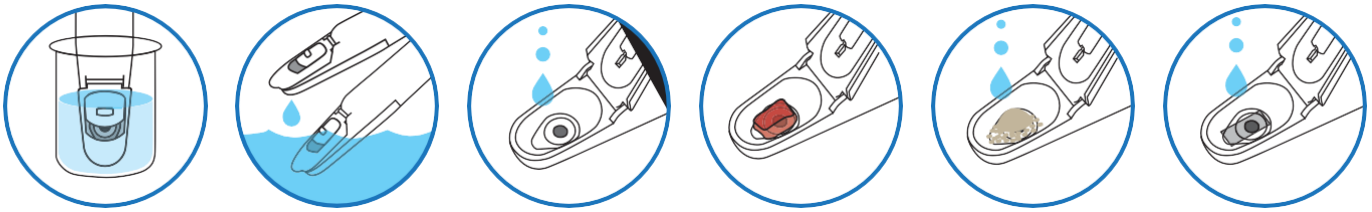
La tecnología HORIBA de sensor plano de alta sensibilidad abre nuevas posibilidades para medir diferente tipos de muestras. Puede hacer una medición a partir de un volumen de 0.1 ml y no necesita vaso para calibrar o medir, solo punga unas gotas directamente en el sensor.

Incluye un estuche para transportarlo de forma práctica.

El estuche compacto contiene todo lo que necesita para las mediciones, incluyendo las soluciones de calibración y una pipeta de plástico.

1 X 6 Un medidor, seis métodos de medición

Only LAQUAtwin allows you to be this flexible!
Choose the best method according to your sample, your situation, and your needs.



1 Inmersión

Cuando se encuentre en un laboratorio, puede analizar la muestra en un vaso de precipitados. Asegúrese que la tapa deslizante que protege el sensor esté abierta.

2 Muestreo

Utilícelo como una pala para analizar el agua, por ejemplo, de un río.

3 Gotas

Los medidores LAQUAtwin pueden medir volúmenes de muestra de tan solo 0.1ml. Coloque una gota de la muestra en el sensor con una pipeta.

4 Muestras sólidas

Los alimentos que contengan cierta humedad pueden analizarse si coloca un trozo pequeño directamente en el sensor.

5 Polvos

Los medidores LAQUAtwin también pueden analizar polvos secos. Simplemente, coloque la muestra de polvo en el sensor y versa encima el volumen definido de agua desionizada.

6 Papel y tejidos

Si desea analizar hojas de papel y tejidos, corte la muestra en trozos pequeños y colóquelo directamente en el sensor. Versa encima un volumen definido de agua desionizada.

Rango

pH

Medición precisa de pH directamente a partir de una sola gota. El pH del agua varía en función al ambiente y un ligero cambio a menudo puede tener un gran impacto. Tanto si debe mantener el pH de un acuario dentro de niveles estrictos, comprobar la acidez del agua de lluvia o la calidad de producto alimenticio (carnes, pescados…), los medidores de pH de bolsillo LAQUAtwin son la solución perfecta. No importa dónde o cuándo debe realizar un análisis.

COND

Determine la conductividad con tan solo una muestra de 0.12 ml. La conductividad del agua de lluvia es una referencia fiable para determinar la pureza atmosférica. En agricultura, la medición de la conductividad del suelo permite a los agricultores establecer el uso óptimo de fertilizantes y comprobar la «salud» del suelo tras el daño provocado por el agua salada. Los medidores de conductividad LAQUAtwin hace que el análisis de la conductividad sea una tarea sencilla que se puede realizar en

Na+

Único medidor de bolsillo para medir rápidamente y con precisión el sodio con un electrodo con membrana selectiva. El amplio rango de medición que incorpora (de 23 a 2300 ppm) permite medir concentraciones altas sin necesidad de realizar una dilución.

K+

Único medidor de bolsillo para medir rápidamente y con precisión el potasio con un electrodo con membrana selectiva. El amplio rango de medición que incorpora (de 39 a 3900 ppm) permite medir concentraciones altas sin necesidad de realizar una dilución.

NO3–

Único medidor de bolsillo para medir rápidamente y con precisión el nitrato con un electrodo con membrana selectiva. El amplio rango de medición que incorpora (de 30 a 9900 ppm) permite medir concentraciones altas sin necesidad de realizar una dilución.

Ca2+

Único medidor de bolsillo para medir rápidamente y con precisión el calcio con un electrodo con membrana selectiva. El amplio rango de medición que incorpora (de 40 a 4000 ppm) permite medir concentraciones altas sin necesidad de realizar una dilución.

CE RoHS

IMS

HORIBA Group is operating Integrated Management System (IMS)
ISO9001 JOA-0298 / ISO14001 JOA-E-90039 / ISO13485
JOA-MD0010 / OHSAS18001 JOA-OH0068

Measuring Sodium and Potassium Concentrations in Athlete's Sweat

Sweat testing carried out by regional patch sweat collection, syringe sweat extraction, and LAQUAtwin analysis is the simplest and most practical method to assess electrolyte losses of athletes in the field for electrolyte replacement recommendations. During exercise or training, athlete's sweat is collected with absorbent patches applied on skin sites and subsequently extracted with a syringe for rapid determination of sodium (Na^+) and potassium (K^+) concentrations with LAQUAtwin Na-11 and K-11 pocket meters, respectively. Baker et al. (2014) compared the results of this field method with those obtained from laboratory-based centrifuge-HPLC and found that they were significantly correlated.

Scan QR code with your mobile device to access online content

LAQUAtwin Na-11 Product Page

LAQUAtwin K-11 Product Page

Introduction

Sweating allows the body to regulate its temperature. It causes a decrease in temperature through evaporative cooling at the skin surface. When individuals are in hot weather or their muscles heat up due to physical activity, more sweat is produced in order to cool down. Sweat is mostly water with small amounts of electrolytes, which include sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). As sweating increases, electrolyte composition in the body decreases. The concentrations of electrolyte loss can vary among individuals.

Measuring the electrolyte losses from athletes' sweat could assist health professionals in planning personalized water and electrolyte replacement strategies. This would prevent water/electrolyte imbalances and heat-related whole-body muscle cramps in sports that could impair athletes' performance. While Na^+ loss is primarily measured since it is the electrolyte lost in the greatest quantities and has the most significant impact on body fluid balance, K^+ loss measurement can also provide valuable information. Both sweat sodium concentration [Na^+] and potassium concentration [K^+] are needed to predict changes in serum [Na^+] from mass balance equations. Furthermore, sweat [K^+] can serve as quality control check of sweat sample. A sweat sample with very high [K^+] can indicate quality issues such as sample evaporation, contamination, or leaching of electrolytes from skin that would not have been detected from measuring sweat [Na^+] alone.

To perform sweat testing in the field, sweat can be easily sampled with absorbent patches placed on clean skin of anatomical sites after the athlete established steady-state sweating during exercise or training. The sweat sample is then extracted from each absorbent patch with syringe for immediate analysis with LAQUAtwin Na-11 and K-11 pocket meters.

The LAQUAtwin Na-11 and K-11 waterproof pocket meters measure sodium concentration [Na^+] and potassium concentration [K^+], respectively, in microvolume samples and display results in just a few seconds. The sensors are replaceable and each has sample well embedded with flat ion selective electrode paired with a reference electrode. With this unique design, the sensors are capable of measuring samples as little as 0.3ml with direct application or 0.05ml with sampling sheet. The reading in the backlit digital LCD can be expressed as ppm, mg/L, or mmol/L unit.

Method

Meter set-up and calibration

Calibrate the LAQUAtwin Na-11 and K-11 pocket meters according to manufacturer's instructions using their respective 150 and 2000ppm standard solutions.

Sample collection and measurement

Sweat tests with athletes should be conducted during exercise or training and in conditions representative of their sport.

1. After the onset of exercise or training (~10 mins), clean the following athlete's anatomical skin sites with alcohol wipe or deionized / distilled water rinse and dry with sterile gauze or towel: right anterior mid thigh, right posterior mid forearm, left posterior mid forearm, upper chest, right scapula, left scapula, and forehead.
2. Attach one sterile patch at each site.
3. Remove each patch with sterile tweezers after absorbing sufficient sample but before complete saturation.
4. Place each patch inside the barrel of a 5-ml syringe. Depress the plunger to compress the patch and expel sweat directly onto the sensors of pocket meters or vial for later analysis.
5. Record the stable readings.

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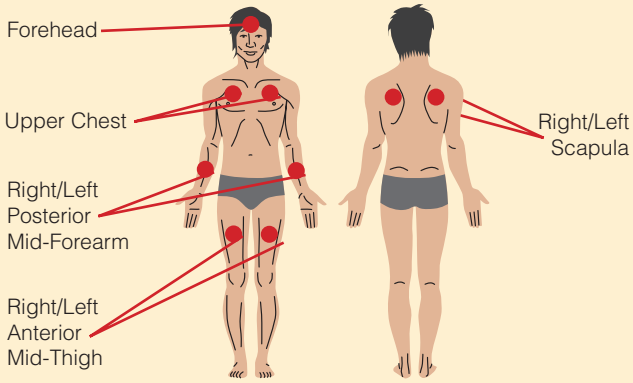
To obtain accurate results, a uniform temperature should be maintained for the standard solutions and samples. If sweat sample volume is not enough to cover the flat sensor, a sampling sheet can be used to disperse the sample on the sensor surface. After measurement, rinse the sensor, tweezer, and syringe with distilled or deionized water and blot dry with soft tissue. For more information on maintenance, refer to **Technical Tip 2: LAQUAtwin Ion Sensor Maintenance Procedures**.



Results And Benefits

To maintain water and electrolyte balance during prolonged exercise or training, it is recommended to drink water and/or sports drink to replace the water and Na^+ loss from profuse sweating. Thus, having a rapid, low-cost method and user-friendly, portable instrument to measure athlete's sweat in the field could assist health professionals in tracking changes in sweat [Na^+] and planning water and electrolyte replacement strategies.

Baker et al. (2014) conducted a study comparing a field versus reference laboratory method for extracting (syringe vs. centrifuge) and analysing sweat [Na^+] and [K^+] (LAQUAtwin vs. HPLC) collected with regional absorbent patches during exercise in a hot-humid environment. They found that the sweat [Na^+] and [K^+] obtained with the syringe-LAQUAtwin field method were significantly correlated to those of centrifuge-HPLC laboratory method (See Table 1 for the results). The LAQUAtwin Na-11 and K-11 pocket meters (superseded the B-722 and B-731 models used in the study) have been proven practical and useful tools in delivering rapid, cost-effective, and highly reliable measurements of athletes' sweat [Na^+] and [K^+], respectively, in field studies.

Table 1: Validity of field technique using syringe extraction of sweat and LAQUAtwin analysis: SYRINGE LAQUAtwin vs. CENTRIFUGE HPLC for sweat [Na^+] and [K^+].

	Sweat [Na^+]	Sweat [K^+]
Mean Difference ± SD (mEq/L)	3.97 ± 10.87*	0.50 ± 0.48*
95% CI of mean difference (mEq/L)	2.49-5.45	0.42-0.59
ICC	0.93*	0.84*
SEE (mEq/L)	8.68	0.44
TEM (mEq/L)	7.68	0.34
CV (%)	12.54	8.48

n = 210 for sweat [Na^+] and 116 for sweat [K^+]. CV, coefficient of variation; CI, confidence interval; HPLC, ion chromatography using the Dionex ICS-3000; HORIBA, HORIBA B-722 for sweat [Na^+] and HORIBA B-731 for sweat [K^+]; ICC, interclass correlation coefficient (based on two-way mixed ANOVA, absolute agreement, average measures); SD, standard deviation; SEE, standard error of the estimate; TEM, typical error of measurement; *P < 0.001.

Source: Baker et al. (2014). Validity and reliability of a field technique for sweat Na^+ and K^+ analysis during exercise in a hot-humid environment.

Sweat [Na^+] determined from anatomical sites can be used to predict whole-body sweat [Na^+] with regression equations. Sweat [Na^+] can vary considerably among individuals and typically ranges from approximately 10 to 90 mmol/L. Unlike [Na^+], sweat [K^+] is considerably lower and less variable despite changes in sweating rate. For this reason, sweat [K^+] can serve as quality control check in sweat electrolyte testing. If the sweat [K^+] is > 10 mmol/L, the potential issues are sample evaporation, contamination, or leaching of electrolytes from skin. Sweat samples that do not fall within these normal ranges: [Na^+] =10 – 90 mmol/L, [K^+] = 2 – 10 mmol/L should be flagged. Initial sweat may have high concentrations due to minerals trapped in sweat pore. To avoid this, clean skin surface and collect sample after 10 minutes of training or exercise or when steady-state sweating is achieved.

To convert ppm or mg/L reading to mEq/L or mmol/L, divide the reading by the molar mass of the ion (Na^+ = 22.989, K^+ = 39.098). Alternatively, refer to **Technical Tip 7: Procedure for Setting mmol/L Unit in LAQUAtwin Ion Pocket Meters** to set the meter to display the reading in mmol/L unit. Callibration in mmol/L unit can also be performed on the LAQUAtwin ion pocket meters.

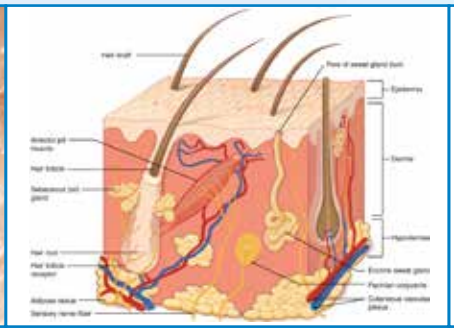
References And Suggested Readings

1. Perspiration. Wikipedia https://en.wikipedia.org/wiki/Perspiration
2. Baker, L., Ungaro, C., Barnes, K., Nuccio, R., Reimel, A., & Stofan, R. (2014). Validity and reliability of a field technique for sweat Na+ and K+ analysis during exercise in a hot-humid environment. Physiological Reports. Volume 2, Issue 5.
3. Baker, L. (2017). Sweating Rate and Sweat Sodium Concentration in Athletes: A Review of Methodology and Intra/Interindividual Variability. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5371639/ on 29 August 2017.

REV 0, 6 September 2017

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

1. Human Skin – Wikipedia. https://en.wikipedia.org/wiki/Human_skin
2. Maibach, H. & Rovee, D. The Epidermis in Wound Healing, p.133 – 135.
3. Agache, P. & Humbert, P. Measuring the Skin, p. 84.
4. Korting, H.C. & Schmid-Wendtner, M-H., pH and Skin Care, pp. 8 – 13.
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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