



UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES



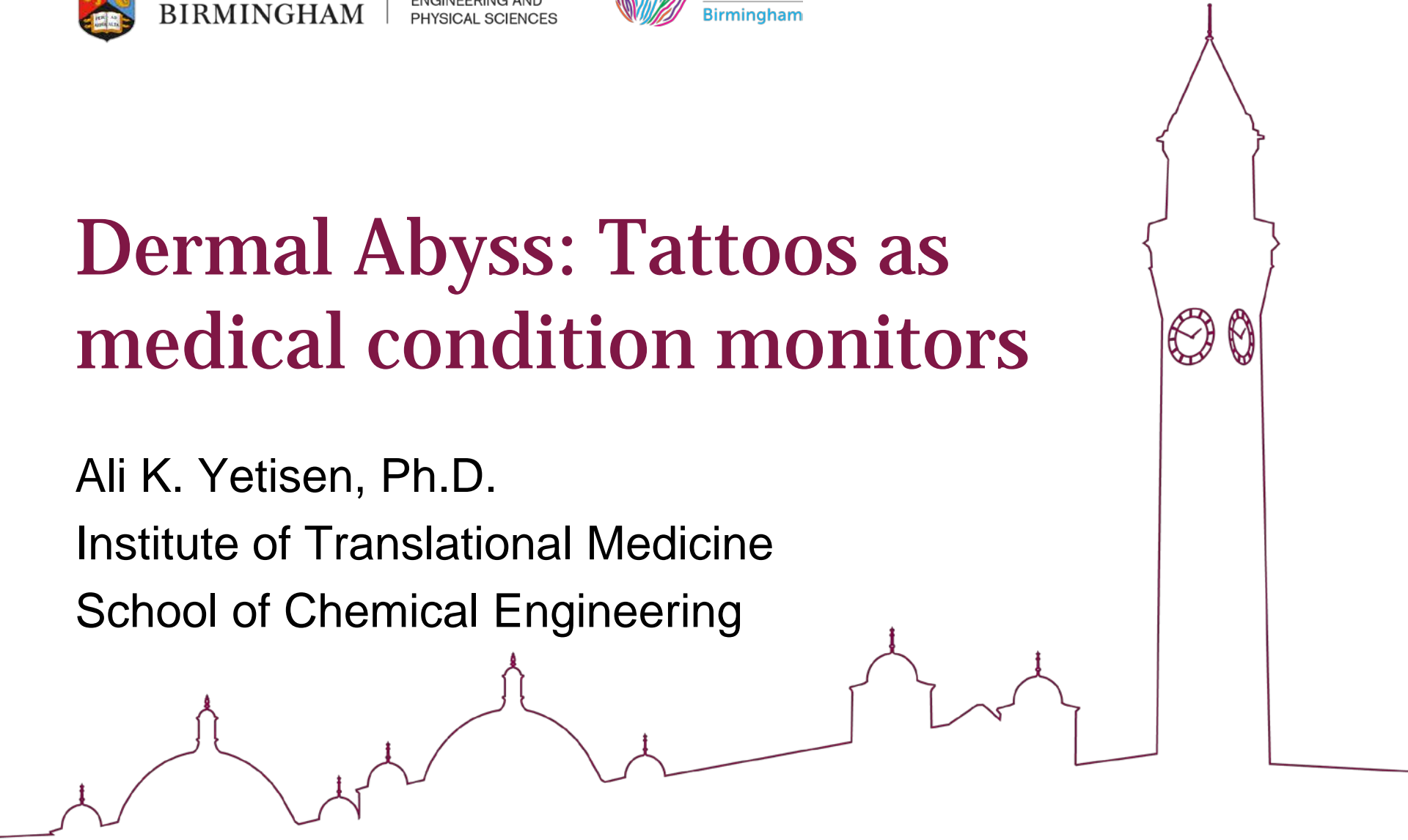
Institute of
Translational
Medicine
Birmingham

Dermal Abyss: Tattoos as medical condition monitors

Ali K. Yetisen, Ph.D.

Institute of Translational Medicine

School of Chemical Engineering



Next Generation Diagnostics

Current Diagnostic Approaches for Patients

Preventive Healthcare



Dipsticks

1980



Point-of-Care Testing

1990-2000



Wearables

2000-2010



Non-invasive
or minimally-invasive
monitoring

2025


Paradigm shift

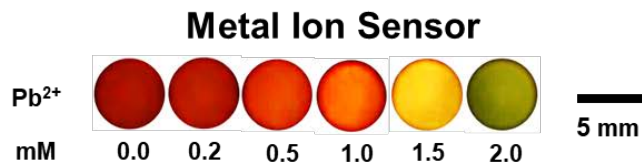
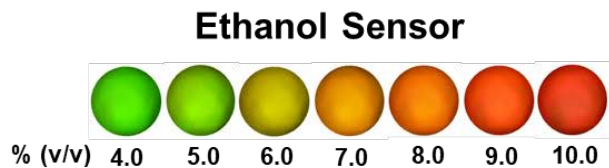
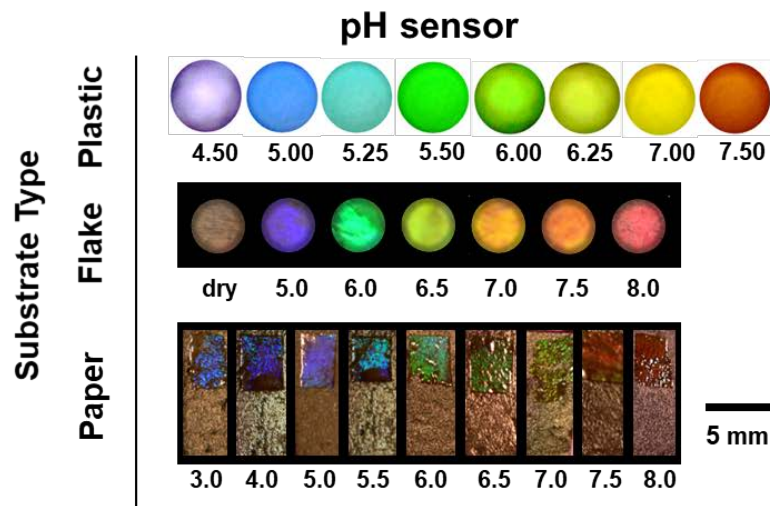


UNIVERSITY OF
BIRMINGHAM

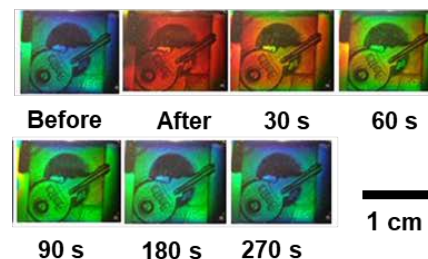
COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

Advanced Materials (2018)
Wearables in Medicine

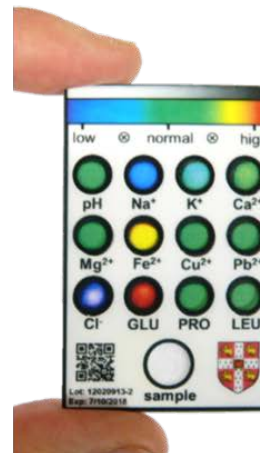
Optical Sensors



Relative Humidity Sensor



Multiplexed Sensors



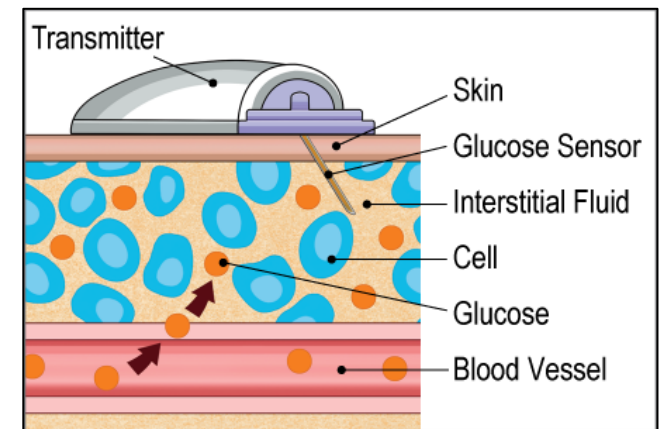
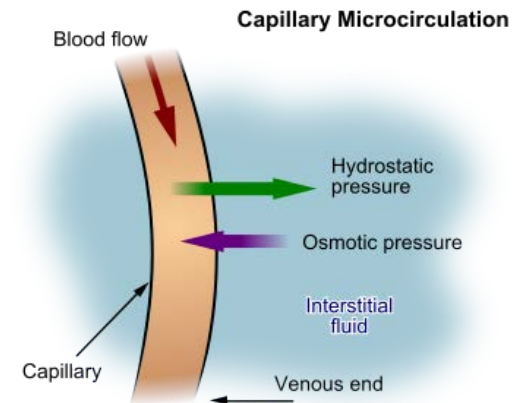
UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

Anal. Chem. 2015, 87 (10), 5101-5108 (2015)
 Photonic Nanosensor for Colorimetric Detection of Metal Ions
 ACS Sensors 1 (5), 493-497 (2016) Photonic Crystal Flakes

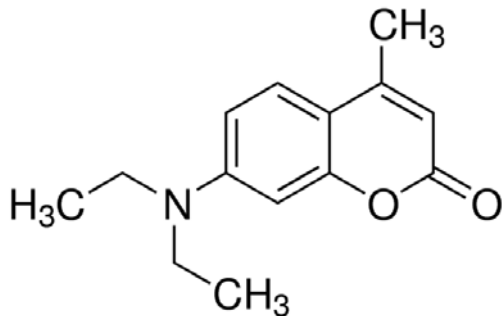
Interstitial Fluid

- ❑ Surrounds the cells
- ❑ Contains carbohydrates, electrolytes, fatty acids, amino acids, coenzymes, hormones, neurotransmitters, white blood cells and cell waste-products.
- ❑ Can be used as a surrogate for blood chemistry
- ❑ Utilized in continuous glucose monitoring systems



Fluorescent Tattoos

- The tattoo produces visible emission when excited with a UV light source.
 - 7-diethylamino-4-methylcoumarin
 - Dispersed in a melamine formaldehyde toluenesulfonamide polymer matrix
 - Polymethylmethacrylate microsphere suspensions



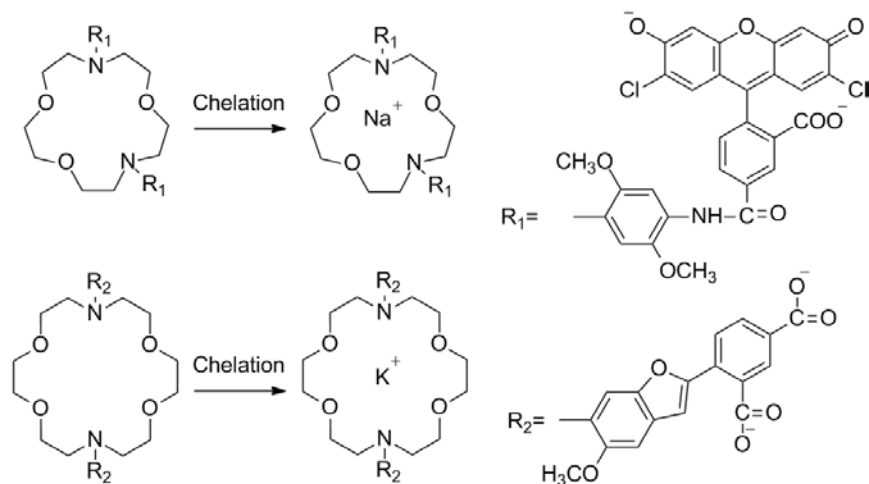
Copyright, SkinCandy Tattoo Supply (2018)



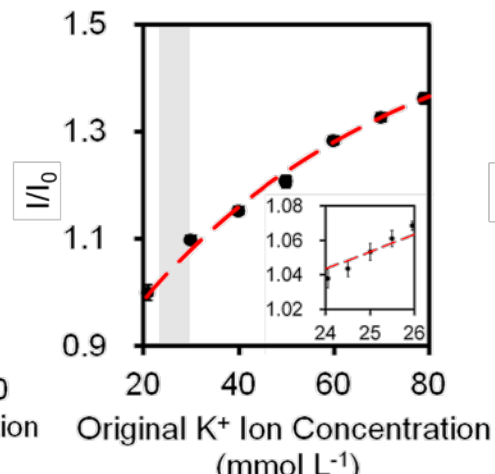
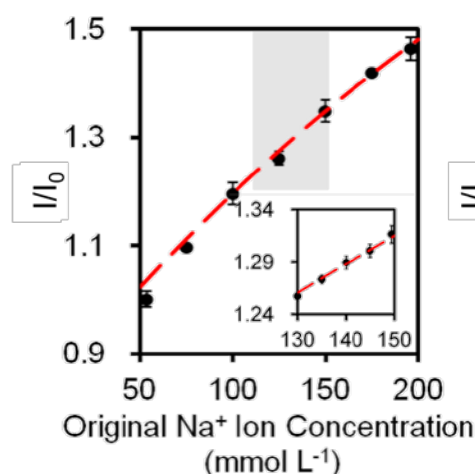
Copyright, Tukoi Oya, Melbourne, Australia (2018)



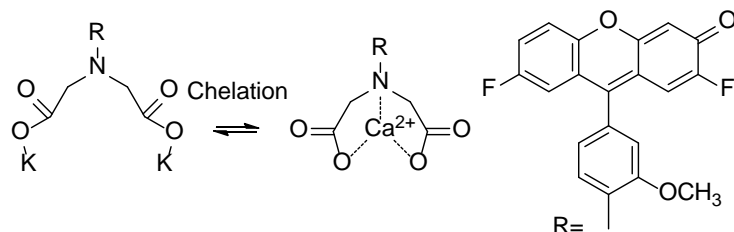
Molecular Probes as Tattoos?



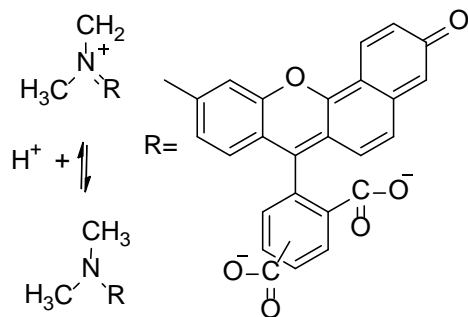
diaza-15-crown-5 and diaza-18-crown-6



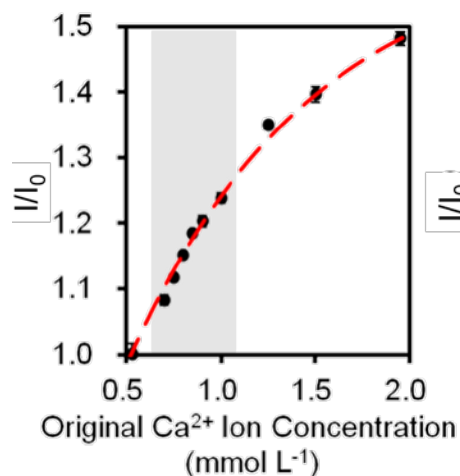
Molecular Probes as Tattoos?



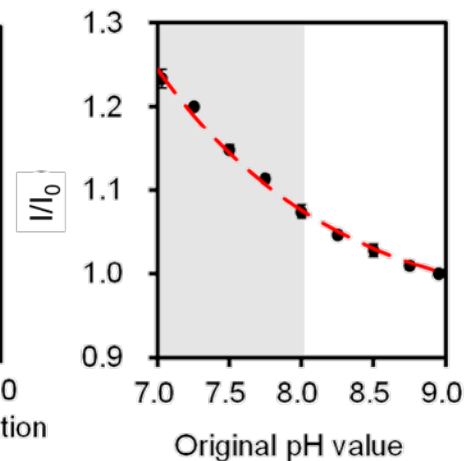
o-acetanisidide



seminaphthorhodafluor.



5 mm



5 mm

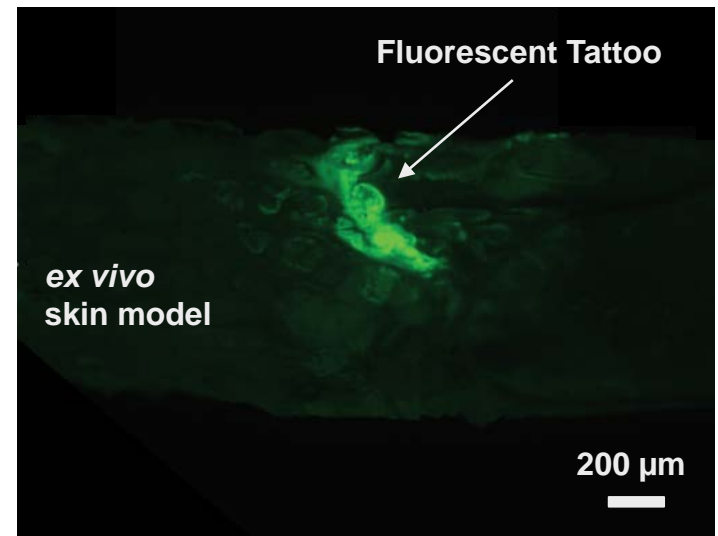


UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

Lab on a Chip. 17, 1137-1148 (2017)
Paper-Based Microfluidic System for Tear Electrolyte Analysis

Tattoos as Diagnostic Devices?



UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

The Dermal Abyss: Interfacing with the Skin by Tattooing Biosensors. ISWC2017 The 16th International Semantic Web Conference, Maui, HI, USA, 138-145 (September 11-15, 2017)

pH and Glucose Tattoo Sensors



pH 7.0



Glucose = 5 mmol L⁻¹



pH 8.0



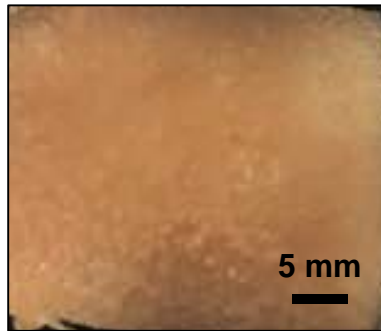
Glucose = 10 mmol L⁻¹



Electrolyte Tattoo Sensors

Broadband
Excitation

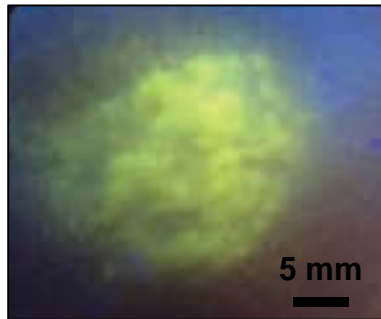
Na⁺ Sensor



pH Sensor



UV
Excitation

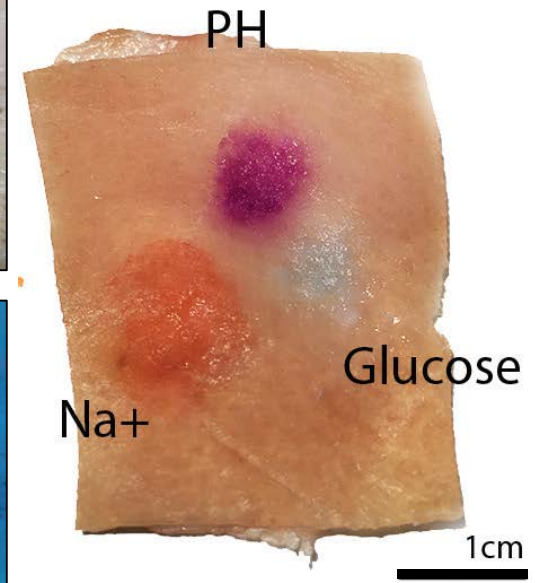
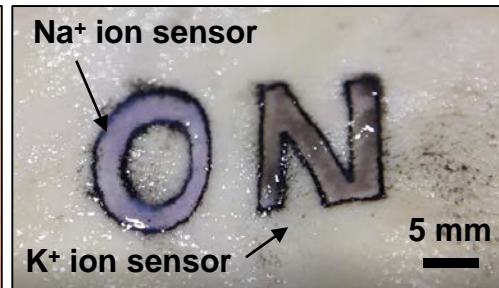
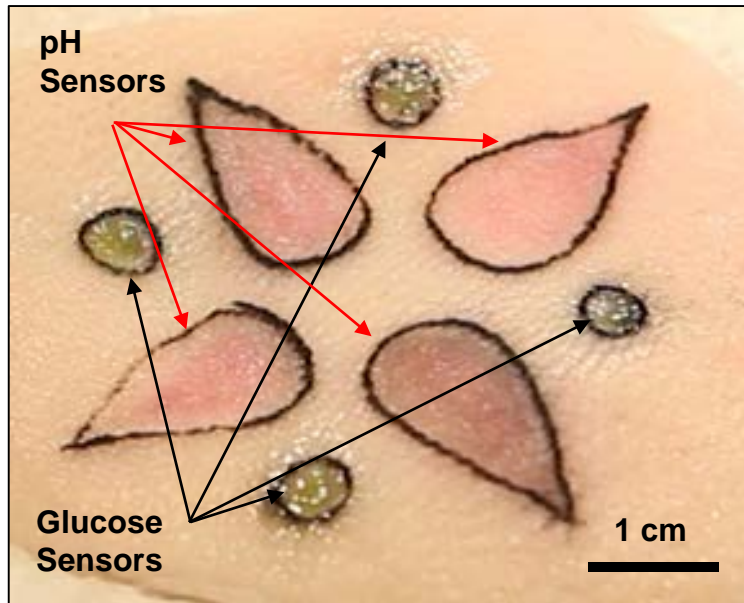


UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

The Dermal Abyss: Interfacing with the Skin by Tattooing Biosensors. ISWC2017 The 16th International Semantic Web Conference, Maui, HI, USA, 138-145 (September 11-15, 2017)

Multiplexed Tattoo Sensors

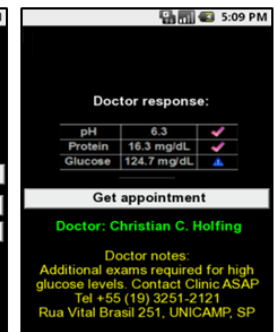
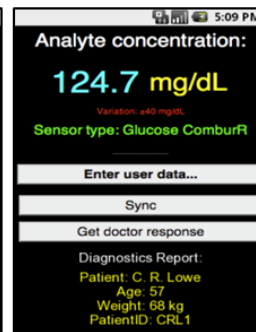
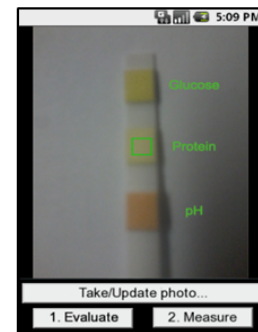
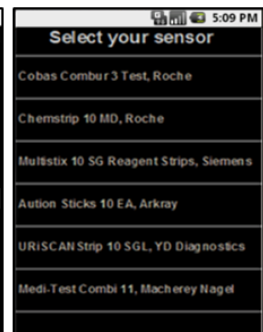
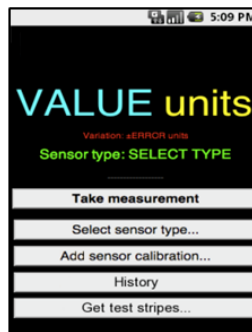
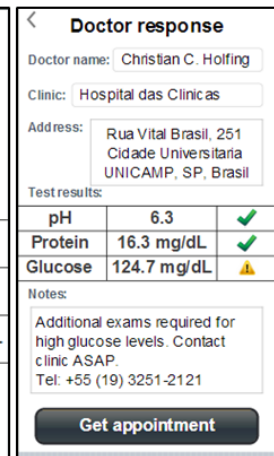
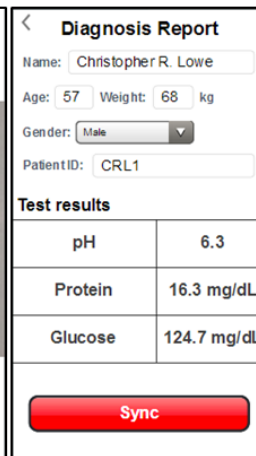
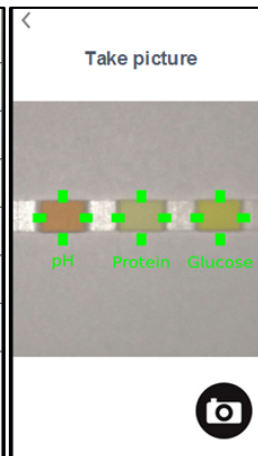
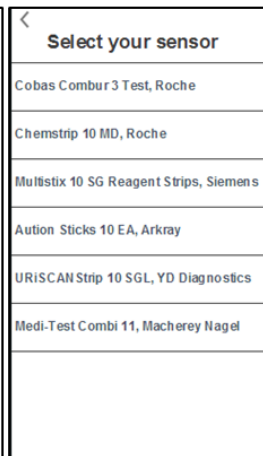
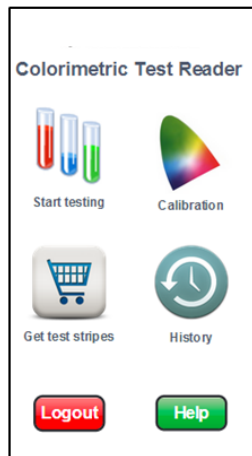
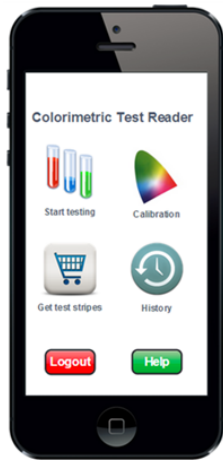


UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

The Dermal Abyss: Interfacing with the Skin by Tattooing Biosensors. ISWC2017 The 16th International Semantic Web Conference, Maui, HI, USA, 138-145 (September 11-15, 2017)

Smartphone Readouts



UNIVERSITY OF
BIRMINGHAM

COLLEGE OF
ENGINEERING AND
PHYSICAL SCIENCES

Sens. Actuators, B, 196, 156 (2014)
A smartphone algorithm with inter-phone repeatability for the analysis of colorimetric tests

High-Tech Tattoo Industry

- Biogenic tattoo ink: SKIN46
 - Carbon is extracted from human and/or animal hair
 - Then added to a base composition of the tattoo ink
- DNA-based tattoos: Everence
 - Adds human/animal DNA into a tattoo formulations
 - Involves encapsulating the DNA in microcapsules



SKIN46 AG, Buchs Switzerland (2018)



Everence Life Sciences (2018)

