

# Application of Biophysics and Bioengineering to the Assessment of Skin Barrier Function

Quan Yang, Sarah Cordery and Richard H. Guy

Department of Pharmacy & Pharmacology, University of Bath, U.K.

## Objectives :

As a result of filaggrin mutation, lower levels of natural moisturising factor (NMF) are generated in atopic skin and this is thought to contribute to an impaired barrier function[1].

The stratum corneum (SC) on the face is thinner, and the surface area of the corneocytes smaller, resulting in a shorter path-length for transport and a noticeably higher permeability. Therefore, it is proposed that forearm and forehead skin from healthy volunteers may be used to model the distinction between a competent SC and one pre-disposed to AD.

The goal of this project is to apply different bioengineering methods to screen SC barrier function and to identify markers for its impairment.

## Materials and methods :

NMF components were extracted from the forearm and forehead of 6 healthy volunteers using reverse iontophoresis, passive diffusion and tape-stripping.

- Transepidermal water loss (TEWL) measurements together with the results from weighing and scanning the tapes were used to derive the thickness of the SC [2].
- The SC was also examined by attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR) before and after each tape-strip to probe lipid quantity and organisation.
- The extracted samples were analysed by LCMS to identify and quantify the amounts of 22 components of NMF.

## Results:

### 1) Thickness of SC

- The greyscale method indicates a thinner SC on forehead comparing to forearm. The weighing method , on the other hand, shows no apparent difference.

Table 1: Estimated apparent thickness (mean ± SD) of SC on both forehead and forearm.

Weighing method (µm)		Greyscale method (x10 <sup>6</sup> integrated pixels)	
Forehead	Forearm	Forehead	Forearm
9.1 ± 1.4	8.3 ± 1.3	57.6 ± 4.5	112.1 ± 12.4

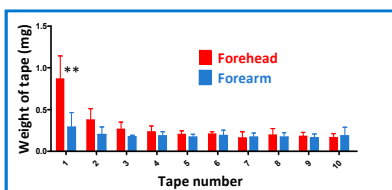


Figure 1: Average weight (mean ± SD) of each tape removed from forehead and forearm

- The latter is , we believe, due to the significant contribution of sebum to the increased weight of the tape-strips (especially, the most superficial - see figure 1)

## Results:

### 2) IR absorbance of lipids (CH<sub>2</sub> stretching absorbances)

- Lipids near to the skin surface were relatively disordered most probably due to the contribution from sebaceous constituents.
- More but less ordered lipids on the forehead are suggested by higher frequency and normalised area of lipid peaks throughout the SC.

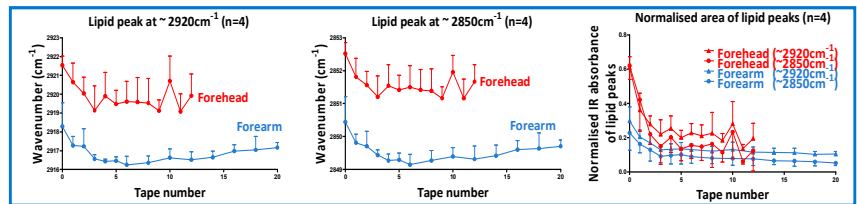
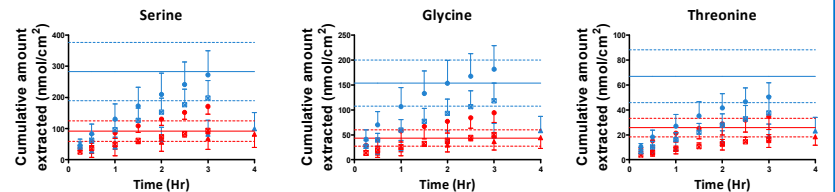


Figure 2: Wavenumber and normalised area (mean ± SD) of lipid peaks from IR absorbance after each tape stripping.

### 3) NMF quantification

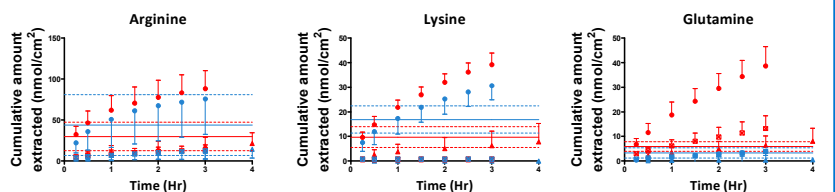
#### Zwitterions

The cumulative amounts of NMF on the forearm were higher than forehead.



#### Negatively charged compounds

The cumulative amount of glutamine detected in forehead was higher than in forearm.



#### Positively charged compounds

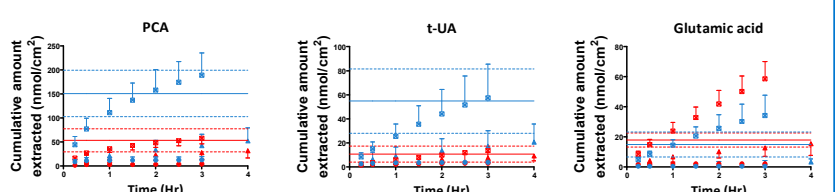


Figure 3: Cumulative amounts of NMF components extracted (mean±SD) at cathode (□), anode (●) and by passive diffusion (▲) as a function of time (n=4) on both forehead (red) and forearm (blue). The average quantities in the SC determined by tape-stripping (n=6) are shown for comparison by the solid horizontal lines, with the ±SD indicated by the dashed lines.

## Conclusions:

The results confirm that forehead SC may be considered a less competent barrier than that on the forearm, as characterised by the presence of

- thinner SC
- less-ordered lipids
- smaller amount of NMF



For further information:

Please contact  
quan\_y@hotmail.co.uk

## References:

- [1] S. Kezic, P.M.J.H. Kemperman, E.S. Koster, C.M. de Jongh, H.B. Thio, L.E. Campbell, A.D. Irvine, I.W.H. McLean, G.J. Puppels, P.J. Caspers, Loss-of-Function mutations in the filaggrin gene lead to reduced level of natural moisturizing factor in the stratum corneum. *J Invest Dermatol* 128(8) (2008) 2117-2119.
- [2] L.M. Russell, S. Wiedersberg, M. Begoña Delgado-Charro, The determination of stratum corneum thickness an alternative approach. *European Journal of Pharmaceutics and Biopharmaceutics* 69(3) (2008) 861-870.