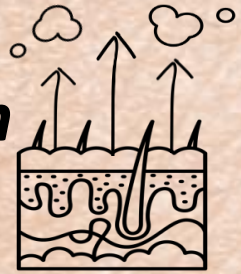
« Development of a material surface mimicking human skin for fragrance release and olfactory perception »



Elise HADJIEFSTATHIOU, *Daria TERESCENCO, Catherine MALHIAC, Geraldine SAVARY, Celine PICARD*

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- Diluted in volatile solvent
- And/or cosmetic matrix
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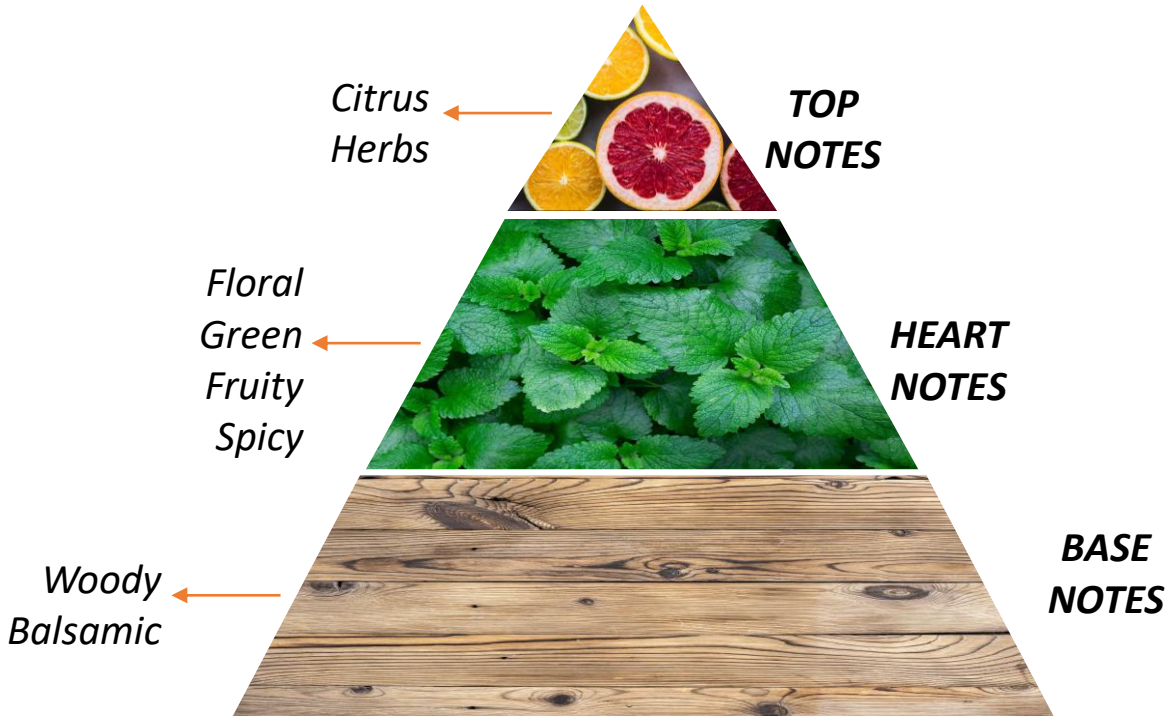

Human skin :

Organised into 3 layers [1]: - the epidermis → **the stratum corneum (SC)**

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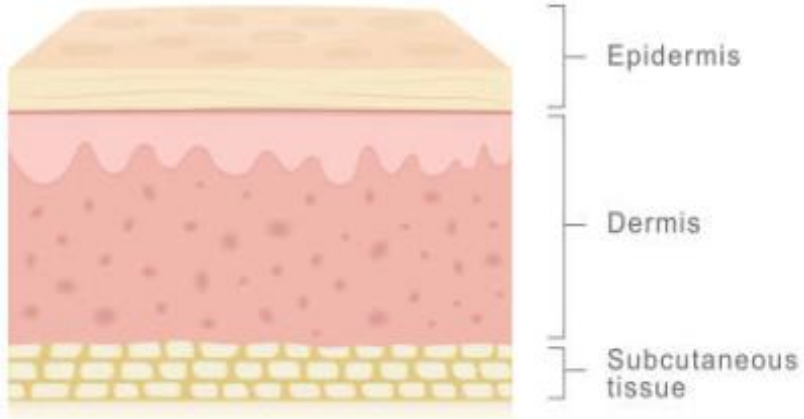

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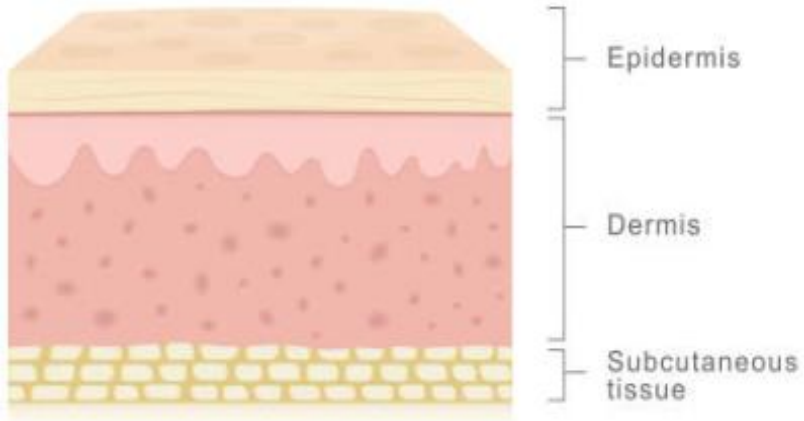

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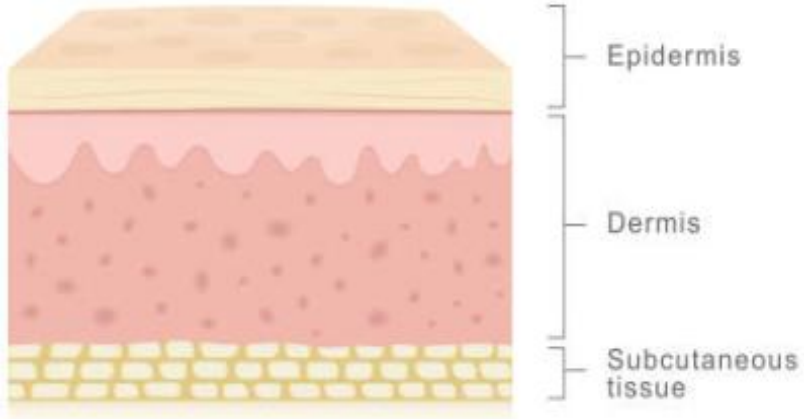

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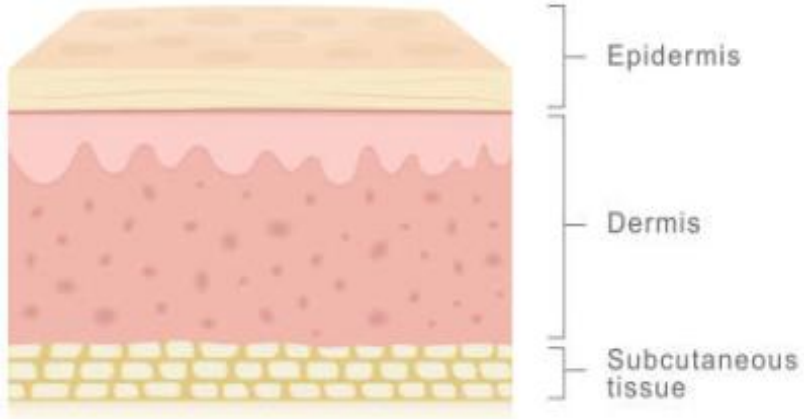

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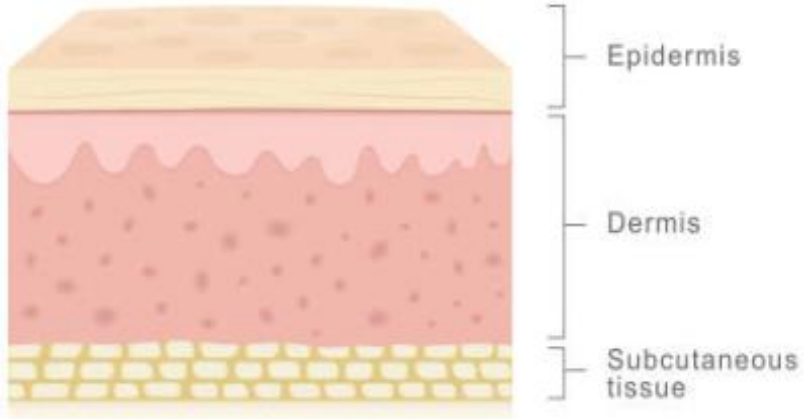

- Variability between skin types: phototype, pH, hydration, sebum level, temperature, transepidermal water loss (TEWL)..

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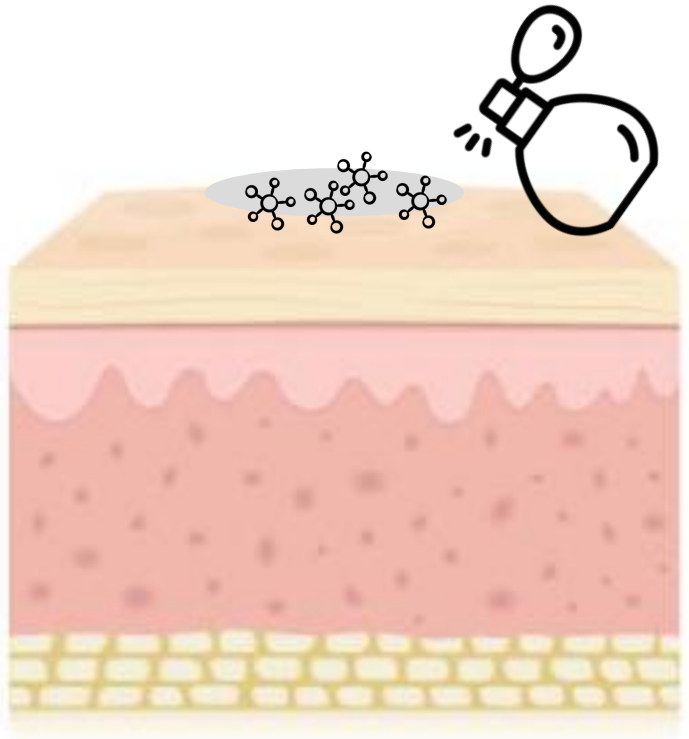
Evaporation and absorption phenomena



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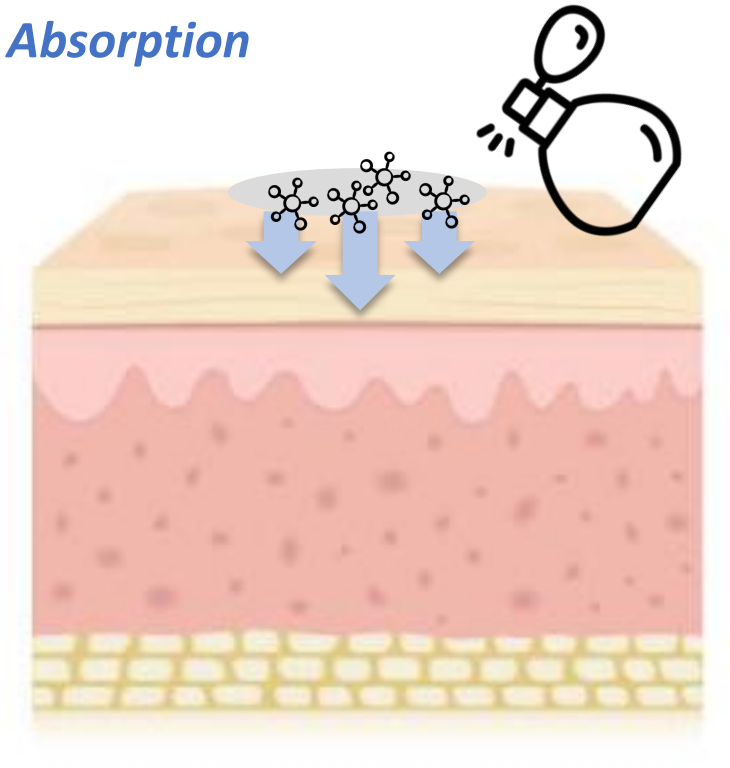

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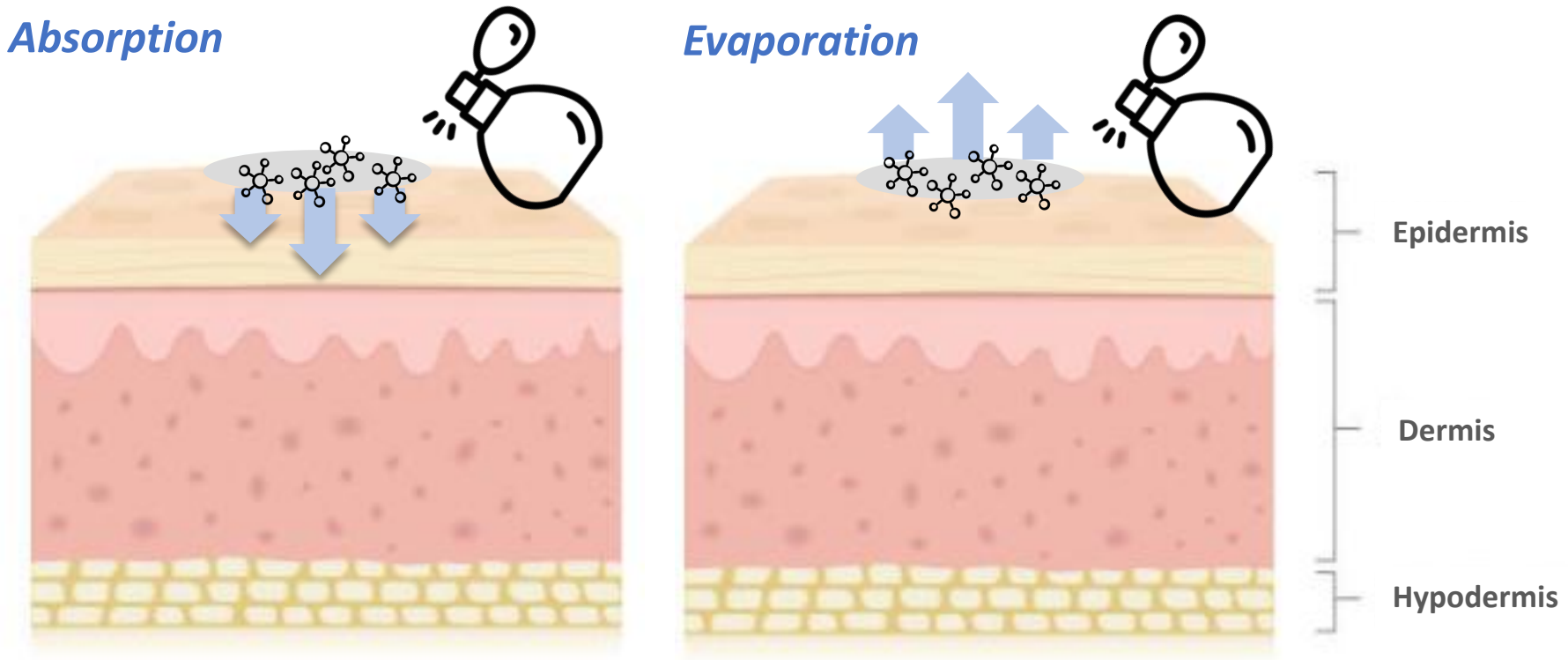

Which parameters influence fragrance retention on the skin?

Skin

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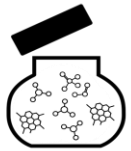

Matrix

Solubility & distribution in SC [8]

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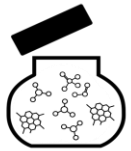

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Solubility & distribution in SC [8]

Volatile compound

Vapour pressure [9] & chemical structure [10]

Chemical interactions between volatile compounds and skin lipids:

- Chemical structure *(polarity, hydrophilic/hydrophobic affinity)* → different **chemical interactions** with skin **lipids**

→ **different release kinetics** *(Behan et al. [9])*

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(10) Vuilleumier, C.; Flament, I.; Sauvegrain, P. Headspace Analysis Study of Evaporation Rate of Perfume Ingredients Applied onto Skin. Int J Cosmet Sci 1995, 17 (2), 61–76

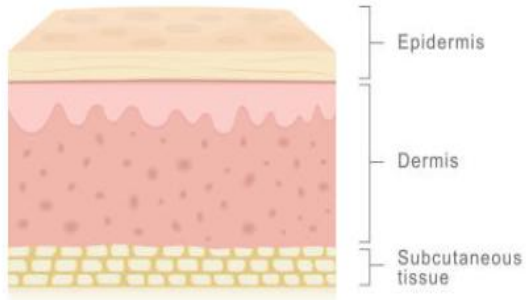
Why develop non-biological skin models?

Biological models

Eg. explants, reconstructed skins

- Difficult to obtain
- Relatively expensive
- Degrade over time
- Limited surface area for sufficient measurements
- Fairly complex

Closely mimic the architecture of native skin



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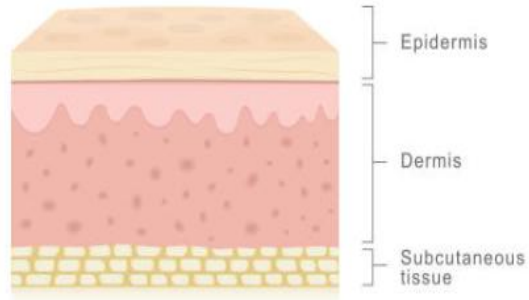

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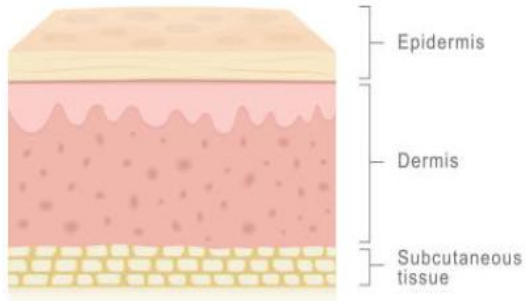

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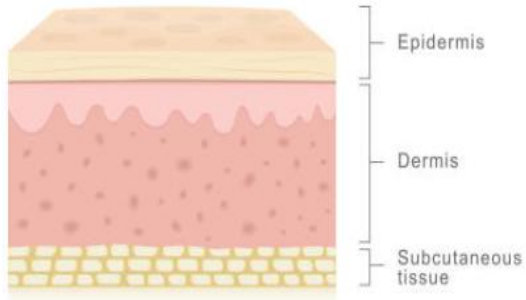


Complex, multi-layer structure

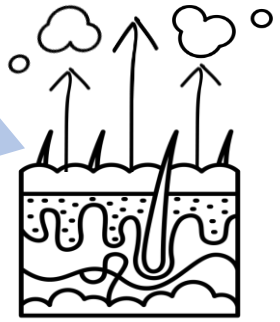
A major challenge !

Ensuring that the model behaves like real skin, capable of mimicking as many of the skin's physico-chemical properties as possible

→ Combine *in vivo* and *in vitro* monitoring of evaporated quantities

What steps need to be taken to study and understand the evaporation of fragrances after they have been applied to the skin to develop a material surface mimicking human skin for fragrance release and olfactory perception

1 **Development of the system for *in vivo* and *in vitro* measurements**



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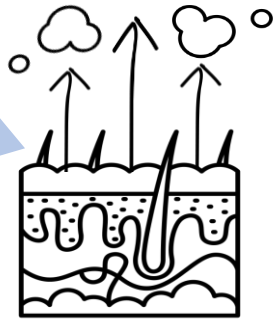

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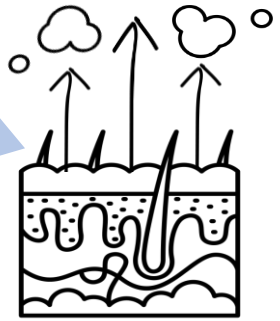

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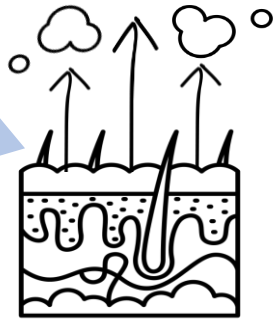
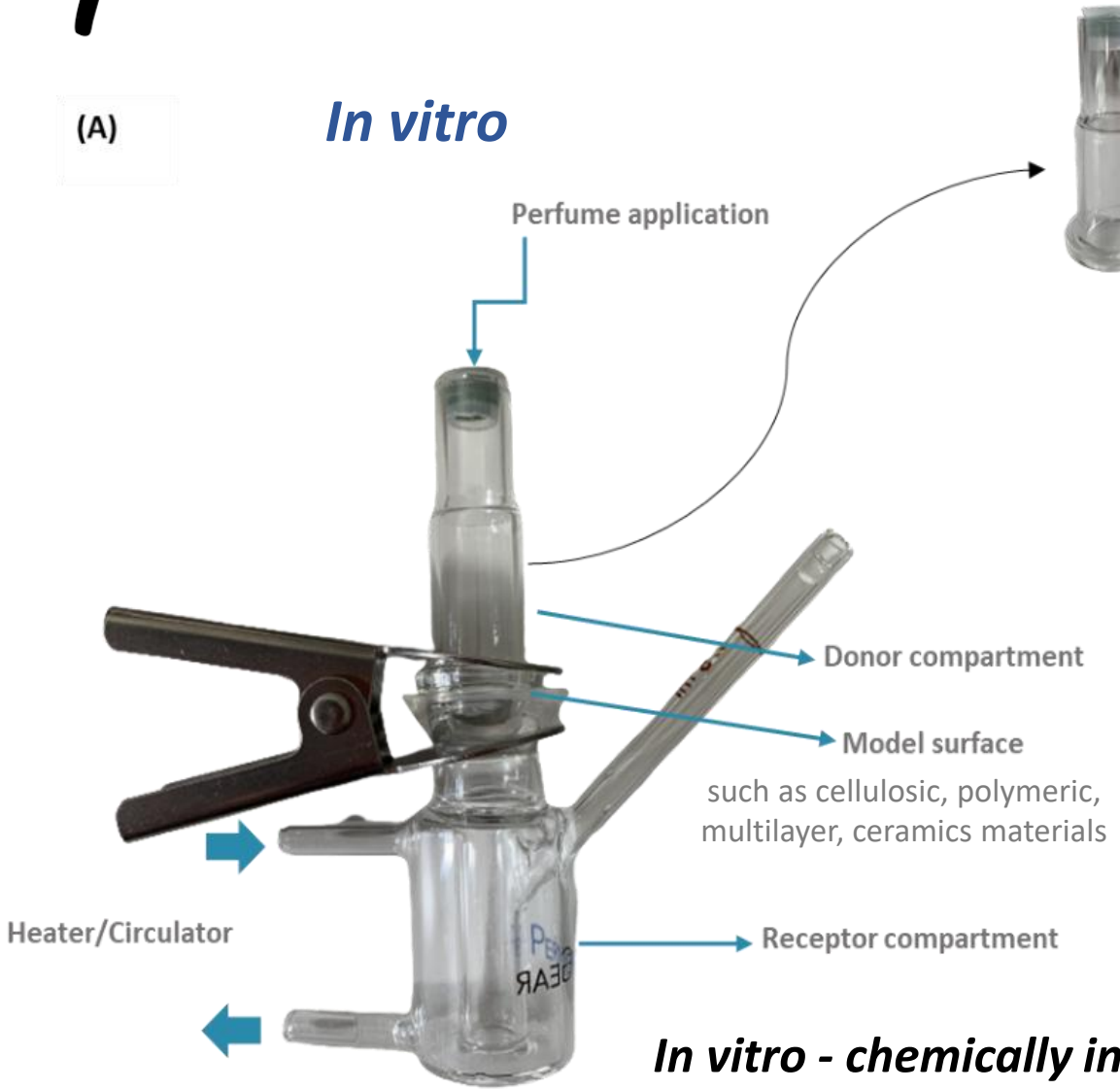


4 Target skin physicochemical properties influencing the release phenomenon

1 *Objective: Set up a closed system in which fragrances are trapped for subsequent analysis*

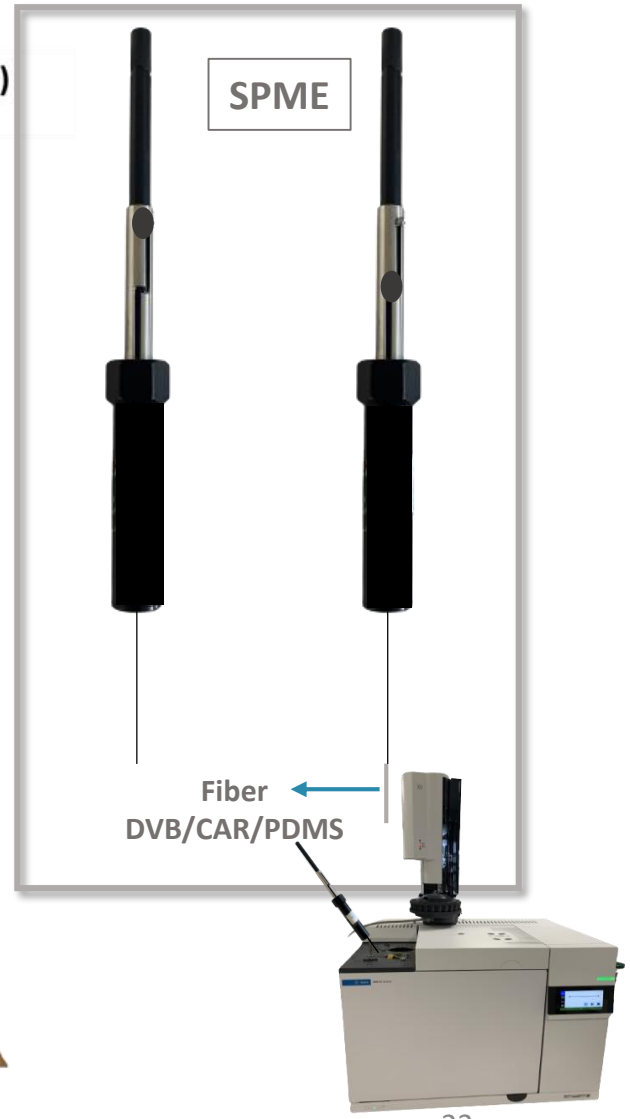
(A)

In vitro



In vivo

(B)



In vitro - chemically inert surface – glass surface

in vivo – volunteer forearm

(11) Hadjiefstathiou, E.; Terescenco, D.; Loisel, V.; Picard, C.; Malhiac, C.; Savary, G. An Innovative Device for in Vivo and in Vitro Study of Fragrance Evaporation after Application on Skin or Model Surfaces. *Talanta* **2025**

2

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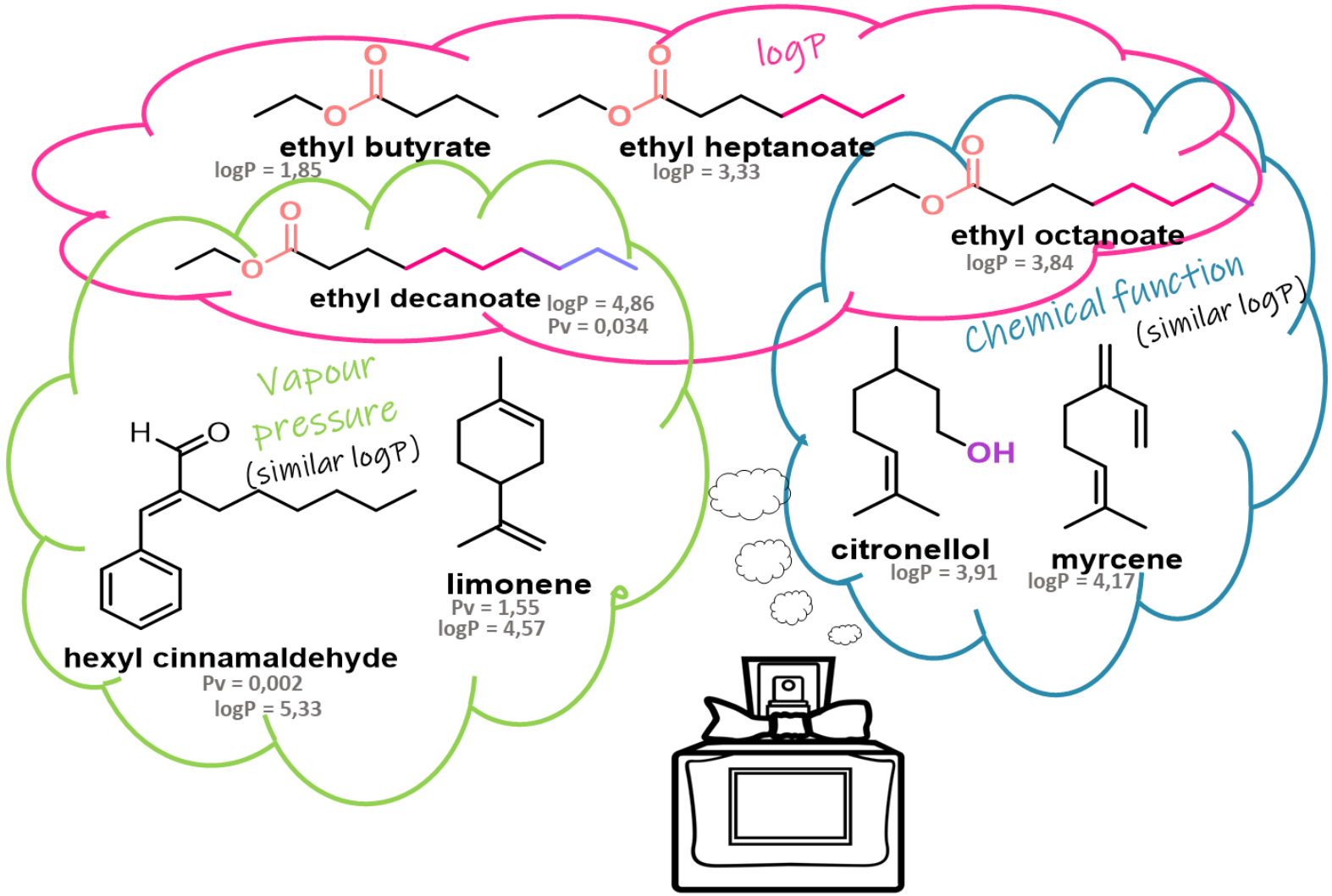

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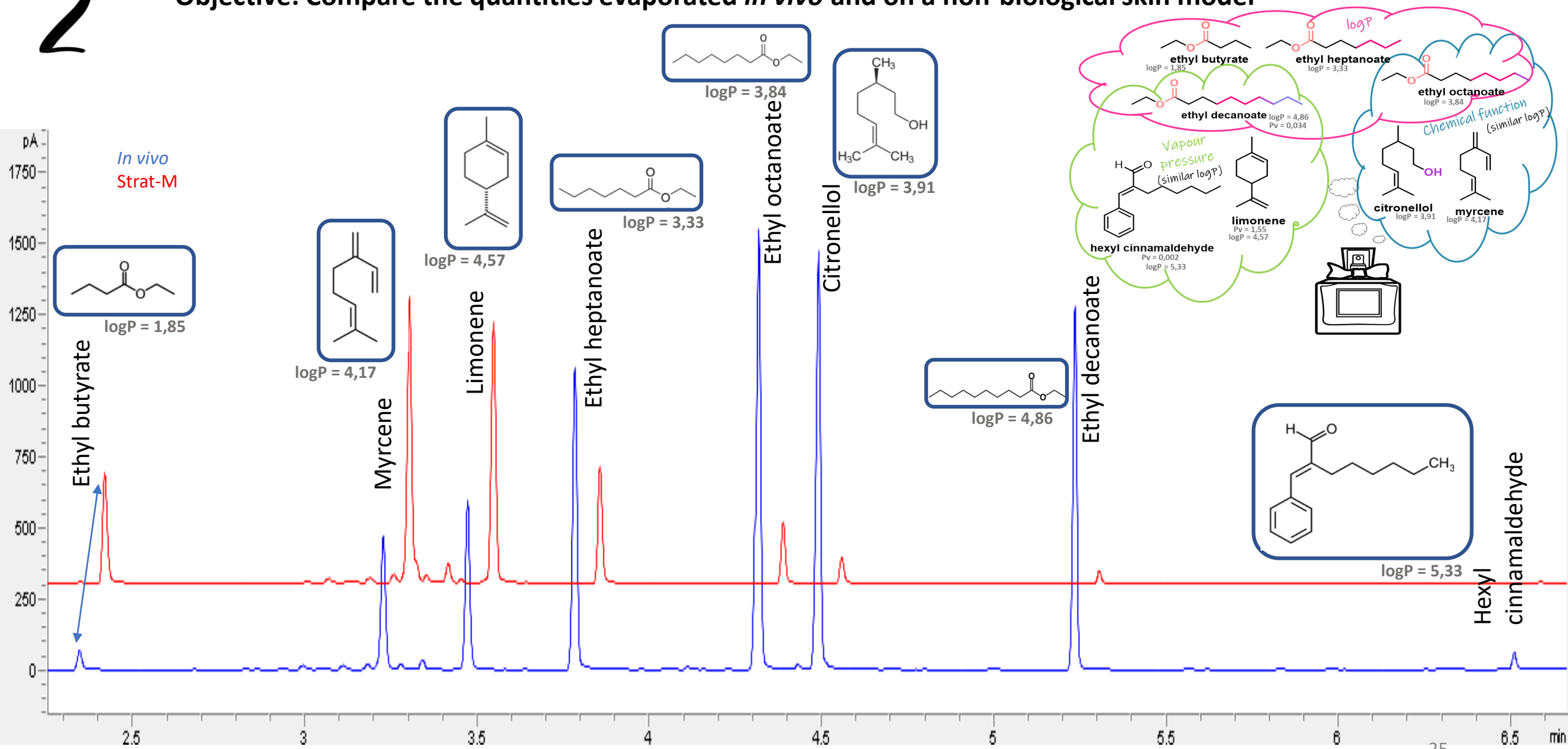

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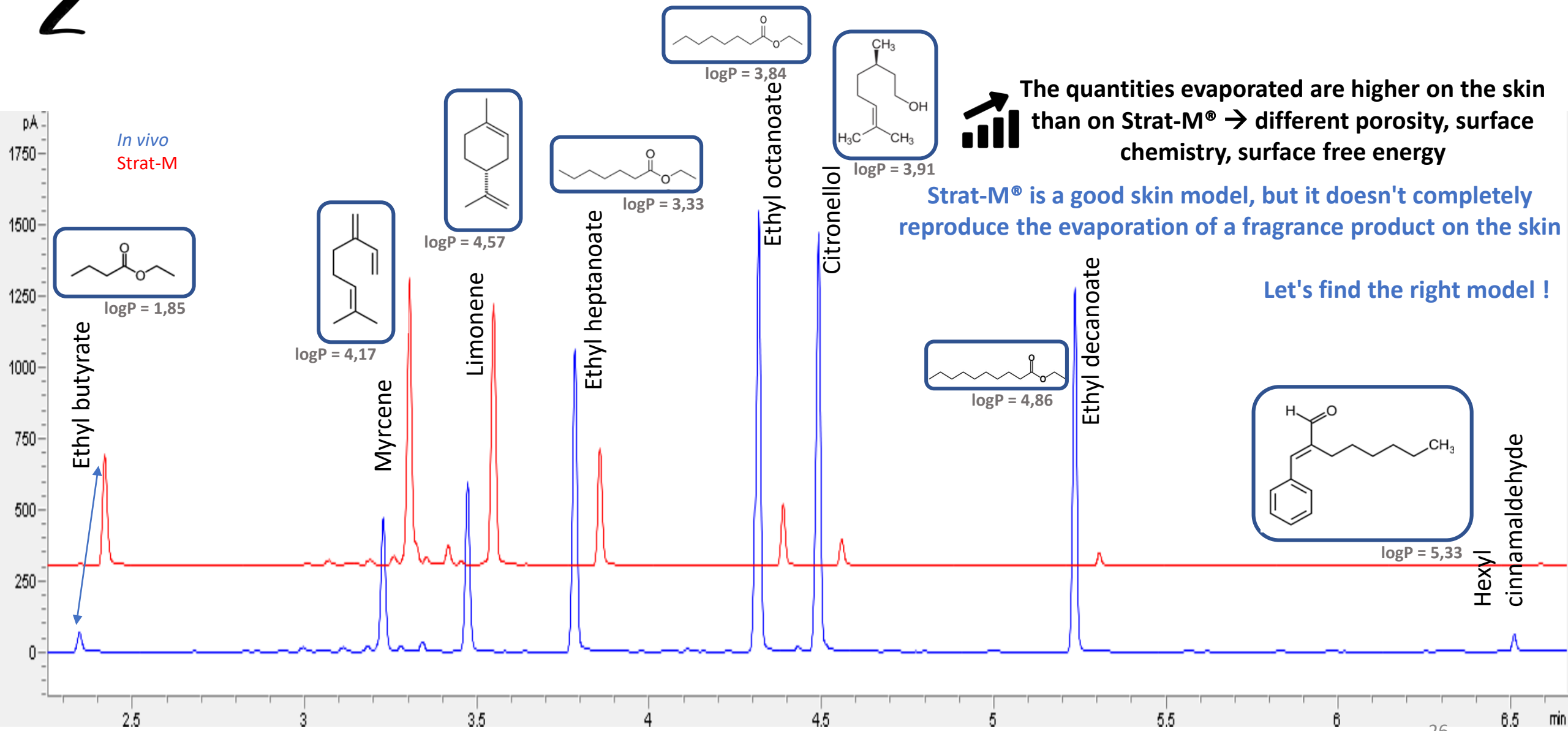

The quantities evaporated are higher on the skin than on Strat-M® → different porosity, surface chemistry, surface free energy

Strat-M® is a good skin model, but it doesn't completely reproduce the evaporation of a fragrance product on the skin

Let's find the right model !

3 Set up an *in vivo* study and highlight the properties of the skin that influence most evaporation

Ten volunteers' arms

Parameters: T_{zone}, pH, hydration, roughness, sebum level measured

Publication submitted

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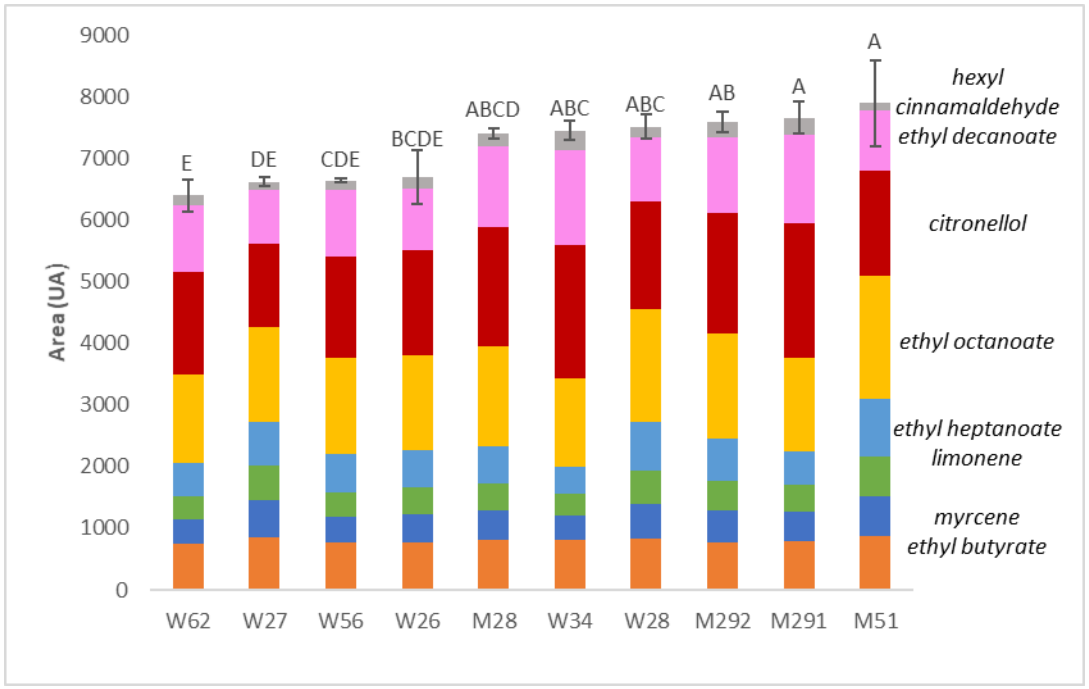

Quantities evaporated for each volunteer obtained by GC-FID when applied to the forearm of each volunteer

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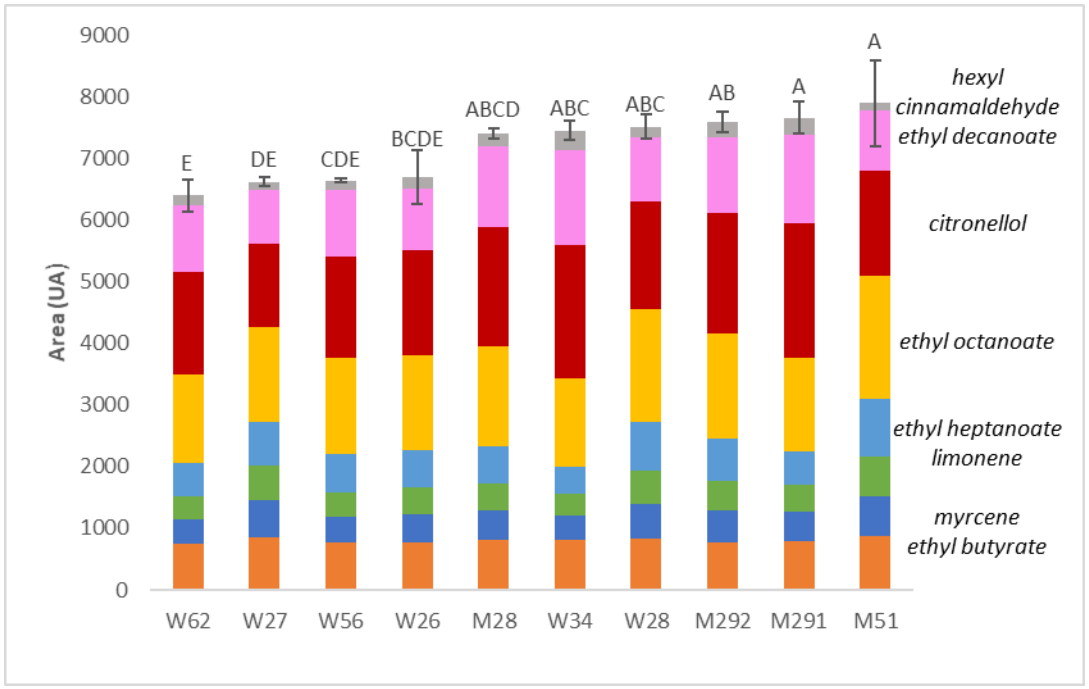

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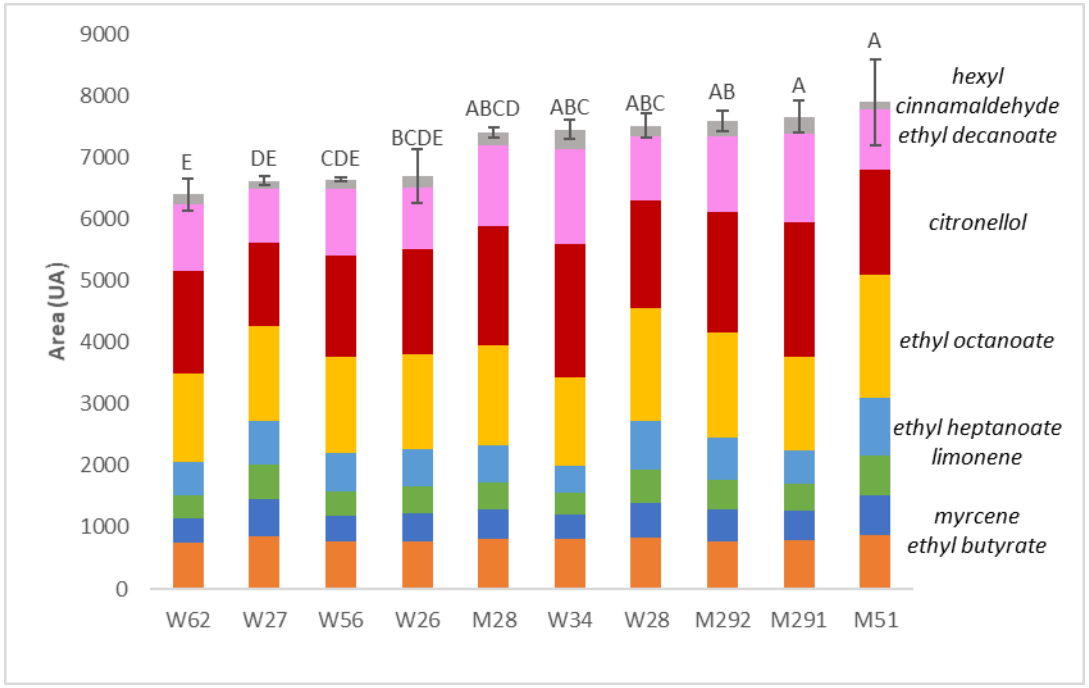

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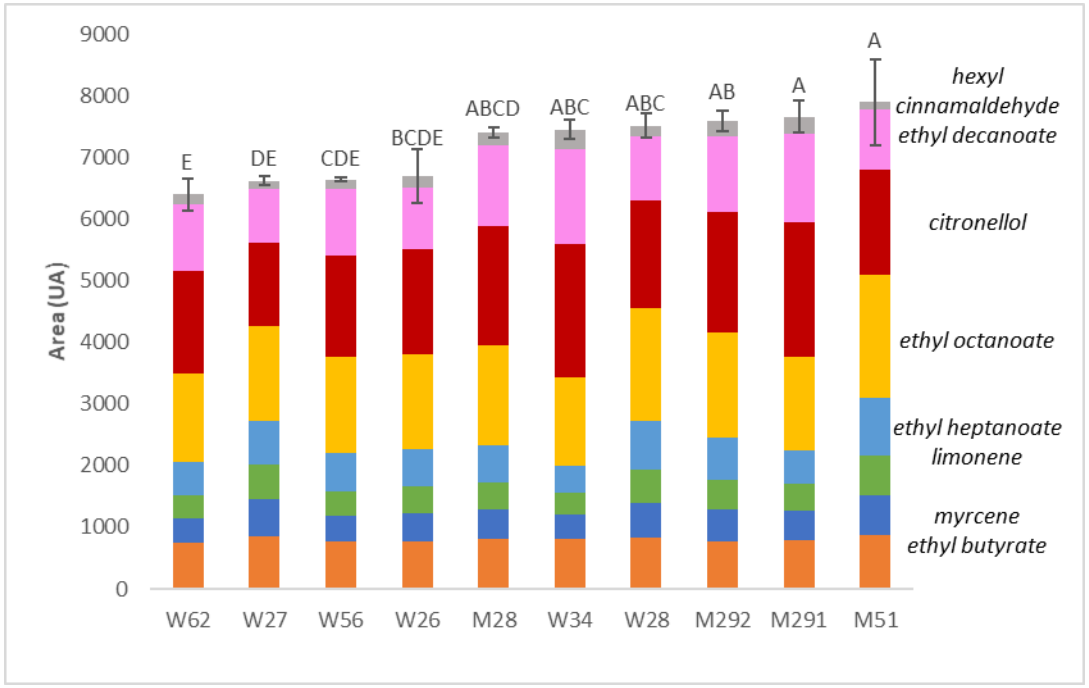
Ten volunteers' arms

Parameters: T_{zone}, pH, hydration, roughness, sebum level measured



Quantities evaporated for each volunteer obtained by GC-FID when applied to the forearm of each volunteer

Results showed that

- Fragrance molecules evaporation influenced by **hydration, TEWL, and roughness**
- Different clusters of fragrance compounds depending on their **intrinsic properties**
- Two patterns of behaviour:
  - the **more volatile** compounds whose evaporation **increases** with **skin roughness**
  - the **less volatile and more lipophilic** compounds **influenced by skin hydration and TEWL**

Publication submitted

4

Objective: Target skin physicochemical properties influencing the release phenomenon

Roughness

Publication in progress

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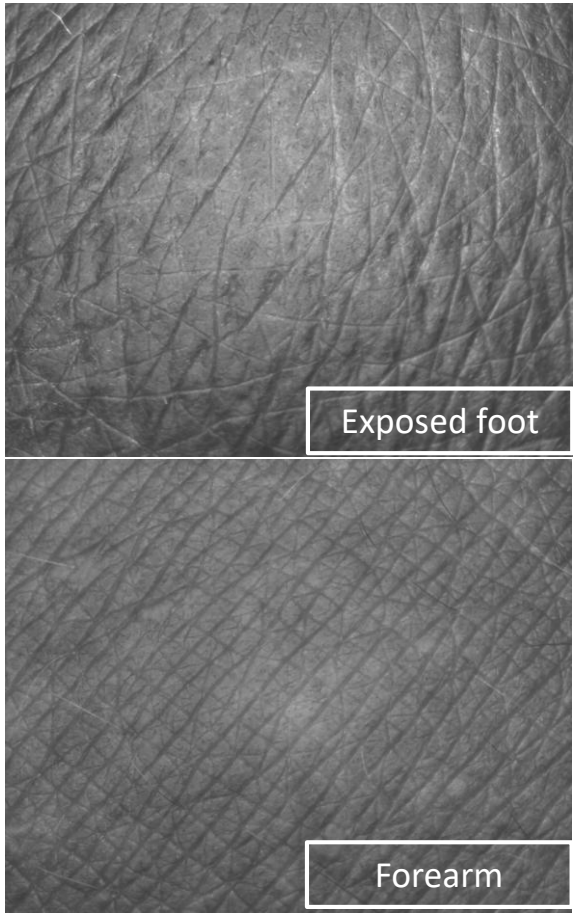

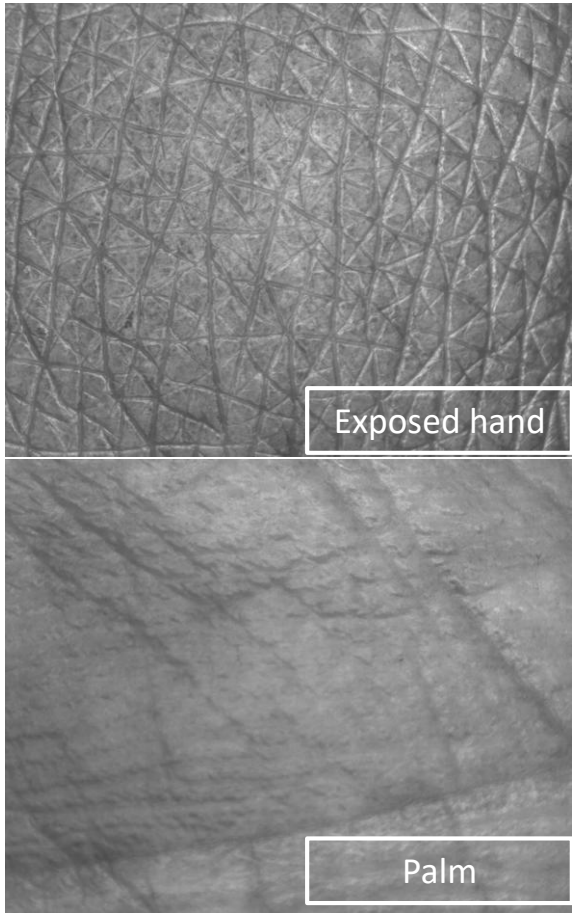

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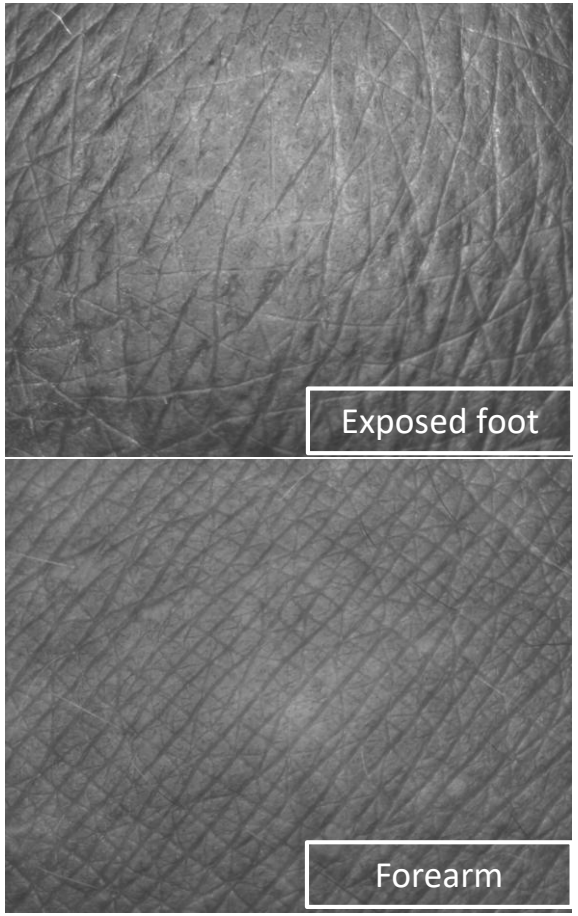
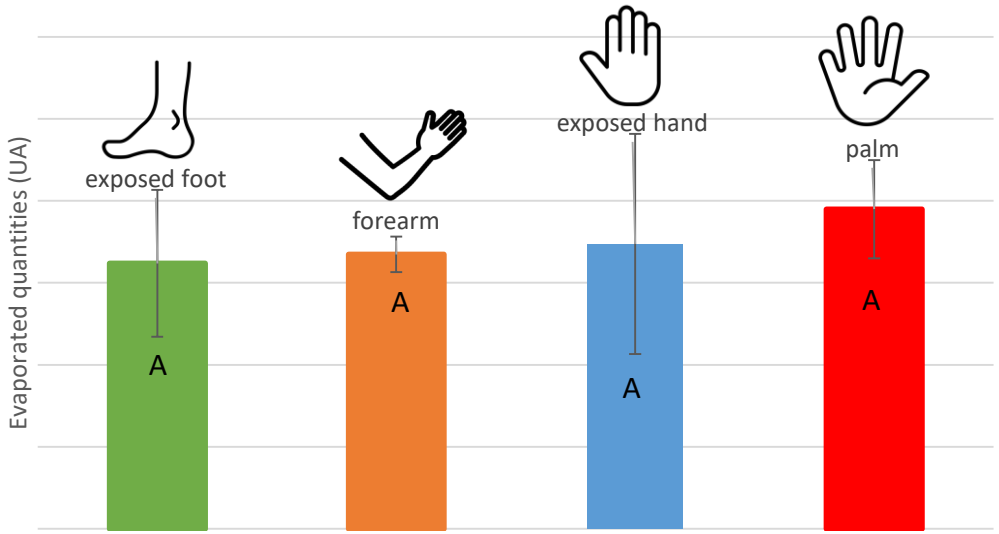
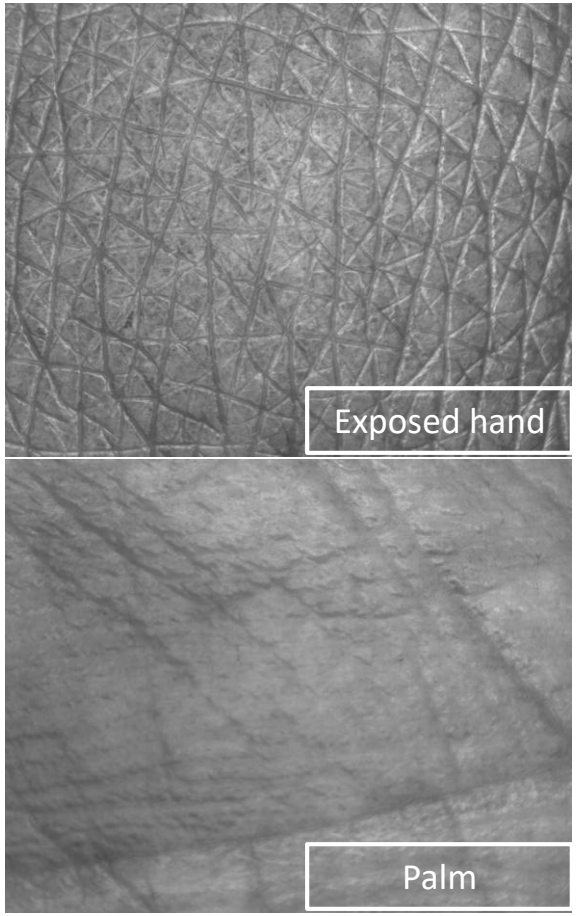




Sum of the quantities evaporated, measured by GC-FID, for each skin area (red: palm, orange: forearm, green: exposed foot, and blue: exposed hand)
Values with different letters denote significant difference (P≤0,05) between areas *in vivo* (A)



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1) Evaporation phenomenon was examined on various skin areas

Skin area	T_{area} (°C)	Hydration	sebum	TEWL	pH	Roughness
Palm	30.56 ± 0.06 (A)	34.83 ± 2.05 (B)	2.00 ± 1.41 (A)	33.23 ± 4.65(A)	5.44 ± 0.06 (A)	4.20 ± 1.35 (A)
Forearm	30.48 ± 0.33 (A)	42.13 ± 2.33 (A)	0.67 ± 0.47 (A)	7.19 ± 1.61 (B)	4.91 ± 0.11 (B)	2.86 ± 0.68 (B)
Exposed foot	28.72 ± 0.69 (B)	38.27 ± 2.85 (AB)	1.67 ± 1.70 (A)	11.80 ± 1.10 (B)	4.98 ± 0.05 (B)	1.29 ± 0.10 (C)
Exposed hand	30.29 ± 0.47(A)	40.37 ± 1.64 (A)	0.67 ± 0.94 (A)	11.18 ± 0.62 (B)	5.43 ± 0.05 (A)	1.13 ± 0.29 (AC)

Summary table of skin parameters (pH, temperature, TEWL, hydration, lipid level) measured on different skin areas (palm, forearm, exposed foot and exposed hand) of one volunteer. Values with different letters denote significant difference (P≤0,05) between areas in vivo (ABC)

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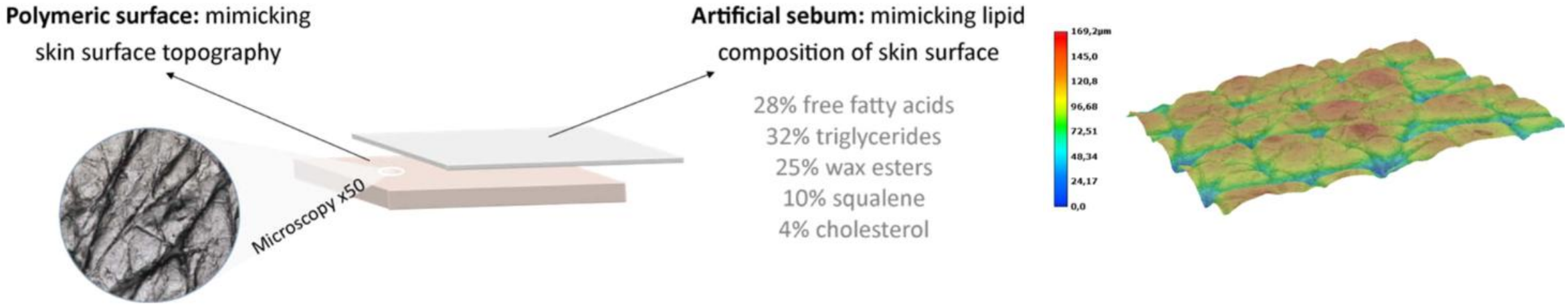

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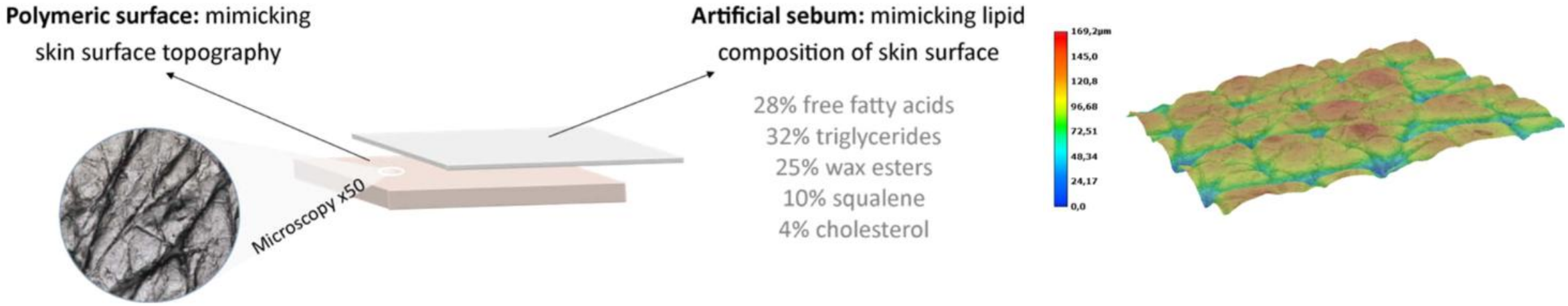

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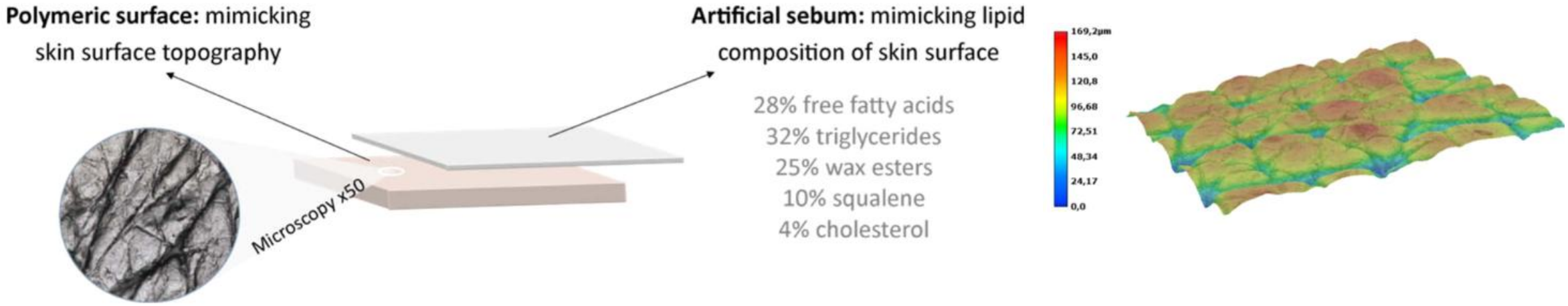

Analysis of the results in progress:

- As skin **roughness increases**, the **specific surface area** available for evaporation also **increases**

→ This greater surface area **enhances the diffusion of volatile compounds** into the surrounding environment

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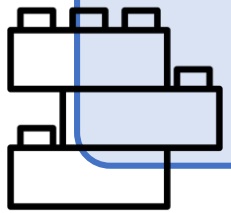
Conclusion & Perspectives

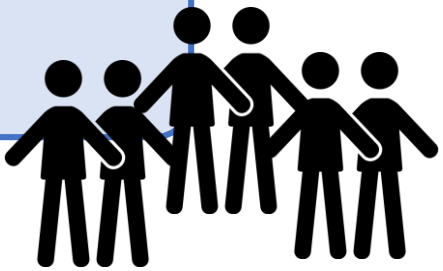


Set up of an innovative, reliable system combining *in vivo/in vitro* measurements to study the evaporation phenomena

Conclusion & Perspectives

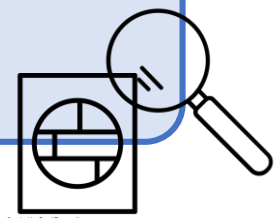
Set up of an innovative, reliable system combining *in vivo/in vitro* measurements to study the evaporation phenomena

Better understanding of the impact of skin physicochemical properties - release of fragrance on the surface of the skin *(with 10 volunteers)*



Conclusion & Perspectives

<u>Aim: Target a material whose evaporation rate is close to that of the skin</u>



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As for the roughness parameter, isolate a property and study its impact on evaporation

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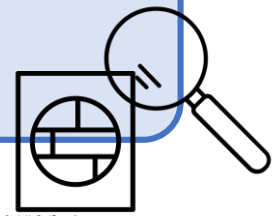

Conclusion & Perspectives

Publication in progress

How does surface properties such as roughness, porosity, surface free energy, and chemistry affect evaporation

Does the olfactory perception on the model material accurately reflect that on human skin?

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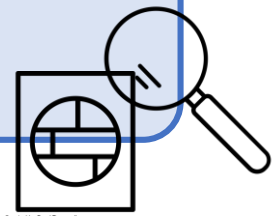

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How does surface properties such as roughness, porosity, surface free energy, and chemistry affect evaporation

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Understand and explain the impact of surface properties on evaporation rates
<u>Aim: Target a material whose evaporation rate is close to that of the skin</u>

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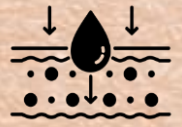
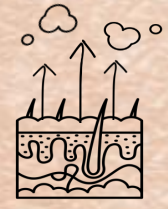
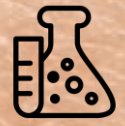



Thank you for your attention

Feel free to contact us:

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