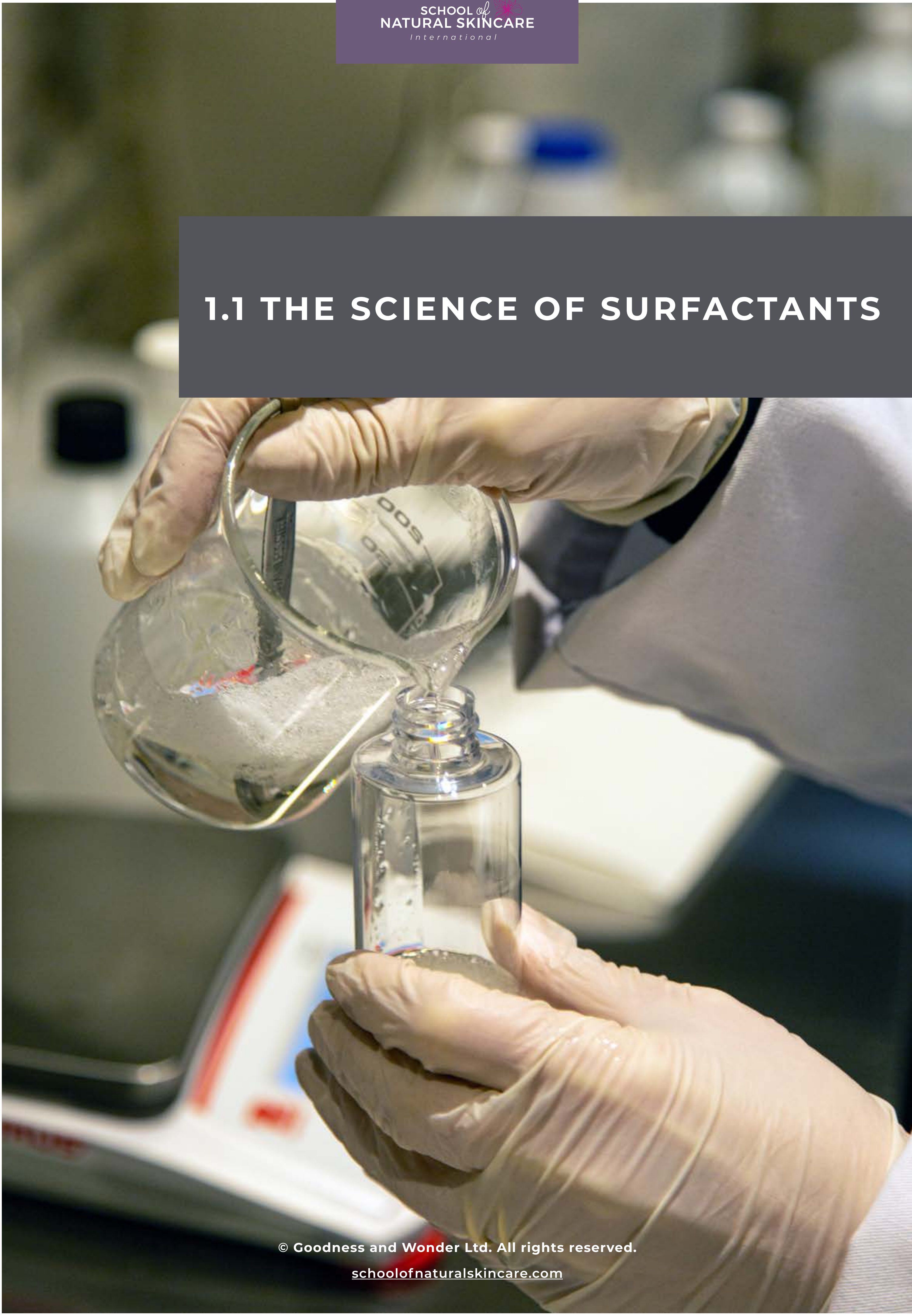
SCHOOL of NATURAL SKINCARE International

1.1 THE SCIENCE OF SURFACTANTS



1.1 THE SCIENCE OF SURFACTANTS

*The word surfactant is a shorter term for **surf**ace **act**ive ag**ent**.*

In this lesson, we will cover:

1. **What is a surfactant?**
2. **The structure of surfactants.**
3. **How surfactant-based cleansing products work.**
4. **Functions of surfactants.**
5. **Hydrophilic Lipophilic Balance (HLB).**

Surfactants are an important category of ingredient in cosmetics. Surfactants function as detergents which help to remove dirt, therefore they are the basis of many types of cleansing products such as face and body washes, hand wash, bubble bath and shampoo.

WHAT IS A SURFACTANT?

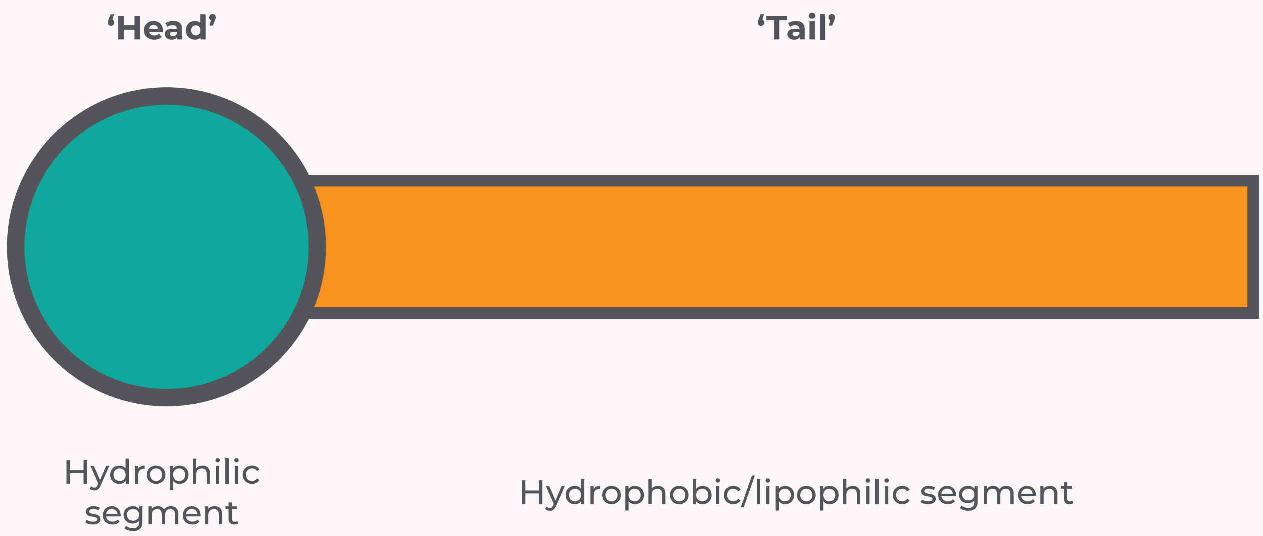
So what is a surfactant? The word surfactant is a shorter term for **surf**ace **act**ive ag**ent**, which actually describes how it functions – it lowers the surface tension between two liquids, between a gas and a liquid or between a liquid and a solid.

To understand what surface tension means, imagine water and oil mixed together. They will not form a homogenous mixture and where the two liquids touch each other (interface) there will be a certain tension, keeping the two liquids separate. If surfactants are added to this mixture, they will lower the tension and allow water and oil to mix.

How is this applied to a product like a face or body wash? Water on its own is not able to remove oils and oil soluble residues from the skin. Surfactants on the other hand, will help oil on the skin mix with water and thus be rinsed off, leaving the skin nice and clean.

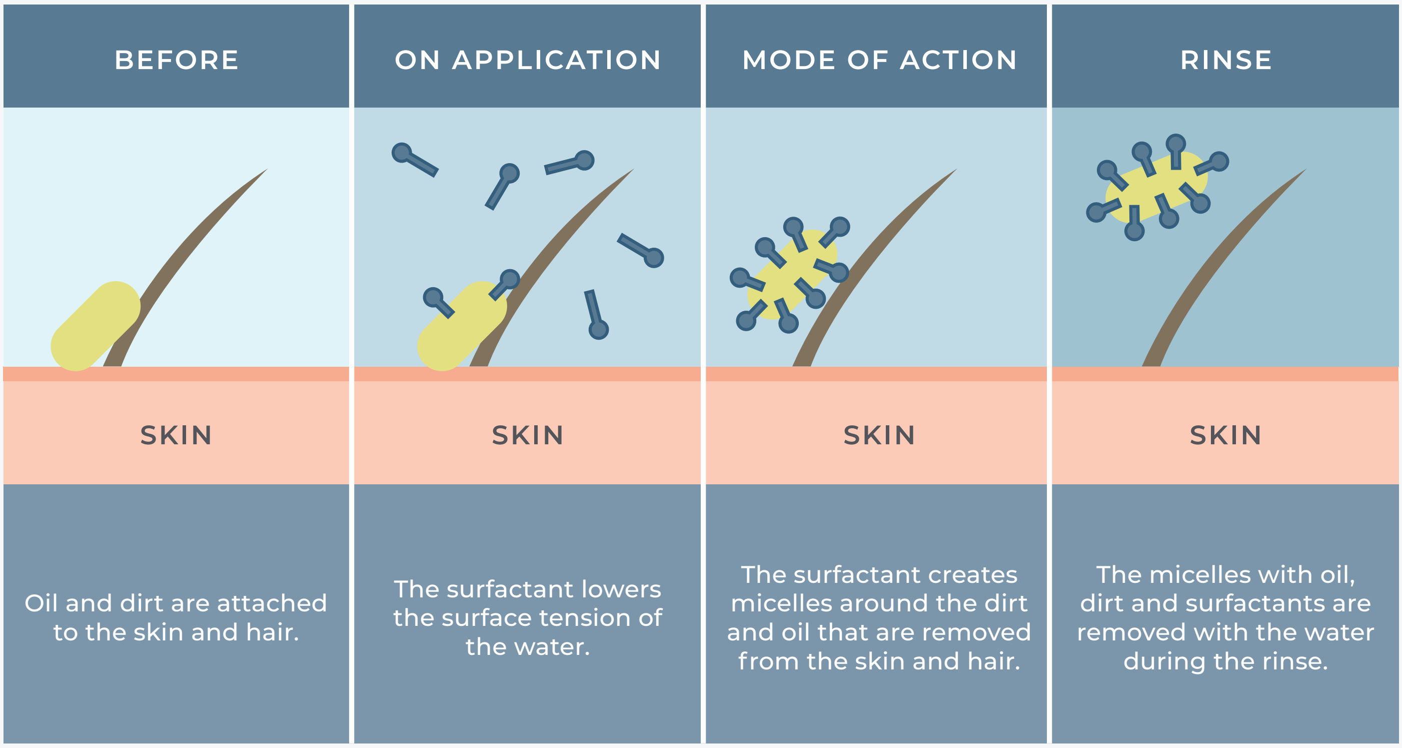
THE STRUCTURE OF SURFACTANTS

A surfactant molecule will always consist of two parts. One part is called the hydrophilic head, which means it is attracted to water and hence is also known as the 'water-loving' part of the molecule. The other part is called the hydrophobic ('water-fearing') tail, also known as a lipophilic ('oil-loving') group since it is attracted to oil. Because of its make-up and the two parts, a surfactant molecule has a dual nature, or amphiphilic nature, meaning that the molecule is attracted to water and to oil at the same time. This gives it unique properties which we will be discussing later in this section.



HOW SURFACTANT-BASED CLEANSING PRODUCTS WORK

The face and body wash ingredients, especially the surfactants (which we will get to know in depth later on), surround and trap tiny droplets of fat (which also contains dirt and pollutants) and thus help to remove it from the skin by rinsing with water.



A surfactant reduces interfacial tension and helps effective dispersion.

FUNCTIONS OF SURFACTANTS

Surfactants have lots of different functions but the main ones we will be focusing on are: wetting, foaming, dispersion, emulsification, detergency, solubilization and viscosity regulation.

1. WETTING

This refers to how a liquid deposits onto a solid or liquid surface and how it spreads out. An example of this is how shampoo and conditioner spreads out onto the hair in order to carry out its function.

2. FOAMING

Surfactants are used to create foam in products such as shampoo, and body, face and hand washes. Foam forms when air is trapped inside so-called 'cells' with liquid film walls.

3. DISPERSION

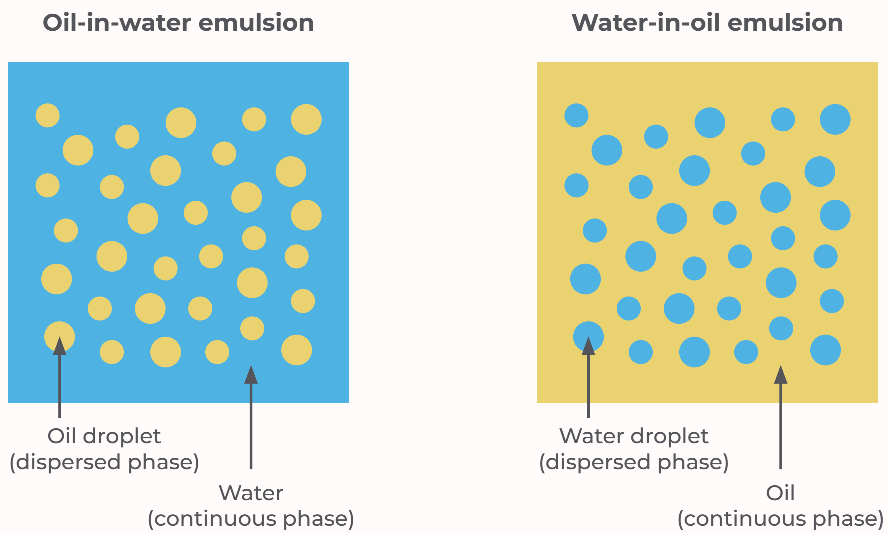
This is normally a powder (solid) dispersed in a liquid. A surfactant reduces interfacial tension and helps effective dispersion.

4. EMULSIFICATION

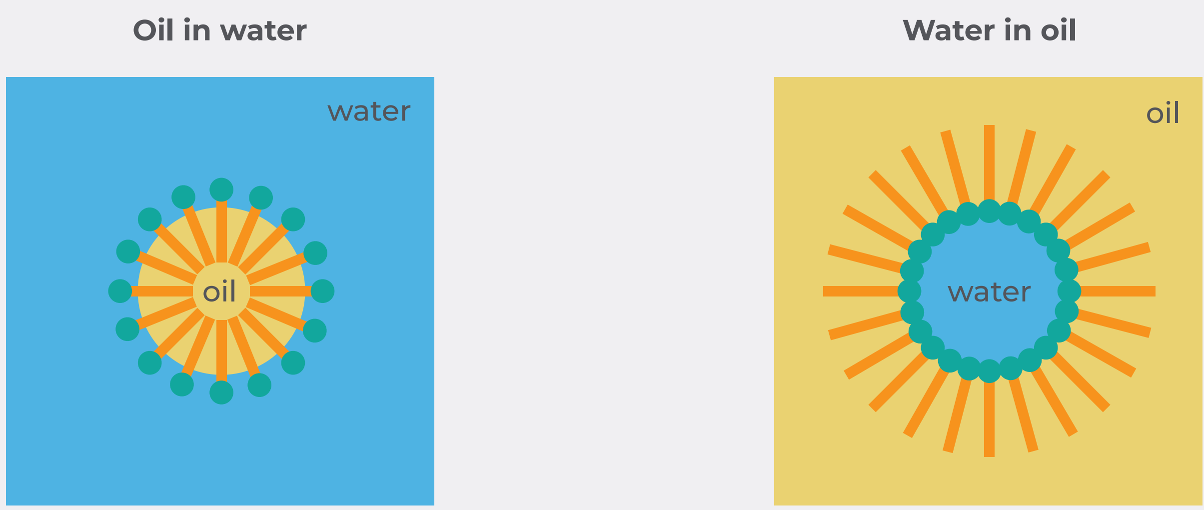
Emulsification is the formation of a dispersed system made of two immiscible liquids (eg oil and water), where one is dispersed within the other in the form of small droplets.

The surfactant is positioned at the oil and water interface, lowering interfacial tension and preventing separation. This is how an emulsifier normally works to allow both oil and water phases to mix.

Below, on the left hand side, we have an oil-in-water emulsion in which the oil droplets are the dispersed phase and the water phase is the continuous phase. On the right-hand side we have a water-in-oil emulsion – the water droplets are the dispersed phase and the oil is the continuous phase.

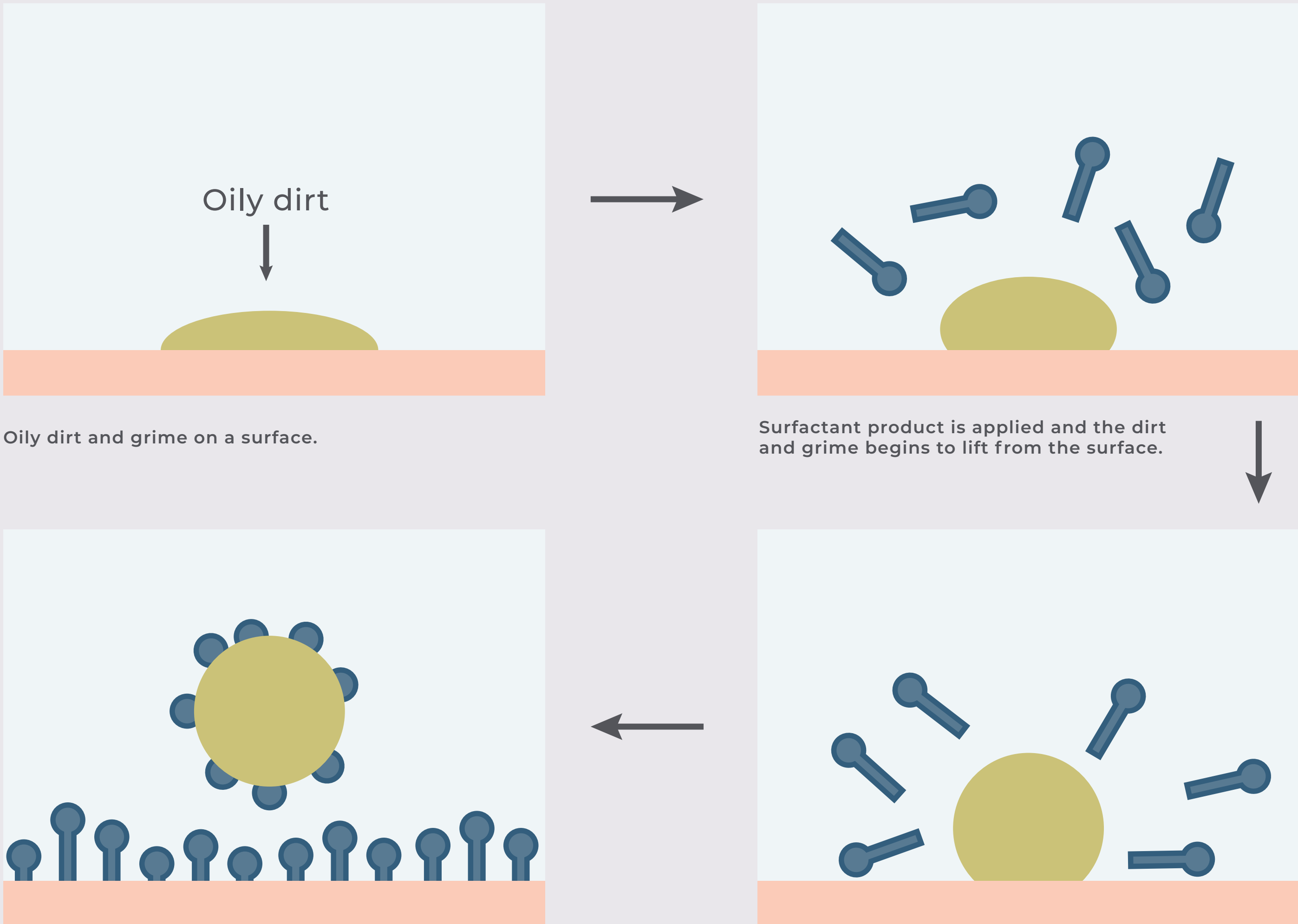


Let us take a look at the arrangement of surfactant molecules in water-in-oil (W/O) emulsions and oil-in-water (O/W) emulsions. Emulsifiers can arrange themselves in two ways, depending on what type of emulsion it is you are making. The most common two types are oil-in-water emulsion and a water-in-oil emulsion. The image on the left (below) shows how a surfactant emulsifier arranges itself in water. In an oil-in-water emulsion, the hydrophobic tails attach themselves to the surface of the oil droplet and the hydrophilic heads are attracted to the water surrounding the oil droplet. For a water-in-oil emulsion, which you can see on the image on the right (below), the inverse occurs with the hydrophilic heads attaching themselves to the water droplet surface and the hydrophobic tails extending into the oil.



5. DETERGENCY

Surfactants have the ability to remove dirt and grime from a surface. The hydrophilic (water-loving) head is attracted to the water and the lipophilic (oil-loving) tail is attracted to the oil in the dirt and grime. These opposing forces loosen the dirt and grime on the surface, eventually suspending it in the water that washes it away.



Oily dirt and grime on a surface.

Surfactant product is applied and the dirt and grime begins to lift from the surface.

The opposing forces loosen the dirt and grime further.

The hydrophilic head is attracted to the water and the lipophilic tail is attracted to the oil in the dirt and grime. These opposing forces eventually suspend the dirt and grime in the water, which washes it away.

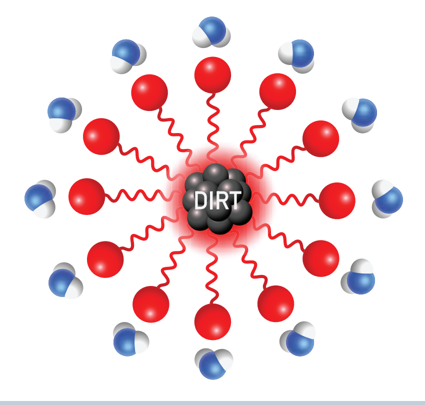
This mechanism is used when we wash our clothes with detergent and when we use shampoo on our hair. Detergency is the function of surfactants that plays a key role in the cleansing action of face and body washes.

High foam does not necessarily mean high detergency, and vice versa.

Notice how foam and detergency are two separate functions of surfactants? High foam does not necessarily mean high detergency, and vice versa. It is only our perception that a product must foam in order to clean well. There are surfactants that do a very good job of cleaning, yet do not produce much foam; these are mainly natural surfactants. In order to satisfy customers' expectations of foaming body washes, surfactants that create good foam can be incorporated into a formula. On the other hand, a less foaming formula is usually perceived as more gentle and nourishing, which can also be used to your advantage.

6. SOLUBILIZATION

Solubilization is the process by which insoluble materials are made water soluble by their encapsulation within micelles. Micelles are a spherical aggregate of surfactant molecules dispersed in a liquid (usually water). Solubilization is required when you want a clear formula but still want to blend oil in a mostly water formula. There are surfactants, fortunately, that can create micelles so small that light can pass through them. This allows the solutions to remain clear. Use of solubilizing surfactants is required when adding essential oils or fragrance oils to a water-based product. For solubilization to occur, oil and surfactant ratios must be at the optimum level. Examples of naturally derived solubilizers include Caprylyl/Capryl Glucoside, Dermofeel G10 LW (INCI: Polyglyceryl-10 Laurate (and) Aqua (and) Citric Acid) and SymbioSolv Clear Plus (INCI: Caprylyl/Capryl Glucoside (and) Water (and) Sodium Cocoyl Glutamate (and) Glyceryl Caprylate (and) Citric Acid (and) Polyglyceryl-6 Oleate (and) Sodium Surfactin).



7. VISCOSITY REGULATION

Surfactants also have the possibility to change the viscosity of the formulation. Oils have quite a low viscosity, as does water. But when the two are mixed with the addition of a surfactant to create an emulsion, the viscosity is greatly increased.

HLB stands for hydrophilic lipophilic balance.

HYDROPHILIC LIPOPHILIC BALANCE (HLB)

HLB stands for hydrophilic lipophilic balance, and this system is used to measure the degree to which a surfactant is hydrophilic or lipophilic.

HLB applies to non-ionic surfactants and their water solubility. So the lower the HLB value, the more lipophilic or oil soluble the surfactant is. The higher the HLB value, the more water soluble or hydrophilic the surfactant is.

The HLB scale

The HLB system is a scale that ranges from 1 to 20. Surfactants which have higher HLB values (normally greater than 10) are more hydrophilic, whilst surfactants with lower HLB values (less than 10) are more hydrophobic or lipophilic. In order for a surfactant to be completely soluble in water, it needs to have an HLB value of approximately 7.3 and higher.

Application	HLB
Solubilizing oils into water	13-18
Detergent solutions	13-15
Oil-in-water emulsions	8-16
Making self-emulsifying oils	7-10
Wetting powders into oils	7-9
Water-in-oil emulsions	4-6
Mixing dissimilar oils	1-3

HLB is useful when you are creating an emulsion or you want to solubilize oils in water, as it can help you select an appropriate surfactant.

Advantages and disadvantages of the HLB system

HLB is useful when you are creating an emulsion or you want to solubilize oils in water, as it can help you select an appropriate surfactant.

The solubility of a surfactant indicates what its likely end use is going to be. Higher HLB surfactants will create oil-in-water emulsions and lower HLB surfactants will create water-in-oil emulsions.

Although the HLB scale does not necessarily give an insight into the properties of the surfactant, it gives a good idea of its relative hydrophilicity compared to other surfactants, and by using the HLB system you can gain a better understanding of how surfactants will behave (which can save you time and money when formulating).

Each non-ionic surfactant will have its own individual HLB value, normally provided by the ingredient supplier. Matching up this HLB value with its required application will ensure good performance. Surfactants can also be combined to achieve the desired HLB value.

The HLB system can be useful, but there are some drawbacks. The HLB system only applies to non-ionic surfactants, it will not tell you how much surfactant to use and it can be confusing for beginners. It is quite a complicated system and not necessarily required in order to formulate with natural emulsifiers successfully.

Natural emulsifiers are usually sold as ready-to-use or complete emulsifiers. This means that they do not require calculating the HLB to successfully determine the types and ratios of surfactants needed to work as an emulsifier. Complete emulsifiers can be used as they are, in the quantities suggested by the manufacturer.

SUMMARY

In this lesson we learned that a surfactant molecule consists of two parts – a hydrophilic ('water-loving') part and hydrophobic/lipophilic ('water-fearing' or 'oil-loving') part. The dual nature of a surfactant molecule means it can function as an emulsifier by lowering the surface tension between water and oil, allowing them to mix. Surfactants can also function as detergents. The hydrophilic head is attracted to the water and the lipophilic tail is attracted to the oil in the dirt and grime, and these opposing forces loosen the dirt and grime on the surface of the skin, hair or clothes, eventually suspending it in the water, which washes it away.