Module 6 – Cosmetic Products for Skin
Practical Cosmetic Formulating
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Objective: After completing this lesson you’ll know the primary hair problems consumer experience, what are the causes and how cosmetic formulators can create products that solve these problems.

Hello and welcome to module 6 – Skin Care Products.

In this module we are going to look at skin care products and the skin care market. We will cover a wide variety of product types, the consumer problems they are trying to solve, and how to formulate. Additionally, we'll, cover the science behind some of the technology in these products.

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Market Data
But first let's begin with some marketing data to give you an idea of the types of products that are out there and the amount of money that is being spent on them. Numbers vary depending on who collects the information or what products are included, but it is estimated that worldwide the skin care market represents over $100 billion in sales. It is the largest of the cosmetic market segments and includes categories such as

Cleansers
Body Lotions
Anti-aging products
Sunscreens
Shaving products
Anti-acne

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According to the data I've collected related to the US market, the largest segment of the skin product market is the Cleanser category. This market sold $5.4 billion in the last 52 weeks and includes a variety of different products such as

Body Wash - $2.35 billion
Bar Soap - $1.8 billion
Liquid Hand Soap - $842 million
Hand Sanitizers - $232 million
Bubble Bath - $176 million

Some of the top body wash brands include Dove, Axe, Old Spice, Dial, Suave and Olay. Interestingly enough, the body wash market is one in which brands targeted towards men perform well versus how men's brands perform in other categories. It turns out men like to be clean too.

I'm most surprised by the size of the bubble bath market. Who knew that there were that many people in the US taking bubble baths?

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Let's next look at the body lotion market. This is a highly competitive one and had sales of about $2.9 billion in the last 52 weeks in the US. Some of the top brands include

Jergens
Vaseline
Aveeno
Nivea
Goldbond
Eucerine

These brands focus on hand and body lotions and moisturizing skin.

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The Anti-aging market is separate from the lotions market with a focus on facial care. It represents a large segment of the skin care market with over $2.1 billion in sales in the last year. It's no wonder that big companies are constantly coming up with products in this large and growing market. The biggest brands include

Olay
L'Oreal
Neutrogena
Roc

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Here's another significant market for skin care products, the Sunscreen market at $1.3 billion in yearly sales.

Some of the top brands include
Coppertone
Banana Boat
Private Label
Hawaiian Tropic
Neutrogena

You'll note here that Private Label is a top brand. Private Label refers to store brands and not something produced by one of the big cosmetic product manufacturers. Store brands are typically produced by a contract manufacturer and made to the specifications of the store that happens to be selling them. You'll find private label brands in nearly all categories. They typically position their marketing such that they look just like a market leading product but the packaging is slightly different and the price is significantly less.

Hopefully, this quick review of the skin care market will give you an idea of who the big producers are and also the expectations that consumers have for their products. Even though you may not be interested in copying the formulations of these big companies it is important for you, as a professional cosmetic chemist, to have a good grasp on what people expect from the lotions and other skin products that they buy. It is only after you understand the existing products that you can competently modify them to make them unique to you.

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Now that we've covered much of the skin care market we're going to get into the formulation of these products. In each section we'll cover the variety of product types currently being sold, the consumer problems trying to be addressed, the science and technology used to solve the problems, and then example formulations.

The primary segments we will cover include

Cleansing
Moisturizing
Sun protection
Anti-aging - Cosmeceuticals
Sunless Tanners
Skin Lightening
Shaving

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**Cleansing products**

Since it is the largest market, let's begin by discussing the skin cleansing market. All consumer products are designed to solve some type of consumer problem and these products are no different. Of course the main problem that cleansing products attempt to solve is to clean skin.

**Consumer problems**

Skin gets dirty due to a number of factors. First, based on the way that skin grows it naturally gets covered with oil (sebum) and dead skin cells. When these build up on the surface of skin they can attract other types of dirt such as small particles from the air, chemical vapors, pollen, or dust. Skin can also get dirty due to whatever activity the consumer may be engaged in like eating food, painting, applying makeup or even gardening. Additionally, skin is home to a large population of microorganisms that eat, reproduce, and create waste that is left behind. This can lead skin to feel greasy, dry, grimy, and even smell. People have long sought products that would remove dirt and restore skin to a more appealing state.

The first products created to solve the problem of dirty skin were soaps. No doubt they method from producing them was accidentally discovered in some ancient fire pit where our ancestors were cooking animal meat. The fat from the meat likely dripped onto some wood ash (which contains alkaline ingredients like sodium or potassium hydroxide) and reacted to form a solid soap. The first cosmetic formula for soap was recorded on a Babylonian clay tablet dating from 2200 BCE.

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While soap is a good technology for cleaning the skin and it's still used today, it can also lead to problems associated with dry skin. These include symptoms such as

Tightness
Roughness
Itching
Flaking, scaling or peeling
Fine lines or cracks
Redness
Deep fissures that may bleed

Later in this lesson we'll talk more about the issues of dry skin, but for skin cleansing products it is not enough for formulators to create a product that just cleans the skin. It has to clean the skin without causing any of the problems of dry skin. And there are a number of other stipulations that your formula must usually have. Yes, it needs to clean the skin but it also should do that in a mild and safe way without causing dryness. It also needs to rinse off quickly and easily. Additionally, you're going to want to create something with a luxurious foam to signal to the consumer the idea of skin moisturization (even if it's not really doing that). Finally, in today's world the product should also be suitably biodegradable.

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Skin Cleansing Products
There are a wide range of skin cleansing products which are marketed in different ways. The biggest segment is body washes which are very much like shampoos when it comes to formulation. The marketing of these products focuses less on the cleansing aspect of the formula and more on what it will do to skin after using it. Popular body wash types include those that are focused on skin moisturizing. You'll also see them referred to as Hydrating or Nourishing or some other language like this. Then there are “experiential” body washes. These are products that are designed to give the consumer a pleasing experience while using the product. They are often driven by fruity or floral scents that are appealing to consumers. There are also products that focus on “gentleness” such as Baby body washes or those for people with sensitive skin.

Some body washing focus more on their cleaning ability and specifically the antibacterial claim which many consumers find appealing despite the lack of evidence that antibacterial ingredients in body wash have any additional benefit over standard formulas.

Recently, there has been a push to sell anti-aging body washes or body washes that are designed to support anti-aging products. There is little evidence you can get anti-aging benefits from a body wash but people seem to like the products anyway.

Finally, there are practical body washes that double as both Shampoos and body washes. The products can be very similar and in fact, when the company I used to work for launched their first product in the body wash market, they simply took one of our standard shampoo formulas and added some additional conditioning ingredients. I still actually use shampoo as a body wash.

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Another significant type of product in the cleansing field is Liquid hand soaps. These products are pretty much the same formulations as body washes but they are marketed slightly different. Most of them are sold in pumps or as concentrates that get put into pumps. The focus of the marketing stories are also on more functional aspects such as odor reducing or antibacterial products but there is also an emphasis on hand moisturizing. Additionally, pump versions which come out as a foam to help reduce water use and speed up application are popular. Big brands tend to dominate this market including Dial and Softsoap. However, there are a number of smaller, “natural” brands that have carved out significant market share. In the US these include brands like Method, Kiss My Face, and Seventh Generation.
While hand and body cleansers can be used anywhere on the body there is also a significant market for products targeted specifically for the face. Facial wash products are theoretically more mild but also are designed to provide additional benefits such as anti-acne, exfoliation or anti-aging benefits.

In the US, bar soaps are not classified as cosmetics unless they make some type of cosmetic claim. This is due to some quirk in the legislation that created the framework for the regulation of the cosmetic industry. However, most of the solid cleansing products sold in the US are not strictly soap bars because they make cosmetic claims. If you make any claims that would be considered cosmetic such as “moisturizing”, “hydrating” or “fresh feeling” your product would then be considered a cosmetic and subject to FDA regulations. Solid cleansing products like these are typically referred to as bath bars or beauty bars.

One relatively new area for skin cleansing is Hand Sanitizers. This market has grown significantly since the mid 1990's and now represents over $200 million in the US alone. The products are basically gelled versions of alcohol or some type of leave-on foam product.

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Skin Cleansing Technologies
Before we talk about specific formulations let's review the types of technologies that are used to make skin cleansing formulas.

Generally speaking, skin cleansing formulations take the form of liquid solutions, loose emulsions or solid bars with liquid solutions being the most common.

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Cleansers – Body Washes & Liquid soaps
As you might imagine the primary technology driving skin cleansing formulations is surfactants. In previous modules we talked about the science of surfactants and the way that they remove dirt from surfaces. One of the key aspects of surfactants used in skin cleansing formulas is the requirement that they must be mild. Or more specifically, the end formulations have to be mild.

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How do we make formulations mild?
Mildness basically means that the formula is able to perform its primary function without causing unacceptable negative after effects. This means that the formula must be non-irritating, cause no allergic reactions, and be non sensitizing. Since we are all genetically different and react to chemicals in different ways, it's practically impossible to create a product that is mild for every consumer. The best you can hope for is making a product that is mild to the vast majority of users. To do that you can first choose mild surfactants as your primary functional ingredient in the formula.

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Mild surfactants can be either anionic, amphoteric or nonionic. As with shampoos, anionic surfactants are the most often used ingredients for body washes and liquid soaps. That is because they clean the best, foam well, are easily rinsed, and are less expensive. There are a number of different anionic surfactants you can use for formulating body washes. Here are some examples along with their irritation potential.
<table>
<thead>
<tr>
<th>Surfactant</th>
<th>Irritation Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acyl Phosphates</td>
<td>Low</td>
</tr>
<tr>
<td>Acyl Polypeptides</td>
<td>Low</td>
</tr>
<tr>
<td>Acyl Sarcosinates</td>
<td>Extremely low</td>
</tr>
<tr>
<td>Acyl Taurates</td>
<td>Low</td>
</tr>
<tr>
<td>Alkyl Ether Sulfates</td>
<td>Mildly irritating</td>
</tr>
<tr>
<td>Alkyl Sulfates</td>
<td>Higher</td>
</tr>
<tr>
<td>Isethionates</td>
<td>Low</td>
</tr>
<tr>
<td>Soap</td>
<td>Higher</td>
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</tbody>
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Of course these are only approximate irritation scores and the irritation potential of your formula will depend on the other ingredients in the formula. You can make a perfectly fine, non-irritating cleanser using Alkyl Sulfates if you include other ingredients to offset the irritation.

In case you were interested the term “Acyl” refers to the structure of the molecule. It is any molecule that features a hydrocarbon chain reacted with a C=O but missing the C-O bond that would create a carboxylic acid. Here are some surfactant molecules that will give you a better sense of what those general names mean.

As far as what is used, the most successful and best selling cleansing products use mild anionic surfactants as their base formula. In fact, the formulas are incredibly similar.

Aveeno - Sodium Laureth Sulfate, Cocamidopropyl Betaine
Dial - Sodium Laureth Sulfate, Cocamidopropyl Betaine
Dove - Cocamidopropyl Betaine, Sodium Laureth Sulfate
Axe - Sodium Laureth Sulfate, Cocamidopropyl Betaine
Old Spice - Sodium Laureth Sulfate, Cocamidopropyl Betaine

A more “natural” based formula like Burts Bees uses anionic surfactants blended with amphoteric surfactants.

Burts Bees - Decyl Glucoside, Lauryl Glucoside, Sucrose Laurate, Cocoamidopropyl Betaine

Another strategy to making mild cleansing products is to use Amphoterics and Nonionic surfactants. Amphoterics are the most popular because they are fairly good cleansers, have minimal irritation potential, and are thought to be substantive to skin so they can provide some conditioning effects. Typically, they are blended with anionics to produce a superior effect that can't be achieved using either surfactant alone.

Common examples include Cocamidopropyl Betaine and Sodium Lauriminodipropionate.
Nonionic surfactants are the third surfactant option for cleansing formulas. They are good for cleansing but are not particularly good for creating the flash foam that consumers expect. For this reason they are used as secondary surfactants except in formulations in which foam is not the primary driver of purchase (e.g. natural formulas).

There are three types of nonionic surfactants used in cleansing formulas including Alkyl Glucosides, Amine Oxides and Poloxamer. The alkyl glycosides like Decyl Glycoside or Lauryl Glucoside are fully biodegradable, have adequate foam and are good cleansers. They are less stable at lower pHs so when you formulate with them you need to keep your pH higher than most cleansing formulas. Amine oxides like Lauramine Oxide are good foam boosters. Poloxamers are actually block copolymers that have foaming properties and function in the same way as other surfactants. They are typically combined with other surfactants to improve mildness and help stabilize foam.

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In addition to choosing more mild surfactants, conditioning ingredients are also used when formulating body washes and other skin cleansers. To improve foam fatty alcohols such as Cetyl or Stearyl alcohol are used. To add conditioning effects any number of humectants, occlusive agents, emollients and polymers can be used.

Some common examples include

Humectants like Glycerin and Propylene Glycol
Occlusives like Petrolatum & Mineral Oil – although these are tricky to include in a body wash because they will significantly reduce foam.
Emollients such as Shea Butter or Dimethicone
Polymers like Guar Hydroxypropyltrimonium Chloride

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**Cleansing Products – formulation controls**

As you may have guessed formulating body washes and liquid soaps are very much like creating shampoos. That means you will have control over characteristics such as the...

Appearance – both color and opacity
Thickness
Odor
Cleansing effectiveness – how stripping it will be to skin
Skin feel – what skin feels like after using the product

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That also means that you will use pretty much the same type of ingredients to make the formula including

Diluent (water)
Surfactants
Thickeners
Conditioning ingredients
Aesthetic modifiers - Color, Fragrance, Preservatives
Feature ingredients

Let's look at this example LOI and see if we can identify the ingredients and what they are likely doing in the formula. This is one of the best selling body washes on the market Aveeno Active Naturals Body Wash. It is a moisturizing formula that claims to “help replenish skin's natural moisture”. So the focus of this formula is on the way it leaves skin feeling – not as much on skin cleansing.

Now let's reorganize the ingredients based on what they are doing in the formula. Of course Water is the first ingredient as it is the primary diluent. In fact, water probably makes up about 85% or more of this formula.

The main surfactants are the amphoteric Cocamidopropyl Betaine, the anionic Sodium Laureth Sulfate & Sodium Lauroampho PG Acetate Phosphate, and the nonionic Decyl Glucoside. This blend will give them a lower foaming product but it will have a creaminess which signals moisturizing. Remember body washes do not have to be heavy duty cleaners, especially ones that position themselves as “natural.”

There are a number of conditioning ingredients in this formula but the ones that will have the primary effect include Glycerin and Guar Hydroxypropyltrimonium Chloride.

Since this is a moisturizing formula it is important to make a pearlized or opaque appearance and for this reason the Glycol Stearate is added.

The formula also has a fragrance and a Quaternium-15 based preservative system. Then it also has standard adjustment ingredients Citric Acid to lower pH and Sodium Hydroxide to increase it.

To support the marketing position of “active natural” there are a number of natural extracts and oils included. There are all the “Avena” ingredients to support the Aveeno brand name - Avena Sativa (Oat) Kernel Flour, Avena Sativa (Oat) Kernel Extract, Avena Sativa (Oat) Kernel Oil. It's likely the company buys this as a standard blend and adds it to all of its formulas. They also have some oils, proteins and starch, Soja (Soybean) Seed Oil, Helianthus Annuus (Sunflower) Seed Oil, Hydroxypropyltrimonium Hydrolyzed Wheat Protein, and Hydroxypropyltrimonium Hydrolyzed Wheat Starch. In truth with the amount of surfactants in the formula it is unlikely that you would notice any difference whether these ingredients were included or not. They are just marketing ingredients added at low levels because they look good on the label.

Skin Cleansing Formulas

Next we'll take a look at some actual skin cleansing formulations and how they are made. In this section we will cover a basic body wash, a moisturizing body wash, a baby or gentle formula and one that could pass for a natural formula. We will also cover a bubble bath formulation.
Here is an example of a basic body wash. It is a solution formulation and is made by simply combining the ingredients while mixing. The surfactant system is a combination of anionic surfactants (ALS and ALES) plus some nonionic and amphoteric surfactants to reduce irritation and improve the creaminess of the foam. Also to offset some of the surfactant harshness a large level of Glycerin is included. Most of this will be washed away so it won't have much effect on the skin after feel. To improve that Polyquaternium-7 is included. It is a cationic polymer which will be left behind on the skin after rinsing.

This formula is created to have good flash foaming and clean rinsing. It is clear and has a high level of fragrance so it can support a number of marketing positions, particularly ones that would be classified as “experiential.”

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Moisturizing Body Wash Formula

This next formula is an example of a moisturizing body wash. It has a slightly different surfactant system featuring the anionic Sodium Laureth Sulfate and Sodium Cocoylglyceryl ether Sulfonate as the primary surfactants plus Cocamidopropyl Betaine and Sodium Lauroyl Sarcosinate as the secondary surfactants. These latter surfactants will reduce the irritation potential of the first and boost foam. They will also provide a moisturizing, creamy feel during formula use. A much higher level of Glycerin is used in this formula to also offset the surfactant harshness and to boost the moisturized feel of the product on the skin. For a good after feel the cationic polymer Polyquaternium-10 is used since it won't be easily rinsed away. Since this is a moisturizing formula, Glycol Stearate is used for opacification and Xanthan Gum is included to help ensure it remains stable. There is a slightly lower fragrance level used because this is a more functional marketing position instead of experiential.

You can expect to get a bit less foam while using this formula since it has a much higher level of conditioning ingredients. After using the product the skin should feel more moisturized.

Of course you can experiment with substituting out different surfactant blends, conditioning ingredients and levels of conditioning. This formula is a good starting point though.

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Baby body wash formula

For some people the previous formulations will be too harsh so it is good to have a mild formulation in your lineup. Here is a formula which uses the more mild detergents of Cocamidopropyl Betaine, PEG-80 Sorbitan Laurate and Sodium Trideceth Sulfate. PEG-150 Distearate is also used to help improve foaming levels. This formula avoids high levels of anionic surfactants and instead focuses on amphoterics and nonionics. For this reason you can expect a lower level of foam production and a slightly moisturized feel after rinsing. Also, while there is 0.5% fragrance in this formula it would work without a fragrance too if you wanted to increase the mildness even more.

Remember formulations like this are a trade-off between foam/detergency and mildness. The more mild you make something the less well it will foam or clean. Fortunately, body washes are not usually required to be ultra cleansing.

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Natural body wash formula

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Just to give you a sense of what a natural formulation would look like here is a solution body wash formula you could create. Now, standards for “natural” differ but all of these ingredients could be described as derived from plants or renewable resources so for most people that will suffice. The surfactants are nonionic alkyl glucosides including Lauryl Glucoside and Coco Glucoside. Cocamidopropyl betaine (which is derived from coconut oil) is used as a foam booster. The foam quality on this formula will be fairly low though it will feel moisturizing due to the substantivity of the betaine. The preservative avoids parabens and formaldehyde donor molecules using Phenoxyethanol, Benzoic Acid, and Dehydroacetic Acid instead. This preservative has been shown to work for some systems although it is not particularly robust. For additional moisturizing Sucrose Cocoate esters are included. There is also room to add claims ingredient like herbal extracts or naturally derived oils. These ingredients wouldn't be expected to do much in the formula but they do support the natural positioning.

Before moving on I just want to point out that we haven't specifically covered a Liquid Soap formulation. This is because there really is no significant formulation difference between a Liquid Soap formula and a body wash formula. You could simply use the basic body wash formula, put it in a liquid soap pump container and sell it as such.

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Bubble Bath formulation

A liquid bubble bath formula is not much different from a standard body wash however since the user will soak in the detergent for longer a lower level is used and it's better to use non-irritating ingredients. In this formula Disodium Laureth Sulfosuccinate and Disodium Cocamid MIPA Sulfosuccinate are mild anionic surfactants which offset any irritation that goes along with the Sodium Laureth Sulfate. The Hydroxyethylcellulose is included in the formula to both thicken, stabilize the foam and make it last longer. To ensure that there is long lasting foam no additional conditioning ingredients are added since they can reduce foam levels & stability. As you can see this is a rather simple solution formula.

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Skin Cleansing Formulations – Facial wash

There are a number of different types of products that are marketed towards the care and cleansing of the face. Typically, these formulas are marketed as more mild than standard body washes or liquid soaps however if you review the products that are on the market, they use many of the same surfactants and technologies. For example, here is a popular facial cleanser marketed as a moisturizing facial wash.

Water (Aqua), Sodium Laureth Sulfate, Decyl Glucoside, Cocamidopropyl Betaine, PEG 55 Propylene Glycol Oleate, Propylene Glycol, Panthenol, Tocopheryl Acetate, Bisabolol, Anthemis Nobilis Flower Oil, Pelargonium Graveolens Oil, Glycol Distearate, Sodium Hydroxymethylglycinate, Polyquaternium 39, Laureth 10, Cocamide MEA, Sodium Chloride, PEG 7 Glycerol Cocoate, Disodium EDTA, Dipropylene Glycol, Methylparaben

Notice the similarities? It contains SLES, Cocamidopropyl Betaine, and Decyl Glucoside. There are a number of conditioning ingredients such as Polyquaternium-39, PEG 7 Glycerol Cocoate, and PEG 55 Propylene Glycol Oleate which we discussed before but these are standard ingredients included to both offset the harshness of the surfactants and to provide some nice skin after-feel.
It should be noted that this formula likely contains a lower level of surfactants than a standard body wash. Instead of the 10-15% detergent as in the previous formulas, this formula contains more like 5-7% detergent.

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**Scrubbing facial wash formula**

A popular type of facial wash is a scrubbing cleanser. This product is not expected to have a high level of foaming and can have a wide variety of thickness. Facial scrubs can be standard cleansing formulas with suspended polyethylene beads in them (these have come under fire recently for doing damage to the environment). Or they can be thick paste like formulas with pumice or other scrubbing materials in them.

Here is a scrubbing cleanser that is a thick paste and contains a variety of scrubbing materials.

The Carbomer is needed to keep the particles suspended and the Triethanolamine is there to neutralize the polymer. The primary exfoliant is the walnut shell powder although pumice could also be used. To aid in removal and cleansing there is a low level of surfactants. To help with the texture and feel of the product Isostearyl Isostearate is used plus Glyceryl Stearate.

It's worth noting that a product like this is thought to help with exfoliation but there is little published evidence that it does. There is even less evidence that products containing polyethylene beads help exfoliate any better than using a standard body wash and a wash cloth. However, consumers like these products and it makes them feel like they are doing more for their skin so that's why they sell so well. You need to be careful not to add too much scrubbing materials as it may be too harsh for people with sensitive skin.

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**Cleansing Cream formula**

Another type of common skin cleansing formula usually used on the face is a cleansing cream. These are emulsions with a high oil phase. The way they work is that you apply the thick product to the face then wipe it off to remove.

Here is a standard cleansing cream formulation. It is a water in oil formulation that contains a high level of both Mineral Oil and Petrolatum. Stearic acid and Glyceryl Stearate are included to emulsify the system and keep it stable. The Isopropyl Myristate will have an emollient effect but it will also help dissolve some of the residual oils on the face. The product is made in two phases with the water compatible ingredients mixed and heated in one vessel and the oil compatible ingredients in another. The two phases are blended when they reach the appropriate temperature and cooled after adequate mixing. The end product will be a thick, stable, white cream that is meant to be applied on dry or damp skin, wiped off with a cloth, then rinsed away. These types of products were more popular before the development of moisturizing cleansers.

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**Cleansers – Bar soaps**

You could take an entire course on how to produce bar soaps but for our purposes we'll focus on some of the unique aspects of soap that makes it different from other cleansing formulas.
Soap is a solid cosmetic form made by reacting fats and oils with some type of alkali material. To this solid form is added ingredients that can make it more moisturizing, deodorant, or antibacterial. Soap molecules are much like synthetic detergents in that they have a fatty portion that is compatible with oil and a polar segment that is compatible with water. It is an anionic surfactant; specifically, Sodium Laurate, Sodium Palmitate, or Sodium Stearate depending on the starting oil.

The reaction that produces soap is called saponification. Essentially, a fatty acid (from a natural oil) is reacted with sodium hydroxide to form water, soap, and glycerin. For the alkaline material you could also use potassium hydroxide or triethanolamine (TEA). Potassium soaps are softer which might be desirable and TEA soaps are slightly less irritating.

But unlike synthetic detergents the head group on soap is a carboxylic acid group (COOH) -. Unfortunately, this group reacts readily with metal ions in the water to form insoluble, waxy salts. These will precipitate out of solution and can build up in a ring around your tub. Modern soap formulations are designed to avoid this problem by including synthetic detergents.

To make soap you follow some basic steps.

Step 1 – Reduce the natural oil which is made up of triglycerides into its component fatty acids using high heat, pressure and water. This results in free fatty acids and glycerine

Step 2 - Neutralize the fatty acids with alkali. This results in soap plus water.

Step 3 – Vacuum dry the wet soap to 10% water to produce soap chips.

From there you can melt it, add fragrance, color, preservatives, and other ingredients then pour it into molds. In a large scale production facilities, the soap chips would be ground down to smaller pellets, blended with additional ingredients then pressed together to create bars.

Soap Bar formula
Traditional soaps are made up almost entirely of the soap as we've discussed plus some additives to improve the in-use and resulting skin feel. The following formula has an additional level of synthetic detergents and would be considered a Syndet bar.

The ingredients are blended together and melted at a temperature above 75C. While hot, the formula is poured into a mold and allowed to cool. The final formula should be a slight yellow colored, transparent bar. You can also add fragrance and color to change the appearance.

Hand sanitizers
The final cleansing formula we will look at are hand sanitizers. These products have experienced a large volume of growth in recent years and the market is anticipated to continue to grow.
The basic technology of hand sanitizers is a simple alcohol solution thickened into a gel using an acrylic polymer. In the US, hand sanitizers are regulated as OTC drugs and have specific requirements for the levels of ingredients and the type of active ingredients that can be used.

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**Hand sanitizer formula**

Here is a standard hand sanitizer formula. It is a simple gel formula which includes Ethyl Alcohol at 62% as the active ingredient. To dilute the product and incorporate conditioning ingredients there is a water and isopropyl alcohol blend. Carbomer is the thickening agent which is neutralized by Aminomethylpropanol (AMP). Glycerin, Propylene Glycol and Isopropyl Myristate are included to improve the hand feel after the alcohol evaporates.

Since this product has a high level of ethyl alcohol that could be flammable it is required to carry a warning label in most markets.

These formulas are interesting because many people claim that they are drying to skin. However, this has not been demonstrated under scientifically controlled conditions. It's possible that people see the product evaporating and that makes them think it is drying hands. But in reality it is only the alcohol evaporating off. None of the oils that are naturally on consumer's hands are removed.

This is another important feature of these types of formulas. While they will kill microbes they are generally not hand cleaners. If you have oils on your hands these products will not remove them as well as a detergent.

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**Skin Moisturizing products**

We move now from skin cleansing to skin moisturizing. These products represent the second largest segment of the skin care market world wide. They are a bit like hair conditioners in that they are designed to put back some of the characteristics that are removed through washing.

**Why do consumers want these products?**

Since this is such a huge market it is helpful to understand why consumers are buying these products. The reasons vary but the primary reason is because of dry skin or Xerosis. People just don't like the way their skin feels when it is dry. As we mentioned before some of the main characteristics of dry skin include...

- Dry feeling
- Scaly skin
- Itchiness
- Redness
- Skin Cracking

Typically, this problem is worse on the arms and legs. This is a result of there being a less dense amount of oil producing glands in this area.
In addition to dry skin, there are a few other reasons people use skin lotions. For example, Aging skin and the things that go along with it such as wrinkles, age spots, cellulite and sagging skin also prompt people to use skin lotions. These may be preventative treatments or treatments that are supposed to repair the damage.

There are also a variety of medical conditions that prompt people to use skin creams. Conditions like Rosacea, Psoriasis, and Eczema are examples. Additionally, specialized skin creams and lotions are used for conditions like Acne, Sunburn, Rashes, Warts, and Athlete's Foot.

Whenever skin is not in a pristine state, most consumers will look for some type of cream to solve the problem.

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**What causes skin dryness?**

There are a wide range of things that can lead to skin dryness but the primary problem is that moisture is somehow removed from the skin. When this happens you get the symptoms of skin dryness.

Water is removed from skin through a number of routes. First, it is helpful to know that your body is constantly losing moisture through your skin. Skin is permeable to water and as water flows around your body some of it moves into your skin. While in the epidermal layer this water helps make skin more pliable and soft which feels good. But when the air around you is dry, the water molecules will naturally move to where there is less water. When it gets to the skin surface the molecules evaporate off into the atmosphere and you're left with dry skin. Incidentally, in more humid climates dry skin is rarely a problem because there is less of a tendency for water molecules to move out from your body to the atmosphere. As a result in most areas skin lotion sales are always higher in the less humid winter months.

While there is a constant drive to remove moisture from your skin this isn't the only thing that leads to dry skin. Skin produces natural moisturizing factors that tend to be oily in nature and help hold in water to moisturize your skin. When you wash skin you remove this oily layer and accelerate the process by which water evaporates from your skin. Wash your skin too much and you'll be left with dry skin. For a similar reason being exposed to a high level of certain types of chemicals can also disrupt the skin natural moisturizing system and cause dryness.

Other things known to cause skin dryness include aging (your skin stops producing as much sebum as you get older), a reaction to some prescription drugs (another problem older people have), and hormone level changes. Malnutrition also can result in dry skin.

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There are varied causes of the other skin conditions that prompt people to use skin lotions. Sun exposure can damage the skin structure and cause wrinkles or sagging skin. UV light can also over stimulate the production of melanin in certain areas to cause age spots. And it can cause sunburns too.

Some of medical conditions for which people use skin lotions have known causes while others do not. Acne is thought to be a result of oil build-up plus an over active immune system. Warts and athletes foot are caused by microorganisms that create a home on skin. The products created for these conditions are over-the-counter drugs which we will discuss later.
Strategy for solving the problem
For the moment we will focus on solving the problem of dry skin. This is really the number one problem people want fixed when they buy a skin lotion.

The solution to dry skin is to put water back on the skin and somehow create a way that keeps it there. In this way your formulation will provide immediate relief to the condition and will also help prevent it from returning any time soon.

What ingredients are used to get skin moisturization?
To implement this solution formulators have a number of ingredients. These were the conditioning / moisturizing ingredients which we discussed in Module 3 of the course. They include

Emollients – Which provide immediate relief to symptoms when applied
Humectants – Which provide some immediate relief plus they help attract water to the skin
Occlusive agents – Provide immediate and longer lasting skin moisturization

If you recall emollients and occlusive agents are not compatible with water and are often sticky or unappealing as the pure raw material. Therefore, skin lotions are necessarily created in the form of emulsions. This allows you to use them to get the moisturizing benefits but also dilutes them so they feel aesthetically appealing when used.

What are the types of products that are used for skin moisturizing?
Although the basic concept of a skin lotion is rather straightforward marketers of these products segment them in a way that can maximize the use occasions.

So, the most common types of skin lotions are

Daily use – designed to be applied frequently
Intensive use – designed for people with severely dry skin
Protectants – designed to prevent future skin dryness
Experiential – focused more on the fragrance and marketing story

Then there are lotions with specific benefits added such as...

Firming lotions – to reduce the appearance of sagging and wrinkled skin
Anti-aging lotions – to address problems of aging skin
Facial moisturizers
Dark circle lotions – to reduce the appearance of bags under the eyes
Overnight lotions – to wear while you sleep

And the list could go on but you get the idea. All of these formulas follow a basic construction and
include the following key formulation elements.

Solvent – typically water
Thickener
Conditioning / Moisturizing ingredients
Emulsifier
Aesthetic ingredients – Fragrance & color
Adjustment ingredients
Stablizing ingredients – preservatives, secondary emulsifiers
Claims ingredients – extracts, naturals, etc.

We talked extensively in Module 4 about emulsions and their structure so we won't repeat that information here. Just remember that emulsions are composed of a water phase, oil phase and an emulsifier which holds it all together.

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**Examples Skin Moisturizing Formulations**

Now we'll look at some standard skin lotion formulations. In this section we will give examples of the following types of lotions

Moisturizing (daily)
Intensive cream
Light Lotion (experiential)
Cold Process lotion

We'll cover other types of lotions in a later segment of this module.

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First a note about lotions, creams and their effectiveness. The primary difference between skin lotions and creams will be the amount of oil that is used in their creation. In general, a higher level of oil will produce a more effective moisturizing formula. However, there is a balance you must strike between a product that is effective against dry skin and one that feels too greasy. The more hydrophobic materials you incorporate into your formula, the more greasy it will feel. And while people want an effective product they aren't going to be happy with a greasy product.

The most effective skin product you can make is one that is made completely from petroleum jelly. Unfortunately, no one would want to use it because their skin would be too greasy and it would be really hard to spread or remove. These are the challenges of a professional formulator.

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**Moisturizing (daily) formula**

Here is a standard oil in water emulsion moisturizing cream. It is designed to provide immediate relief to dry skin while being non-greasy. The effect will not last as long as other formulations with higher oil levels but for an every day lotion this will work well.

The primary conditioning ingredients in this formula include Mineral Oil, Isopropyl Myristate, and Glycerin. If you wanted to substitute Mineral oil for something like Coconut Oil, Soybean Oil, or
Olive Oil that should not be a problem. The formula will likely not be as effective but these things are often a matter of personal (or consumer) taste so you have to experiment. The formula uses Carbomer as the suspending agent and Cetyl and Stearyl Alcohols as opacifying agents, thickeners and moisturizing ingredients.

This formula is relatively easy to produce and is stable. Of course, product stability also depends on the quality of the starting raw materials. The formula will have a light feel and be non greasy. You will also feel a cooling sensation when applied to skin because the external phase of the emulsion is water.

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**Intensive cream**

This next formula is for consumers who have severely dry skin and are looking for something that is longer lasting. I've tried to keep most of the ingredients the same to give you a sense of what to modify to get a different effect. Of course, you can experiment with modifying any number of the ingredients in the formula to produce a different feel, longer lasting, or just to get a better marketing story. For example, you may want to try Shea Butter or Lanolin in the formula rather than Petrolatum.

This formula is still an Oil in Water emulsion but we've increased the level of Mineral Oil and Glycerin to provide additional moisturization. Petrolatum is included as an occlusive agent which will help bring longer lasting moisturization. To stabilize the extra oil levels the amount of Glyceryl Stearate has been increased. The procedure for making the product is the same as for the moisturizing formula.

This particular formula will feel more greasy than the previous formula but it will be more effective on excessively dry skin and will last longer.

**Light Lotion (experiential)**

This next formula shows how you can go the other way and produce a light feeling, low viscosity lotion using very similar ingredients. In this case we've reduced the level of Mineral Oil and replaced Petrolatum with Isopropyl Myristate. You can use a different emollient if you like. With less oil in the formula the level of Glyceryl Stearate can be lower and since this is a lotion the level of Cetyl and Stearyl Alcohols are reduced. You still need the Carbomer / Triethanolamine blend to help stabilize the particles which makes the formula last longer.

**Cold Process Lotion**

Just to give you some variation, we'll include here a formula here which is a light moisturizing formula follow a cold process procedure. This formula is made up of about 75% of a water phase and 25% of an oil phase which makes it an oil in water formula. The emulsifiers and oils are liquid and can be blended at room temperature. The product achieves thickness through the use of the water based thickeners Xanthan Gum, Carrageenan Gum, and Bentonite. To produce a stable formula the product must be mixed using high sheer with a homogenizer.

While this formula can provide light moisturizing it might be a challenge for people outside a cosmetic laboratory to produce a stable version.

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Practical Cosmetic Formulating
Sun protection products
We next shift gears and move on to another type of skin product with a significant market share, sunscreens. In the US sunscreens are not technically classified as cosmetics since they “cure or prevent” a disease. They are over-the-counter drugs and are strictly regulated by the FDA. There is an FDA Monographs which lists exactly the active ingredients you can include and the claims you can make about the product. But before we get into the specific products and technologies, let’s consider the problems that consumers are having which prompts them to purchase these products.

Consumer Problems
The main reason that consumers seek out sunscreens is because their skin gets burned. Too much exposure to UVB rays causes redness, tightness and even blistering if it is bad enough. Sunscreens can prevent this problem. They can also prevent other problems associated with too much sun exposure such as photosensitivity, wrinkles, freckles and skin cancer.

Sunscreen Technology
There are two ways that sunscreens can prevent the problems associated with too much sun exposure. They can reflect the UV rays away from the skin like a mirror or they can absorb the UV rays and convert the energy into heat which dissipates in the skin. To understand this a bit better we'll review the science of UV exposure.

Sunscreen UVB protection
For many years, most marketed sunscreens have provided protection against UVB radiation (290 — 320 nm), the rays that are responsible for sunburn. A sunscreen’s sun protection factor (SPF) is the ratio of the minimum erythemal dose (MED) — the amount of UV radiation it takes to turn the skin slightly red — of skin protected with sunscreen to the MED of unprotected skin. Higher SPFs mean greater protection against burning (and, presumably, skin cancer). This would be great but UVB is not the only type of damaging energy the sun delivers.

UVA protection
The sunscreen rules in the US are being changed and they will soon also be required to provide protection against UVA radiation (320 — 400 nm) to avoid having a warning label. UVA rays are the ones commonly known as the “tanning rays” as they stimulate the production of melanin and tanned skin. They do this because the longer wavelengths allow them to penetrate more deeply into the skin than UVB rays – through the outer layer, the epidermis, all the way to the dermis. The only visible short-term effect of UVA irradiance is skin tanning, and short wavelength UVA exposure actually has a beneficial effect in children, converting 7-dehydrocholesterol into vitamin D, thereby reducing the incidence of rickets, a bone-softening disease.

But as with UVB irradiation, long-term UVA exposure has detrimental effects. In the dermis, it degrades collagen, a critical structural component, resulting in sagging and wrinkling of skin. And UVA radiation contributes to the incidence of basal cell and squamous cell carcinomas, as well as malignant melanoma. Like UVB radiation, it decreases the number of Langerhans cells, which lowers resistance to infection.

Limiting the sun’s effects

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So there are good reasons to limit sun tanning, and one way to do that is to apply a broad-spectrum sunscreen (one that significantly reduces the amount of both UVB and UVA rays that reach the skin). A sunscreen’s UVA Protection Factor (PFA) is determined by measuring persistent pigment darkening (PPD), the appearance of brownish skin pigmentation within three hours of exposure to UVA. Products with higher PFA provide better resistance to persistent pigment darkening. Rather than using this in vivo measure of UVA protection, the FDA chose to use the critical wavelength — the wavelength at which the integral of spectral absorbance curve reaches 90 percent of the integral over the UV spectrum from 290 up to 400 nm.

Therefore, the higher the critical wavelength, the greater the level of UVA protection. The FDA’s new Final Rule requires a critical wavelength of at least 370 nm (and an SPF of at least 15) for a sunscreen to be called “broad spectrum” and to avoid a “Sun Alert” warning that includes the statement “This product has been shown only to help prevent sunburn, not skin cancer or early skin aging.”

**Formulation**

Sun protection includes not only classic “beach wear” sunscreens, but also the “daily wear” sun protection that is built into lip balms, color cosmetics and general skin care products. Consumer product forms from which sun protection may be delivered include creams, lotions, gels, sprays, and sticks. The most common form is creams but we will look at a variety of different forms.

The ingredients typically found in these formulas include many ingredients we’ve seen before but also materials specifically included to make the sunscreen work better and last longer. A typical formula would have the following ingredients.

- **Formula solvent**: 50 — 80%
- **Humectants**: 0 — 4%
- **Sunscreen Active Ingredients**: 2 — 40%
- **Fragrance**: 0 — 0.5%
- **Emulsifier**: 0 — 10%
- **Thickeners**: 0 — 10%
- **Water-Resistance Polymer**: 0.8 — 2%
- **Claims Ingredients**: 0 — 0.5%
- **Sunscreen Solvents**: 0 — 10%
- **Photostabilizers**: 0 — 6%

**FDA Sunscreen Monograph**

The sunscreen active ingredients are selected from the FDA monograph which are listed here. You must use authorized levels and combinations (e.g., Homosalate and Octisalate or Octinoxate with Avobenzone). Generally speaking, the higher the level of sun protection, the greater the quantity and number of sunscreen active ingredients that are needed. Zinc Oxide and Titanium Dioxide, work well for standard formulas but they are unsuitable in alcohol-based sprays because they are not soluble in alcohol, and their high densities would result in their rapid settling during storage.

**Sunscreen ingredients**

A water resistant polymer, such as Acrylates/Octylacrylamide Copolymer, is required for two reasons. First, it helps retain the sunscreen on the skin and, second, it promotes uniform deposition on the skin, preventing the sunscreen solution from pooling in crevices, which results in disproportionate protection.
of the crevices and a lower than expected overall level of sun protection. A uniform layer of sunscreen produces the maximum possible sun protection ratings.

When you increase the levels of solid organic sunscreen active ingredients (e.g., Avobenzone and Oxybenzone), the liquid sunscreen active ingredients may prove inadequate to keep them in solution, particularly at low temperature. If these solid sunscreen active ingredients crystallize on the skin after the alcohol has evaporated, a reduction in sun protection level and an increased potential for skin irritation will result. Consequently, addition of sunscreen solvents (e.g., Butyloctyl Salicylate, Dimethyl Capramide and/or Diisobutyl Adipate) may be required to ensure adequate solid organic sunscreen active ingredient solubility.

Photostabilizers are particularly important for any sunscreen using Avobenzone as the active ingredient. This is because, although Avobenzone strongly absorbs UVA and UVB radiation, it is prone to degrading as a result, markedly reducing its UV absorbing capabilities, especially when Octinoxate, a strong UVB absorber, is also present. While solvent polarity optimization can be used to some effect (by using sunscreen solvents of higher than usual polarity, such as those listed in the previous paragraph), triplet state quenchers such as Polyester-8 and Undecylcrylene Dimethicone are frequently more effective. When Octinoxate and Avobenzone are used together, the photostabilizer of choice is singlet state quenching Ethylhexyl Methoxycrylene, which can remove the existed state energy from Avobenzone perhaps a thousand times faster than even triplet state quenchers, allowing substantial photostabilization of this notoriously photolabile combination.

Other standard ingredients like humectants are included to improve the feel of the product on skin. Fragrances are added to off set the base sunscreen odor. Then there are preservatives, adjustment ingredients, and of course claims ingredients to help with product marketing.

Types of sunscreen products
Since sunscreens are regulated in both the ingredients they can use and the claims they make the varieties available are not as numerous as other types of cosmetics. As mentioned previously the forms of sunscreen products include creams, lotions, gels, sprays, and sticks. You can find an SPF range of anywhere from 4 – 100+ although the new regulations require a minimum of SPF 15 and a maximum of 50. Sunscreens also vary in how well they stay on the skin when exposed to water. There are water resistant, water proof and sweat proof variants.

Formulations
In this section we'll review emulsion sunscreens as well as a gel, and spray formula.

Water resistant emulsions sunscreen
This first formula is a water resistant sunscreen formula with an SPF of 18. It is a basic sunscreen cream formula that will feel lightweight while providing adequate protection. It includes Cyclomethicone which will aid in spreading and help provide a light feel. The formula is an oil in water emulsion with a high level of emulsifier (Octyl Palmitate), silicones, and emollients. To achieve the SPF rating the formula uses Titanium Dioxide and Zinc Oxide. The Ceresin wax helps to thicken the formula while also providing some film forming properties.

Water proof emulsions sunscreen formula
This is another oil in water emulsion but with a much higher level of sunscreen actives and
subsequently a higher SPF rating (this is an SPF 30). It takes advantage of an emulsifier blend from Croda which is a blend of Cetearyl Alcohol, Dicetyl Phosphate, and Ceteth-10 Phosphate. This blend helps improve substantivity and resist rinse off. The Jojoba oil improves the feel and spreadability as does the Octyl Stearate. It also uses Carbomer as a thickening and suspending agent. The large amount of sunscreen ingredients are stabilized through the use of Carbomer.

**Sunscreen Gel formula**
Not everyone likes a cream formula as they can be perceived as too thick so you'll find a number of sunscreen gel formulas on the market. Here is an example of that type of formula. The gel is produced the same way as other Carbomer based gels are made. You start with water and blend in the Carbomer. Then you add the other ingredients at a slightly elevated temperature and neutralize the polymer upon cooling.

This formula gives an SPF rating of around 10 which could be improved by increasing the level of sunscreens in it. An organic sunscreen is used so that the formula will remain clear upon completion. This example would not be adequate to be sold in the US without a warning based on the new regulations because it does not contain a UVA blocker. To get UVA protection this formula will require the addition of an ingredient like Avobenzone.

**Sunscreen Spray formula**
In this aerosol spray formula there is enough organic sunscreens to get an SPF rating of 50. The ingredients are soluble in alcohol so no emulsifier is required. This is a solution-type formula. To improve the feel there is an emollient included. The plasticizer helps make the polymeric film more flexible and longer lasting on the skin which subsequently makes the sunscreen work longer. This is a concentrate formula which would be put into an aerosol can and pressurized. The typical propellant that sunscreens use is compressed air.

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**Anti-aging**
One of the main drivers for consumers as they get older is to prevent the signs of aging which are particularly evident in your skin. Aging skin is a result your genetics, the amount of exposure to UV rays, chemical exposures and possibly related to diet. Products designed to be anti-aging promise to keep skin looking wrinkle free, reduce age spots, reduce sagging, and keep skin looking tight and flush. Unfortunately, there are very few products that actually have a measurable effect. However, as a cosmetic formulator you should be aware of the current science of some of these “cosmeceuticals” and what effect (if any) they might have when included in your skin formulas.

**Anti-aging technology**
As a formulator, you're going to hear of numerous ingredients that represent the best anti-aging technology. But how can you know whether they actually are worth including in your formulas or not?

Some years ago the famous dermatologist and researcher Albert Kligman pondered this question and he came up with three question about anti-aging ingredients that you should find answers to for assessing the usefulness of the ingredient.

The three “Kligman questions” to ask about any anti-aging ingredient are...
1. Based on the chemistry of the ingredient, is there any scientific mechanism that could explain why it would work?

2. Does it penetrate to the part of the skin where it needs to be in order to work?

3. Are there peer reviewed, double blind, placebo controlled studies demonstrating the ingredient really works when applied to real people?

With these questions in mind we'll review some common anti-aging ingredients for which we could find data including

Retinol
Kinetin
Niacinamide
Soybean extract
Green tea extracts

There are certainly other anti-aging ingredients like plant stem cells, hyaluronic acid, superoxide dismutase, and more but we'll restrict ourselves to the ingredients for which there is at least some published scientific research.

**Retinol**
Retinol is a vitamin A derivative which is claimed to smooth skin, unclog pores, lighten age spots and improve skin texture.

Is there a working mechanism? Yes. Retinol fades dark spots by reducing the contact time with pigment creating cells; reduces fine lines/wrinkles by stimulating synthesis of collagen and glycosaminoglycan. May also inhibit enzymes that breakdown collagen. Smooths skin by modulating genes involved in epidermal cell turn over.

Does it penetrate skin? Yes. Retinol has the right chemical structure to penetrate skin and this has been confirmed two ways: In vivo by measuring the level of a skin enzyme induced by presence of retinoic acid. (Also confirms metabolism to active version.) In vitro by measuring retinol metabolites on skin biopsies and cell cultures. There are some unresolved questions about how much bio-converts, however.

Topical application effectiveness? Yes. Retinoic Acid has undergone extensive clinical testing although fewer studies have been on the over the counter versions. Retinol has been shown to be effective vs placebo but not as effective when compared to retinal for wrinkle reduction.

So as far as anti-aging actives go, retinoic acid and other retinoids have some level of substantiation and are likely worth using.

**Kinetin (N-furfuryladenine growth factor)**
Kinetin is a plant growth hormone that supposedly promotes cell division and acts as an antioxidant. It nourishes skin cells to keep them healthy longer/ Boosts skin’s energy for increased radiance
Mechanism of action - Testing on cultured human skin cells (lab testing aka in vitro testing) has shown kinetin can impact cell growth factors which cause age related changes, however the mechanism is not understood. Multiple studies have shown kinetin to be an effective antioxidant; it acts like Superoxide Dismutase, an natural free radical scavenger in skin. There are no reported mechanisms for how it helps wrinkles, age spots, or barrier properties.

Penetration – It's not known whether it can penetrate because no studies have been published on skin absorption of kinetin.

Effectiveness – The data on whether it is effective from a topical product is inconclusive. There’s very limited research on topically applied kinetin. One study showed it can partially improve photo-damaged skin and increase skin’s ability to retain moisture. Another showed that when combined with niacinamide it works synergistically to reduce hyper-pigmentation. It's questionable whether this ingredient is worth using.

**Niacinamide**

Niacinamide is a version of vitamin B3 (Niacin) which is thought to brighten the complexion, erase wrinkles, reduce transepidermal water loss, improve elasticity, and fight inflammation.

Mechanism - The mechanisms for ALL these proposed benefits are not fully understood. However, Niacinamide’s ability to increase the antioxidant capacity of skin is well studied. It works by reducing (the opposite of oxidizing) NADP. Niacinamide may reduce water loss by increasing production of lipids and ceramides and by increasing cell turn over. It may reduce wrinkles by increasing collagen production. Finally, it lightens age spots by reducing the amount of pigment transferred from melanocytes to keratinocytes.

Penetration ability - Yes, penetration has been proven directly at sufficient levels in one study. In addition several studies indirectly proved penetration by measuring increased NAD in cells after topical application (which increases due to the skin metabolizing vitamin B3.)

Effectiveness - Yes. Skin brightening has been proven in several half-face studies. Some of the studies also measured niacinamide’s ability to reduce photo-aging. Based on the available evidence, Niacinamide is a worthwhile anti-aging ingredient to use.

**Soybean extract**

Soybean extracts consist of two active ingredient types (isoflavones and protease inhibitors) which neutralize free radicals, stimulate collagen production, increase skin moisture, and reduce hyperpigmentation.

Mechanism of action - For antioxidancy: One study shows soy isoflavones work 4 ways to fight oxidation in skin. They MAY work as cell signaling molecule but no conclusive proof. Even though mechanisms are unconfirmed, evidence shows they are antioxidants. For collagen production/skin thickening: Only data on collagen is in vitro. Specific components of soy (genistein and daidzein) MAY have sufficient estrogenic activity to counter act thinning skin. For moisture increase: Appears to boost hyaluronic acid production but we don’t know how. For depigmentation: appears to reduce pigment production and block transfer of pigment between cells.
Penetration - Not known for sure. There is little direct evidence the primary soy isoflavones penetrate skin. However, there is evidence that similar compounds can reach the epidermis and dermis. It is also known that penetration depends on the formula from which the isoflavone is delivered and its pH.

Effectiveness - Yes, partly. Preliminary in vivo tests confirm skin lightening benefits (undenatured only). However, anti-aging benefits related to antioxidancy are unconfirmed in large scale tests on humans. This ingredient definitely has potential if the ingredient supplied is properly processed.

**Green Tea**

Green tea is an extract containing polyphenols which are known to be potent antioxidants that may protect against UV damage and help photo-aged skin.

Mechanism - There’s no doubt that green tea extract is an effective antioxidant which works by quenching several reactive oxygen species. It is also capable of limiting enzymes which cause collagen breakdown and to increase synthesis by fibroblasts, but again in in vitro testing.

Penetration - Probably not. The active component EGCG is water soluble so it is not well suited for skin penetration. Also, It’s difficult to stabilize green tea extract long enough for it to penetrate skin. To make things worse there is little standardization about which components are contained in extracts and how much of them.

Effectiveness - Maybe, for UV prevention. At least two studies indicate at high concentrations of the active components can prevent the damaged caused by UV exposure. However there is no comparison to indicate if it as good as conventional sunscreens. The only randomized, double-blind, controlled, clinical trial involving topical green tea extract showed no improvement in photo damaged skin from topical application of green tea extract after 8weeks. There were some trends in the data which indicate that a longer questing period might have yielded better results. But so far the ingredient remain unproven.

Since the active component in green tea extract is unstable and it’s not easy to get the ingredient to where it needs to be work, it is doubtful that this is a worthwhile anti-aging ingredient.

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**Skin color**

We'll turn our attention now to skin products designed to change the color of skin. Specifically, we'll look at skin lighteners and skin darkeners (self-tanning products). We'll begin with skin lightening. To understand skin lightening you first have to understand skin darkening. So let’s talk about what causes hyperpigmentation.

**Causes of hyperpigmentation**

Hyperpigmentation (HP) means your skin produces too much melanin. Melanin is the pigment that colors your skin, hair and the iris of your eyes. It comes from the Greek term meaning “dark.” Melanocytes are cells that actually create the pigment particles. Melanosomes are little vesicles, or capsules, that hold the melanin and carry them to various parts of the skin.

There are 2 basic causes of HP. Not surprisingly, both involve melanocytes which are the pigment producing cells in your skin.
1. If the melanocytes increase the amount of melanin they produce, this is called Melanotic HP.

2. If the melanocytes make the same amount of pigment but the NUMBER of melanocytes are increased, this is called Melanocytic HP. Both conditions lead to increased melanin.

HP is further classified by WHERE this excess pigment is: If its in the outer layer it’s called Epidermal HP In the middle it’s called Dermal HP. There are many different types of HP including…

**Freckles**
Everyone is familiar with freckles but I bet you didn’t know that they are technically called (ephelides) e-fel-i-deeze. These are melanotic which means your skin has a normal number of melanocytes but they produce more pigment. And the more you are exposed to the sun, the more freckles you’ll get and the darker they’ll become. Also, freckles are kind of the cute version of skin HP.

**Age spots**
Age spots are formally known as Solar Lentigines (len-tij-in-eeze ) and they are small brown patches on the skin. As the name implies, they are caused by sun exposure. These used to be called “liver spots” because they were associated with liver problems that occur as you age. Lentigines are melanocytic which means they are caused by the creation of MORE melanocytes. While these are triggered by sunlight, once they’re formed they pretty much stay stable in their color even if you get more sun exposure.

**Post inflammatory HP (PIH)**
This is skin darkening that occurs as a result of skin injury or trauma. As part of the healing process the melanocytes kick into high gear and produce more pigment. These spots may become darker if exposed to sunlight. Two examples: dark marks from acne. Have a zit which is infected, the trauma causes the “scar.” Do you know another area of the body that’s prone to PIH? Armpits! Shaving your pits causes some micro trauma which triggers melanin production. A lot of people complain about dark armpits. Even rubbing of clothing against armpits can cause this.

**Melasma**
It causes brown to gray-brown patches on the face. Most people get it on their cheeks, bridge of their nose, forehead, chin, and above their upper lip. It’s caused by sun exposure but may be triggered by hormones so you can get it due to pregnancy or taking a contraceptive pill. In fact, it’s so common that it’s called “the mask of pregnancy.”

**Other conditions**
Acral melanosis usually located on the acral areas of the fingers and toes. It is mostly seen in newborns or during the first years of life. Not very common. Tinea versicolor – typically occurs on the chest and it is caused by yeast growing out of control. It is one of the most common skin diseases in tropical and subtropical areas of the world.

**How to treat HP**
For each of these conditions, treatment depends on WHERE the pigment is. For Dermal HP – there’s not much you can do. Not much helps with this except for certain lasers. You basically have to cover it up. Epidermal HP – The good news is that most common types, like freckles and age spots, are
epidermal so you have several treatment options.

Topical treatments – creams and lotions
Abrasive methods – chemical peels (combined with topical)
Surgical methods (Dermabrasion, Cryosurgery, Lasers)
Since this is a formulating course, we’ll limit out discussion skin lightening creams and lotions.

Active Ingredients

Hydroquinone (HQ)
Hydroquinone, like many skin lightening ingredients, is a phenolic compound. That means it contains a 6 carbon ring with an OH group attached. This structure allows it to inhibit melanin synthesis by acting as a substrate for tyrosinase. Tyrosine, an amino acid, is acted upon by the enzyme tyrosinase to form melanin. These phenolic compounds “interrupts” this reaction by giving the tyrosine something else to attach to. That way the tyrosine never makes melanin particles.

Nothing works better than HQ – it’s considered the gold standard for skin lightening. Now, that doesn’t mean it works instantly – it can take several months of usage to reach maximum lightening efficacy.

What are the concerns about HQ?
There are some concerns about HQ, as you probably have heard. The reaction that’s responsible for it working so well also causes damage to the melanosomes and melanocytes which is one of the reasons HQ raises safety concerns. And animal and cell culture studies have shown that HQ can cause DNA damage which has raised concerns about cancer. Another concern: In some people HQ causes a condition called Ochronosis which is a permanent bluish-black discoloration of the skin. This is rare and some dermatologists say it only occurs after prolonged use of high concentration hydroquinone.

HQ Safety
The studies that raised cancer concerns were based on oral or injected application and there have been no clinical studies or cases of skin cancer or any kind of internal malignancy related to topical HQ use. Therefore, the International Agency for Research on Cancer (IARC) considers hydroquinone as “not classifiable” as to its carcinogenicity in humans. As far as the Ochronosis is concerned, this is one of reasons that regulatory bodies in other countries have banned HQ for over the counter use. It has has to be prescribed by a doctor which helps prevent the kind of long term abuse that can lead to that permanent discoloration. In the US the FDA has even proposed banning over-the counter skin bleaching agents containing hydroquinone but as of right now it’s still available.

One important point – it’s a myth that’s HQ is “banned” in other countries, it’s really just restricted to prescription use. Europe and Asia currently allow hydroquinone at 2-5% concentration by prescription. The drug is valued worldwide but is regulated to protect against misuse and bad formulations.)

There are quite a few other ingredients which have skin lightening properties but based on everything we could find, nothing works as well as HQ and some of the ingredients that work pretty well have their own issues. While it’s generally recognized that HQ is the gold standard, there are not a lot of studies directly comparing all these other agents to each other. So it’s difficult to rank them. But we’ll give you a quick run down.
**Mequinol**
This is a derivative of HQ which According to Dr. Draelos, this outperforms OTC alternatives and is a prescription alternative to hydroquinone. Of course, as you’ll see with almost all these agents it has side effects as well which include erythema, burning, pruritus, desquamation, skin irritation.

**Azelaic acid**
It’s a dicarboxylic acid which occurs natural in wheat, rye, and barley. inhibits DNA synthesis in melanocytes and has a modest antityrosinase effect. According to some sources, it works better than 2% hydroquinone and about as good as 4%. The interesting thing is that its apparently safe to use during pregnancy. Side effects of itching, mild redness, scaling, and burning but overall this is a good contender. It’s also prescription. Kojic acid This is a fungal metabolite and also a famous cop show from the 70s. It works by inhibiting the production of free tyrosinase. Could not find any data directly comparing it to other agents but one source considers it to be be the most effective skin-lightening agent behind hydroquinone. We do know that it can cause greater irritation, it is highly sensitizing and may be mutagenic. For this reason, it is banned in Japan, just like over-the-counter (OTC) hydroquinone.

**Alpha arbutin**
Arbutin is chemically related to hydroquinone and was originally obtained from the bearberry plant. Like HA it decreases melanin biosynthesis through the inhibition of tyrosinase activity. It also inhibits melanosome maturation and is less cytotoxic to melanocytes than hydroquinone. However, several studies have shown that arbutin is less effective than kojic acid for hyperpigmentation. Deoxyarbutin is a synthesized topical derivative. Studies have shown that it has an enhanced sustained improvement, general skin lightening and a safety profile comparable to hydroquinone.

**Vitamin C**
A study compared 5% ascorbic acid and 4% hydroquinone in 16 female patients with melasma and found 62.5% and 93% improvement respectively

**Niacinamide**
It works by interfering with the interaction between keratinocytes and melanocytes, thereby inhibiting melanogenesis. We’ve talked about this in our anti-aging show and it does work but not much data comparing it to other options.

**Licorice extract**
Licorice extract improves hyperpigmentation by dispersing the melanin, inhibition of melanin biosynthesis and inhibition of cyclooxygenase activity thereby decreasing free radical production. Glabridin, a polyphenolic flavonoid is the main component of licorice extract. Studies have shown that glabridin prevents Ultraviolet B (UVB) induced pigmentation and exerts anti-inflammatory effects by inhibiting superoxide anion and cyclooxygenase activity. However, more studies are needed to prove its de-pigmenting action.

**Retinoids**
Works three ways: dispersion of keratinocyte pigment granules, interference with pigment transfer, and acceleration of epidermal turnover Something like 68% improvement (although you can’t really compare numbers across studies.) Side effects: erythema, peeling, and possible post inflammatory hyper pigmentation. Can help with Melasma which is in the dermis. Works very slowly. Takes 24
weeks or more at 0.1% Need a prescription. One paper we found listed something links an additional 16 other ingredients that have some data but not enough to fully validate them.

Skin lightening vs brightening vs “imperfection correctors”
True skin lightening products are drugs and have to be labeled with very specific language. If you are selling an HQ product it has to be labeled as a “skin lightener” or a “skin bleach.” If you are selling a cosmetic that uses any of the other ingredients we talked about you CAN’T call it a skin lightener or a bleach which is why you see products called “brighteners” imperfection correctors” and so forth. These are marketing terms that are NOT regulated by law which explains why they are so confusing.

Skin lightening cream
Here is a standard OTC hydroquinone cream. It is an oil in water emulsion which features Mineral Oil and Isopropyl Palmitate as the primary emollients. Hydroquinone is use at the maximum level of 2% in non-prescription formulas. Additionally, a sunscreen is incorporated into the formula. A sunscreen should be used in a skin lightening cream because it may take only a few hours out in the sun to undo the lightening accomplished by the HQ.

Darkening
Next we move away from lightening to skin darkening. Self tanning products are designed for people who want to darken the color of their skin without risking the negative health effects of UV exposure. Technology improvements in the purification of the main active ingredient and better awareness of the dangers of excessive UV exposure has led to an increase in the sales of these types of formulations.

What self tanning formulas do
Self tanners are active cosmetic formulations that stain the outer layers of the skin and give it a more yellow/brown/orangish hue. They can be applied as a lotion or spritz and will slowly change skin color as the dye reacts with skin protein.

How do self tanning products work
The primary active ingredient that makes self-tanners work is Dihydroxyacetone (DHA). This is a white, crystalline powder whose skin staining effect was first discovered in the 1950's.

DHA is a 3-carbon sugar that naturally forms a dimer. When heated in a solvent, the molecule can revert to a monomer which is more effective. The reaction that causes skin browning is the Maillard reaction in which the hydroxyl group on the DHA reacts with skin amino acids & proteins. It typically requires about an hour for the color change to be noticed. The color will wear off over time as the outer layers of the skin are naturally removed via exfoliation.

The delivery of DHA is typically in the form of an oil-in-water emulsion similar to a skin lotion. Since the palms will stain darkest, consumers have to wash it off or wear gloves for application to prevent unnatural looking browning on the hands. One of the biggest challenges with formulating a self tanner is the odor of the DHA. You'll need a good fragrance to mask its slightly unpleasant smell.

It's worth noting that while there are some spray-on self tanning products, this use has not been approved by the FDA.
Self Tanning formula
Here is an example of a self tanning formula. It is a light lotion with a slightly acidic pH. This will help it to be easily spread and speed up the reaction of the DHA on the skin protein. In the oil phase there are some light emollients like Methyl Gluceth-20 Benzoate and Isopropyl Myristate. Cetyl Alcohol helps with thickening and emulsification but the primary emulsifier is PEG-40 Stearate. To get the self tanning effect 5% of DHA is used. The product should also have a fragrance incorporated into it to cover the odor of the DHA.

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Shaving
Shaving cream is a product put on the skin (primarily face and legs) to provide lubrication which helps prevent razor burn and discomfort during shaving. It comes in a wide variety of formats including creams, gels and most commonly foams.

What shaving creams do
Shaving creams are placed on the area of the skin in which shaving will take place. The cream is spread in a thick layer where it coats the hair that will be removed. One benefit of the foam is that it lets the consumer know where they still need to shave. The consumer (or operator) then takes a razor and slowly runs it through the shaving cream. This removes the cream and hair. The razor is rinsed and subsequent passes of it on the skin removes the rest of the unwanted hair.

How shaving cream works
Shaving cream formulations have a number of different ways in which they help in the removal of unwanted hair. One function is to soften the hair via moisturization to make cutting easier. Wet hair is easier to cut. Another function is to act as a lubricant between the razor and the skin. This inhibits cuts and knicks but does not interfere with hair removal.

Shaving Cream ingredients
While shaving creams can take many forms from liquids, lotions, gels, and creams, they all contain ingredients that help soften the hair and lubricate the skin. The primary ingredients include surfactants, solvents, humectants, conditioning agents, lubricants and aesthetic ingredients.

The most common surfactants used in shaving creams are soap based surfactants such as Stearic Acid, Palmitic Acid, or other coconut fatty acids. These are neutralized with TEA, NaOH, or KOH. Additional foam stabilizing surfactants may also be used such as Sodium Lauryl Sulfate. The surfactant system typically makes up about 10% of the formulation.

To lubricate and moisturize the skin, humectants and other conditioning ingredients are included. These can be mineral oil, lanolin, glycerin, guar gums, or a variety of polyquaternium compounds. These ingredients make up around 5-10% of the formula.

The other ingredients include aesthetic materials like fragrance, preservatives, pH adjusting materials and sometimes colorants. For aerosol systems a propellant is needed. This can be something like Isobutane. In California, there is a 5% limit on the amount of VOCs that can be used in a shaving cream foam. Fortunately, the typical propellant level is between 3 and 4%.
Shaving Cream Formula

Here is a standard shaving cream formula which is designed to make the skin easier to shave and feel better after. It is a Stearic Acid based emulsion which includes Propylene Glycol for skin smoothness and Sodium Lauryl Sulfate for creating the foaming effect. Since Stearic Acid is a solid the formula has to be heated up to melt the ingredient for incorporation. The concentrate is put into an aerosol can and an isobutane / propane propellant blend is used. The opening of the container can be wide since the product does not have to come out in a spray so a lower amount of propellant is required.

Summary

In this module we have covered a lot of information and certainly a number of topics could have been expanded even further. As a reminder we covered skin cleansing, moisturizing, sunscreens, anti-aging products, skin lightening and darkening, plus shaving products.

In the next module we will focus on color cosmetics but also double back and review some of the skin care products that we didn't cover here such as bb creams, anti-perspirants, deodorants and anti-acne products.

If you have any questions or want to ensure that I cover a topic more in-depth, feel free to post them in the forum, write in the comments, or send me an email.

I'm Perry Romanowski and I thank you for watching.