How We Smell and Why We STINK

By Doris R. Kimbrough

"Can someone please tell me what is the deal with B.O.? Doesn't make any sense. Do something good—hard work, exercise—smell very bad. This is the way the human being is designed. You move, you stink. Why don't our bodies help us? Why can't sweat smell good? Be a different world, wouldn't it? Instead of putting your laundry in the hamper, you'd put it in a vase. Go down to the drugstore, pick up some odorant and perspirant. You'd have a dirty sweat sock hanging from the rearview mirror of your car."

—Jerry Seinfeld

We all agree that air pollution can be a serious problem, but what about the kind of air pollution that is not related to car emissions or industrial smokestacks? We're talking about *personal* air pollution—pollution that makes you wrinkle your nose in disgust when guys don't bother to shower after gym class. It's the pollution that makes you sit as faaaaar as possible from that girl in your English class who wears half a bottle of perfume to school. And it's the pollution that leaves no doubt about who likes onions and who likes extra garlic on their pizza.

ILLUSTRATION BY DAN SHERBO

Dealing with personal air pollution is a multimillion-dollar industry marketing deodorants, antiperspirants, mouthwashes, and breath mints to consumers who don't want to stink, while selling fragrances, perfumes, and air fresheners to those of us who just want to smell better.

Your nose is an excellent chemical detector

What causes something to have a scent? Your sense of smell involves some very interesting chemical interactions. In order for our noses to pick up a scent, a substance must first evaporate; you can't smell something unless it travels through the air. Once the molecules arrive in the nose, they must bind to our scent receptors to be detected. Thousands of human scent receptors, deep within the nose, cover an area the size of a postage stamp. Furthermore, we humans detect and discriminate a fairly complicated, yet fairly dilute array of molecules. When you correctly identify the smell of a strawberry, you have sorted through about 300 different components at a concentration of 10 parts per million. That's pretty sensitive, although still not in the same league with real experts like dogs and many other mammals. Bloodhounds, for example, have 40 times as many scent receptors as humans.

The binding of a molecule to a scent receptor involves a highly specific chemical reaction that is not at all well understood. Scientists do know that each of the approximately 10,000,000 receptors in your nose responds to

PHOTO COURTESY OF MICHAEL TINNESAND

Eccrine sweat glands are especially concentrated on the hands and feet. They produce evaporative sweat to cool our bodies.

more than one different molecule and that the same molecule can trigger more than one receptor. Concentration and proportion are both important. A substance that smells agreeable when dilute may be unappealing in higher concentrations, and a particular mix of substances can have a very different odor if the proportions of those chemicals are changed.

What about the connection between smell and memory? How often have you caught a scent of something, good or bad, and exclaimed, "Oh man! What's that smell? It reminds me of . . ." Smells can evoke strong memories because when molecules bind to your scent receptors, the resulting nerve signals travel to the limbic system, the primitive part of the brain responsible for emotions and memory. Here, scents and memories are intimately linked (see Figure 1).

Why are some smells pleasant and others extremely disagreeable? There are a lot of hypotheses but not much in the way of experimental evidence. What ***is*** known is that some odors are universally disagreeable to all humans (skunks, rotten food, decaying animals, or fecal odors), whereas others are objectionable only to some (cigar or pipe smoke, certain spices, or the perfume worn by that girl in your English class). It's likely that our hate of certain smells is even a survival advantage. Avoiding rotten food and decaying animals automatically makes you a healthier person who will live longer!

Let's talk armpits!

Face it. Humans, as well as most of our primate relatives, are a pretty stinky bunch. Relying on our perspiration to regulate our body temperature, we make our skin and clothes a warm and moist breeding ground for all kinds of bacteria. And those bacteria metabolize the odorless chemicals naturally found in our perspiration into smellier varieties. The armpit—or the *axillary vault*, if you prefer—is the source of odors that most modern humans find offensive.

Humans have two types of sweat glands: *apocrine and eccrine*. Eccrine glands are found all over the body, including the armpits, but especially in the hands and feet. They are stimulated by heat to produce the evaporative sweat that cools us down when we are baking in the sun or exercising vigorously. But they also respond to emotional stress, like that sinking feeling you get when you forgot to do your homework.

Apocrine glands are located in the armpits and pubic area and are also stimulated by emotion and stress. The odors characteristic of armpits are due to apocrine secretion. Apocrine fluid is rich in organic substances, odorless when fresh but irresistible to bacteria, which quickly convert them into new chemicals with characteristic stench.

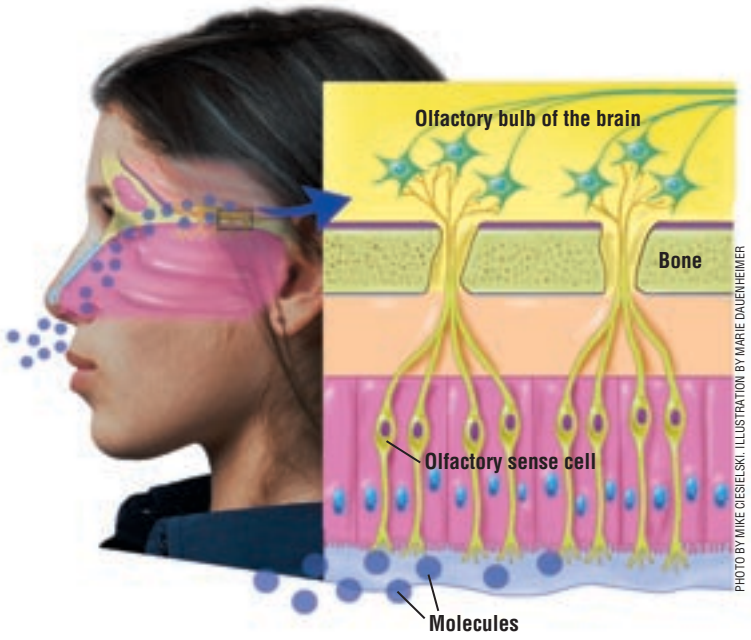

PHOTO BY MIKE CIESIELSKI, ILLUSTRATION BY MARIE DAUENHEIMER

Figure 1. Our noses are sensitive to molecules of evaporated substances that stimulate tiny hairs of olfactory sense cells. Resulting nerve signals travel rapidly to the brain.

PHOTO BY MIKE CIESIELSKI

There are so many different chemicals present in our odiferous axillary vaults (stinky pits) and fuming pedicurial regions (smelly feet) that chemists have still not identified all of them. The smelliest are butanedione, isovaleric acid, 4-ethyloctanoic acid, 5-androst-16-en-3-one, and 5-androst-16-en-3-ol. Butanedione smells "cheese-like", and isovaleric acid has a sweaty odor (big surprise there!). The smells of the last two have been described as resembling stale urine and goats, respectively. Aren't you glad we didn't include a scratch 'n sniff strip?

Now that we know why we smell, how do we keep from offending people? Today's consumer already knows the answer to that question: soap, deodorant, and antiperspirant! Soaps do a double duty by washing away offensive chemicals as well as killing the microbes responsible for turning them into smelly substances. But, as you well know, soap provides only a short-term solution. There are always more microbes where those came from, always ready to produce more stench. Washing with deodorant soaps provides a slightly more lasting effect since they kill more bacteria.

$$\underset{\text{Aluminum chlorohydrate}}{AlCl_3{\cdot}6H_2O} + H_2O \rightarrow \underset{\text{Insoluble hydroxide gel}}{Al_x(OH)y{\cdot}nH_2O} + \text{other salts}$$

Is there a difference between a deodorant and an antiperspirant? Maybe not in terms of smell, but there is a big difference in their chemistry! Deodorants kill the bacteria that produce the stink. And they usually contain other, more appealing odors to mask the offensive ones (see the discussion on perfumes on the next page). Antiperspirants, on

the other hand, do a double duty of killing bacteria while constricting and blocking your sweat glands. Most antiperspirants contain aluminum and/or zirconium salts, which form an insoluble hydroxide gel for blocking sweat pores.

The metal salts also act as astringents, substances that shrink pores, allowing less perspiration to flow. Actually salts of most of the metals in the periodic table would work well as antiperspirants. Unfortunately, many would be so toxic that there would be few customers coming back for more!

Dragon breath

There are two kinds of bad breath or *halitosis*, to be fancy: chronic and food-related. We'll assume you don't smoke cigarettes. If you do then your bad breath is your own fault! Like other body odors, chronic bad breath is caused by—you guessed it—bacteria. Give them secure moist places to set up shop, and they readily turn their organic-rich surroundings into smelly byproducts. To cure and prevent this kind of bad breath, you need to do all those things that the dentist nags you about—regular professional cleanings, flossing, brushing, and limiting sweets. But if you do all of these things and the bad odor persists, then you should see your dentist. You might have an infection.


PHOTO BY MIKE CIESIELSKI

What can we do about garlic and onion breath? Not much, it turns out. Onions and garlic owe their pungent smells and tastes to sulfur-containing organic molecules, a stinky collection shared by rotten eggs and skunks. Eat a clove of raw garlic, and a set of these compounds ends up in your bloodstream to be delivered to the rest of your body. In the lungs they freely cross over membranes to enter your breath. Mouthwashes and toothpastes may mask these smells, but only time will really get rid of them.

Scents sense

Deodorants and antiperspirants were not readily available until the 20th century. And before indoor plumbing became widely available in the late 1800s, bathing was a complicated process. Think about it. You couldn't just hop in the shower. You had to heat water on a stove, haul it to the tub, fill the tub, and then haul it away when you were done. Indeed, until this century, frequent bathing was viewed by many people as unhealthy. Given the effort involved, they may have been right!


PHOTO BY PHOTODISC

Just because baths were less available didn't mean humans needed them less! What was an odiferous pre-Victorian person to do to avoid offense? It's no coincidence that the popularity of scents and perfumes dates back to ancient Egypt.

For centuries humans have been burning incense, smearing themselves with scented oils, and spraying on perfumes and colognes—all in an effort to mask or eliminate unpleasant odors. The art of perfumery is ancient and complex. The base ingredient of any perfume is its essential oil. Historically, the source of essential oil or essence was plant material (such as flower petals, bark, fruits and their peels, nuts, and leaves), and occasionally animal material (such as musk, ambergris, and civet). This concentrate was derived in a variety of different ways. Today, essences still come from plant and animal materials, but synthetic substitutes are often used in modern perfumes. Sometimes, the synthetic version of an essential oil exactly duplicates the molecular formula of its natural source. But other perfumes contain synthetic ingredients that have no natural counterpart—they just smell good.

Perfume artists—actually chemists—make perfume by mixing different essential oils. Examples of some chemicals that are contained in essential oils can be found among the "good"-smelling molecules on page 11. The resulting combinations are tested at different temperatures and pHs to make sure that the scent will not change in changing conditions. You wouldn't want to walk out the door smelling great, only to smell like a garbage can upon entering a warm room! The perfume oil must be dissolved in a solvent—typically, an ethanol–water mixture—at the correct concentration for perfume (20–30% essential oil), cologne (8–15% essential oil) or aftershave (1–3% essential oil).

In pre-Victorian times, perfumes masked the smells of unwashed humans, rotting garbage, and raw sewage. Perfumed handkerchiefs and gloves were very popular, sometimes pressed over the mouth and nose to protect against the "bad air" blamed for disease. Today, our modern combination of cleanliness and effective medicines means that we can rely on fragrances for what they do best—smell good.

PHOTO BY MIKE CIESIELSKI

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The Good

Vanilla
Vanillin

Spearmint
R-Carvone

Bananas
Isoamylacetate

Peaches
Benzylacetate

Wintergreen
Methylsalicilate

Citrus, Lemon
Citronellal

Clove
Eugenol

Cinnamon
Cinnamaldehyde

The Bad

Strong cheese smell
Butanedione

Stale urine
5-Androst-16-en-3-ol

Rancid sweaty smell
Isovaleric acid

More stale urine
5-Androst-16-en-3-one

Onion
Allyl propyl disulfide

Garlic
Diallyl disulfide

Goats
4-ethyloctanoic acid

Rotten Eggs
Hydrogen sulfide

Rotten Fish
Trimethylamine

Skunk
3-methylbutane-1-thiol

The Ugly