

Clearing the Way

to Acne-Free Days

By Joely Johnson Mork



MEGAN TRIED ALL THE POSSIBLE PRODUCTS on the market. She spent lots of time and plenty of money and got only dried-out—but *still* broken-out—skin in return. Then came what Megan calls the Upper Lip Breakout of 2014. “It was earth-shattering. I mean, my sister started calling it my ‘zit stache.’ It lasted almost a whole year.” Megan was desperate.

Hopefully, your breakouts won’t be as bad as Megan’s. Even minor acne, however, can be a serious problem. While no one has ever died of pimples, acne can have such a big impact on self-esteem and confidence that experts consider treatment essential.

Unfortunately, 80% to 90% of teenagers will have to cope with their share of acne. But they are not the only ones. As unfair as it may sound, people in their 30s, and even 40s, can still experience breakouts. More than 17 million U.S. residents see spots when they look in the mirror.

What causes acne?

In technical terms, pimples are called *acne vulgaris*, and *Propionibacterium acnes* are the bacteria responsible for stirring up all that trouble. Interestingly, *P. acnes* is found on almost everyone’s skin, whether or not pimples are visible.

This common, anaerobic organism needs certain conditions in which to create its signature brand of havoc, and the main requirement is an excess of oil. (The other contributing factor is an overgrowth of skin cells.) Our bodies produce plenty of oil on purpose. Once this slick substance, called sebum, makes its way to the surface of our skin, it becomes a

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barrier that works in two ways: 1) it limits the amount of water that sinks into our skin, and 2) it prevents us from losing too much water through our skin. Also, sebum protects the skin from bacterial and fungal infections. But you can have too much of a good thing.

Sebum comes from sebaceous glands located inside hair follicles (*not* from pores, which are the openings to sweat glands). Sebum is composed of lipids, or fats, which do not dissolve in water, which is why sebum can keep water both outside *and* inside the

skin. Sebum contains a variety of different lipids, but the exact composition of sebum varies with a person’s age.

When too much sebum is produced, a follicle can become blocked, allowing the oil, along with dead skin cells, to build up. Add some *P. acnes* bacteria to the mix, and you have all of the ingredients for a slow-growing infection that will lead to swelling, redness, and inflammation. In other words: a big, nasty zit (Fig. 1).

Pimples can be spotted by that telltale bulge they create in the skin. Dead skin cells and oils collect in the opening to the hair follicle, producing a bump called a comedo. If the skin over the bump stays closed, the bump is called a whitehead. When the skin over the bump opens, exposure to the air causes it to look black (due to oxidation), and another type of pimple, called a blackhead, forms. An acne infection that happens deep within a hair follicle produces the dreaded, painful, and lumpy pimple called a cyst.

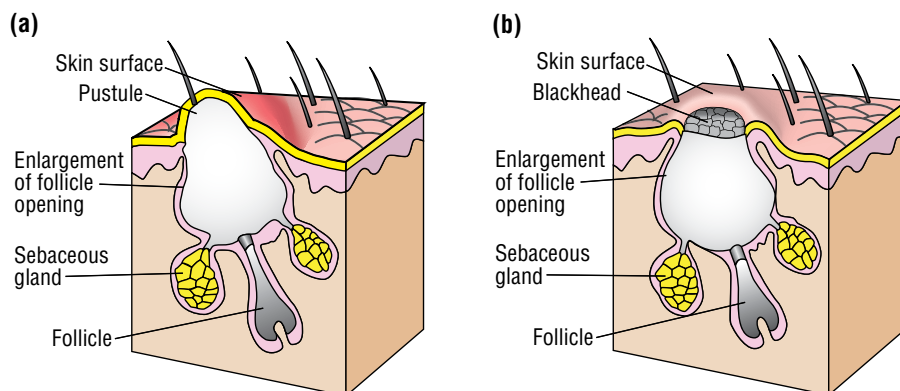


Figure 1. Two types of pimples: (a) a whitehead; and (b) a blackhead

Diet and acne

Acne affects mostly young people: preteens and 20-somethings. Sebum production is under the control of the sex hormones, the most active of which is testosterone. Also known as androgens, these hormones stimulate sebaceous gland cells to produce more sebum. Higher levels of androgens encourage bigger breakouts.

In the 1960s and 1970s, studies and news stories sounded the alarm that eating chocolate, soft drinks, and basically anything with added sugar was the main cause of pimples. The evidence, however, was shadowy at best, due to flawed research.

But new research shows that **androgens are not the only chemical that influences sebum production. Insulin-like growth factor-1 (IGF-1) and a series of other chemical compounds also increase sebum and are implicated in the development of acne.**

Insulin is a storage hormone that helps control blood glucose levels. Eating processed carbohydrates will cause insulin levels to increase. Any time insulin increases, so does IGF-1, which stimulates sebum-producing cells to increase sebum production. IGF-1 also makes skin cells grow faster and stimulates the production of more androgens. The effects of these chemicals may point the way to the link between diet and pimples.



Better living through chemistry

What you eat may affect your pimple production, but it will take time and dedication to your diet to find out. If you need more or faster help, there are numerous over-the-counter and prescription treatments for acne. Start with products that you can buy without a prescription, such as cleansers, scrubs, masks, or spot treatments that aim to remove dead skin cells, kill bacteria, or minimize oil production.

Benzoyl peroxide ($C_{14}H_{10}O_4$) (Fig. 2) is a popular over-the-counter antimicrobial compound that kills *P. acnes* by preventing the organism from reproducing. In addition, benzoyl peroxide is lipophilic, meaning it can dissolve in oil—making it the perfect weapon to penetrate deep into pimples. This ingredient can be found in gels, creams, lotions, and cleansers.

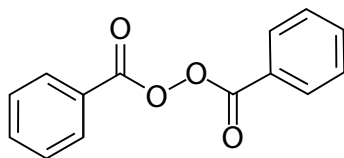


Figure 2. Chemical structure of benzoyl peroxide

Chemical Compounds that Clear Acne

Benzoyl peroxide ($C_{14}H_{10}O_4$) is an organic compound in the peroxide family. It consists of two benzoyl groups bridged by a peroxide link. In addition to treating acne, it is also used to bleach hair, to whiten teeth, to make bleached flour, and to remove dye and ink during the production of plastic toys.

Salicylic acid ($C_7H_6O_3$) has a structure where the OH group is *ortho* to the carboxy group. It was originally derived from the white willow plant, which was used to treat fever and pain in ancient Greece and Egypt. Native Americans also used white willow as a medicine.

Retinoids are a class of chemical compounds that are related to vitamin A. The basic structure of a retinoid molecule consists of a cyclic end group, a polyene side chain, and a polar end group. Research is being conducted to use retinoids to treat cancer, in particular Kaposi's sarcoma.

Spirolactone ($C_{24}H_{32}O_4S$) is primarily used to reduce fluid buildup in the body due to heart failure or kidney disease. It is also one of the main drugs used for hormone replacement in transgender women (males who are transitioning to female).

—Joely Johnson Mork



Salicylic acid (Fig. 3) is another over-the-counter treatment that can be useful for acne without causing irritation or dryness. It does not kill the bacteria; instead, it loosens and removes the outermost layer of skin and unclogs hair follicles.

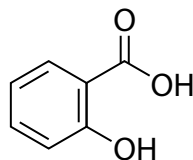


Figure 3. Chemical structure of salicylic acid

If you need stronger measures, your doctor might prescribe topical or oral antibiotics, which have been used against moderate acne for more than 50 years. A cautionary note about using antibiotics is that the bacteria may become resistant to the drugs, making them useless.

For moderate to severe acne that does not respond to other treatments, the most common prescription medications include a class of potent chemical compounds known as retinoids, which are related to vitamin A. Applied topically, these drugs have exfoliating and anti-inflammatory effects, but they take a few weeks or more to work and can also cause your acne to get worse before it gets better.

If you are a woman, your dermatologist might prescribe oral contraceptives, or a drug called spironolactone, to help control severe acne. Birth-control pills work by regulating hormone levels, but also pose a slightly increased but serious risk of blood clots. Spirolactone also blocks the influence of androgens on the sebaceous glands, reducing oil production in the skin and improving acne.

Find what works for you!

Today, there are many ways to treat pimples, including managing insulin by eating more low-glycemic foods and fewer processed carbohydrates; using over-the-counter products that contain salicylic acid or benzoyl peroxide; and finding a dermatologist who might recommend prescription lotions or pills.

If you are one of the many of us who deal with pimples on a regular basis, keep in mind that the pimples won't last forever. Megan was able to laugh about her truly awful breakouts (at least some of the time), and things did get better for her (and her skin). "Finding the right makeup and cleanser for my oily-and-sensitive-at-the-same-time skin helped," she said. "And so did getting older!" ^{CM}

SELECTED REFERENCES

Rohrig, B. Demystifying Gross Stuff. *ChemMatters*, Oct 2011, pp 12–14.

Baxter, R. Battling Zits. *ChemMatters*, April 2005, pp 4–6.

Acne Treatments: Medical Procedures May Help Clear Skin. Mayo Clinic: <http://www.mayoclinic.org/diseases-conditions/acne/in-depth/acne-treatments/art-20045892> [accessed Sept 2016].

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