# Hydrogen Peroxide: the body's best defence system

How does that happen? A foam forms when bubbles of a gas are trapped in a liquid or solid. In this case oxygen is generated when hydrogen peroxide breaks down into oxygen and water on contact with catalase, an enzyme found in liver.

By Joe Schwarcz | 18 Jan 2017 |

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Enzymes are special protein molecules that speed up chemical reactions. But why should liver contain an enzyme that helps degrade hydrogen peroxide? Because hydrogen peroxide actually forms as a product of metabolism and can do some nasty things. It can break apart to yield hydroxyl radicals that attack important biochemicals like proteins and DNA. To protect itself, the body makes catalase, the enzyme that decomposes hydrogen peroxide before it can form hydroxyl radicals.

Actually, the formation of hydrogen peroxide in cells is an attempt by the body to protect itself from an even more dangerous substance, superoxide.

Oxygen is a double-edged sword. We can't live without it, but it also hastens our demise by playing a role in the aging process. Here's what happens. Electrons are the "glue" that hold atoms together in molecules, and all sorts of electron transfers occur between molecules when they engage in the numerous chemical reactions that go on in our body all the time. Sometimes during these reactions an electron is transferred to oxygen, converting it into a highly reactive "superoxide" ion that attacks and rips other molecules apart.

But we have evolved a defence system, in this case an enzyme called "superoxide dismutase" that gets rid of superoxide by converting it into hydrogen peroxide, which although potentially dangerous, is less dangerous than superoxide. Still, it does present a risk and this is where catalase enters the picture. It breaks the peroxide down into

oxygen and water. And that is why hydrogen peroxide foams when poured onto liver.

If you have ever used hydrogen peroxide to disinfect a cut, you may have also noted some bubbling since blood can decompose hydrogen peroxide into oxygen and water. The catalyst this time is not an enzyme, but the “heme” portion of hemoglobin, the oxygen-carrying compound in red blood cells.

Swiss chemist Christian Friedrich Schonbein, best known for his discovery of “guncotton” upon using his wife’s apron to wipe up an accidental spill of nitric and sulphuric acids, was the first to note bubbling when hydrogen peroxide was mixed with blood. He reasoned that if an unknown stain caused foaming on treatment with hydrogen peroxide, it probably contained hemoglobin, and was therefore likely to be blood. Introduced in 1863, this was the first presumptive test for blood. But since hydrogen peroxide tends to decompose slowly by itself, looking for extra bubbles was a challenging endeavour.

A significant improvement was introduced in the form of the “Kastle-Meyer test” that produced a colour change in the presence of hemoglobin. This relied on the chemistry of phenolphthalein, well-known today to students as an acid-base indicator. Phenolphthalein is colourless in acid but turns a deep pink in a basic solution. In this case, though, the important feature is that phenolphthalein can be reduced with zinc into colourless phenolphthalin, which along with a base is present in the test reagent.

In the usual process, a drop of alcohol is added to an unknown stain to dissolve any hemoglobin that may be present, followed by rubbing with a swab that has been treated with the Kastle-Meyer reagent. A drop of hydrogen peroxide is then applied to the swab. If hemoglobin is present, the hydrogen peroxide decomposes to yield oxygen that in turn oxidizes the phenolphtalin to phenolphthalein. Since the solution is basic, a pink colour develops indicating the presence of blood. The test is very sensitive, but is not specific for human blood. Animal blood will also yield a positive reaction as will oxidizing agents such as some metal ions.

This reaction of hydrogen peroxide with hemoglobin is also the basis of the “luminol” test used by crime scene investigators to detect traces of blood that may not be visible at all. The technique is to spray the suspect area with a solution of luminol and hydrogen peroxide. If blood is present, the peroxide will yield oxygen that then reacts with luminol to produce a blue glow. This reaction was first noted in 1928 by the German chemist H.O. Albrecht and was put into forensic practice in 1937 by forensic scientist Walter Specht.

Even dried and decomposed blood gives a positive reaction with the blue glow lasting for about 30 seconds per application. The glow can be documented with a photo but a fairly dark room is required for detection. The reaction is so sensitive that it can reveal blood stains on fabrics even after they have been laundered. In one case, a pair of washed jeans with no visible stains gave a positive test with luminol on both knees.

Neither the Kastle-Meyer test nor the luminol test can identify whose blood is involved, but once a stain has been determined to be blood, traces of DNA can be extracted and an identification carried out. In the example of the jeans, DNA analysis was able to exclude the blood coming from the owner of the jeans.

Luminol analysis does have drawbacks. Its chemiluminescence can also be triggered by a number of substances such as copper-containing compounds and bleaching agents. Had the jeans been washed with a detergent containing a bleaching agent, the blood would not have been detected. Criminals aware of this have been known to try to wash away traces of their crime with bleach. The result is that residual bleach makes the entire crime scene produce the typical blue glow, which effectively camouflages any blood stain.

And if you want to see a really impressive glow, spray a piece of liver with a luminol test solution. Don’t eat it after.

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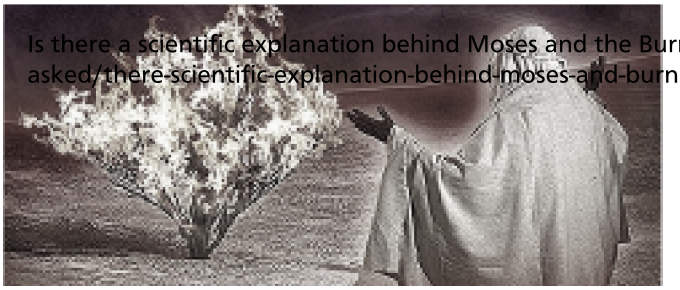

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