

American Chemical Society AMA: I am Susan D. Richardson, Ph.D., a Professor of Chemistry at the University of South Carolina and expert on water treatment chemistry. Ask me anything about the chemistry of swimming pool disinfection!

AmerChemSocietyAMA¹ and r/Science AMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Hi Reddit! Ask me anything about the chemistry of disinfecting water for swimming pools or other treatment needs!* I'm Susan D. Richardson, Ph.D., the Arthur Sease Williams Professor of Chemistry in the Department of Chemistry and Biochemistry at the University of South Carolina in Columbia, SC. Prior to coming to USC in January 2014, I was a research chemist for several years at the U.S. Environmental Protection Agency's National Exposure Research Laboratory in Athens, GA. For the last several years, I've been conducting research in drinking water and in swimming pool water—specifically in the study of toxicologically important disinfection by-products (DBPs). These are the unintended consequence of trying to kill harmful microorganisms in drinking water and in pools. The disinfectants kill bacteria and contaminants that can cause deadly illnesses such as cholera, but they can interact with natural organic matter formed from decaying leaves and plants in rivers. Disinfectants like chlorine will react with that natural organic matter to form DBPs, that can in turn cause detrimental human health effects in drinking water, including bladder cancer, miscarriages, and birth defects. Pool DBPs have also been implicated in cases of asthma and bladder cancer. I work on identifying new DBPs or other unknown chemicals in the environment, drinking water, and pools using mass spectrometry. I also study wastewater treatment plants and the effects of disinfectants on river water. Most recently, I've started to investigate the impact of hydrofracking on DBPs in water. You can read about some of my newest research on DBPs in swimming pool and spa water in this Editor's Choice open access article in Environmental Science & Technology and my work is also covered in a recent article from Chemical & Engineering News. My B.S. in chemistry and mathematics is from Georgia College & State University and my Ph.D. in chemistry is from Emory University. I also have an honorary doctorate from Cape Breton University in Canada and was recently named an ACS Fellow. I serve as an Associate Editor for Water Research, on the Editorial Advisory Board for Environmental Science & Technology, and write on emerging contaminants in water/environmental analysis for Analytical Chemistry. I'll be on at 1pm EDT. I'm live now! I look forward to answering your questions! -sr

[REDDIT](#)

American Chemical Society AMA: I am Susan D. Richardson, Ph.D., a Professor of Chemistry at the University of South Carolina and expert on water treatment chemistry. Ask me anything about the chemistry of swimming pool disinfection!

AMERCHEMSOCIETYAMA [R/SCIENCE](#)

Hi Reddit!

Ask me anything about the chemistry of disinfecting water for swimming pools or other treatment needs!

I'm Susan D. Richardson, Ph.D., the Arthur Sease Williams Professor of Chemistry in the [Department of Chemistry and Biochemistry at the University of South Carolina in Columbia, SC](#). Prior to coming to USC in January 2014, I was a research chemist for several years at the [U.S. Environmental Protection Agency's National Exposure Research Laboratory in Athens, GA](#). For the last several years, I've been conducting research in drinking water and in swimming pool water—specifically in the study of toxicologically important disinfection by-products (DBPs). These are the unintended consequence of trying to kill harmful microorganisms in drinking water and in pools. The disinfectants kill bacteria and contaminants that can cause deadly illnesses such as cholera, but they can interact with natural organic matter formed from decaying leaves and plants in rivers. Disinfectants like chlorine will react with that natural organic matter to form DBPs, that can in turn cause detrimental human health effects in drinking water, including bladder cancer, miscarriages, and birth defects. Pool DBPs have also been implicated in cases of asthma and bladder cancer.

I work on identifying new DBPs or other unknown chemicals in the environment, drinking water, and pools using mass spectrometry. I also study wastewater treatment plants and the effects of disinfectants on river water. Most recently, I've started to investigate the impact of hydrofracking on DBPs in water.

You can read about some of my newest research on DBPs in swimming pool and spa water in this [Editor's Choice open access article in Environmental Science & Technology](#) and my work is also covered in a recent [article from Chemical & Engineering News](#). My B.S. in chemistry and mathematics is from [Georgia College & State University](#) and my Ph.D. in chemistry is from [Emory University](#). I also have an honorary doctorate from [Cape Breton University in Canada](#) and was recently named an ACS Fellow. I serve as an [Associate Editor for Water Research](#), on the [Editorial Advisory Board for Environmental Science & Technology](#), and write on emerging contaminants in water/environmental analysis for [Analytical Chemistry](#).

I'll be on at 1pm EDT.

I'm live now! I look forward to answering your questions! -sr

[READ REVIEWS](#)

[WRITE A REVIEW](#)

CORRESPONDENCE:

Hi thanks for this AMA. How safe are swimming pools in terms of the people swimming catching any illnesses from other infected swimmers. Can the water in the pool cause such spreading?

[mistymountainz](#)

DATE RECEIVED:

August 10, 2016

Swimming pools are treated with disinfectants (chlorine, bromine, ozone, etc.) that kill most pathogens.

DOI:

Although some disinfectants are better than others. So, the risk of catching an illness from other

10.15200/winn.147074.43473

ARCHIVED:

August 09, 2016

CITATION:

AmerChemSocietyAMA ,
r/Science , American Chemical Society AMA: I am Susan D. Richardson, Ph.D., a Professor of Chemistry at the University of South Carolina and expert on water treatment chemistry. Ask me anything about the chemistry of swimming pool disinfection!, *The Winnower* 3:e147074.43473 , 2016 , DOI: [10.15200/winn.147074.43473](https://doi.org/10.15200/winn.147074.43473)

© et al. This article is distributed under the terms of the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and redistribution in any medium, provided that the original author and source are credited.



swimmers is low if the pool is operating well. SR

Is it possible to safely treat large open bodies of water like the Copacabana beach venue of the current Olympics?

[stewedRobot](#)

Unfortunately, it is probably not practical to treat large bodies of water that are open to the ocean. SR

With summer coming to an end, many people will start to consider draining their pools. Is there a best practice for draining an entire backyard pool while minimizing the impact to the downstream environment?

[raflcopter](#)

This is a difficult question to answer. For sure, you would minimize your DBP exposure if the pool water was drained/exchanged more often. But, there could be impacts on the downstream environment, depending where the water goes. I don't think this has been well studied yet. One example that I can think of is: if stabilized chlorine is used for treating a pool, high levels of cyanuric acid will build up in the pool over time, and these would be discharged to a wastewater treatment plant or to the environment. Someone needs to research this. :) SR

How much chlorine and other chemicals do we ingest daily by drinking tap water? What other chemicals other than chlorine are used in tap water, why and what volume are those used in?

I heard that in Flint they were able to add some kind of chemicals to the water to prevent lead from leeching into the water further, what are those chemicals and are they basically like doing chelation therapy on everyone at once? How much of those chemicals do we ingest?

[rollineyes](#)

In Flint (and other locations in the U.S.) orthophosphate is added to coat the pipes to prevent lead from leaching into the water. It is a safe additive. SR

Are salt pools a better alternative to chlorine pools?

Also what is the "state-of-the-art" method for disinfecting drinking water? I would assume that there are multiple stages.

[i_make_song](#)

As mentioned earlier, salt water pools also generate chlorine. But, they could be a reliable way to constantly provide chlorine at low doses. And, salt is safer for operators to handle than bleach or stabilized chlorine. SR

Are salt pools a better alternative to chlorine pools?

Also what is the "state-of-the-art" method for disinfecting drinking water? I would assume that there are multiple stages.

[i_make_song](#)

Current methods for disinfecting drinking water include: chlorine, chloramines, ozone, chlorine dioxide, and UV disinfection. There is also coagulation, flocculation, and filtration (multiple steps that you guessed) that are generally applied to help clean the water. SR

What are your thoughts on Ozone and the removal of Chloramines? In conjunction with UV? Finally, what are the positive and negative effects of treating city water with chloramines, and how those inorganic chloramines differ in regards to human exposure to organic chloramines?

[Tadddd](#)

Ozone and UV are also great disinfectants. Although, generally chlorine would also be used with them in a pool setting to maintain a residual disinfectant in the pool. With ozone and UV, they are used not in the pool directly, but separately, near the pool filter. Ozone is quenched on the filter generally (so it just kills harmful microorganisms but doesn't present a direct exposure to the swimmers). As a result, it would probably have limited degradation/removal of chloramines in a pool setting. Humans are exposed to inorganic chloramines and organic chloramines. Trichloramine is one of the inorganic ones we're concerned about. SR

What exactly happens when someone urinates in a pool? I'm sure the chlorine reacts with some of the nitrogen compounds in urine, but which specific DBP's are known from this reaction?

[hello1321](#)

Urea comes from urine, and this reacts with chlorine to form trichloramine, which is volatile and goes into the air. Trichloramine is a known respiratory irritant and is suspected in the cases of asthma for elite swimmers. There are also other nitrogen-containing DBPs that form from urea. SR

Would you let your child swim in a pool in your backyard knowing what you now know about by-products? Or a public pool like at a YMCA?

[Notsogros](#)

Good question! I actually used to have an outdoor pool, and I let my children swim in it! My pool source water was ground water (with low organic matter precursors), and I carefully treated with chlorine, to have a residual, but not over-do the dose. And, with outdoor, pools, you get much more ventilation of the volatile pool chemicals, so I feel they are safer. My opinion is that for casual swimmers (not spending many hours per week swimming), pools (even indoor ones) are a safe form of exercise. SR

Dr. Richardson, thanks for doing this. Very cool of you.

I own a craft brewery and have two questions for you:

1. Would you weigh in on the corrosivity of DI water? We use straight DI to build our brewing water and every now and again I get folks telling me that the DI is corroding my stainless and I need to be more careful. I think if it is corroding my stainless it's going to take an incredibly long time.
2. Do you have any thoughts on why Ozone or UV sterilization isn't used in place of disinfectants like chlorine? We ozonate our process water and I can imagine a system that ozonates and then degasses pool water could be safe and effective, but even more so a large inline UV system might

be worth while. Any other alternative disinfection methods you think are worth discussing?

Thanks again! <3

[jurassicloth](#)

1. DI water is corrosive. That is because all of the ions have been taken out. Bottled water companies and drinking water treatment plants that use reverse osmosis have to add minerals back in afterwards to keep the water from being corrosive. However, I don't know if the brewing process puts back enough minerals where you are ok with your beer.
 2. Ozone and UV are great disinfectants.
- SR

I am a high school science teacher, but also a certified pool operator who spent many years in charge of a high traffic YMCA pool (1000-2000 bathers per week), so this is a subject near and dear to me.

Can you speak to methods that may mitigate the risk associated with asthma and swimming in a chlorinated pool?

Also, of the following methods, which is the most efficient in terms of cost vs effectiveness, and which is the most effective without cost considerations?

Liquid chlorine (Sodium hypochloride a.k.a. bleach) applied by a pump turned off and on by an ORP sensor

Solid chlorine (Calcium Hypochloride) applied manually (Is there an automatic method for solid chlorine?)

UV light with supplemental chlorine

salt water pool (generally requires supplemental chlorine in a commercial setting depending on state laws)

Bromine

Chlorine gas diffusion (outlawed or effectively regulated out of use in most U.S. states, but still used overseas)

Ozone with supplemental chlorine

[monkeydave](#)

All of these are effective disinfectants. Although the biggest thing that can be done to reduce asthma in swimmers is to have people not pee in the pool. Urine is probably the greatest contributor to trichloramine formation, which is suspected as the causal agent. For disinfection purposes, UV-chlorine and ozone-chlorine are good ways to go. Because of the more toxic bromine-containing DBPs that are formed with bromine disinfection, I personally think bromine should be avoided. SR

Hi, Susan, we have met before at a conference. I had two brief questions:

1. What are your thoughts on the use of peracetic acid as an alternative to more conventional chloramine, ozonation, etc.. treatment processes?
2. How does occurrence data reflect recent weather? I see plenty of occurrence studies that often collect from source and finished waters at different time points through a year (usually to measure seasonal variation), but I have rarely seen any comments on practices to adjust data to recent

weather. For example, summer and winter months (e.g. June and December) appear to be popular measurement months (reflecting seasonal extremes); however, last year, at least in Missouri, we had an unusually wet November and December. If samples were taken during December, would you expect to see significant dilution effects in the occurrence data?

Thank you for your valuable work!

[Custergrant](#)

1. We've actually studied peracetic acid before. It is also a good disinfectant (not widely used yet), but one downside is the production of acetic acid as a by-product.
2. For drinking water sources (and outdoor pools), for sure there are seasonal effects (temperature, rainfall, etc.). Increased rainfall can dilute organic matter precursors and it can also results in increased precursors from runoff, just depending. And, generally, the warmer the temperature, the higher levels of DBPs that form. SR

Can bacteria and other microorganisms grow resistance to pool disinfectants (chloramine and such), similarly to what happens with antibiotics?

[Olexandra](#)

I'm not 100% sure, but I believe that they can grow resistance. But, I think that the doses of pool disinfectants are high enough to still kill most of them. SR

The city of Minneapolis put in a self-cleaning, non-chlorinated pool near my house. Apparently it uses plants and other "natural" means to clean the water. How safe are these types of pools vs traditional chlorine treated pools?

[mnbitcoin](#)

I'm not aware of treatments involving plants. SR

What was it like working for the EPA and how did you get there?

Im pursuing a B.S. In chemistry at Clemson and am hoping to get a job in environmentally related Research and Development

[Coffeaisnope](#)

It was mostly great! Feel free to email me and I'll give you some further details off line. (richardson.susan.h2o@gmail.com). SR

So how "disinfected" is the average pool? How clean is it? What does chlorine kill? Does it take care of viruses and fungi or just bacteria? What's left after the chlorine kills whatever it kills?

[olaoghair](#)

If a pool is operated properly, the harmful microorganisms should be killed by chlorine or the other disinfectants used. There are situations where the system could be overwhelmed and it not be safe, however (leaky diaper, etc.). The downside to disinfection is that disinfection by-products (DBPs) are formed as by-products. That is mostly what is left behind.

SR

What is the best treatment for pink algae?

[WinstonWonders](#)

Pink algae is actually a bacteria that is easily killed with chlorine (and other disinfectants). I assume you are referring to the pink-peach colored slime that we often see in our showers and toilets. SR

Thanks for doing this timely AMA. Rather than halide based disinfection such as chlorine, bromine, etc., do you see advantages of using Advanced Oxidation Processes (AOPs) to accomplish the desired results without generating unwanted or unintended byproducts? Our research and products seem to indicate that this is a "cleaner" means of disinfecting water sources in that the oxidants (ozone, peroxide, hydroxyl radical and superoxide anion) are all oxygen and/or oxygen-hydrogen based, eliciting more favorable oxidized compound by products. Your thoughts and comments are appreciated.

[mjfleck34](#)

Advanced oxidation (for example, with UV and hydrogen peroxide) is being used in some wastewater treatment. Overall, it does a great job of removing many harmful chemicals (although sometimes a few new ones can form). Advanced oxidation is not used much for drinking water treatment yet. SR

Is there actually a chemical that will change the water color if I pee in the pool?

Follow-up: How much pee is in an average public pool?

EDIT: Go Gamecocks!

[BLT_Special](#)

Urban myth on the color change with pee. :) On average, a swimmer introduces 30-80 mL of urine to a public pool. SR

Are there contaminants that build up over time in a pool that don't burn off naturally or get filtered out? I reduce the water in my above-ground only about 1/3rd every winter, and have done for fifteen years, so if there are these contaminants, I would imagine a setup like that would be the ideal place for them to build up.

[Johnny_La_Rue](#)

Yes, there are DBPs that build up over time. A good example are the haloacetic acids, which are non-volatile and accumulate to very high levels over time. SR

What are the most concerning DBPs that you've studied?

[ever_the_skeptic](#)

For drinking water, I would say the iodine- and bromine-containing DBPs and the nitrogen-containing ones (e.g., nitrosamines, halonitriles, haloamides, halonitromethanes). For example, iodoacetic acid forms in drinking water treated with chloramines when iodide is present in the source water (e.g., in coastal cities). This DBP is not regulated but is the most genotoxic DBP identified to-date, and it is

tumorigenic. For pool water, it is difficult to say. We recently identified some new brominated imidazoles that we are currently getting toxicity info on. I'm also particularly concerned about the haloacetic acids which are not volatile and build up to very high levels in pools and also the trichloramine in the air. Halobenzoquinones may also be a concern. SR

International comparison! Are there any ways in which water treatment in the US is better or worse than what other (modern) countries do? Techniques that are used in the US that are almost unknown elsewhere in the world, or problems that America has that other countries handle easily?

Is your research mostly focussed on the US, or do you work a lot internationally?

[ADogNamedDiesel](#)

I have done some research with drinking water and pools from other countries (in addition to the U.S.). In Europe, there is much less chloramines used for drinking water treatment. Ozone and UV are more popular. The U.S. uses mostly chlorine and chloramines for drinking water disinfection, with some ozone. For pools, we use chlorine (including stabilized chlorine), bromine, ozone, and UV. SR

Hey, I listened to a retired doctor named Gunnar Holmgren and he talked about a simple way to make water safe to drink in hot 3rd world countries.

- Fill a PET bottle 3/4 full.
- Shake it.
- Full up the rest of the bottle with water.
- Throw it on the roof and let it sit for 24 hours.

What is your opinion on this method?

[Zylan-](#)

This would be using UV in sunlight to kill microorganisms. It could be effective, but it depends on the light penetration in the bottle and the contact time. SR

Dr. Richardson,

As a consulting engineer for wastewater and drinking water treatment, I'd like to know if you or your colleagues/students are pursuing research in disinfection byproduct formation in distribution systems.

Thanks!

[bradforrrd](#)

Yes, we have. It is important to look at drinking water distribution systems (in addition to the water just leaving the plant) because this is the water we are really drinking and some DBPs will increase in concentration, while others degrade and decrease over time. SR

What I don't understand is how Chloramine doesn't evaporate like chlorine. Is it more stable at room temperature ? ? is that the only benefit of using one over the other ?

[Johnnyfiftyfive](#)

Chloramine is more stable than chlorine in water. This is why you can't just let it "air out" before putting in your tropical fish tank. Chloramine has grown in popularity for use as a drinking water disinfectant because it forms lower levels of regulated DBPs than chlorine does. However, in some locations, other unregulated toxic DBPs can form with chloramines, and there is growing concern about using this disinfectant for drinking water. SR

Hi Thanks for the AMA! Is there another feasible alternative to chlorine in regular swimming pools? Something that is more friendly to the hair and skin.

[HumanInHope](#)

Unfortunately, most disinfectants are strong oxidants and they will have effects on the hair and skin. Some ideas are to use UV-chlorine, and with the use of UV, potentially lower levels of chlorine could be used. Also, some hot tubs are treated with silver-impregnated filters, which don't introduce oxidants to the water (and as a bonus, would not form DBPs). Don't know if this could be implemented on larger swimming pools. SR

Is chemical treatment necessary? Aren't there advanced physical filter filtration systems available?

[dareka1](#)

In my opinion, I believe chemical (or UV) disinfection is necessary for swimming pool environments. Advanced physical removal is used a lot in Europe for drinking water, such that a disinfectant isn't always necessary. I think this is a great way to go for drinking water, but pools are more problematic (because swimmers can introduce pathogens directly to the water, and it takes a long while for all of this water to move through the filters). SR

What with Chloramines and the build up around indoor pools. A facility I previously worked at has a positive pressure air handling system which was designed to cause a layer of air to sit over the pool. The end result was that we had an issue with chloramines sitting over the pools causing a smell and signed of breath in some people.

What is the best way to clear out the chloramines? We also had a build up of a slime like substance in the balance tanks for the pools. The pools were regularly dosed correctly to keep the pools within regulation.

[Disturbedsleep](#)

In my opinion, the best ways to clear out the volatile chloramines (in the air space above the pool) is with good ventilation. Also swimmer behavior, like showering before entering a pool and not peeing in the pool, would help a lot. SR

Is swimming in an overly chlorinated pool dangerous?

[royal_fish](#)

Excess chlorine can form higher levels of DBPs. But, it's hard to judge how hazardous this is at this time. There is one study showing increased bladder cancer, and it is likely that the pool waters will be more mutagenic. SR

Is there an understanding of how these DBPs interact with body chemistry? What do they do to cause disease? How long do they stay in the body?

[nursecatchit](#)

There is some understanding, but there is a lot more research needed to fully understand their mechanisms of toxicity and behavior in the body. For example, Dr. Michael Plewa (Univ. Illinois) has discovered that haloacetic acids can bind to an enzyme in the body (GAPDH), which affects the TCA cycle, reducing ATP production, and increasing reactive oxygen species (ROS), which can lead to genotoxicity and potentially cancer. Most DBPs should not be bioaccumulative, so they are different from other traditional contaminants like PCBs and dioxins that do accumulate. But, our exposure to DBPs is chronic (we drink them every day), so we always have a fresh dose. Some DBPs are metabolized (THMs), while others are not. And, some (e.g., the THMs) require metabolic activation to become mutagenic. SR

What are your thoughts on well water as drinking water? Any ideas on how to make sure it's safe? My HOA controls it, not me.

[Qwertyz13](#)

I'm actually a big fan of well water! I had a well for many years when I lived in GA. Mine was 300 ft deep, beneath a layer of clay and granite, and was always cold and didn't have to be disinfected with anything. :)

In general, if your well is at least 100 ft deep, you are usually ok (from a bacteria and chemical runoff standpoint). There are places you could send your water to for testing if you're concerned. SR

Very very interesting work Dr. Richardson! A few questions:

- 1) Most DBPs seem to be halogenated organics, which as a class of compounds contains the most persistent organic pollutants. What are the residence times of DBPs and are there treatment methods that reduce this time? What are the sorts of quantities we deal with in pool water and drinking water typically?
- 2) What is the quantity of DBPs released to the environment by flushing pools? Given the attempts to phase out CFCs, are there concerns about how to regulate pool effluent? Do you have much chance to sit down with policy makers on this issue?
- 3) What are the best ways to detect DBPs? Do pools regularly check for them? Is there any feasible way for citizen scientists to check for one or a few DBPs cheaply?
- 4) I have heard calls to completely sunset chlorine from use. Is this feasible at all or in disinfection? What kinds of alternatives exist?
- 5) How much have we studied the toxicology of DBP compounds in animals?

Sorry, that was a lot!

[Imhotep_Is_Invisible](#)

1. Most DBPs are stable in drinking water distribution systems (between the plant and your tap), but they are not as persistent as many other classical persistent organic pollutants, such as PCBs and dioxins. In drinking water, they are usually parts-per-billion levels (which is much higher than other contaminants that can be in drinking water), and in pool water, they are generally at similar levels, except for the ones like haloacetic acids, which accumulate in pools and can be 1000x higher than

in drinking water.

2. See above answer for levels that would be released. I haven't seen anything yet about regulating pool effluents. And, pools aren't regulated in the same way that drinking water is regulated (there aren't DBP regulatory limits in the U.S. for pools).
3. Mass spectrometry (MS) is the best way to detect DBPs. We use gas chromatography (GC) and liquid chromatography (LC) with MS. GC-MS and LC-MS can detect trace levels (very sensitive technique), and each chemical gives it's own "fingerprint" (a mass spectrum) that we can use to identify them. Membrane introduction mass spectrometry (MIMS) is another technique sometimes used for volatile DBPs (Dr. Ernest "Chip" Blatchley at Purdue Univ. uses this). I don't know about how to do this cheaply... That is a good question. I wonder if there is a Hach kit or something like this that can detect a few DBPs.
4. It could be possible. Or at least, to use UV or ozone with chlorine so that the chlorine dose could be lowered. And, I wonder if somehow we could scale up silver-impregnated filters (like used in some hot tubs) to disinfect pool water without DBP formation (but make sure the silver isn't sloughing off into the environment).
5. We have studied about 90 DBPs in cells so far (in vitro assays), but far less in animals. This is a major stumbling block to understanding human risk and taking steps to regulate or reduce these DBPs. We need more animal research for them, but these studies are more costly. I'm doubtful that new chemicals (and DBPs) will be regulated and controlled if there are not animal studies showing they are a problem.

Great questions! SR

Thanks for the AMA!

How do these harmful things hurt us? Do we only have to have our skin exposed to it by swimming, or do we need to swallow pool water to really see any deleterious effects?

[positive_electron42](#)

You will have some accidental ingestion of pool water, but your more major sources of exposure are breathing the vapors and dermal exposure (some DBPs go across your skin and enter your bloodstream). We know from human epidemiological studies that there is the possibility for asthma and bladder cancer for pool exposures, and also miscarriage and birth defects with drinking water. We hope to solve these important issues! SR

Do you think waste water plants should move away from chlorination and into ozonation to combat the growing concern of pharmaceutical waste in our waters. It's know that chlorination of said compounds such as ciprofloxacin increases their harmful affects.

[Levofloxacin](#)

Yes, chlorine can react with some pharmaceuticals and other wastewater contaminants to form DBPs. Ozone is generally a good way to go, and I think UV is, as well. I would be a fan of moving away from chlorine to other disinfectants for wastewater. SR

Is fluoridating drinking water really necessary?

[baylenmiller](#)

This is a very controversial topic. Dentists and most health officials would say yes, since fluoridation has significantly reduced tooth decay. At the same time, there is a narrow range where it is effective against cavities and doesn't cause tooth mottling/bone decay. SR

[removed]

[\[deleted\]](#)

1. They are likely treating your tap water with chloramines (DC area).
2. Bio-filtering is good, but there also needs to be some kind of disinfectant to kill the harmful pathogens. SR

Go Gamecocks! Welcome to USC. The rivers around Columbia are an incredible natural resource. Unfortunately they are not always safe for recreation due to bacteria. [Link to recent occurrence](#). Does your research involve any of the rivers local to Columbia? If so, what would you like residents of Columbia to know?

[Cactapus](#)

Thanks for the welcome! Yes, the high levels of bacteria in some of our rivers is troubling. They think a lot of it is inadequate treatment of wastewater. Sometimes it can be due to CAFOs. We are collecting river water for some of our drinking water research, but I haven't been measuring bacteria in the waters.

As far as what residents should know, I think recreational swimmers/kayakers/etc should take care and not get in the water if they have any open wounds... But, as far as drinking water goes, the Columbia water treatment plant does a great job of killing the harmful bacteria and other microbes. SR

Hi Susan, when I was in highschool, the custodian in charge of the pool would over chlorinate the pool, often just before my swim team got in to start practice. There were several instances in which we hopped in the pool, and pretty much hopped back out immediately. My question for you is this, can I expect any long term health affects from this? How dangerous is it to swim in a pool that has been recently over treated?

[buvet](#)

I think short-term exposures are likely not a problem. But, spending several hours per day in an indoor pool like this may be a problem. SR

Thanks for doing this AMA! It's really appreciated.

I have questions about two things.

1. A friend mentioned the other day that water fluoridation has negative health effects. A quick skim through [World Health Organization Drinking Water Guidelines](#) indicates this is probably just conspiracy-theory nonsense. The only way I can see any legitimacy to his assertion is if fluoride creates DBPs - is that the case? Or is fluoride added purely for dental benefits?
2. Various individuals and organizations have predicted water scarcity issues emerging this century. Does anything in your work make you optimistic about non-obvious solutions to these sorts of

issues? Are there any new techniques or insights that will be useful in less-developed countries struggling with water scarcity issues?

[jazzandgin](#)

1. Fluoride does not contribute to DBPs, fortunately. But, there is a narrow range where it is effective for preventing cavities while not causing bone decay/tooth mottling. I do have some concerns in this regard. Fluoride is added solely for dental benefits.
2. Good question! Water scarcity is a HUGE issue now. We will likely continue to have increasing droughts (and floods) due to climate change, and growing populations in areas of water scarcity is an issue. I am optimistic, however, because we have lots of smart scientists tackling these issues now. My research group is even doing some new work in this area involving better/more sustainable ways to remove contaminants in the water.
Due to water scarcity, we will likely be reusing wastewater more for drinking water (with advanced treatment technologies), and we are building more desalination plants. The use of membranes for treatment is definitely increasing. SR

How shady is the pool chemical marketing? Over the years, I've used floccinators and clarifies and PH up/PH down, but in the end, I've found that if you just keep the chlorine in check, everything tends to follow. Am I lucky, or is this a gork?

[Johnny La Rue](#)

I agree with most of these comments that chlorine and pH are the most important things to control. There is a pH range where chlorine is most effective, so it's important to stay in that range so your chlorine is effective for killing the microorganisms. SR