“That’s Understandable” Season 2 - Episode 6
“Green Chemistry & The Green Patient” Transcript
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Brendan (00:08)
Hello everyone and welcome to That's Understandable. I'm your host, Brendan McEvoy, US head of external communications at AstraZeneca. If this podcast has been enjoyable and informative for you, take a moment to like and follow on your favorite streaming service. And if you know anyone else interested in today's topic, be sure to share because our goal is to help make everyone, because our goal is to help everyone to better understand what science can do when we all work together.

You get a call from your family practitioner's office. A few days ago, you had your annual checkup in labs. Everything came back fine, but like 47 million other Americans, your cholesterol is a little high. So the doctor prescribes you a medicine to lower your bad cholesterol and tells you to watch your diet. No big deal, you think? Well, until 2012, many of the medicines used to treat bad cholesterol were developed using a process that was actually quite bad for the environment.

Not only was the process incredibly inefficient, but it also produced a large amount of toxic byproducts. Fortunately, Dr. Ying Tang used a principle called green chemistry to develop a more efficient and environmentally friendly method of manufacturing these drugs. This was a turning point, as up until this time, hundreds, if not thousands, of life -saving medicines were manufactured using techniques that produced highly toxic byproducts and had serious impacts on both

the environment and human health. But Dr. Tang's work demonstrated that effective medicines could be manufactured using a cleaner, more efficient and safer process. Today, many pharmaceutical companies, and yes, AstraZeneca is one of them, are embracing green chemistry principles to reduce the impact of medicine development and manufacturing on the environment. And it isn't just the pharmaceutical industry.

Healthcare providers and patients are calling for better approaches to how medicines are made as the environmental effects on human health become increasingly clear. Joining me today are three guests who can help us add a little color to our conversation on green chemistry and taking another step, the green patient. First up is Dr. Cheryl Holder, retired associate dean of diversity, equity, inclusivity, and community initiatives at Florida International University's Herbert Wurtham College of Medicine. She has dedicated her career to improving the health of underserved populations and setting the links among climate change, poverty, and health. Welcome Dr. Holder.

Dr. Cheryl Holder (02:33)
Thank you.

Brendan (02:34)
My other two guests are AstraZeneca colleagues. Dr. Steve Swallow has spent more than 19 years at AstraZeneca as a chemist, including the last two years as our principal scientist for sustainability. He has helped contribute to the development of several clinical candidates over his long career. And joining Dr. Swallow is Dr. Magnus Johansson, senior principal scientist at AstraZeneca in research and development and an associate professor at Stockholm University. Welcome Dr. Swallow and Johansson.

Magnus Johansson (03:02)
Thank you, Brendan.

Steve Swallow (03:04)
Thank you, nice to see you.

Brendan (03:05)
Why don't we jump things right off in establishing a little bit of baseline when we say green chemistry. So Dr. Swallow and Johansson, can the two of you give us a quick overview of what exactly green chemistry entails?

Steve Swallow (03:18)
Yeah, sure. Shall I kick off? This idea, the concept of green chemistry was probably first properly described in a book published by John Warner and Paul Anastas back in the late 1990s, where they introduced the idea of 12 descriptors or principles of green chemistry. I won't go into those now, but maybe we can dig into those, some of those a bit later, but they essentially cover a few key concepts that really drive, I guess, a mindset or philosophy. So for me, in the context of pharmaceutical manufacture, that they can kind of be summarized as being about the design and development of pharmaceutical products and processes that minimize both the use and generation of hazardous materials and substances, while also reducing waste in general, but also thinking about improving the efficiency of energy use, etc. during manufacturing processes. So it's about the processes we design, but it's also about the materials we select and the efficient use of those resources when we use those processes and trying to make sure that materials are kept in use for as long as possible and where possible waste disposal is used as an last resort. So I think the example that you cited is a great one, in that it was an example that addresses a number of those areas at the same time through the targeted use of biocatalytic approaches.

Brendan (04:48)
Great, thanks. Dr. Johansson, anything to build on?

Magnus Johansson (04:50)
I think, I mean, considering the fact that Steve and me, we have the similar background being organic chemists and chemists, but maybe I can add to what Steve said to say that. So in drug discovery, I mean, it's a long process. We spend in principle around 10 years to take a drug from design to production and to patients. And then green chemistry is something that...

we try to implement already in the early days. So we try to design now molecule features that brings, you know, adds to the greenness and in sort of reducing the carbon footprint that we have overall in making new drugs. What's interesting also related to the 12 principles of green chemistry are the UN sustainable goals.

And I guess Dr. Holder will sort of relate to the sustainable goals because that's sort of building also on green chemistry, but also add to the green patients later on. What I want to add is the importance of health, education, and what also adds is the use of water usage and sanitation, for example, in the UN sustainable goals.

Steve Swallow (06:15)
I think Magnus raised an interesting point there as well that the climate challenge is something that's come very much into focus for us in more recent years. So a new dimension to the challenge around green chemistry that most pharma companies are also looking at.

Brendan (06:34)

And I think that actually, you know, it's helpful to have that explanation. And it's a great segue into a question for Dr. Holder, which is really around a little bit about that, the connection between, you know, environment and human health. So I guess my first question would be, Dr. Holder, what is the impact of green chemistry on patients? And in your opinion, what defines a green patient?

Dr. Cheryl Holder (06:58)
Thank you. Great question because you know medicine, especially for patients, they love the concept that we are moving towards this green chemistry, which means that you're considering the environment, you're considering biodegradability, you're considering sustainability, and you're considering a way that if we're supposed to get a medication that makes you well, why have all these other toxicities? It defeats the purpose of becoming better.

So the concept in labeling green chemistry, we hope will be chemistry, the way we do things day to day, because our goal in medicine is always to do no harm. And when we prescribe, we are hoping that we're getting improvement in the disease without the risk of other complications. So this is the perfect movement and climate change does add the urgency to it, not just that we're going to eventually get there, but there's an urgency looking at what the temperature rise that we will get there faster. Now, the green patient concept is very new and the population I work with, honestly, another label to what they believe in is probably not desirable because in many ways, patients and humans have been somewhat understanding sustainability. So the concept of somebody definite by behaving a certain way are green and other people who may not demonstrate those behaviors are not labeled green, we really want to avoid. So when I tell my patients about this movement and what we are doing, I bring them back to think about it. Baby boomers like my age remember when our parents used to say, turn off the lights, you're not in the room.

Don't waste food. What we look at now is that sustainability. That's respecting the planet, using the amount of resources that you need when you need it and not go forward. So I bring that concept into my exam room with patients like, you know, we're all green. We're just exhibiting different behaviors based on our abilities. But we have to make that effort to be faster and better at it. The young folks get this and so you're… classic what you might think of your green patient who will be out there advocating, will be sending letters to the pharmaceutical telling you you're killing the ocean, you're doing this. They're going to be. So I see my Gen Zers, some of my millennials are really pushing the needle and pushing the effort to move this faster. And they will be what might be considered the green patient. But I want the industry to understand that when they're competing interest in a person's life doesn't mean that they're not as concerned as the other person who's out there on the picket line. When you're lower wealth, you often have too many competing interests to demonstrate in the traditional sense of what people will now classify as a green patient. And that often gives the liberty of big powers to take advantage of that inability to voice your complaint but they are as complained and they are, lower wealth are making as much effort to be green as other people and they are as concerned. So I think this is great and we'll just see where it goes.

Brendan (10:30)
Yeah, no, I appreciate that that clarification, Dr. Holder, because what I'm taking away from what you said is it's it's sort of we're all on a spectrum, right? Everyone is doing what they can based on a variety of factors that impact them, you know, where they live, income, all kinds of things. And so I appreciate that clarification, because you're right. I think the last thing we want to do is label anyone. We're all doing the best that we can with sort of the situation that we're in, that we're in. So I appreciate that you highlighting it. I did want to build on this a bit more. So Dr. Holder, you've spent a lot of time studying the intersection between climate poverty and human health. How does green chemistry intersect there in terms of improving human health?

Dr. Cheryl Holder (11:02)
I think it's a perfect way to improve health when we look at the harm. In medicine again, it's harm benefits risk. You've got to look that up and what are the alternatives? The risk benefits alternatives. That's the informed consent. That's what we're doing. So when we see an industry look and take on providing care and you're providing life -saving medicines, you want that same understanding to be a foundation. So what we're seeing now is the way it should be. You know, science helps keep up. So the minute we have the science from 2012, when we found a better way, this is what we want to be moving forward rapidly. So for lower wealth, that intersection, they often again don't have the power to make that change. But if we understand what we are responsible for as the providers of medicines, you could not make a medicine where the alternative and the benefits, the risks are worse than the benefits. So I think the structural way of improving the system benefits all of us and it will also benefit lower wealth communities, it'll benefits the world. So we really pushing for structural changes is often the fastest, best way to address the disparities that we see.

Brendan (12:36)
Thank you. Dr. Johansson or Swallow, anything to add on or build on Dr. Holder's comments?

Magnus Johansson (12:41)
Yeah, maybe I can start. I think it was interesting what Dr. Holder talked about. And so my reflection, you know, coming from the science side and early drug discovery side is the educational component and that we need to reach also the younger generation in so many different ways. And one way that I see in my daily job is that we try to do outreach as scientists and go to preschool schools and then meet teenagers before they make their career choices and actually talk about science and just to try to engage them in a way so that they also see the opportunities in going for a career in science or medicines for that matter. And then related also to what Sheryl is talking about, I think, Green chemistry is important. I mean, not only for the pharma business. I mean, this is a general problem, isn't it? We have chemicals in production and building cars, you know, paints and everything that we do, shampoo, you know, et cetera. So in our daily lives, there are chemicals everywhere. And green chemistry is helping to reduce the footprint all over this area.

And I think in the United Nations Climate Conference, COP28, heat related deaths will increase, will triple in the coming 20 years, it said. And that's an effect of climate changes. So we need to work on reducing carbon footprint.

Steve Swallow (14:23)
I guess, you know, from a technical perspective, it's kind of, you know, thinking about the thing about thinking about the materials that we use and having that mindset. And I guess the education piece around getting people to think about the chemicals that they're using and where they end up, I suppose. So, you know, from a very practical level with, with with pharmaceuticals, you know, the, we've got a joint responsibility, I suppose, to try and educate people in the

For example, in the safe disposal of medicines that they're not using. It's a great kind of practical aspect from our kind of perspective is make sure that those things get taken back to the pharmacy, use schemes to take advantage of schemes that are available to ensure return of medicines so they don't end up in the viremen, for example. So yeah.

Dr. Cheryl Holder (15:11)

Yeah, I agree 100 % that the pharmaceutical industry should expand the concept of green chemistry for the entire process, not just the manufacturing, because when you look at where it gets disposed and you track it all the way through, many times, final disposal in poorer communities in the U .S. And we've tracked it to poorer communities without the power to be able to say, no, not in my backyard.

And that often ends up in the low wealth communities, which based on historical records and how the structures of countries are in the US, it's black and brown communities. So I think if the pharmaceutical industry expands and re -imagines green chemistry, not just in this production, but towards the whole process, that will be really instrumental in improving health outcomes for the entire continuum, not just the richer, not just the folks, but everybody right down to the folks who have to get the stuff disposed in their backyard. And I think that would be an incredible improvement. It would also improve our planet, but we'll improve the health of everyone in that whole cycle. So I wish that would definitely move forward, not just in the manufacturing. Same thing with the beauty industry, because being a black woman, when we look at the chemicals that were used in the beauty industry for black hair, the rate of cancers and the data shows that these chemicals have created some harm. Yet when the industry overall have been able to grandfather in many of these chemicals, so it leaves the vulnerable population continuing to fight against these chemicals.

When… if we look at the whole process of greening the industry, why would the people who are being harmed have to fight back? Why can't we look at it as a group and say, why are we making this stuff? Why can't we get those brilliant scientists that we know is in the industry to reformulate these products? Because we've demonstrated the harm, the increase in uterine cancer. So this is where we want to expand the whole idea of what is green chemistry.

So these health impacts are incorporated in the decision making and pushing the brilliant scientists to go one step further. Rather than having a poor community fight, fight, fight. When we got the brains and the money on one side, I can do this.

Brendan (17:47)
It's making, I think it's, you know, what I'm, what I'm grasping is this sort of concept of responsibility, right? In whether it's the pharmaceutical industry, the beauty industry, or really any industry that, you know, has the ability to make improvements in their, I'll say end to end process to be more sustainable. It, you know, I want to get into the principles of green chemistry, but I guess one question I have, for anyone is, is the concept of green chemistry, is that being adopted outside of the pharmaceutical and healthcare industry? Or is that still, is it, cause I would imagine in the beauty industry, there's chemists and scientists as well. Is there any perspective from anyone on whether it's, it's being a concept that's expanded beyond pharmaceuticals and healthcare?

Dr. Cheryl Holder (18:39)
From my experience so far, because I've been working with the National Medical Association on some of these pharmaceuticals, on the beauty industry and chemistry, we don't see that. It's still much more in the pharmaceutical world because it's so immediate. Because often you think of beauty products and you don't think of the other effects. And so I think we're getting that awareness much more now, but definitely in the pharmaceutical industry, it's there. And I hope we can extend it to what drugs mean and what medications and what chemicals are. Taking that whole concept that these are chemicals.

Magnus Johansson (19:20)
Yeah, I tend to agree with Dr. Holder on that answer. But maybe I want to expand on this because what I've seen lately, I mean, I do think and I do agree with Dr. Holder that the pharma

industry has been sort of been front runners in looking at, you know, and awareness of toxicology, you know, from cradle to grave, actually, from fine chemicals to final APIs. But more lately, AstraZeneca and other pharma companies but also other chemical industries or chemical intense industries. We tend to work in a pre -competitive space nowadays and share experience, share knowledge and that's really nice to see. So for instance, I work in a consortium in Europe called Safe Chem where we work with companies like H Volvo, BASF and other big industries.

And we share experience in exactly this space to push boundaries because everyone has the same ambition. We want to reduce carbon footprint and we want to be more sustainable in a very short time frame. So not to be competitive, I mean, not to be pre -competitive, that's not an option for us.

Steve Swallow (20:38)
I'll just echo what Magnus has said, I think, from some of the things that we see. And it's nice to think that we're perhaps leading, but others are also in this kind of area. And I guess just seeing the kind of, the nature and breadth of scientific publications that we perhaps, you know, myself and Magnus follow over the last 10 years or so is that the increasing number of publications and research in this area is significant, which is really, really very encouraging and lots of new interesting discoveries. But also, I guess we have an interest in kind of looking at the materials that we use and we see an increasing interest in the kind of fine chemicals area and looking for more renewable starting materials and that kind of area seems to be growing quite rapidly as well. So that's kind of looking at more fundamental chemicals, building blocks. So I get the sense that it's and those are used in all industries, I guess. So my sense is that's a kind of growing area too, as well as the kind of reclamation technologies, I suppose the use of waste materials.

Brendan (21:50)
TRANSITION 1
I wanted to dive into the impact of green chemistry, especially as it pertains to efficacy and safety. Are patients really getting the same benefit from medicines produced by “green” chemistry as by traditional processes?

So I think Dr. Johansson, you said, you know, you're seeing sort of this best practice sharing, right? It's, you know, if we are doing something or we're finding a way to do things better, more sustainably, let's not keep that to ourselves or other companies as well, right? Let's share those best practices, help others sort of get on board with doing things in a, you know, a greener, healthier way.

If I, if I go back to the, the 12 principles of green chemistry, that you mentioned in your, your definition upfront, one of the principles is design safer chemicals and products. And we hit on this, I think, you know, Dr. Holder, I think you hit on this a bit, but I'm curious, Dr. Swallow and, and Johansson in doing that, is there the possibility of an effect on the efficacy of medications or is this, is it really referring to the end product with which most patients would be familiar?

Steve Swallow (23:03)
Yeah, so maybe I can start on this one. Magnus, chip in if you think I missed something or it needs further elaboration. But I guess, yeah, several of the 12 principles mention safety. And while some of those are about the reagents and chemicals that are used, I guess one of the concepts is very much about avoiding unintended toxicology in the active pharmaceutical ingredients. So that's the, the molecule or component of the medicine that elicits the biological effect. And so, yes, reducing the unintended toxicology of those APIs, those molecules, should improve the efficacy. So I elaborate a little bit on this. If we think about the properties or

features of a molecule that lead to the unintended toxicology, those are built in quite early. So in what we call the drug discovery phase,

And so those negative effects and features in the molecules that drive them can unfortunately kind of be discovered much later in the development process. Perhaps when it's too late to change the structure or the feature that's driving those toxicities. So when that kind of situation is observed, those toxicologies would typically limit the dose that can be used so that you can reduce the potential for toxicity, but that would also lead to a reduction in the positive effects or the efficacy of the medicine. So in reality, as I guess both Magnus and myself have all of experienced and observed in the programs that we work on, this will often lead to the development of a medicine being terminated or stopped and a whole new research program being developed.

So identifying and removing those toxicities as early as possible can improve the efficacy of metanin and therefore be highly beneficial to patients. So this is an area that's had a lot of active investment in recent years. And in fact, I worked in this area myself for a few years, a decade or so ago, as this was a particular area of focus for AstraZeneca as this kind of problem, this kind of failure due to toxicity, had become a significant bottleneck in the industry back in the 1990s, I guess it was. So, yeah, lots of approaches developed to kind of reduce those side effects and hopefully lead to increased efficacy. I guess you can also see, I guess thinking from a green perspective as well, you know, that in addition to kind of improving efficacy for patients, that attrition, that failure of medicines to progress is also really very wasteful in resources. So, you know, there's another green element to this is that, you know, you're, by improving the efficiency of your, I guess, drug development process, that you reduce that kind of waste as well. I don't know if that made sense. Magnus, maybe if you want to chip in and...

Magnus Johansson (26:17)
I think it was a good answer, Steve. Maybe I just can comment and say, I mean, of course we tried to reduce the tritony in the drug discovery process because it's such a lengthy and expensive process. So, and of course also efficacy and the fact that we're developing, I mean, the ultimate goal is to design safe drugs and nothing else. But the green principle is something that we usually adapt later in the process when it comes to the actual process of making the API. But I think we're constantly evolving in these areas. And now we're also looking at, you know, what is the face of a drug after usage? And, you know, when it goes out the patient into the sewage system and into nature. And those are parts of, of course, the UN sustainable goals that we look, you know, what's life below water, what's life on land, you know, how do we affect these things. So it's not getting less complex. The complexity is increasing. But we also have new techniques that we can use. I mean, we use a lot of in vivo and in vitro models to, of course, look for toxicity and actually try to predict as much as possible early on. But nowadays, we also have machine learning and AI technology and a large number of data that we generate throughout the pharmaceutical industry. And that helps us a lot in also reducing talks.

Dr. Cheryl Holder (27:43)
I think, you know, with patients, we definitely, they want drugs that are efficient at work. Now, what we're seeing with some of the push to being integrative medicine and natural medicines and rejection of some of the traditional pharmaceutical agents, I think this is important that the patients understand that this is happening and that the reduction in toxicities are occurring. Because my big problem as a doctor when I write that prescription, will that patient fill the prescription? And if they fill it, will they take it? And you see the drop off in the data. So what makes them be afraid often is that the negative press that's out there and all the, and now we have all this internet and it happens rapidly. So I think it's important that this information about

what's going on with manufacturing the toxicity so that my patients will have faith when I write that prescription that it's not gonna kill them in the future. Now there are certain diseases that are so acute and dangerous that they will take it. And you see what happens in chemotherapy. Those agents are very toxic, but people will say yes. Yet when I have a blood pressure or diabetes or some other things, if the alternative, is some sort of natural regimen that is sold online, they will often reject what we know really works for something that's out there. So I think it's really important that the pharmaceutical industry understand that the biggest challenge for doctors is to take what I prescribe and for us to have them believe in the medicines, they have to understand that it's not filled with chemicals that 20 years down the line will kill them.

And that's so important because chemotherapy, they're up against a cancer that'll kill them before the drug will. But if it's a chronic disease, they may not opt for that because the press out there, the media is very much against what we're manufacturing. So I think it's so important that the companies understand this.

Brendan (29:51)
So that's a great, that's a great point. And then something I, you know, here we are talking about green chemistry and hopefully, you know, people will, you know, will listen to this, this podcast episode and gather some more information about all the efforts that's being made. But, but it's a, it's a great point, Dr. Holder, that this, this information, this effort needs to be much, it needs to be broad, right? Amplified broadly the education piece, so that it is something in a sense that minimizes any objection that a patient might have to taking the most appropriate medicine that their doctor's prescribing.

I, you know, thinking about, you know, obviously we're talking about the, the, the environmental benefits of, of green chemistry, but I'm curious if there are, you know, other, you know, other benefits as well from either, you know, an economic standpoint or really, you know, benefits or even are there any, you know, on the opposite side, negative impacts in terms of delays or anything like that by approaching chemistry from a green perspective versus a not green perspective. Dr. Johansson, can I start with you on this one?

Magnus Johansson (30:52)
Yeah, sure. So I do think there are, of course, you know, economic factors that play in all the in green chemistry and, you know, I mean, we're now facing new legislation when it comes to, you know, greenness and carbon footprint and toxicology of pharmaceuticals. And there is certainly a cost associated with maybe sometimes increased development times that I guess,

He will also comment on what happens in the production phase of APIs, where we've been applying the concept of green chemistry for a long, long time in pharmaceutical production. But certainly, the move from fossil materials to biorenewables, that will be a challenge for any chemical industry. But I do think, as a scientist, I see this also as an opportunity and something new to explore. And AstraZeneca as a company, I'm super proud to work for AstraZeneca because we invest a lot of effort in this area. So moving to maybe reducing CO2 to biomethane that we then can use as intermediates in future production of API. So we can also turn the screen technology into into reduction of cost. But maybe Steve can comment on that a little bit more.

Steve Swallow (32:24)
Yeah, yeah, yeah, happy to. Yeah, I guess, I guess, yeah, I'd echo the point really, that I think it's in the manufacturing environment or the development environment, we often see that many of the green benefits will also bring economic benefits. So maybe just to kind of illustrate a little, you know, if you take the example of reducing waste, you know, if we minimise the waste,

by definition, we're reducing the amount of material we have to import. So through kind of clever design, if we, you know, if, if there's 150 kilograms of waste for a kilogram of product per se, that means we've put 151 kilograms of material into the process. If we can reduce that import through that kind of clever design and by reducing the waste, we reduce the input materials and in many cases, the cost. So there's kind of great benefit, I think, from great potential for kind of economic benefit from that kind of efficiency in the processes use. And as Magnus says, some materials may end up costing us more. So particularly if we think about those catalysts that might help us to shorten a route of synthesis or a renewable material that enables us to move away from a fossil fuel material, those may cost more. But if we can also think about a more circular approach where we keep those materials in play or recover them and reuse them then the economic benefits or the costs may be offset. So there's real kind of some real potential, I think, and excitement around those kind of opportunities. So yeah, so there's a lot to do in that, in that kind of, from that kind of angle. Okay, so you talked a little bit about the trade -offs too. So this idea that, you know, we have to spend a lot of time developing these green processes.

Does that lead to a trade off, I suppose, in terms of delaying access? Because I guess access is important, isn't it? So if you delay a launcher of medicine, then this potential affects access for patients. So I think it's fair to say we can do a lot of good work in the time available to kind of not have an impact on access. But we can also do changes post -launch. So we can launch the medicine and then do improvements and modifications subsequently.

That's more burdensome and more challenging, but it's certainly something that we do.

Dr. Cheryl Holder (34:53)
Yeah, you know, this concept of it's sort of siloed when you look at cost and benefit and economics, because if we move it out the silos and you look at all the health benefits, now there are structures, I know they're talking in this green chemistry of rewarding companies that do this, because so that they don't take the economic loss when they're basically expanding the concept of where the money is made and where the savings are made.

So as you improve human health, the savings may be made in the insurance industry and not in the pharmaceuticals, but because we're so siloed, then how do we find some way to connect some of the savings and the profit gains back into the pharmaceuticals? I think this is a systems issue that is solvable if we work together. But rather than just keeping it in silos that for this quarter, I'm gonna make more money if I make a more toxic drug.

But overall, if I look 20 years, we've improved health outcomes and we've saved our planet. So I think this is the climate world and climate change is pushing industries to work differently that they can still get the profits. Cause we're not saying with climate change, you're going to lose and you have to go into this thing. It's just reworking how you work and where the profits are gained and how to get the dollars back to the industry that made some of these push. And I know there are some efforts in green chemistry to make sure that they're rewarded, whether it's in the developmental stage or in the production stage, that the dollars stay in that group that's doing the right work. And that will push it overall to keep this movement because it's best for everyone, not just for people, but everybody to move it this way. So I think we can change it if we move our structures of payment and profit rewards and profit sharing out of silos.

Brendan (36:57)
TRANSITION 2

As the guests talked about the benefits to patients, I was struck by something Dr. Holder had said: you couldn't look at the benefits for patients without considering the environmental and economic impacts. This made me wonder: how will green chemistry continue to evolve, enhancing its impact?

I'm going to shift in a moment here to the future of green chemistry. But Dr. Holder, I was just, I was thinking, I'm curious from your perspective, if, you know, a lot of times right now, when we think about making decisions around, you know, products that we buy or companies that we purchase from, you're seeing more companies be very, you know, vocal around their sustainability efforts. And I think, you know, building on something you said earlier, I think younger generation in particular is, is very tuned into that. And so there, I would, I would, you know, I would say there's probably a larger population of younger folks who are considering maybe buying a pair of jeans from one company over the other, because they're doing something more sustainable than the other. Do you, do you think from, or from a physician's perspective, from your perspective, and then I'll ask you from sort of a patient perspective, based on your experience when working with patients, do you ever foresee a time where a physician might make a decision, a prescribing decision based on the fact that, and I'll say efficacy being equal or comparable across medicines, do you foresee a physician ever making a decision to prescribe a medicine based on sort of the, you know, that it was manufactured in a green process versus a, you know, a not green process.

Dr. Cheryl Holder (38:22)
Definitely, because it's risk benefits alternatives. And you're telling me that the non -green product is more toxic in the long run to treat the same disease. Again, acute versus chronic, we look at if the efficacy and you're facing a cancer that may only have a three year survival, then they're going to go, we're going to choose the most efficacious that may save that person's life. And because the risk benefit equation, skews that way. But for some other things, if the risk is higher and the benefits, it's, you're going to go with the one that has the less risk for long -term toxicity. Because again, the patient's going to go online, go to Dr. Google and come right back and tell me, Dr. Holder. Then I'm going to end up writing the same thing. Now, unfortunately for medicine, we're now the corporate interests who owns us and sets that formulary often makes that decision. And that then leads a huge process of getting approval to switch out something. So for my low wealth communities, I'm going to end up being forced to use the list for richer folks. They will then override or buy the drug they want, but everybody wants a drug that's least toxic and takes care of the problem. So absolutely that will be the choice.

Brendan (40:01)
And I'm hearing, you know, sort of an echo of the need for system change, right, to eliminate the less toxic, more green medicine being only accessible or available to the wealthier population. So I think that's a great point that it's not, I think it was said several times on here, it's not just an industry, It's not a healthcare, it is sort of a, let's look at all of the players involved, work together so that there's equal access to green chemistry, less toxic medicines, and obviously those that are not only benefiting the patient, but also the environment.

Dr. Cheryl Holder (40:50)
Thank you, exactly.

Brendan (40:52)
So if I shift to the future of green chemistry. I guess, you know, where Dr. Johansson and Swallow, where do you see the movement towards green chemistry going?

Magnus Johansson (41:08)

Yeah, maybe I can start to pick up on this. I mean, if we look back now 20 years in time and look at Nobel prizes awarded in green chemistry, there aren't any directly focused on green chemistry, but if we look at sort of the wider picture and the principles, I mean, catalysis has been awarded eight or nine times during the last 20 years and biocatalysis was awarded to Frances Arnold three years back in time. So I do think that I mean, and we also see legislation moving, I mean, in Europe, in the US, UK and globally, towards the change, towards reduction of the carbon footprint. So I do foresee that in chemistry, I think we're sort of taking on the challenge of doing chemistry and want to drive this for a more sustainable future, including biorenewables, new technologies replacing chemicals for sunlight, electricity in largely in processes. So we can become much more green and of course also less toxic. I mean, the challenge is really about the word chemistry and chemicals. I mean, it has a bad sort of vibe to it, doesn't it? But it's not a bad thing. I mean, sugar is a chemical. Yeast is, is, beer, wine, everything. Dr. Holder talked about shampoo and additives in cosmetics. And so we have chemicals everywhere and we need to embrace that and make sure that we actually produce the less toxic chemicals. I think it's a scientific challenge, but it's also a community challenge that we need to embrace.

Brendan (43:07)
And I'm picking up on something you said there. While there are companies that are already adopting green chemistry, sort of as early adopters are on their own, it's an interesting point around the regulations that may force companies to change their practices over time, which obviously it'd be greater or better, I should say, if companies sort of adopted prior to being forced into it. But I guess the end result, If more, you know, having more, more industries that are in the chem, you know, the chemistry space, adopting green principles obviously will, will hopefully help to curb that, you know, long -term environmental impact.

Steve Swallow (43:50)
I think just kind of coming back to one of Dr Holder's points, I suppose, around pressures and other influences on the industry, and it kind of links to your point there around legislation, perhaps. But I guess, you know, pharmaceutical or payers for medicines and health care systems, you know, they're going to have their own targets, their own kind of expectations around things like carbon reduction, which will affect the way that they think about sourcing and purchasing medicines from the manufacturers. So those kind of drivers around footprint, et cetera, will naturally influence, I think, what companies like ourselves do. So even without that kind of legislation, per se, it's a natural driver.

Dr. Cheryl Holder (44:45)
Yeah, I agree that what Dr. Johansson talked about getting in the community, it sounds like maybe it's just sort of charity work, but really it isn't. If we can have the community understand science, because I'm out there and I tell everybody we're all scientists, and understand the concept of chemicals, because I see an acceptance of what's called natural medicine, and I'm like, it's the same chemical structure. Get… That's the bias, but it comes from that lack of understanding. So I think there has to be a way if this industry is to really go future and make all these changes and I can't get my vision to take it. I've lost. So this is why it's important that we look at the entire, the whole circle and starting from getting in the communities and understanding these chemicals and then supporting the groups that are making that shift towards less toxic chemicals. So then you can come out and give me a drug that my patient will take. And I think that's, and will save the environment. And then it's all win -win because the young generation will push that. The baby boomers, not so much. They'll take what I give them, but the younger folks and listen, you're talking about the future. So you're going to have a majority of the younger people thinking, taking over the world and my generation that older will be less. So I think this is the way to go and getting in our community so folks understand

that chemicals are chemicals and just because GNC says they're natural doesn't mean it's any different or safer than what I prescribe.

Brendan (46:26)
So we're nearing nearing the end of our time here. I you know, I did before before we close, I did want to give each of you the opportunity. You know, if there's anything still on your mind that you want to make sure our listeners hear from you about about today's topic, you know, I want to make sure that that you have that opportunity. So I'll go to each of you sort of your parting thoughts, if you will, on the topic. So Dr. Holder, is it okay if I start with you?

Dr. Cheryl Holder (47:01)
Yeah, well, I love the topic. I love everything when we talk about sustainability and we look at all the equitable ways of doing this because when we approach it in this manner, we're benefiting everybody. It's not charity. It's not special interest. It's not about black, brown or whatever. It's about creating a system that produces healthier, better drugs, short term and long term where the risk benefit analysis comes out positive for the planet and human health. And that is the only way to go. So then we will eventually, I'm a DEI person. I don't care what they say about DEI. It makes sense, because it's really about thinking how we can live a better world. So I won't have to say green chemistry and green patient, because it is the right way to be when we decrease toxicity and improve structurally how everybody lives on this planet. So that's...

We have to go and we have to support it.

Brendan (48:04)
Yeah, very well said. Dr. Swallow, how about you?

Steve Swallow (48:09)
Yeah, I guess for me, I think it's a really exciting time to be a scientist or a chemist. I think there's this huge opportunity. We've done some great things. We're building on great kind of stepping stones that have been built in, I guess, in our industry and the broader chemistry community. And I just think the momentum is really starting to build. And I just think it's a really exciting time. And I think we've got a great opportunity to have a big impact across that holistic perspective. I think it's really quite exciting and it's great to be part of that movement.

Brendan (48:48)
Awesome. How about you, Dr. Johansson?

Magnus Johansson (48:51)
Okay, so yeah, I will come back to the educational component and maybe to also reemphasize what Dr. Holder said. First of all, we go to schools, we get to educate our kids early on. We collaborate with universities and academia. This is what we do in our daily jobs. We collaborate with brightest minds to solve the and production problems and solve ways of making your API. And then we also reach out to other industries. I think this is really important, you know, the pre-competitive space, let's share, you know, our experiences with other industries so that we can drive the change faster and progress much faster than, you know, being a siloed industry like Dr. Holder talked about.

And finally, you know, I think always a scientist, we should embrace these problems and just, you know, solve them, you know, work on this problem, embrace it and say like, okay, so we're chemists, so we're dealing with these bad things called chemicals, but it's not bad things because they can do great things. They can save your grandmother's life or, you know, so they

are life changing in many ways. So be proud of that and turn, you know, chemistry into something beautiful. Yeah. So. Be proud of in chemistry.

Brendan (50:17)
Great. This is a really, really fascinating conversation today, so I really appreciate all of the thoughtful answers. The connective tissue between not just our environment and our health, but also the way we develop and manufacture the medicines that keep us healthy is a complex web. And I think each of you shared through your perspectives and different lenses all of those parts, all of the players, the need for the collaboration, the need for education. I really appreciate that perspective.

So with that, I want to thank you again for speaking with me today. So Dr. Swallow, Dr. Johansson, Dr. Holder, thank you so much for joining. I'll give you each the opportunity to say a final thought here and then we'll close.

Dr. Cheryl Holder (51:03)
I'll start. Thank you for having me. Thank you for this incredible conversation. I get a chance to share our patient perspective and with scientists who are developing this and I reward, I thank you for doing this work because we so depend on these medications to make the lives better. I mean, that's why we're in medicine. And it's the aspect of medicine that I often don't get to interact with even though it's so important that every day I write hundreds of prescriptions and I never get to meet the chemists and the scientists behind it. So I thank you for your work and we will work together to make this world better. Thank you.

Magnus Johansson (51:44)
Yeah, so maybe I can continue. So thanks, Brendan, for the invitation to come and speak about this super urgent topic. Green chemistry is close to my heart. And I'd just love to discuss these things and to be able to discuss this also together with Dr. Holder, which is sort of the other end of the drug discovery where we see patients and the ultimate use of it. It's just fantastic. And I love that interface.

Yeah, I can only say that the collaboration and to work together towards these goals is what we need to do for the future. So thank you.

Steve Swallow (52:19)
I can really just echo those comments. I think it's been fabulous to be invited and to get involved in this discussion. It's been really enjoyable. It's been great to meet you, Dr. Holder. Again, you say you don't get to meet our end of the organization. We rarely get to have conversations with doctors too, so other than perhaps when we're ill. But lovely to get that discussion and perspective and very much looking forward to working in the space going forward.

Brendan (52:45)
Well, to our listeners, thanks for joining us on That's Understandable. For more information about today's episode and guests, be sure to check the show notes. Until next time, be well, be healthy, and be understanding.

END OF SHOW