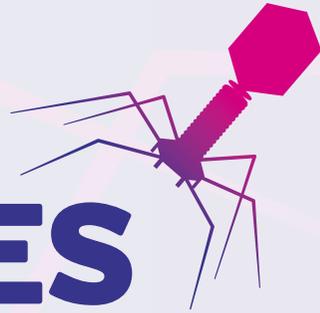


PHAGE FUTURES CONGRESS



The Future of Phage: A Biotech Perspective

An interview with Assaf Oron, CBO of BiomX

Written by Jessica Sacher and Jan Zheng, co-founders of Phage Directory, in anticipation of the Phage Futures Congress – Washington D.C – January 29-30.

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BiomX

 **Phage Directory**

The Phage Futures Congress will bring together biotech, pharma, academia and governmental bodies to help move phage therapy forward into clinically and commercially viable therapeutics.

In attendance will be Assaf Oron of BiomX, an exciting biotech commercializing a platform for using phages as tools to eradicate bacteria associated with chronic diseases. He spoke with Jessica Sacher, Co-Founder of Phage Directory, to talk about going to clinical trials, patenting phage technology and the promising applications of phage within chronic microbiome indications.

Can you tell us about your role in BiomX and how the company got started?

I'm the Chief Business Officer of BiomX. The company was founded in 2015 in Israel by Prof. Eran Elinav, a well-known immunologist who's published extensively on the microbiome and on diseases like inflammatory bowel disease (IBD). He teamed up with Prof. Rotem Sorek, a phage and CRISPR expert from the Weizmann Institute in Israel. Later on, Prof. Tim Lu from MIT joined as a third scientific founder. Tim brought in the capabilities to synthetically engineer phages aimed at enhancing their performance.

They had the vision that with increased understanding of the microbiome, it would be possible to point out specific harmful bacteria associated with chronic diseases like IBD, liver disease and cancer. They aimed to use phages as tools to specifically eradicate bacteria associated with these diseases.

The company initially raised some financing as part of an incubator in Israel, and in 2017 had a Series A financing of \$24 million, with the VCs of Johnson & Johnson, Takeda, and Orbimed leading the investment round. Both have strategic interests in the area of the microbiome, phage, and IBD. Since then, BiomX has grown to around 55 employees.

What is BiomX focused on now?

We're building up the capability to identify bacterial strains that we want to eradicate, and we're building the platform to do the eradication using either natural phages, if we can find them, or synthetic phages if we need to improve or enhance the capabilities of the phages that we find. We're focused on acne, IBD, liver disease and colorectal cancer.

We're still preclinical, but our acne product, a topical gel-based cocktail of natural phages designed to eradicate *Propionibacterium acnes*, is expected to enter clinical trials in the first half of 2019.

Can you tell us more about this clinical trial?

What we're going to do first is a phase I trial, so the intent is to show safety when we apply phages to the skin. Second, it's going to be a proof of mechanism. The idea is to get a sample of the microbiome prior to the treatment and then to check after treatment to see whether *P. acnes* is eradicated. We'll also evaluate different dosages and treatment regimens to optimize the clinical protocol in our phase II trial.

So you'll check the microbiome before and after phage treatment? Is this also to see the side effects on other bacteria of the microbiome?

Right, so the main goal will be to see the eradication of *P. acnes*, but as part of that, we're also going to see what happens to the rest of the microbiome. For instance, other bacteria present on the skin will likely become more relatively abundant once you eradicate *P. acnes*.

BiomX seems to have a unique focus on the microbiome—can you talk a bit about this?

Yes, we do feel that we're unique in that we first and foremost address chronic microbiome-related indications as opposed to infectious diseases. We think there's huge potential here. On a monthly basis, we see new publications on microbiome-related indications like IBD, liver disease and cancer, where new discoveries point to certain bacteria as being potentially harmful. For example, Prof. Kenya Honda from Keio University found specific strains of pro-inflammatory bacteria in IBD patients. So just like there are beneficial bacteria that may help in cases like IBD where there's gut dysbiosis, there are also harmful bacteria that aren't necessarily causing the disease but may be driving some of the flare-ups. And we know that antibiotics are not really a solution for IBD patients – many actually get worse when they use antibiotics. So it's clear that harmful bacteria exist in certain chronic indications, and to eradicate them, you need a more targeted and precise tool. That's exactly how phages have evolved naturally, so we think there's a great opportunity here.

Two or three years ago, when we started, we felt more reluctance from pharma companies: more reluctance to look at phages as a therapy, and a perception that it's something old, since they were discovered 100 years ago... the fact that we have Johnson & Johnson and Takeda's VCs investing is an indication of increased pharmaceutical interest.

Do you see interest and investment in phage-based products ramping up lately compared to historically?

Absolutely. Two or three years ago, when we started, we felt more reluctance from pharma companies: more reluctance to look at phages as a therapy, and a perception that it's something old, since they were discovered 100 years ago. But I think in the last few years there's much more openness to the idea. You see specific conferences now that are covering industry and phage. And the fact that we have Johnson & Johnson and Takeda's VCs investing is also an indication of increased pharmaceutical interest. But of course in the microbiome area in general, the pharmaceutical industry is looking to see how these technologies translate from preclinical to clinical results.

What do you see as your main hurdles right now?

Seeing our treatment modality work in the clinic is a hurdle. One example is dosage – phages are not standard small molecules. Also, when phages reach their target bacteria and kill, they multiply, so you can't apply standard ways of looking at pharmacokinetics/pharmacodynamics. Manufacturing is also an issue.

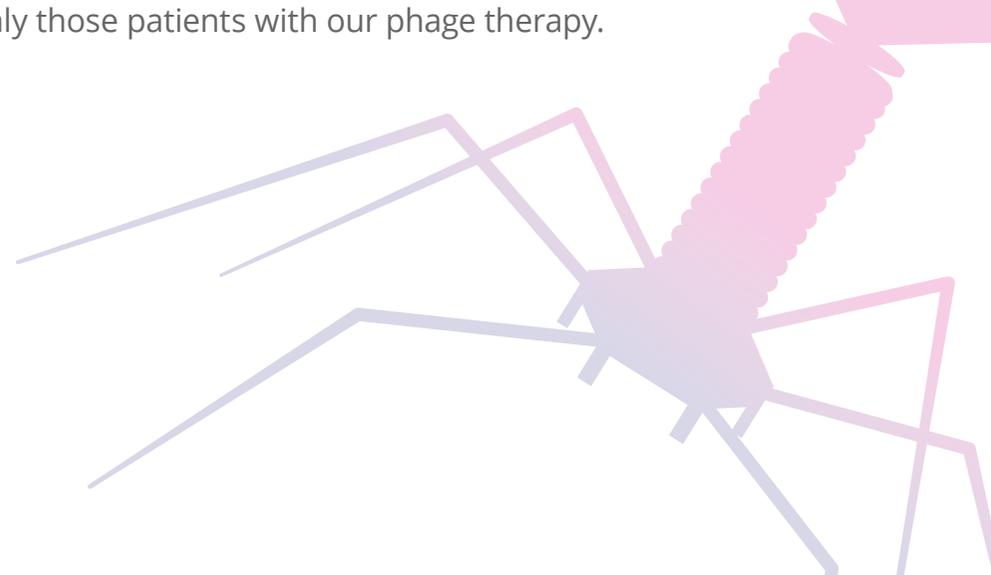
Once you need to manufacture a cocktail of phages, each one needs to be produced separately. So there are some challenges in having that done efficiently and then ramping that up. So seeing how the modality works in the clinic, how efficiently it eradicates, finding the right dosage, and manufacturing – these are hurdles that we need to think through when we design our clinical trials.

Do you see intellectual property issues as being a hurdle?

From an IP perspective, phage treatments face the same challenges as the rest of the microbiome industry. But we found that we need cocktails to build an effective treatment, and once you're using combinations that are not naturally found, then those are patentable. In addition, we believe that in cases of synthetically engineered phage, a new composition of matter will be patentable.

What do you think about the new framework in Belgium, where compounding pharmacists are now able to give custom phage treatments?

We're intrigued by that initiative; it's encouraging to see openness to using phage in a personalized fashion. We're not looking to develop treatments that are personalized to that degree. That can be very relevant from a treatment perspective, but from a commercial perspective we think that could be really challenging. But for each indication we're working on, we want to check for the relevant bacteria that we know are harmful. For example, we know that the specific strains we're targeting for IBD are relevant for about 30% of the IBD population. So our treatments won't be personalized in the sense that they're adapted to each person, but for clinical trials, we're going to take stool samples from IBD patients, check that they have the relevant strains, and then treat only those patients with our phage therapy.



Is BiomX involved in compassionate use phage therapy cases like the ones you see popping up around the world?

We haven't been involved, but I think the reason is our choice of disease indications. In Israel, there was a case a few months ago where someone had an infection in his leg that was at the point of needing to be amputated, and phages actually saved his leg. Cases like these are more relevant to infectious diseases, which to date we have not been focused on, however may be relevant for us in the future. If there were an extreme case of IBD, with someone that had a really strong flare-up driven by inflammatory bacteria that we're working on, and if phage could help avoid surgery or cutting part of the intestine, we may get involved, but we haven't yet.

How will you commercialize your treatments?

Our therapies for cancer and IBD would have to be designated as drugs. They're all going to undergo all evaluations as any other drug. However, we see a lot of interest from the cosmetics industry in the therapy we're developing for acne. We're now collaborating with a leading multinational cosmetics company who's interested in our product. We see more and more microbiome considerations in the cosmetics industry, and since we're using natural phage and not engineered phage, the product could be considered a natural additive, so we may go down that path. So for the acne product, we still have some flexibility to see whether it would be a cosmetic or medical therapy, but if it does go through the cosmetics route, it could potentially be on the market much earlier, maybe a few years from now.

At conferences, everyone knows everyone, and we're rooting for success of each other. If another company succeeds in a clinical trial, it will increase confidence in the field and drive more investments by VCs and pharma... it would be a win-win for the entire industry.

Does BiomX collaborate with other groups or companies? And are you looking for other kinds of collaborators?

Yes, absolutely. Working with academia and industry is an important aspect of what we do. We're licensing technologies and looking for new bacterial targets and phages to license. Beyond that, we have collaborations and continuous discussions with academia and with the pharmaceutical and cosmetics industries.

We're a platform company, meaning we have broad capabilities and are looking to advance multiple indications in the pipeline, so we expect to pursue some of them by ourselves, while we'll look to license or collaborate on others.

Do you think the microbiome and phage treatment fields are going to grow in popularity over the next 5-10 years?

Of course we think so, but the microbiome industry is still trying to evaluate that. What we've seen in the last few years is more investments every year in this field, more financing, and VC investments, and we expect to see more companies going public. You also see more clinical trials, which is a very important part of building up the credibility of the field. So yes, you see a clear trend of increasing activity. Having said that, I think it all depends on the results of clinical trials. In a way, this is a small industry, and we need each other. At conferences, everyone knows

everyone, and we're rooting for success of each other. If another company succeeds in a clinical trial, it will increase confidence in the field and drive more investments by VCs and pharma... it would be a win-win for the entire industry. So I think it's more about seeing results in the clinic, and if we see that, for sure we're going to see much more activity in this field.

This interview has been lightly edited for clarity.

Connect with Assaf, Jessica, Jan and the rest of the global phage community at the Phage Futures Congress.



Jessica Sacher,
PhD



Jan Zheng

Co-Founders, Phage Directory



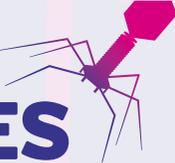
Phage Directory

About Phage Directory

Our mission is to accelerate the safe and effective use of phages in medicine and industry around the world. We aim to accomplish this goal by curating phage-related content, advising on phage-related topics and coordinating collaborations within and across disciplines.

For regular updates on phage therapy research, subscribe to their newsletter – Capsid & Tail at phage.directory/capsid

PHAGE FUTURES CONGRESS



About Phage Futures Congress

Washington D.C – January 29-30

The Phage Futures Congress will bring together peers from biotech companies and academia, along with experts from regulatory bodies, pharmaceutical companies and government institutions, to discuss how to actively progress clinical science and viable phage application routes to market.

**View the full agenda and register to attend at
www.phage-futures.com**