Craig ([00:00](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=0.86)):

Hi, I'm Craig Smith and this is eye on AI.

Craig ([00:05](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=5.7)):

This episode is sponsored by [Paperspace](http://www.paperspace.com/), which provides the tools for end-to-end management of machine learning workflows. It comes with dedicated GPUs in the cloud. Check them out at paperspace.com.

Craig ([00:16](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=16.951)):

COVID-19 continues to sweep through the human population, killing some and damaging the lungs of others. While this podcast is normally focused on machine learning, I thought I'd take a detour of sorts to talk about some groundbreaking tech that could someday help restore those scarred lungs to pre-COVID health, and even prevent pandemics in the future.

Vittorio Sebastiano an assistant professor of stem cell biology at Stanford University, has recently demonstrated that old or damaged cells can be returned to their youthful state with gene expression techniques. While this doesn't mean that we're on the road to immortality, it does suggest possible treatment for a host of diseases. Vittorio talked about the mechanisms at work in the process, his hope for *in vivo* human trials in the coming years, and his hunt for machine learning collaborators to understand the process further. I hope you find the conversation as astonishing as I did.

Craig ([01:28](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=88.34)):

So where are you from? You sound Italian. And how did you get into this level of biotech?

Vittorio ([01:36](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=96.18)):

Well, yes, I am Italian. I was born and raised in the outskirts of Milan, so in the South of Milan. So I did my grad studies and undergrad studies in [Pavia](https://web.unipv.it/), which is a small village, again in the South. Which is one of the oldest universities, definitely in Italy, in Europe, and probably in the world. And I'm actually particularly proud of that. That is actually a good explanation of, you know, why I am here, where I am today. Because of this kind of tradition, scientific tradition, that has its roots really in the end of the 18th century. So I studied in Pavia, and then I did my––as I said, for my grad and undergrad studies––then I went to Germany, in Münster, which is Northwest of Germany. I was at the [Max Planck Institute for Molecular Biomedicine](https://www.mpi-muenster.mpg.de/2377/en). There, I had actually the opportunity to be trained and, you know, to be working with [Hans Schöler](https://en.wikipedia.org/wiki/Hans_Robert_Sch%C3%B6ler), who is one of the most renowned stem cell biologists––who is actually the scientist who discovered "[Oct-4](https://en.wikipedia.org/wiki/Oct-4)," which is this very important gene that we are also using in our cocktail for reprogramming and for rejuvenation. So, I was very fortunate to train with him. And then in 2009, I decided to actually to move to California. The reason being that, you know, back then California was really the only place in the world where we could actually do significant research, in particular with human embryonic stem cells.

Craig ([03:08](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=188.11)):

You did your PhD at Max Planck, and then a postdoc in California? Or your PhD in Italy?

Vittorio ([03:14](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=194.47)):

I did a PhD in Italy, a first postdoc at the Max Planck, and then I did a short second postdoc at Stanford. The reason being, my training was, you know, all on mouse development. So I was primarily working with mice, and I was actually using the very first method of nuclear reprogramming, which is the somatic cell nuclear transfer. Which was the only way back then actually to reprogram the cells to an embryonic-like state. So I was really formally trained you know, with that. But then, I really wanted my research to be, you know, translational. And I really wanted to get a formal training, you know, with human cells. Because I wanted really to make a difference and make sure that my discoveries, you know, could be applied, could be translated into something tangible and something meaningful for people. That's the reason why I moved to California. So yeah, I did a short second postdoc there. And then I became an instructor. I was, you know, teaching and training a lot of people on how to make iPSCs how to differentiate embryonic stem cells and Induced pluripotent stem cells. And then at the end of 2014, I became a faculty, and I'm currently an assistant professor in OB/GYN.

INTERLUDE ([04:40](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=280.31)):

CHORD

Craig ([04:40](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=280.7)):

So you've been on this track of stem cell research, or returning cells to their stem-cell state, for a while. And you started working with the [Yamanaka factors](https://www.nature.com/articles/cr2008309) when?

Vittorio ([04:53](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=293.28)):

Right after the publication of the work.

Craig ([04:57](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=297.45)):

I see.

Vittorio ([04:57](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=297.45)):

So 2006, 2007. Yes.

Craig ([05:00](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=300.77)):

What are the Yamanaka factors? What chemical compounds are they?

Vittorio ([05:06](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=306.63)):

So, the Yamanaka factors. I mean, we broadly refer to them as Yamanaka factors. The original Yamanaka factors were four: Oct-4, Sox2, Klf4 and c-Myc. So these are the Yamanaka factors. But then by extension, we refer to the Yamanaka factors, you know, more broadly, to sets of genes or sets of proteins that can perform this so-called nuclear reprogramming *in vitro* in the test tube. Similar to what happens *in vivo* when we do the somatic cell nuclear transfer, or when we do these, you know, reprogramming experiments using the eggs.

The breakthrough discovery of Yamanaka was, you know, the simplification of this process, and showing that a very similar phenomenon––namely what happens, you know, when you transfer the nucleus of a cell into an egg––the simplification of this process, showing that actually the same process or something very similar to that can happen in the test tube just by providing a handful of factors, which are these four, plus many others.

We use the original four plus two more for a number of reasons that I can explain later. So, in a nutshell, basically, these are proteins. So these are products of the cells. So these are genes that are activated, transcribed, made by specific types of cells, typically the so-called embryonic cells. So these are factors that are specifically expressed by embryonic cells. And they had expressed for a reason. Because they are required, basically, for the development, the proper development of the embryo to occur.

What Yamanaka has discovered is that since they are so specific to the embryonic cells, if we can overexpress them in cells that typically don't express them, so like somatic cells (and by somatic cells I mean cells that have completely differentiated: they have a unique function, a unique purpose, which is, for example, being a skin cell, a liver cell a neuron, and so forth), so if [you have] this handful of factors, and you force their expression in those cells, these factors are so potent that they can basically wipe away all the information that is in that original cell type, and they can set up a completely brand new embryonic-like program.

Craig ([07:45](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=465.1)):

They also erase the DNA, is that right? Or they just reset the DNA.

Vittorio ([07:52](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=472.39)):

They just reset the DNA.

So, let me explain what happens: the function of a cell is defined by two codes. The first code is the genetic code, which is really the sequence of the DNA. For the most part, the genetic code defines, you know, what is different between you and me, what is different between us and other animals.

The way this information, though, is assembled, and the way this information is utilized, is defined by the second code, which is the so-called [epigenetic code](https://en.wikipedia.org/wiki/Epigenetic_code). "Epi" Means, you know, "beyond." It means, you know, it's an additional layer of information that takes the basic information, and organizes it in a way that is meaningful for the different cells. So that, despite having the same genetic information––so, all the cells of our body, you know, it's a simplification, it's not really the case, but, all the cells of our body share the same genetic information. Why a neuron is so different from a liver cell? That's because they have different epigenetic codes. And that's because basically, there are, there is an additional layer of information––which is the way the genetic information is organized in the nucleus, for example, the way it's silenced or activated––that at the end of the day, defines, you know, this difference.

And so the Yamanaka factors, if expressed for a very long time, typically two to three weeks, they have this, you know, incredible ability to actually reset, completely, the epigenetic information. But they don't, they don't, for the most part at least, they don't change the genetic information. So at the end of the process, you still have the same genetic information, but you just have a different cell type. And this is, obviously, this is incredible.

And, of course, you know, iPSCs afford great potential, you know, great promise. Because now you have a cell which can, you know, differentiate back into not only the original cell type, but every cell in the body. And you can imagine, this is incredible, and you can start thinking about, you know, making neurons. You can start thinking about, you know, any cell type. Screen drugs, model diseases, and develop therapies. And that's what my lab is also doing.

INTERLUDE ([10:36](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=636.37)):

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Craig ([10:37](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=637.3)):

Now we're talking about Yamanaka's protocol. And, for example, you could take a cell in my body and reset it to an embryonic state, to a stem cell state, but it still is my DNA. And then you could differentiate it into another kind of cell for my body that is compatible with my DNA.

Vittorio ([11:00](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=660.85)):

Precisely.

Craig ([11:01](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=661.65)):

Does that mean that you no longer need to harvest stem cells? Is that right?

Vittorio ([11:06](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=666.91)):

You're no longer required to derive the stem cells from embryos. You can actually develop a personalized approach.

So now I can have your cells, which are immuno-matched to you and only you, and I can generate any cell of your body. In principle, of course. I mean we are not right there yet. So this was the starting point, right? And as I said, I mean I actually kind of went through historically, and through my training I went through, you know, the entire history of this field.

What our discovery, which I believe is really a game changer, our discovery now kind of adds an additional layer of complexity to this in the sense that, when you do this reprogramming all the way back to the embryonic state, there's two things that are happening. I mean, because of the Yamanaka factors. The first thing is that you are erasing the epigenetic information that defines a cell identity. But at the same time, you're erasing also the epigenetic information that defines cellular age. Why am I saying this? Because it has been shown, you know, on multiple levels, that actually you are not only now turning, say, a skin cell, into an embryonic cell. But you're also turning an old, or you know, aged skin cell (because we can do this with cells that are isolated from anybody. From, you know, newborns to 94 or centenarians, you know), we can now also turn back the clock, the epigenetic clock, to almost zero. Okay? Obviously, you know, the real answer or the real proof of this can be shown in mice. Because, you know, in mice, you can actually perform all sorts of experiments, and you can even make pups. Or you can even make newborns that are derived from these iPSCs. And these pups have a normal lifespan. So they live like, you know, other pups that have been conceived by fertilization.

Craig ([13:09](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=789.8)):

Actually, can you just stop and explain that process? How does that happen?

Vittorio ([13:14](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=794.76)):

The process of...

Craig ([13:16](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=796.41)):

With the mice. So you reset an adult mouse's cells and they will grow into a full grown mouse?

Vittorio ([13:23](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=803.96)):

No. What you do is you make these embryonic-like cells from mouse cells. So you the process works, you know, similarly in other animals too. But you know, let's take the example of the mouse. So you make these induced pluripotent stem cells, which are these embryonic-like cells. And now, in mice you can inject these cells into a host embryo before it implants into the uterus. By doing so, basically the cells can engraft into the embryo and they can basically participate in the development of the developing embryo, to the point where you can even substitute the entire embryonic tissue with the cells that you're injecting. And this is really the final proof that actually by doing so, you get a new mouse, which is born, which is entirely derived from these cells that you made in the test tube. And these mice have a normal lifespan, you know, so they can live normally.

Craig ([14:26](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=866.12)):

And are they genetically identical to the host?

Vittorio ([14:29](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=869.24)):

Yes.

Craig ([14:29](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=869.24)):

So it's a form of cloning?

Vittorio ([14:30](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=870.83)):

It's a form of cloning. Exactly.

And so, this really shows that, you know, that the technology of reprogramming that we did *in vitro* can really wipe out both the identity information, but also the age information. So capitalizing on this, we said, "okay, we know that two phenomena are happening. So can they separate it? Can they be uncoupled? Can we work on the epigenetic resetting of age without touching at all the epigenetic setting of identity?" And our data show that, yes, it is absolutely possible.

We can basically reset, or bring the clock back enough, to change the age of that cell without affecting its identity. And this opens up an endless number of opportunities, and really sets us up in a way that now we can really start thinking about a completely groundbreaking, completely new way of thinking about diseases, tissue regeneration. Why? Because when you do the reprogramming to iPSCs––I mean, as we said, you know, this is great––but then the problem is that you have now to differentiate the cells back. And now, that's possible. But of course there's probably 250, 300, probably more cell types in the body. So if you want to make a tissue out of that, you have to basically make all the cells of that tissue, and it's not easy.

But if you don't have this complete reset of identity, and you can just, you know, turn back the clock just enough to make a younger version of that cell, or that organ, or tissue, then, you know, you're taking advantage of the fact that the cell hasn't changed its identity, but it's just the younger version of itself. So this is why we think that this could really be a new approach for tackling aging associated diseases, and an endless number of diseases.

Craig ([16:25](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=985.61)):

I've seen a talk: a guy, he's spoken at some of the big machine learning conferences because he's looking for collaborators in the machine learning space, and he works with flatworms. And he's been able to reprogram the cells of flatworms by manipulating the electric field around the cells, and that affects how different proteins are expressed. Are you familiar with that work?

Vittorio ([16:50](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1010.27)):

I am familiar with that work, and I'm also familiar with the flatworms, actually. This is one of the things that I actually studied. And this also speaks to, you know, this idea of not being concentrated on one tiny little, you know, thing, but trying to be holistic in our way of looking at science.

Yes, actually. Those flatworms, they are called [planarians](https://en.wikipedia.org/wiki/Planarian). They are, you know, remarkable animals. Those animals are immortal––are actually one of the few examples of immortal animals. Why? Because they can use sexual reproduction, but they can also use asexual reproduction. And you can actually cut them up, up to 245 pieces. And every single piece can regenerate an entire animal, and you can do this over and over and over and over. Why? Because they have embryonic-like cells in their body. They're called the [neoblasts](https://dev.biologists.org/content/140/5/951).

This is probably one of the few examples where you have these embryonic-like cells that are living in the body. We don't have them. We don't have them for reasons, I mean, we don't understand; probably from an evolutionary standpoint. But it's the same principle applied, you know, in different contexts. You know, those cells have the ability to differentiate into any cell of that body. And they do it in a very controlled way. We don't have them in our bodies, so what we need to do is to take them out from an embryo and keep them in culture. And those are the embryonic stem cells. Or, here comes back Yamanaka, or we can make them artificially by reprogramming the cells back to that state, again, *in vitro*. And then we can make tissues in the test tube.

Craig ([18:21](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1101.38)):

But the manipulation of the protein expression, is there an electrical field or charge that you're manipulating? Or how are you manipulating the expression of the protein?

Vittorio ([18:33](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1113.09)):

No, we are not manipulating the cells in that way. But I can absolutely foresee that at some point we will be able to do so, to express the genes endogenously in the cells. What we are doing right now, is to express them ex-dogenously. So, what we do is to provide the cells, or to transfect the cells with [messenger RNAs](https://www.genome.gov/genetics-glossary/messenger-rna), (mRNAs), which are basically molecules that can make the corresponding proteins. So we're providing the cells with six different mRNAs. Once in the cells, these mRNAs express the corresponding proteins, and these proteins then go into the nucleus of the cells and perform this reprogramming process.

Why is it so important to use mRNAs? And I think this is one of the reasons that distinguishes our work from others: is that these mRNAs cannot integrate into the host, the genome. And so they do not change the genetic information of the cells. What they do is just provide these factors that change the epigenetic information, and so they can perform this reprogramming without altering the genome and the genetic structure of the host cells.

And this is very important from a clinical standpoint because, of course, you know, you don't want to change dramatically the genome of the cells. Otherwise, you know, you end up with cells that, yeah, sure, they may be younger, but they may also be carcinogenic for example. And that's something you don't want, of course, in particular, when we will start doing, you know, *in vivo* experiments, which is our next step. So the manipulation of the cells, directly, in the tissue, without taking it out of the body.

INTERLUDE ([20:29](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1229.47)):

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Craig ([20:30](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1230.31)):

And over the life of the cell, the cell accumulates errors. Now where are those errors exactly? And it's those errors that are being reset so the cell is back to its optimal state. Is that right?

Vittorio ([20:43](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1243.9)):

Yeah. So let's go back for a minute to the concept of epigenetic information. So, we have said that actually the epigenetic information defines the identity of the cell. And this is important during development, because as we said, you know, we need to have distinct cells having distinct properties and distinct functions. And this is what happens during development. Okay?

As we age, of course, you know, the epigenetic information defining identity does not change. But as we age, you know, we are exposed to pollution. We are exposed to inflammation. We are exposed to all sorts of sun damage. We are exposed to a number of triggers that influence the epigenome. And so, what happens is the so-called epigenetic drift. Over and over and over with time, what happens is that this information starts to become disregulated, dysfunctional, because we start accumulating errors in this code which are probably random. I mean, even though there is still some kind of controversy in the field that some people believe that there is an embedded program that explains this, I am more inclined to think that, yes, there could be a program but for the most part these errors are completely random.

So what happens is that, you know, you have this accumulation that for the most part doesn't mean anything, until you reach a threshold where you really have a crash. And this really explains well, for example, why our muscles that, you know, start aging when we are, I don't know, 50 or so; why our eyes start aging when we are 40; why our different parts of the body start aging or start having, you know, symptoms of aging at different times points. Because the timing of this accumulation is different in different parts of the body for reasons that we don't fully understand, you know, in complete honesty.

But this actually can explain why there's such a heterogeneity of aging across individuals, or within the same individual across tissues and across cell types. Is it happening in specific parts of the genome? Probably there are some hot spots. But again, we do not fully understand that process yet. It is also possible that it's happening in some hotspots, but again, in general it's happening, you know, in the entire [chromatin](https://en.wikipedia.org/wiki/Chromatin) and this is the reason why, for example, at some point you know genes that are supposed to be on are off, and genes that are supposed to be off are on. And this can happen, you know, randomly in different cells and different, again, different tissues of the body.

So, the epigenetic changes––I'm not saying that this is necessarily the cause of aging. What I'm saying is that, despite it being the cause or the consequence, at the end of the day, the epigenome is really what is responsible, at the nuclear level, for determining what genes are on and what genes are off. If we can reset that information, we can basically bring the cell back to the point where the cell knows what's supposed to be on and what's supposed to be off. And this is really what we are trying to do here.

We are trying to reset that information, so that, in a cell autonomous fashion, meaning from a cell-centric standpoint, the cell is now younger and more functional. But this can also trigger a number of cascading events. Because if a cell is younger, it's going to secrete younger, juvenile factors, which can systemically affect all the cells around it. All the tissues around it. And this could potentially have, you know, systemic benefits.

INTERLUDE ([24:25](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1465.26)):

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Craig ([24:25](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1465.71)):

You say you're looking toward *in vivo* studies. How does that happen?

Vittorio ([24:30](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1470.84)):

Yeah, we are actually looking at *in vivo* in two different ways. In academia there's only so much we can do. You know, in academia we imagine things. We can think about experiments. But at the end of the day, when it comes to making something tangible for people, you know, really that's not the space. That's the reason why we actually founded the company, [Turn BioTechnologies](https://www.turn.bio/). The goal of the company is really to bring this to people, and to make the difference when it comes to treating diseases.

We're thinking about two different approaches. The first approach is to use an *ex vivo* therapy. Meaning, we isolate the cells from the body, we treat them in the test tube *in vitro* in the lab, and then we can transplant these cells back into the tissue that requires, you know, more juvenile cells. So, this is the first approach for a very simple reason: because safety is what really matters the most here. We want to make sure that what we are doing is not even worse than what we are trying to cure and treat, right? And so by doing experiments *in vitro*, we can make sure that the cells have not changed their identity, they are non-tumorigenic, they are more youthful, and they can perform better, you know, on a number of different levels. Once we know that, now we are safe to transplant those cells back into the patient. And we are thinking about a variety of different indications. You know, dermatological indications, respiratory indications––and this is particularly important for what we are sadly, you know, living these days––and for osteoarthritis, which is another disease for which there is no cure.

Craig ([26:08](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1568.32)):

Before you do *in vivo* in humans though, you were talking about the work in mice. But that was the full Yamanaka factor treatment. Have you done this treatment––the milder treatment, so that you're only erasing the age, you're not erasing the identity––have you done that in other animals?

Vittorio ([26:27](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1587.87)):

Our work, the work that we have published, and also the work that we have not yet published but, you know, we have done, is, I would say for 95% of it is on human cells. So we have treated now eight different cell types, human cell types, and we have shown that actually what we have found is true across all those eight cell types. We are starting doing some experiments *in vivo* as well, and we have done some experiments (which are in the paper) on mouse cells, on mouse stem cells.

When we transplant the cells, we need always to start from animals. Even if we're reprogramming the human cells, we have to transplant them into animals, because those are for clinical studies, of course, that are needed to verify, you know, efficacy, but most importantly, safety. And we will continue doing so for a number of months, for sure, to show that, or to prove that, really, our technology is safe.

At the next level, though, when we will start doing *in vivo* experiments, again, we will start with animal models, for obvious reasons.

But one day, what we are envisioning is really to try to do these experiments directly into tissues, into human tissues––you know, in living people––with the idea, really, to reboot or to rejuvenate, you know, their tissues and their organs directly *in vivo* without isolating them.

Craig ([27:45](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1665.31)):

Do you envision this also as a cancer treatment? Because cancer is the mis-programming of existing cells.

Vittorio ([27:54](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1674.28)):

Probably, but not with these factors. Not with the factors that we're using right now. Because these factors that we are using right now, and this is a very important point to make, these factors have the potential if expressed for too long, have the potential to turn a cell into a tumorigenic cell. So if we add these guys now to an already tumorigenic cell, we'll probably make things even worse. But that same approach and the same concept could be used for example, to turn a cancerous cell into a non-cancerous cell if you know what genes to express. So absolutely, the idea could be applied, but not with the same factors.

Craig ([28:30](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1710.85)):

In taking osteoarthritis as an example: So you would take aged cells from the patient, reprogram them, or reset them to a healthy state, a younger state. You would reintroduce them to the joints, and then those cells would express, as you were saying, the juvenile factors that could, what, reset the other cells around it? Or what happens then?

Vittorio ([29:00](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1740.06)):

Yeah, this is exactly what we are thinking and hoping is going to happen. And we have some preliminary evidence of that.

Of course it's going to be tissue, you know, it's going to be different, you know, considering different tissues. It's, you know, the paradigm that we are using is can be, you know, universally used across different cell types, but then we need to address, you know, specific questions depending on the tissue we're using. But yes, absolutely.

Imagine you could you know, isolate, you know, your joint cells when you were 20. Right? And then you can cryo-preserve them. And then at some point, you know, when you are 90, you inject those cells back into your knee. Well, obviously, you cannot do that because you have not cryo-preserved your cells when you were 20, right? But now we are making your 20 years old-like cells, you know, from your endogenous cells. And it's the same idea.

By transplanting a younger version of the same cell type, you are instigating, you know, a number of, you know, corollary effects or, you know, cascade effects, which can yes, absolutely regenerate for example, the cartilage in the joint, but also trigger a number of other things like, you know, reduce the inflammatory profile, reduce the pain, reduce the suffering. And then, you know, this obviously can have even less scientific effects. For example, you know, affecting your mood, and affecting the way you feel and this could actually be beneficial on its own.

Craig ([30:29](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1829.81)):

And, you're a scientist, but entertain me for a minute in fantasy, because certainly I'm sure you've thought of this: If this approach is eventually refined and effective, you could treat every individual cell type in the body and rejuvenate the entire organism. Is that right?

Speaker 2 ([30:51](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=1851.08)):

That is right. Obviously, it could be complex because, you know, we have a number of different tissues in the body. But, absolutely, you know, that could be one approach. Another approach could be, for example, targeting key organs or key systems in the body, which are known to, you know, systemically affect, for example, the inflammatory profile. The [endothelium](https://en.wikipedia.org/wiki/Endothelium), for example. The endothelial cells––which are the cells that basically make our vessels, the blood vessels, you know––they secret a huge number of inflammatory [cytokines](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2785020/), which, as we age, become worse. And so they can even, you know, make the entire process of aging even worse. You know, if we can address that, for example, if we make sure that the cells are no longer aged, but, you know, they are more juvenile, they express, not pro-inflammatory factors, but anti inflammatory factors that, again, could have an effect systemically on the body.

Or another example: the [hypothalamus](https://www.medicalnewstoday.com/articles/312628). The hypothalamus is, you know, that region of the brain that regulates, you know, the so called [neuroendocrine aging](https://www.ncbi.nlm.nih.gov/pubmed/7595179). So, as the hypothalamus ages, it starts secreting, you know, bad actors that have a systemic effect, and again, make things worse. If we could , and this is obviously going to be more difficult to do because we're dealing with the brain, but if we could target the hypothalamus and make sure that they don't do so...that the hypothalamus remains young, this could also have an effect systemically on the body.

Now does this mean that, you know, we're going to... this is usually the typical question, right? Does this mean that we're going to be, you know, immortal? That we are going to be, you know, living forever? That we are going to have, you know, 90 year old individuals, you know, in the body of a 20 year old? No. Probably doesn't.

What we are envisioning is really a way to reduce as much as possible, you know, the suffering, pain, and the problems that actually occur with age, by making sure that we actually reduce the window of time where we are exposed, or we are at risk to develop those diseases; cardiovascular disease, respiratory disease, dementia, Alzheimers, and many more. What the medicine has done so far was to extend our lifespan, which is great, but at the same time we have extended, you know, the window of time where we are more fragile. Where we are developing those diseases. And you know, there's even people that think "Why do we have so many Alzheimer patients right now?" Just because we will live longer, and Alzheimer's is an aging-associated disease. Now, can we shorten that window of time? Can we make sure that we live longer, but we live better as well? That's what we care about and that's what we are trying to do.

Craig ([33:33](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2013.59)):

You mentioned the idea of having 20 year old cells from knee joints injected into an 80 year old individual, and of course people weren't thinking about doing that. Have there been experiments like that? I mean, have there been cells taken from a young individual and re-injected into that individual when they're older?

Vittorio ([33:55](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2035.75)):

Not in a personalized fashion. I mean, because again, you have to be kind of, you have to make sure that you have cryopreserved your own cells, you know, when you were young, and then, you know, you have to do the experiment when you're older. So, no, we haven't had those kinds of experiments as of yet.

What some people have done is to transplant cells from donors, from younger donors into the recipients. So for example, there's some experiments done with [mesenchymal stem cells](https://www.eurostemcell.org/mesenchymal-stem-cells-other-bone-marrow-stem-cells), even though it's not entirely clear if the mesenchymal stem cells, you know, still have a clear effect on different diseases. Or you can transplant tissue specific cells, younger tissue specific cells, from donors again to recipients. And there seems to be definitely some, you know, effects. The problem though there is that you are... It's like an organ transplantation. So you have the immune rejection issues. And so you have a number of complications that actually can mitigate the effect of the cells, you know, per se, just because now you have to ablate the immune response through drugs. Here, we are thinking about the same concept, but using your own cells, using patient-specific cells.

Craig ([35:06](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2106.73)):

Could you theoretically reset liver cells in someone who has a damaged liver, and grow *in vitro* a liver, and then transplant that liver into the patient?

Vittorio ([35:19](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2119.94)):

In principle, yes. Yes. And this is also what Turn is trying to do. So, we are really trying to think and develop a platform company where we can actually tackle a number of different, you know, diseases. I mean, again, you think about it, the implications are, you know, the indications are endless. You can think about any type of tissue, any type of organ. And yes. Yes, you could start by, you know, specific tissues, rejuvenate them *in vitro*, and then, you know, put the cells back. And cells then, you know, with the graft would grow. And would reestablish the proper function in the body.

So yes, absolutely. We are thinking about respiratory diseases, you know. Not so much well at least, not yet to prevent the pandemic from happening, but why not? At some point we could even use this approach as a preventative approach. You know, to really make sure that the, you know, the cells of the body react to the infection the same way they react as [when] we are young. And this is, again, this is really something that is astonishing. You know, we're seeing it under our own eyes, right? Why young people are more resistant than older people. Well, probably just because the cells are way more performant, you know, for some reason. And if we could make the older cells younger maybe, you know, maybe we could prevent the pandemic from happening.

Craig ([36:40](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2200.99)):

That's interesting.

Vittorio ([36:42](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2202.28)):

Or we could even think about, of course, the post-coronavirus approach where, you know, now you have a tissue that, even in young people, you have a tissue which is compromised. You know, there's clear data. The lungs become fibrotic. So is there a way to bring it back in time, you know, pre infection? And that's why I think this is really exciting because I think it extends way beyond aging as we think about it. You know, if you think about aging, aging happens, you know, from the very day we are born and it continues, you know, [laughs] until we die. But there's different steps of aging, you know? And we could really use this even to make sure that we can regenerate tissues that cannot regenerate, even in young people.

Think about, you know, central nervous system damage. You know spinal cord injuries. The neurons, even in a very young boy, cannot regenerate. Not because they are old. No, that's because they're postnatal neurons. They have lost the ability to regenerate. So if we can bring the clock of that cell type back to the point where, if it's still a neuron, but it is a regenerating neuron, that's bingo. I mean, you can regenerate the tissue in situ, even in young people. So I think that, again, I'm biased here of course, because you know, this is research, but the potential here is humongous, is endless.

INTERLUDE ([38:19](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2299.46)):

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Craig ([38:24](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2304.46)):

Turn.Bio: How many people are there now? How have you been funded? Where are you in your development?

Vittorio ([38:32](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2312.67)):

It's a relatively new company. We started about a year and a half ago, and we started thanks to the generous funding of an angel investor, which is the [Methuselah Foundation](https://www.mfoundation.org/), which is a foundation that actually funds these types of startups which are particularly, kind of, linked with a mission to treat and cure aging as a whole. So we're really grateful to that.

Craig ([38:59](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2339.36)):

Can you repeat their name?

Vittorio ([39:01](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2341.33)):

M Funds. So it's Methuselah. Methuselah Foundation, and Methuselah Funds. We're just about to close the bridge funding, and we are closing, it's about $2 million. And of course now we are preparing to Series A, which is going to be the next round. And we're planning to get there in about six months to a year. Because of course, obviously, you know, this is very expensive research and we really need resources to go to the next step.

Craig ([39:30](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2370.5)):

You still have a position at Stanford, is that right?

Vittorio ([39:33](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2373.1)):

I do, yeah.

Craig ([39:34](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2374.45)):

So the research to date has been within Stanford. But are you taking it out of Stanford then, as you get funding?

Vittorio ([39:42](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2382.09)):

So we are actually doing research on both sides. So I still have my lab where, as I said, I can still keep imagining new things, imagining new experiments. There are still a number of things that we need to understand from a molecular standpoint, and that is the typical academic type of research.

What Turn is doing, and we have already started, you know, it's been a long time now, we have already started experiments in Turn. What Turn is doing is to develop therapies for specific indications. As I said, we are looking at dermatological indications, respiratory indications, and osteoarthritis. But also we have an R & D component. We are also trying to develop new cocktails. We're trying to develop, you know, new types of interventions, and show as a proof of principle that we can actually tackle other diseases and other indications. So that's why I said it's a platform company, because we really want to try to tackle both: the research, but the implementation as well.

Craig ([40:41](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2441.19)):

Is the research at Turn computational, or do you have a wet lab?

Vittorio ([40:46](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2446.23)):

Yeah, for now it's a wet lab. So we are doing work with cells, so we are doing work with animals. At some point, we want to actually get to become, you know, computational and to develop even, you know, an AI based approach. Why? Well, the reason is very simple.

Even though we see every day in the mirror that aging is happening, is occurring, we don't really understand what is happening, you know, at the cellular level, at the molecular level. We don't have the full grasp, the full understanding of this process. And I think that probably AI could play a role here, because you know, by feeding basically this platform with information from aged people, from aged cells, from aged tissues, maybe we can come up with signature that then can help us, well, on one hand to understand aging, but also develop a platform where we can very easily address if the treatment that we are providing actually reverts that signature. I'm simplifying it of course, because I'm not an expert of AI, but that's how I'm picturing it. But I think that the potential there is really huge, and we are looking actually at some point to partner up and to interact with experts in the field.

Craig ([42:00](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2520.13)):

Have you reached out at all to the machine learning community?

Vittorio ([42:03](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2523.29)):

We have had a couple of connections, but in complete honesty actually, it would be great if we could actually strengthen that type of interaction and start brainstorming about potential exploratory work and, you know, new ideas, why not. We really need some experts in the field.

Craig ([42:20](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2540.481)):

Are there any other labs or companies that are doing anything approaching what you're doing?

Vittorio ([42:27](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2547.5)):

Yes. There's at least one other company that is doing something similar. It's a company that's part of the ecosystem of [Life Bio](https://www.massbio.org/members/life-biosciences-inc/). And they're basically using the same approach for the regeneration of the optic nerve, if I'm not mistaken. So, yes. We are not alone. Which is actually a good thing, I mean, we don't want to be alone. We want to make sure that actually this works, you know. And the more the better.

Craig ([42:56](https://www.temi.com/editor/t/P1FDkUd-6gY6YYJmatR5oeASgmsmunfp3XpnxQrTwQkQ_Pu7sajEZWalQ6wvcM3oOYUI5_ufq_CbkcRnYXwAJ9-Zl_M?loadFrom=DocumentDeeplink&ts=2576.69)):

That's it for this week's podcast. I want to thank Vittorio for his time. If you want to learn more about Vittorio's work, or his company, [Turn.Bio](https://www.turn.bio/), you can find a transcript of this episode on our website, eye-on.ai. We love to hear from listeners, so feel free to contact us with comments or suggestions.

And remember, the singularity may not be near, but AI is about to change your world. So pay attention.