Funding for Yale Cancer Answers is provided by Smilow Cancer Hospital.

Welcome to Yale Cancer answers with your host doctor in East JGP are Yale Cancer answers features the latest information on cancer care by welcoming oncologists and specialists who are on the forefront of the battle to fight cancer this week. It’s a conversation about the molecular mechanisms of cancer with Doctor Daryl Klein. Doctor Klein is an assistant professor of pharmacology at the Yale School of Medicine, where Doctor Chad Power as a
professor of surgical oncology.

So Darrell maybe we can start off by you telling us a little bit more about yourself and what it is exactly that you do.

Yeah, I mean I think. My path to become a medical researcher involves my personal back story and my love of competition. In some ways, I feel like I’ve been destined to study kinases and cancer and their mechanisms and with the hope of developing useful cancer therapeutics. And my career trajectory if you will, began long before my formal training.
I grew up in New Jersey just outside of Philadelphia, and at a young age, my sister was diagnosed with MLE or chronic myeloid leukemia. Over 40 years ago now, Peter Noel at the University of Pennsylvania in Philadelphia was studying the driving mutations that lead to CML. And he discovered a chromosome alteration that he dubbed the Philadelphia chromosome and kmle patients, like my sister and the results.
Is that a new protein is made a fusion of a tyrosine kinase signaling protein? That's that's stuck in the on position, and that instructs cells to. To divide and grow and thus cancer. And that protein became a target for drug discovery and it really heralded the era of precision medicine that is specifically targeting a single. You know bad protein with a drug and that was really exciting. And in 2001 there was this huge success with. The mat neighbor or Gleevec, and that became the first drug that was developed to target a
specific kinase to treat a disease,

and in this case, someone.

And patients treated with this drug can live long lives with controlled disease.

Unfortunately for you know, Kimberly, at that time it was just the beginning of understanding this disease.

And there were no therapeutics, and that meant you know, little could be done, and.

In this powerlessness drives me to find ways to spare other families similar devastation and to better understand cancer.

You know,
I really have spent a large part of my career investigating the molecular basis for oncogenic signaling. And you know on that path I attended the University of Pennsylvania for my undergrad in my PhD, and my medical degree, and I did clinical rotations at the Children’s Hospital of Philadelphia. So I was walking the same halls as Peter, Noel and my parents and my sister years before. I joined the MSTP or medical scientist training program and. This was funded by the NIH,
the National Institutes of Health, to grant to train a group of physicians, also to be researchers, and the goal of that program is basically to link basic science findings to the clinic. The bench to the bedside and to Brig lab progress into useful therapeutics as rapidly as possible. And I think the success of Leave Act was just the beginning of targeting kinases. These these tires and kinases other kinases and cancer. And so when I was at Penn, I studied under Professor Mark Lemon.
He was working on those other kinases that lead to different cancers. And you know, to see how they might cause cancer and how we might leverage understanding their mechanisms to develop new therapeutics. I also mentioned you know my my desire for you know competition. And so one thing I I’m not sure that people really understand is how competitive research compete. I grew up playing sports in college and I love competing and and track and field and crew and football and baseball. And when I first joined Mark’s
00:04:46.397 --> 00:04:48.056 I was first introduced to lab research, and I realized there that.

NOTE Confidence: 0.932154455

00:04:48.056 --> 00:04:49.199 Scientific research is intensely competitive and I think it makes Olympic sport seem safe by comparison and I love that and I loved everything about that.

NOTE Confidence: 0.932154455

00:04:51.410 --> 00:04:53.246 And then the problem is in sensually in science.

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00:05:02.500 --> 00:05:04.852 You’re competing with unknown competitors and an unknown number of teams and the rules of the game are undefined and you don’t even know when the conversation started.

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00:05:17.940 --> 00:05:18.302 So,
and certainly your competitors have
more money and resources than you do,
so you’re always the underdog and and
that excites me and I and I like that.
You know an example.
When we started the project will chat
more about in a in a little bit.
We were certain that that you know
half a dozen other groups in the world
were already working on it and and we
didn’t know how far along they were.
And if you want to win,
I once spent 50 hours straight in the lab
when I was a grad student without sleeping.
And then you know that was exciting to me. That's something you can't do in sport after the game you go home, but science is a years long competition with no timeouts and the intensity is off the charts so. I think that that frames kind of.

Why I became a medical researcher and why? So let's take a step back for a bit. Why I love doing the work that I do, and and interesting in terms of how this kind of came full circle. How you? Had this experience.
00:06:34.175 --> 00:06:36.753 with your sister and then went on
NOTE Confidence: 0.885244987777778
00:06:36.753 --> 00:06:38.961 to to become a scientist that’s
NOTE Confidence: 0.885244987777778
00:06:38.961 --> 00:06:41.157 hopefully making a difference in the
NOTE Confidence: 0.885244987777778
00:06:41.157 --> 00:06:43.245 lives of other patients like her.
NOTE Confidence: 0.885244987777778
00:06:43.250 --> 00:06:44.694 But for our audience,
NOTE Confidence: 0.885244987777778
00:06:44.694 --> 00:06:47.643 maybe you can take a step back and
NOTE Confidence: 0.885244987777778
00:06:47.643 --> 00:06:50.467 tell us exactly like what is a kinase
NOTE Confidence: 0.885244987777778
00:06:50.548 --> 00:06:53.390 and why are they important in cancer?
NOTE Confidence: 0.80161613
00:06:54.420 --> 00:06:55.578 Sure, sure, yeah.
NOTE Confidence: 0.80161613
00:06:55.578 --> 00:06:57.894 I mean I should also mention
NOTE Confidence: 0.80161613
00:06:57.894 --> 00:07:00.409 that while I trained as A and
NOTE Confidence: 0.80161613
00:07:00.409 --> 00:07:02.610 MDP MD PhD physician scientist,
NOTE Confidence: 0.80161613
00:07:02.610 --> 00:07:05.780 I’ve actually chosen a path
NOTE Confidence: 0.80161613
00:07:05.780 --> 00:07:08.142 devoted entirely to research.
NOTE Confidence: 0.80161613
00:07:08.142 --> 00:07:11.088 So during training, when I you know,
NOTE Confidence: 0.80161613
00:07:11.088 --> 00:07:12.723 find myself engaging with patients
and talking to them about the
unfortunately limited treatment options I,
I found that difficult and frustrating
and all I wanted to do was rush
back to the lab and and find
new potential therapeutic avenues.
So I made a choice to devote
myself entirely to lab work,
but at the same time I'm still
working with other physicians,
scientists and clinicians to
help bridge our discoveries.
Kinases are often drivers of
cancers and the one that I've
been working on recently ALK and a plastic lymphoma kinases is a well known cancer related protein. And much like the protein involved in my sisters of Mle, it’s a tyrosine kinase and basically tyrosine kinases instruct the cells to grow and divide, and if this is unregulated that leads to cancer. So ALK well, unlike the Siml case, ALK is located in a different part of the cell than the CML kinase.
the CML kinase would be a submarine
and ALK would be more like an aircraft carrier at the surface and so this. Localization difference has therapeutic implications.
As you might imagine, you can’t target a submarine the same way you would target in an aircraft carrier. So in the clinic we use small molecule.
Kinase submarine whereas for ALK we have an opportunity to use antibodies that can target it at the cell surface, so more like a.
You know a B52 bomber.

It’s been known for years that ALK is a driver of neuroblastoma.

Now neuroblastoma is a cancer of the peripheral nervous system.

It’s one of the more common pediatric cancers that accounts for more than 10% of childhood cancer mortality.

But clinically useful therapeutics have been slow to develop, and I think one of the key reasons for this slow development of treatments is likely the lack of a structural framework for the target alck.

Simply put, we have no idea what it is.
looked like or how it functioned.

It was a complete mystery before our work. I mean the fact that ALK is expressed on neuroblastoma cells but is not present. On healthy tissue makes Alk a veritable oncogenic beacon. That's a perfect target for precision medicine. It's much like the novel fusion protein and kmle. Specifically, if you're targeting the protein specifically, it should have little side effects outside of the cancer itself.
And the hope is that if we can target this kinase alken neuroblastoma.

That we might have the same positive outcomes for neuroblastoma that we see for patients with KMLE.

So you know one of the things that always fascinates me is how you find these things to begin with. I mean, how do we know that these kinases play a role in cancer? How does that? How do you figure that out? How do you know which kinases are submarines and which kinases are our aircraft carriers, I mean.

And how did you figure out that these were important anyways?
How does that happen?

That’s a good question.

That’s certainly outside of my lab’s expertise.

A lot of that is done through genomic work and associating certain genes with certain disease phenotypes, and so where my lab’s expertise comes in pretty much after the fact. Once these associations are known, that’s where we come in to help define bio physically and structurally, exactly how these kinases and uncle genes are acting, and hopefully if we have a molecular...
picture of that how we might design
and develop therapeutics to.
To stall that and prevent disease.
So when you say that it kind of all
starts with understanding what genes are expressed in what genes aren’t.
I mean it sounds like the progress that we make in terms of cancer medicine is really investigators.
Building on other investigators work.
So somebody you know maybe was sequencing some genes and found that some genes were overexpressed in some cancers versus not.
And then other people kind of discovered that gene was associated with a protein like.
A kinase and then you look at that kinase and say well where is it and how can we target it? 
Is that kind of how that works? That's exactly right, right? I mean, it's work of a tremendous number of individuals with differing expertise. Certainly the approach my lab takes is just one cog in that machine, one that's a bit further down, and probably less than the discovery stage. But one one that is keenly important to understand the mechanism of how molecules work,
which can then give us insight

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into how we might target these

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develop therapeutics.

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Around their function.

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And then the other question

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that I often have is.

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OK, so you discover this kinase and

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you discover that it’s important in cancer.

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Why is it that some kinases are important

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in some cancers but not in others?

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I mean, how do these kinases?

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Why? Why do you have these genes

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for these kinases to begin with?

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And why are they differentially expressed?

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Cancer often recapitulates the the paradigms

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that are important and during development.
So all of these kinases are crucially important in the stages of development and help patterning and complex tissues. After that, they aren’t used so much in adulthood, and it’s only during cancer that a lot of these developmental pathways are reawakened, and they can be reawakened in different tissues and different places, but they all lead to the same thing. Basically once you turn on a kinase on your turning on the growth instructions and
when that’s not counterbalanced, that’s how cancer develops.

Well, we’re going to take a short break for a medical minute, but when we come back, let’s learn more about the molecular mechanisms of cancer and how exactly we target these differentially expressed kinases to actually make a difference for patients, please stay tuned for more with my guest doctor Daryl Klein.

funding for Yale Cancer Answers comes from Smilow Cancer Hospital with an event focused on nutrition for cancer survivorship presented by the Smilow.
00:15:01.944 --> 00:15:03.589 Cancer Care Center in Trumbull.
NOTE Confidence: 0.884235398214286

00:15:03.590 --> 00:15:06.894 April 14th Register at Yale Cancer Center.
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00:15:06.900 --> 00:15:09.658 Org or email cancer answers at Yale.
NOTE Confidence: 0.838554415

00:15:11.920 --> 00:15:13.832 The American Cancer Society
NOTE Confidence: 0.838554415

00:15:13.832 --> 00:15:16.368 estimates that nearly 150,000 people
NOTE Confidence: 0.838554415

00:15:16.368 --> 00:15:18.986 in the US will be diagnosed with
NOTE Confidence: 0.838554415

00:15:18.986 --> 00:15:20.917 colorectal cancer this year alone.
NOTE Confidence: 0.838554415

00:15:20.920 --> 00:15:23.070 When detected, early colorectal cancer
NOTE Confidence: 0.838554415

00:15:23.070 --> 00:15:25.800 is easily treated and highly curable,
NOTE Confidence: 0.838554415

00:15:25.800 --> 00:15:27.864 and men and women over the age of
NOTE Confidence: 0.838554415

00:15:27.864 --> 00:15:29.643 45 should have regular colonoscopies
NOTE Confidence: 0.838554415

00:15:29.643 --> 00:15:31.633 to screen for the disease.
NOTE Confidence: 0.838554415

00:15:31.640 --> 00:15:33.088 Patients with colorectal cancer
NOTE Confidence: 0.838554415

00:15:33.088 --> 00:15:35.260 have more hope than ever before,
NOTE Confidence: 0.838554415

00:15:35.260 --> 00:15:38.080 thanks to increased access to advanced
NOTE Confidence: 0.838554415
therapies and specialized care.

Clinical trials are currently underway at federally designated Comprehensive Cancer Centers.

Such as Yale Cancer Center and its Milo Cancer Hospital to test innovative new treatments for colorectal cancer tumor.

Gene analysis has helped improve management of colorectal cancer by identifying the patients most likely to benefit from chemotherapy and newer targeted agents, resulting in more patient specific treatment.

More information is available at yalecancercenter.org.
Welcome back to Yale Cancer answers.

This is doctor in East Egg part and I'm joined tonight by my guest doctor, Daryl Klein.

We're learning more about the molecular mechanisms of cancer and right before the break Daryl was telling us about this profoundly inspiring story of his sister who is diagnosed with CML, which really started his journey on becoming a physician scientist, and one who is particularly interested in these molecules called kinases, which really work.

To activate the growth of cancer
cells and so you know Darrell before
NOTE Confidence: 0.895207821666667
the break you were mentioning that
NOTE Confidence: 0.895207821666667
eurolab really after we know that
NOTE Confidence: 0.895207821666667
you know a kinase is involved in a
NOTE Confidence: 0.895207821666667
particular cancer is really involved
NOTE Confidence: 0.895207821666667
in looking at its structure
NOTE Confidence: 0.895207821666667
and kind of how to target it.
NOTE Confidence: 0.895207821666667
Is that right?
NOTE Confidence: 0.904520128571429
my lab is a structural biology lab,
NOTE Confidence: 0.904520128571429
so you know, we're sensually photographers.
NOTE Confidence: 0.904520128571429
But we take pictures of very tiny things, molecules and proteins,
NOTE Confidence: 0.904520128571429
and so this. Requires specialized
NOTE Confidence: 0.904520128571429
equipment cameras if you will.
NOTE Confidence: 0.904520128571429
That use X rays and electrons rather
than light in the visual spectrum that we’re used to.

You know, many people know DNA, so let’s start there.

People have heard of DNA and Watson and Crick and they’re double helix.

And DNA is basically a cookbook with 10s of thousands of recipes, mostly protein recipes, so I guess it’s a keto or Paleo cookbook.

The recipe in the DNA cookbook tells us the ingredients and the order to make ALK.

But one big problem with this DNA cookbook is it’s not illustrated.
so we have no idea what the final product will look like.

So you know my lab follows the recipe to take pictures of the final products to.

To illustrate this, this DNA cookbook.

So we take molecular photographs of the protein and also the mutants that are found in cancer.

And in these pictures give us a better understanding of how things supposed to look like and how it changes in cancer.

And in this can inform us about approaches to designing targeted therapeutics.

So my lab just reported the structure of the protein ALK in nature.
That’s the tyrosine kinase that’s important in neuroblastoma.

And this gave us a first look at this unique uncle Gene and it’s, you know it’s going to be impossible for me to relay the complexities here. But if we stick to our Analogy of the the cell is an ocean, it’s. It’s not unreasonable to say that Alcc did actually look a bit like an aircraft carrier. I mean it had this Unusual a long gated structure and it probably lies parallel to the to the surface, so it’s like an aircraft carrier floating on the water.
00:19:44.448 --> 00:19:46.770 Or the surface of a cell.
NOTE Confidence: 0.904520128571429

00:19:46.770 --> 00:19:48.228 And and furthermore,
NOTE Confidence: 0.904520128571429

00:19:48.228 --> 00:19:52.430 we can see how it actually gets activated.
NOTE Confidence: 0.904520128571429

00:19:52.430 --> 00:19:54.716 Basically two of these aircraft carriers
NOTE Confidence: 0.904520128571429

00:19:54.716 --> 00:19:57.840 line up next to one another and in
NOTE Confidence: 0.904520128571429

00:19:57.840 --> 00:20:00.126 that position they’re then capable to
NOTE Confidence: 0.904520128571429

00:20:00.203 --> 00:20:02.926 sell to send their their growth signals,
NOTE Confidence: 0.904520128571429

00:20:02.930 --> 00:20:05.120 which ultimately end up being
NOTE Confidence: 0.904520128571429

00:20:05.120 --> 00:20:06.434 cancerous growth signals.
NOTE Confidence: 0.904520128571429

00:20:06.440 --> 00:20:08.588 To the neuroblastoma cell.
NOTE Confidence: 0.904520128571429

00:20:08.588 --> 00:20:10.736 Uncontrolled ALK activation like
NOTE Confidence: 0.904520128571429

00:20:10.736 --> 00:20:13.948 this leads to cancer and it and it
NOTE Confidence: 0.904520128571429

00:20:13.948 --> 00:20:16.432 results from the tumor continuing to
NOTE Confidence: 0.904520128571429

00:20:16.432 --> 00:20:18.960 express this developmental out gene
NOTE Confidence: 0.904520128571429

00:20:18.960 --> 00:20:23.930 along with its stimulatory ligand.
NOTE Confidence: 0.904520128571429

00:20:23.930 --> 00:20:26.090 Our research reveals an approach
to shutting off ALK and that it can be quite straightforward. Potentially if we use our structure as a blueprint, we can see clear areas where we would want to target this. This aircraft like molecule. I mean there’s certain vulnerabilities that are revealed in the structure that we can strategically target and and you know sync this aircraft carrier, and so my lab now is designing potent antibodies that specifically target these regions in ALK, and you know there’s small
molecules currently out there in use for.

Neuroblastoma, as well as many other
different cancers that are driven or
or partially dependent on kinases.
And compared to small molecule
therapeutics antibodies,
I think can offer a great benefit.
The small molecule drugs that
are now currently in use like
prison and and learn Latin.
The actual kinase domain of the protein out.
And one problem with these types of
inhibitors is that you can’t keep
the cancer figures out this
00:21:37.322 --> 00:21:39.446 trip quite fast that you’re trying
NOTE Confidence: 0.7377237425
00:21:39.446 --> 00:21:42.118 to inhibit it in this in this domain,
NOTE Confidence: 0.7377237425
00:21:42.120 --> 00:21:44.745 and they and the cancer makes changes
NOTE Confidence: 0.7377237425
00:21:44.745 --> 00:21:46.829 that diminish the drugs impact.
NOTE Confidence: 0.7377237425
00:21:46.830 --> 00:21:48.690 Whereas I think the antibody
NOTE Confidence: 0.7377237425
00:21:48.690 --> 00:21:51.599 approach is is is a more brute
NOTE Confidence: 0.7377237425
00:21:51.599 --> 00:21:53.770 force approach and it’s harder for
NOTE Confidence: 0.7377237425
00:21:53.770 --> 00:21:55.270 the cancer to overcome this,
NOTE Confidence: 0.7377237425
00:21:55.270 --> 00:21:57.194 the strategy of inhibition.
NOTE Confidence: 0.7377237425
00:21:57.194 --> 00:22:00.080 I think the the therapeutic future
NOTE Confidence: 0.7377237425
00:22:00.163 --> 00:22:02.373 will likely use a combination
NOTE Confidence: 0.7377237425
00:22:02.373 --> 00:22:04.583 of these two to completely.
NOTE Confidence: 0.7377237425
00:22:04.590 --> 00:22:08.660 Dismantle the the out machinery.
NOTE Confidence: 0.7377237425
00:22:08.660 --> 00:22:10.940 In some ways you know cancer can be
NOTE Confidence: 0.7377237425
00:22:10.940 --> 00:22:13.157 feod viewed as having some of the
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similar challenges that we see for SARS, Co V2 and both use similar strategies to overcome disease. Both you know cancer and viruses mutate rapidly. And they can evolve to different inhibitor approaches. And just as we use antibodies through vaccination or or directly injecting recombinant antibodies and small molecules to overcome COVID. Now we have a new blueprint for ALK to help us overcome similar challenges that are encountered in in particular neuroblastoma. And it sounds like when you know the
But you can be very specific about you know targeting those particular molecules as opposed to normal cells. So you might have you know a bomber that only targets, aircraft lands on the aircraft carrier. Or you can have some sort of a. A mechanism whereby these two aircraft carriers can’t line up together that really wouldn’t apply in any other situation, so you can try to get more precise or more targeted therapies. Is that right?
That’s exactly right, and remember that I said that you know, since alpha is expressed only on neuroblastoma cells but not present on healthy tissue, it really makes targeting ALK the perfect for you know. Set up for precision medicine and then a layer on top of that, which I think you were just referring to is now that we know the detailed structure and blueprints of this. And that’s exactly what we’re trying to design. Block areas on the protein that are
involved in important for it’s activation.

That is precisely where the ligand binds to activate the receptor and getting back to how it’s activated.

Where we see the the two molecules lining up side-by-side to each other, we’re designing antibodies that can block that interface to prevent it from being activated independent of ligand. Which could be caused by certain mutations, which is further research that we’re doing now or with the ligand.

So we’re using all this information to specifically design antibodies.
that are tailored to this molecule
and the and the type of mutations
specifically in neuroblastoma.
And so as you design these antibodies in these treatments,
you’re doing that in the lab. How?
How does it actually get into patients?
Because that’s where the story really started and how long
Cancer Research is so matured and specialized now that it really requires
you know effort to put these discoveries into usable formats and for others to build upon and meaningful ways.

And just as the NIH created that MSTP program to link basic science and patient care now I think we need similar links between basic science researchers. I mean, the you know RNA biologist and chromosome researcher and. And in the biophysicist like me trying to link up with the model organism biologist to test the a lot of these and preclinical setups. We all speak a different scientific dialect and we have different perspectives,
00:26:06.300 --> 00:26:10.460 so you know how do we work together
NOTE Confidence: 0.796460149
00:26:10.555 --> 00:26:12.577 and in one answer to that is is,
NOTE Confidence: 0.796460149
00:26:12.580 --> 00:26:14.996 you know being part of the Yale Cancer
NOTE Confidence: 0.796460149
00:26:14.996 --> 00:26:17.377 Biol Biology Institute that I’m a part of.
NOTE Confidence: 0.796460149
00:26:17.380 --> 00:26:19.942 You know we we really bring
NOTE Confidence: 0.796460149
00:26:19.942 --> 00:26:21.650 together desperate researchers among
NOTE Confidence: 0.796460149
00:26:21.718 --> 00:26:23.518 those interested in cancer.
NOTE Confidence: 0.796460149
00:26:23.520 --> 00:26:26.310 And so you know now I have and and
NOTE Confidence: 0.796460149
00:26:26.310 --> 00:26:29.380 being a physician scientist so you know
NOTE Confidence: 0.796460149
00:26:29.380 --> 00:26:32.250 now there’s a cohort of people and
NOTE Confidence: 0.796460149
00:26:32.250 --> 00:26:35.024 colleagues that I can work with that
NOTE Confidence: 0.796460149
00:26:35.024 --> 00:26:37.148 can bring our developing antibodies
NOTE Confidence: 0.796460149
00:26:37.148 --> 00:26:40.292 that we have into preclinical testing
NOTE Confidence: 0.796460149
00:26:40.292 --> 00:26:43.850 quite rapidly to see if they do.
NOTE Confidence: 0.796460149
00:26:43.850 --> 00:26:48.230 So good activity in vivo and then that
NOTE Confidence: 0.796460149
00:26:48.230 --> 00:26:50.430 hopefully can be rapidly leveraged
into reaching the patients that desperately need these treatments.

Sounds very much like you had mentioned earlier, this is kind of a microcosm for the macrocosm of how science works, that your lab puts together. People who all kind of come at the problem of ALK from a slightly different vantage point. But the work in your lab kind of builds on the work of other people’s labs, and so maybe in the last few minutes that we have, you could tell us kind of a little bit about.
How that works in the grand scheme of things?

One of the things that we’ve realized with the pandemic is that the world is shrinking, and hopefully the scientific discovery bounces around fairly easily.

How does that collaboration work?

I think it is. It is certainly a challenge and I think you know getting researchers to talk to each other and work together is an important part of that.

And like you said, I think you know during the pandemic and having people communicate in different ways like we are now through zoom and other things.
Maybe the world is shrinking a bit and I think that’s a good thing for science and that’s a good thing for research because. Of course, all of us working independently and making advances. We don’t want them to go unnoticed by the people next in that chain that you were talking about. That’s necessary to make the leap to bring these discoveries to their therapeutic potential.

Doctor Daryl Klein is an assistant professor of pharmacology at the Yale School of Medicine. If you have questions,
the address is canceranswers@yale.edu
and past editions of the program
are available in audio and written.
F arm at yalecancercenter.org.
We hope you’ll join us next week to
learn more about the fight against
cancer here on Connecticut Public
radio funding for Yale Cancer Answers
is provided by Smilow Cancer Hospital.