Transcript of Warren C.W. Chan, Ph.D.

Date: July 30, 2024
Case: BioNTech SE and Pfizer, Inc. -v- Moderna TX, Inc. (PTAB)

Planet Depos
Phone: 888.433.3767
Email: transcripts@planetdepos.com
www.planetdepos.com

WORLDWIDE COURT REPORTING & LITIGATION TECHNOLOGY

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

_____

BIONTECH SE AND PFIZER INC.,

Petitioners

v.

MODERNA TX, INC.,

Patent Owner

_____

Case IPR2023-01358

IPR2023-01359

Patent Nos. 10,702,600

10,933,127

_____

DEPOSITION OF WARREN C.W. CHAN, Ph.D.

Tuesday, July 30, 2023 7:13 a.m.

WilmerHale

60 State Street, Boston, MA 02109

Reported by:

Janet McHugh, RMR, CRR, CLR

JOB NO. 547014

July 30, 2023

7:13 a.m.

Deposition of WARREN C.W. CHAN, PH.D., held at the offices of WilmerHale, 60 State Street, Boston, Massachusetts, pursuant to Agreement, before Janet McHugh, a Registered Merit Reporter, Certified Realtime Reporter, Certified LiveNote Reporter, and a Notary Public within and for the Commonwealth of Massachusetts.

APPEARANCES:

WILLIAMS & CONNOLLY LLP
(By Michael Xun Liu, Esquire, and
Kathryn Kayali, Esquire) (Via Telephone)
680 Maine Avenue, SW
Washington, DC 20024
202.434.5000
mliu@wc.com
kkayali@wc.com
Counsel for the Petitioner

WILMERHALE
(By Andrew Danford, Esquire, and
Wenli Giu, Esquire)
60 State Street
Boston, Massachusetts 02109
617.526.6000
andrew.danford@wilmerhale.com
wenli.giu@wilmerhale.com
Counsel for the Patent Owner

APPEARANCES: (Continued)

PAUL HASTINGS LLP
(By Ryan Meuth, Esquire)
200 Park Avenue
New York, NY 10166
212.318.6000
ryanmeuth@paulhastings.com
Counsel for the Petitioner, BioNTech

ALSO PRESENT:
Rebecca Hilgar, In-house Counsel, BioNTech
Jacob Moore, In-house Counsel, ModernaTX

I N D E X

WITNESS	DIRECT	CROSS	REDIRECT	RECROSS
WARREN C.W. CHAN, Ph.D.				
By Mr. Liu	6			

PREVIOUSLY MARKED EXHIBITS

Number	Page
Exhibit 1001	9
Exhibit 2198	11
Exhibit 1009	53
Exhibit 2021	261
Exhibit 1010	282

P R O C E E D I N G S

WARREN C.W. CHAN, Ph.D.,

having been duly sworn, after presenting identification in the form of a driver's license, deposes and says as follows:

DIRECT EXAMINATION

BY MR. LIU:

Q. Good morning, Dr. Chan.

A. Good morning.

Q. Can you just state your full name for the record.

A. My full name is Warren Chee Hoi Chan.

Q. And, Dr. Chan, as you probably just heard before the deposition, my name is Michael Liu. I represent Pfizer in this matter.

Dr. Chan, do you understand that you are here in a deposition for two separate IPR proceedings in Pfizer and BioNTech v. Moderna before the Patent and Trademark Office?

A. Yes, I do.

Q. Dr. Chan, have you ever been deposed before?

A. No, I have not.
Q. Have you ever testified at any trial before?
A. No, I have not.
Q. So as you can probably tell, the court reporter is taking down a transcript of what we're saying today. So because of that, I'm going to request that you give oral answers to my questions instead of a head nod or gesture.
Is that okay?
A. Yes. That is fine.
Q. And can you let me know if for any reason my questions are unclear to you?
A. Yes, I will do so.
Q. I'll do my best to clarify those questions.
If you answer my question, can I assume that you have understood it?
A. Yes.
Q. And if you need a break at any point during the deposition, please just let me know. My only request is if there's a pending question

on -- there's a question pending, that you answer that question before we go on break.

Is that okay?

A. That's great.

Q. Is there any reason why you can't testify truthfully today?

A. No.

Q. So, Dr. Chan, you understand that you have submitted two expert declarations in proceedings before the Patent and Trademark Office, right?

A. Yes.

Q. And you understand that this deposition is with respect to both of those proceedings?

A. Yes.

Q. Okay. And you understand that those proceedings relate to Moderna's Patent No. 10,702,600 and Patent No. 10,933,127?

A. That is correct.

Q. Dr. Chan, I'm going to hand you two exhibits, both of which are going to be marked Exhibit 1001.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 9 of 375

(Previously marked Exhibit 1001 incorporated by reference.)

THE WITNESS: Thank you.

BY MR. LIU:

Q. So I just handed over two exhibits marked as the Exhibit 1001. Can you just verify that one of them is Patent No. 10,702,600, which is one of the patents at issue in this proceeding?

A. Yes. One of the patents is 10,702,600.

Q. And the other patent in front of you is also marked Exhibit 1001, and that is U.S. Patent No. 10,993,127?

A. Just to -- you said '993. It's actually 10,933,127.

Q. Okay. I apologize. 10,933,127?

A. That's right.

Q. Great. And you understand that those are the two Moderna patents that are at issue in these proceedings?

A. I do understand that.

Q. And you understand that the

specification for these two patents are identical?

A. What do you mean by "specifications"?

Q. Sure. So do you understand that there is text in the patents before the claims, correct?

A. Yes.

Q. Do you understand that that text in the patent, as well as the figures, are identical between the '600 and '127 patent?

A. I think they're the same; there's just, like, differences in terms of the claims and the objective.

Q. Great. But you understand the actual disclosure in the two patents are identical, right?

A. Yes.

Q. Just for convenience, throughout the deposition, I'm going to refer to citations in the '600 patent. Can we agree that the citations and discussion we have about the disclosure in the '600 patent also applies to the '127 patent?

A. Yeah.

Q. Just to get some more housekeeping stuff out of the way, as we established earlier, you had submitted two declarations in these proceedings, correct?

A. Yes.

(Previously marked Exhibit 2198 incorporated by reference.)

BY MR. LIU:

Q. So, Dr. Chan, I've handed you two documents, both of which are marked Exhibit 2198 and both of which are titled "Declaration of Warren Chan."

A. That is correct. That's what I see here.

Q. And can you just verify that these are the two declarations that you submitted in the IPRs against the '600 and '127 patents?

A. Give me two seconds. I just want to go through it, just make sure.

Okay. That is correct.

Q. Just so we have a clear record, because

both of the documents are titled "Exhibit 2198," can we agree that if I'm referring to Exhibit 2198, or your declaration, that I'm referring to your declaration with respect to the '600 patent?

A. Okay.

Q. And can I also assume that you are doing the same unless you specify otherwise?

A. That's correct.

Q. Okay. Dr. Chan, what did you do to prepare to testify today?

A. What did I do to prepare to testify?

Q. Correct.

A. I -- can you clarify the question, because that could be broadly?

Q. Sure. So you understand that you're here for a deposition today, right?

A. I do.

Q. Did you prepare for the deposition today?

A. Yes. I went through the declaration again, some of the documents, as a reminder

because it's been a couple of months. I met with WilmerHale and Jake the last couple of days. So that's how I prepared.

Q. Other than the -- so you said you reviewed your declaration and a couple of documents. What documents did you review aside from your declaration?

A. I went through and looked at the '600 patent again, the '127 with the claims, went through some of the references that I had in the declaration as well.

Q. When you say "the references," do you mean the references that are cited in your declaration?

A. That's correct.

Q. Other than the documents that are cited in your declaration, did you look at any other material in preparation for your deposition today?

A. I have not.

Q. And you say you met with your attorneys. How long did you meet with them?

A. Just the last two days or so. Sunday. From Sunday on.

Q. Did you speak with anyone, other than your attorneys at WilmerHale and Moderna, in preparation for your deposition today?

A. No, I have not.

Q. So, Dr. Chan, what is your current employment?

A. So I was at the University of Toronto until July 1st. I was a professor at the University of Toronto in the Institute of Biomedical Engineering. I was associated with a number of other departments as well there.

I moved to Nanyang Technological University, or NTU, in Singapore in July. It was at the end of June, but my -- yeah. I moved to NTU, and right now I'm transitioning between University of Toronto and NTU.

So I'm not officially resigned, in some sense, from University of Toronto yet, so I'm kind of straddling both until the transition gets completed.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 15 of 375

Q. Understood. And when you say July 1st, I assume you mean July 1st of 2024.

A. That's correct.

Q. Why did you leave the University of Toronto?

A. NTU recruited me, and so -- yeah, they recruited me to move there to serve as the new dean of engineering there and also as a professor there as well.

Q. Is your research focus going to be the same at NTU as it was at the University of Toronto?

A. It will be a continuation of the work I've done at the University of Toronto. At the University of Toronto, my labs focus on two areas. One is on nanoparticle delivery and the other one is diagnostic devices.

And so as an academic, you know, you start off with a certain fundamental framework and then, of course, you continue down the particular stage, but maybe at a different level, right?

Q. Were you recruited to NTU to do any

specific research?

A. No. They just recruited me there to serve the administrative position as well as to, you know, continue to build my lab and to teach as well.

Q. And were you tenured at the University of Toronto?

A. I was tenured at the University of Toronto.

Q. So I want you to turn to your declaration at page 62.

A. Sixty-two.

Q. It should fall under Appendix A. Sorry, excuse me, 92.

A. Ninety-two. Okay.

Q. Can you just verify that the document starting at page 92 of your declaration is an accurate copy of your CV?

A. It is an accurate copy of my CV at the time that I submitted it to WilmerHale.

Q. And obviously you have since moved to NTU.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 17 of 375

A. Yup.

Q. Is there any other updates -- is there any other substantive updates to your CV since you submitted this document?

A. Aside from the change in employment, also would be, like, more publications, more presentations, and -- I have to look at it. There is one or two more grants. And also the list of people that work -- that I train may be different because people graduate. You hire new people in since then. It's a very dynamic system.

Q. About roughly how many publications have you made since you submitted this CV?

A. Let me look at this. I don't know where it ended. Let's see. Probably about three or four more papers that's either submitted or that was published. But I might have already indicated the list submitted. I have to look at it.

Yeah. There's a number of submitted papers that I normally would include in my CV that I did

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 18 of 375

not include here.

Q. In general, what were those three or four papers that you published since your CV on?

A. I don't know if -- I can't recall if it's published or submitted. But some of the papers that have been submitted that is in revision at this point, after this; one, for example, is using 3D transmission electron microscopy to image nanoparticles in blood vessels.

And so in that paper, we created a 3D movie of imaging, three dimensions, of where the particle is located within the tumor space.

Another paper that's in revision now that was also submitted is looking at how the macropinocytosis process was involved in transporting nanoparticles from the blood vessel into the tumor microenvironment.

Another paper that was also submitted was a paper that focused on developing a diagnostic device for infectious disease detection or pathogen detection. So there's a lot of other

things that are just ongoing.

Q. Were any of those papers focused on mRNA vaccines?

A. They were not.

Q. So I want you to go to page 97 of your declaration. There should be, under the title, "Section 2 - Publications."

A. Okay. The one that has the research interests overview?

Q. Correct.

A. That's correct.

Q. Do you see under Research Interest Overview, you state, "The overall aim of the Chan Group is to synthesize and characterize nanostructures and to elucidate their interactions with biological systems"?

Do you see that?

A. I see that as the first sentence.

Q. And then in the next sentence, you say, "The developments and findings from these studies will be used in the creation of biomedical devices for cancer and infectious disease

applications."

Right?

A. That is correct.

Q. What type of biomedical devices for infectious disease applications are you referring to?

A. In this particular statement, it refers to diagnostic devices for detecting infectious pathogens.

Q. So is it fair to say that with respect to infectious disease applications, your research has been focused on diagnostics?

MR. DANFORD: Objection to form.

Q. You can still answer.

A. Okay. It is referring to biomedical devices for diagnosing infectious diseases. What we do there is specifically focus on developing the devices for detection and we collaborate with researchers that are -- with the clinical analysis and clinical sample, because that is not my area of expertise, right. So we're mostly focused on the engineering side of the equation.

Q. And have you ever developed an mRNA vaccine before?

A. I have not developed an mRNA vaccine prior, but I have studied how nanoparticles transport into lymph nodes for vaccine purposes. And in the last couple of years, we've also been contemplating idea of adding mRNA into our repertoire of research activities.

Q. But you've never personally been involved in developing an mRNA vaccine, correct?

MR. DANFORD: Objection to form.

A. Myself, the kind of work we do on nanoparticle delivery, just we work on the sort of the mechanistic side of the equation, right, to understand how to design nanoparticles for that purpose, which is what this -- elucidating their interactions with biological systems, because we try to study how design relates to how it interacts with biological examples. So our results are -- informs people who develop vaccines how to apply them, how to use them.

Q. When you say "the mechanistic side of

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 22 of 375

the equation," are you referring to how the nanoparticles that you've developed interact with cells?

A. So what we study is to understand what happens to the nanoparticle once it's injected into the blood system. But what we do is focus very much on the chemical side of the equation.

Q. So have you ever developed a nanoparticle specific for vaccine applications?

MR. DANFORD: Objection to --

A. As I said, because we're an academic, right, we are studying these interactions to help design delivery technologies.

Q. I understand that you're studying the interactions. I'm asking, I guess, a more specific question, which is, have you ever developed a nanoparticle that was specifically tailored for a vaccine application?

MR. DANFORD: Objection to form.

A. Again, I just focus on the fundamentals in our research, and other people can apply this information to whatever they like.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 23 of 375

Q. So you've never actually developed a nanoparticle that was specifically designed for a vaccine application, right?

MR. DANFORD: Objection to form.

A. Again, as I said, I just focus on the basic principles, right.

Q. Have you ever put mRNA vaccines in the clinic before?

A. So myself, directly, I have not.

Q. And I assume you've never designed a clinical trial before, right?

A. I have not designed a clinical trial.

Q. Have you ever developed a vaccine itself?

MR. DANFORD: Objection to form.

A. Again, my research involved the development of nanoparticles, right. And other people may use that information for their development, right.

Q. For example, you couldn't name a specific vaccine for an infectious disease that you've developed, correct?

MR. DANFORD: Objection to form.

A. Again, I just focus on the fundamentals. The reason I keep on repeating is because that is essentially the framework of how I do work. Other people can use that information.

Q. And when you say "fundamentals," do you mean the basic science behind nanoparticles?

A. So when I say "fundamentals," it's stated here, right. It's to elucidate their interactions with biological systems. That's a fundamental aspect of studying nanoparticle delivery and transport.

Q. So, Dr. Chan, you received your bachelor's and Ph.D. in chemistry, right?

A. I received my undergrad in chemistry at the University of Illinois, and then I received my Ph.D. in chemistry, specifically focused on analytical chemistry.

Q. And you don't have an advanced degree that's focused on nucleic acids, correct?

MR. DANFORD: Objection to form.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 25 of 375

A. Again, there's no such thing as a, you know, a Ph.D. in nucleic acids, right, because a Ph.D. is a philosophy degree at the end, right.

And what you do within that philosophy education, if you want to call it that way, is what gives you the expertise, right.

Q. Well, what did you focus on during your Ph.D.?

A. So during my Ph.D., I focused on developing quantum dots for bioimaging applications. Quantum dots are also called semiconductor nanocrystals.

Within that context of work, I worked with proteins, nucleic acids. These are the molecules that you can attach onto the surface of a nanocrystal or a quantum dot.

Q. Would you characterize your Ph.D. as focused -- let me rephrase.

Would you characterize the research during your Ph.D. as focused on nucleic acids?

MR. DANFORD: Objection to form.

A. Again, as I said, we work with nucleic

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 26 of 375

acids within the course of the project. We work with proteins as well as other types of molecules. I also worked with carbohydrates as well.

Q. But your research wasn't in, for example, studying the interaction of mRNA with the innate immune system, right?

MR. DANFORD: Objection to form.

A. Are you talking about during my Ph.D.?

Q. Correct.

A. Yeah. So as I said, when you do your Ph.D., the Ph.D. is a philosophy degree, right. Because it's a philosophy degree it's focused on the philosophizing about solving problems.

In fact, I also ask my students during their defense, why did you get a Ph.D. degree and not a Ph.D. in biomedical engineering. Why not a Ph.D. in chemistry? Right? Because it's a general degree that talks about philosophy.

Within that philosophy, you learn to solve problems. And when you're solving problems, it could involve nucleic acids, proteins, cells,

nanoparticles, and so that is essentially the framework of this.

Q. So I'm not entirely sure I got an answer to my question.

During your Ph.D., did you research the interaction with mRNA and the innate immune system?

MR. DANFORD: Objection to form.

A. Again, it's just that I focus on the topic that I presented to you. Right?

Q. Which was quantum dots?

A. Quantum dots with molecules, nucleic acids -- nucleic acids, proteins. We worked with cells. You can look up the one paper I published at that time, right. And it essentially talks about the application of nanocrystals for a variety of applications, because we looked at how the nanocrystals integrate or interact with proteins, nucleic acids, as well as I played around with carbohydrates. There was a lot of things we did that was not published as well.

Q. Did your Ph.D. involve any research

into lipid nanoparticles?

A. As I said, I focused on the nanocrystals. Focused on the different types of molecules you can put on the nanocrystals. And nanocrystals are part of the nano family. At that time, all of these things were starting to be defined.

Q. Just to be clear, nanocrystals are not lipid nanoparticles, correct?

A. Some people would define it as part of nanocrystals because it's part of the nano family, right.

Q. Did you work on lipid-based particles during your Ph.D.?

A. So the reason I keep on focusing on what I focused on with the nanocrystals is that was my main Ph.D. thesis. But I also worked with other people who were working in that particular space. So during the educational framework, you learn all about these different technologies, right.

Q. So did you work -- did your own

research focus on lipid-based particles during your Ph.D.?

MR. DANFORD: Objection to form.

A. Yeah, the reason I'm just answering directly this is because there's also side things you do, so it depends on what you mean by "work," right.

Q. Sure. Did the research related to your thesis focus on lipid nanoparticles during your Ph.D.?

A. My thesis focused on the semiconductor nanocrystals as the main theme.

Q. Which are not lipid nanoparticles, right?

A. So within the theme -- again, the reason I -- it's -- the reason is "work" and what thesis is a little bit confusing to me, right. The reason for that is because as time went on, we discussed different aspects of how to encapsulate the nanocrystals, right.

Q. I just want to make sure that I'm understanding your testimony. Are semiconductor

crystals a type of lipid nanoparticle?

A. So it's actually not the crystal that is important, right. It's the nano that is important.

The nano, at that time, was defined as structures that are below 100 nanometers in at least one dimension.

So that definition has evolved, and because of that, categories of materials that are -- that has one dimension in that size range is within the framework of a nanocrystal, right.

And the term "crystal," it's got evolved also through time, right. Because that definition of a crystal is referring to repeated units of components within the nanostructure, right.

And the reason about commenting about work, because when you asked me "work," it's a very general concept. Of course, during that time, you had discussions about nanocrystals, other types of nanoparticles as well. It's just part of the discussion, right.

So during that course, I can't recall explicitly, but they're all part of the repertoire of the education and the research activities there, right.

Q. Sure. So, Dr. Chan, I think my question is a little bit different. As a scientific matter, are semiconductor nanocrystals a type of lipid nanoparticle?

MR. DANFORD: Objection to form.

A. So let's go back, right. The reason I say that the semiconductor nanocrystals is the term "semiconductor" is the first part of that equation, right. So that defines a component contains something that has a semiconductor property associated with it, right.

And that's usually related to the energy gaps of the material. So that's the work that is a descriptor of the function of that particular nanocrystals.

The term "nanocrystal" itself, it's a generic terminology and it's broken out into two halves. One half is "nano," which as I defined,

it refers to one dimensions that are in a certain size range that was kind of defined at that time. And it has evolved.

And then "crystal" just -- is a generic term that defines things that have repeated units of something, right.

Q. Dr. Chan, just -- you understand that your testimony in this case is both under oath and public, correct?

A. Yes.

Q. Now, as a scientific matter -- it's a yes or no question -- are semiconductor crystals a type of lipid nanoparticle?

MR. DANFORD: Objection to form.

A. So, again, the reason I don't want to directly -- not directly say this, right, because the thing is that with lipid nanoparticles and other lipid-based systems, many times with nanocrystals, they could be incorporated into the system, right.

So unless you can clarify more specifically what you're asking me, right, like working,

research, during the course of Ph.D. or -- you know, as a researcher in this space, you have discussions and educations, and you talk to each other about these things, right. It's part of the education mandate. Regardless of what I put in my thesis or not, right.

And working, you know, if you've done enough experiments, you start to realize that when you do enough experiments, you do enough permutations of different chemistries involved in the process.

Q. You understand I'm not asking you about what you worked on at this point during your Ph.D., right?

A. No. But the way you framed that question is, did you work on lipid nanoparticles, right?

Q. So my question is, as a scientific matter, are semiconductor crystal -- nanocrystals a type of lipid nanoparticle?

MR. DANFORD: Objection to form.

A. Repeat that again.

Q. So just as a scientific matter, are

semiconductor nanocrystals a type of lipid nanoparticle?

MR. DANFORD: Same objection.

A. Again, the reason that I'm only addressing that with a semiconductor is because as time goes on, lipid systems have very interesting properties, right, depending on how you assemble them.

So in some sense, yes; and in some sense, no. It depends on the context by which you're putting this through.

Q. Did you work on self-amplifying mRNA during your Ph.D.?

A. Self-amplifying RNA only started to become -- I became more familiar with it around 2010 or 2012, around that time frame.

Q. And in what context did you become familiar with self-amplifying mRNA?

MR. DANFORD: Objection to form.

A. So the broader category of RNA was starting to become relatively popular in the academic field around 2000 to around 2010 or so,

right.

Because it became popular, of course, you start to read about it to just understand what that is, right.

And around 2012, I also became an editor of ACS Nano, and in ACS Nano, I handle papers in the nanomedicine field. So you start to get familiar with the topic as a whole, right.

Q. Why was RNA becoming more popular from 2000 to around 2010?

MR. DANFORD: Objection to form.

A. Because there was -- you know, as you know, there's different journals that are published, and some of the journals that a lot of people read are the "Nature" journals.

And I myself read it from that particular perspective because, you know, you see it in this journal I subscribe. I don't subscribe, but the library subscribes to these journals.

SaRNA is one type of RNA, right. And that was -- there's a number of papers that was published at that time, right. So you start

reading it and then you just get interested -- you just get interested in the topic, right.

Q. So would you agree that -- let me rephrase.

Were there more publications on RNA in scientific journals between 2000 and 2010?

MR. DANFORD: Objection to form.

A. So I cannot comment on that. It's just that, you know, when I'm reading, you're flipping through the journals, you see an article and you say, oh, this is super interesting, and you just read it, right. It just happened that I was flipping through, and this is what was popping up, right.

Q. So you yourself started seeing more articles on RNA in the scientific publications between, like, 2000 and 2010?

MR. DANFORD: Objection to form.

A. Yeah. So "more" is -- I can't say yes or no, right. It's just I flip through and look at what is interesting. Just like when you're watching TV shows. You're flipping through

different TV shows and just, oh, that one sounds interesting. You just watch it, right.

Q. Were there -- what are the developments in RNA research around the 2010 time frame that you can recall?

MR. DANFORD: Objection to form.

A. Can you be more specific?

Q. Sure. I'll rephrase the question.

You said that around -- you said that around, like, the 2012 time frame was when you yourself became interested in RNA research, correct?

A. No. What I said was I started going through journals, right, and I started to notice articles in these journals, and I flipped through and I just thought it was interesting, so I started reading it.

Q. Was there particular research developments that spurred your interest in RNA?

A. I read a lot of papers. I was a new faculty, right, in 2002, and I just liked reading science papers, regardless of whether it's

RNA-based, siRNA.

I spent a lot of time just reading about stem cells at that time, right. It doesn't mean I work in stem cells in some sense, but I just read it because it's an interesting topic.

Q. So have you yourself conducted any research into self-amplifying mRNA?

A. So, again, it's more of a research topic that I'm interested in, right.

Q. Can you identify any papers you've published on self-amplifying mRNA?

A. I have not -- I do not have papers on saRNA.

Q. Have you ever worked on self-amplifying mRNA in the laboratory?

MR. DANFORD: Objection to form.

A. Again, so can you clarify what that means?

Q. Sure. So, presumably, you have a laboratory at University of Toronto, right?

A. Yup.

Q. Have you ever performed any experiments

on self-amplifying mRNA in that laboratory?

MR. DANFORD: Objection to form.

A. Again, we spend a lot of time doing work in my lab with nucleic acids, right.

Q. Well, have you ever synthesized self-amplifying mRNA?

A. I don't think anyone nowadays synthesizes. You buy from companies, right.

Q. Have you ever purchased self-amplifying mRNA in your lab?

A. So we've purchase RNA. Well, let me clarify. We purchase nucleic acids, right. We purchase a lot of nucleic acids, right.

Q. Have you ever purchased self-amplifying mRNA?

A. Again, we purchase a lot of nucleic acids, right. The reason that I'm not asking -- there's a lot about diagnostic, there is also amplification processes in these things, right.

Q. I'm not sure I got an answer to my question.

Do you ever recall an incidence in which

your laboratory purchased or synthesized self-amplifying mRNA?

MR. DANFORD: Objection to form.

A. Okay. Can you define for you -- like, what you mean by "saRNA"?

Q. Sure. Well, how do you define saRNA?

A. For me, it is -- it's a type of RNA, right, that -- well, actually, let me go backward.

In this context, there's one definition. There's also RNA that you amplify, right. You amplify outside. Structurally, it's not the same, right. So in a lot of our diagnostic systems that we work on, we actually amplify the nucleic acid, right.

Q. So is your definition of saRNA any type of RNA that can be amplified?

MR. DANFORD: Objection to form.

A. No. In this case, it's specific, but the way you asked the question, right, it's like the specificity is not clear for me to be able to answer that question, right.

Q. What is your --
A. You have to provide me with greater context before I can start to answer that.
Q. What is your understanding of saRNA as it relates to this case -- well, let me rephrase actually.
You used that term "saRNA" in your declaration, right?
A. Yes.
Q. What did you understand that term to mean when you used it in your declaration?
A. Again, it's -- within the declaration, I defined saRNA here. But, again, it's like how you ask the question in that context, right.
On page 8 for you of the declaration --
Q. Yes.
A. So, again, paragraph 199, it says, "Self-amplifying RNA includes a genetically engineered replicon derived from a self-replicating single-stranded RNA virus.
"The self-amplifying RNA translates to produce a viral replicase, which then amplifies

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 42 of 375

the administered saRNA and produces new transcripts in the cell.

"Beyond these amplified replicases of the original saRNA, the replicase also produce as subgenomic RNA. The subgenomic RNA, smaller than the self-amplifying RNA, encodes for the antigenic protein of interest."

Q. So applying that definition of saRNA, have you ever synthesized saRNA in your laboratory?

A. I do not synthesize RNA in my laboratory.

Q. Have you ever purchased saRNA in your laboratory?

A. I have purchased isothermal amplification systems for nucleic acid.

Q. So you've never actually purchased saRNA directly in your laboratory, correct?

A. I have purchased amplification kits, right, for isothermal application of nucleic acids.

Q. So those are to amplify RNA that is not

self-amplifying, correct?

A. They are amplification kits, right. And I can't tell you what is in the formulation there with the application kits because those are priority -- they're private to the company, right.

Q. You would agree that an amplification kit is not the RNA itself, correct?

MR. DANFORD: Object to form.

A. Again, it's in the kit. I can't tell you exactly what is in the kit that we purchase from. But it is -- the purpose of these kits that we purchase is to amplify the nucleic acids. And a lot of these kits are proprietary.

Q. So you don't know what is in the kits?

A. We know the amplification product. We know that it amplifies the nucleic acid product.

Q. Have you published any papers on the mechanism by which self-amplifying mRNA expresses a protein?

MR. DANFORD: Objection to form.

A. Again, we buy the amplification kits

and we present the results of the amplification in our papers.

Q. Have you ever published any papers, recent, discussing research on the mechanism by which self-amplifying mRNA expresses a protein?

MR. DANFORD: Objection to form.

A. Again, as I said, we buy the amplification kits, and we present what we can in these particular papers in terms of the amplification kits.

Q. Have you ever conducted any research specifically directed to the difference between self-amplifying mRNA and nonself-amplifying mRNA?

MR. DANFORD: Objection to form.

A. Can you repeat that question?

Q. Sure. Have you conducted any research specifically directed to the difference between self-amplifying RNA and nonself-amplifying mRNA?

MR. DANFORD: Objection to form.

A. As I mentioned, right, we buy these amplification kits for nucleic acids and we have also worked with nonamplified nucleic acids.

Q. So setting aside the amplification kits, have you ever conducted any research specifically directed towards self-amplifying mRNA?

A. As I said, we buy these kits for the amplification purpose, right.

Q. Understood. Setting aside those kits, can you identify any other research that -- let me rephrase.

Setting aside the kits, have you conducted any research that is specifically directed towards self-amplifying mRNA?

MR. DANFORD: Objection to form.

A. Of course, we buy the amplification kits, but we also do other kind of optimization experiments in the lab, right.

Q. Can you identify any papers that you contend to be specifically directed towards self-amplifying mRNA in your CV?

MR. DANFORD: Objection to form.

A. As I said, we essentially work on amplification of nucleic acids, right. And I can

identify the papers where we use amplification as part of our diagnostics, right.

Q. Can you identify any papers, sitting here today, in your CV that are specifically directed to your research -- let me rephrase.

Can you identify any papers in your CV that are specifically directed towards self-amplifying mRNA?

A. As I said, like, we essentially can identify papers where we use an amplification of nucleic acid, right.

Q. Can you identify those papers for me?

A. Yeah. One is number 73. And the diagnostics one that is also in the other -- sorry, it's been a while since I looked at my CV carefully.

I would actually have to pull out my papers because some of the diagnostics used amplification and some didn't. But that one, definitely.

We start playing around with amplification in reference 5 for you, the Chen, et al., paper.

Again, we used a certain amplification for reference 56. And I need to look at reference 64 carefully.

Q. All right.

A. Okay.

Q. Just to -- so I understand, when you say "amplification" in this context, what exactly do you mean?

A. It's a way to either increase the signal or increase the number of nucleic acid product in solution.

Q. And how do you increase the number of nucleic acid products in solution?

A. Again, one of the ways we do that is by -- is by buying these isothermal amplification kits. That's one way. The other way is to create what are called DNAzymes.

Q. And how did the isothermal amplification kits increase the number of nucleic acids in products in solution?

A. The isothermal, they have enzymes in them, and then the enzymes increase the number of

products. It's, in some sense, like a PCR, right.

Q. And the DNA enzymes that you're referring to, is that only -- let me rephrase.

Are the DNA enzymes that you're referring to used to amplify DNA?

A. Again, it's a nucleic acid enzyme system, right. It just happens this one has the DNA structure, right. It's a way to amplify the number of nucleic acid in solution.

Q. When you say "in solution," that occurs outside of the cell, correct?

A. People could use this inside or outside the cells, right.

Q. The amplification kits and the DNA enzymes that you're referring to, those don't involve mRNA that encodes for a replicase, correct?

MR. DANFORD: Objection to form.

A. Well, they involve enzymes, right. For amplifications to occur in all these cases, there's an enzyme component to it, right.

Q. Is there mRNA that encodes for a replicase in either the amplification kit or the DNA enzymes that you're referring to?

A. Can you repeat that question again?

Q. Sure. Is there mRNA that encodes for a replicase in either the amplification kit or the DNA enzymes that you're referring to?

A. Can you ask the question a different way?

Q. What don't you understand about it?

A. Well, because some of these kits have certain properties associated with them, right.

Q. Sure. Do the amplification kits that you're referring to contain mRNA that encodes a replicase?

MR. DANFORD: Objection to form.

A. Again, they contain enzymes, right. And you have a nucleic acid. The enzyme works by interacting with the nucleic acid in some ways, right.

Q. So the kits come with the enzymes in them already?

A. I believe so.
Q. Can you identify -- can you identify any papers that you've published in which you develop a novel lipid nanoparticle?
MR. DANFORD: Objection to form.
A. What do you mean by "novel"?
Q. Have you ever developed a new lipid nanoparticle formulation in your lab?
MR. DANFORD: Objection to form.
A. Again, can you be more specific what that means?
Q. Do you know what a lipid nanoparticle is?
A. Yes.
Q. Okay. Do you know what I mean by "lipid nanoparticle formulation"?
A. Yes. But the word that you should -- I would like for you to clarify, what does "novelty" mean. Novelty means a lot of different things in the context of science, right.
Q. Have you ever synthesized a lipid nanoparticle in your lab?

A. My lab synthesizes lipid nanoparticle systems.

Q. Have you ever synthesized a lipid nanoparticle in your lab that, to your knowledge, has not been published or described before?

MR. DANFORD: Objection to form.

A. Again, my lab works with all types of nanoparticles, which includes lipid nanoparticles.

Q. So to the best of your -- so sitting here today, you're not able to identify any lipid nanoparticle that you developed in your lab that has not been published or described before?

MR. DANFORD: Objection to form.

A. The reason I don't really understand this question, right, because it's a very general question that you're asking me, right.

So I can say my lab works -- has made lipid nanoparticles. The -- and this is -- you know, you can see it in some papers where we use lipid nanoparticles, as an example nanoparticle, out of many different types of nanoparticles we work

with.

Q. Can you identify the papers that reflect your work on lipid nanoparticles?

A. So you can look at paper 101. You can look at paper 122. The other one I can't find here.

There's also the base particle, the paper -- 94. There's a few other ones, but those ones will give you a sense of what we've done with lipid-based nanosystems.

Q. Can you identify any paper where you've synthesized -- well, let me rephrase.

With respect to lipid-based nanosystems, are you using that term more broadly than lipid nanoparticles?

A. Say that again.

Q. Sure. Let me rephrase the question.

Does lipid-based nanosystem encompass more types of delivery vehicles than just lipid nanoparticles?

MR. DANFORD: Objection to form.

A. Yeah. So I also like the term

"lipid-based nanosystems," right, because we've made anywhere from lipid nanoparticles to liposomes to other category of lipid-based system, right.

Whether we published it or not, we worked with these systems as part of the entire nanoparticle systems that we have dealt with in Toronto for the last 20 years, right.

Q. Dr. Chan, I'm going to ask you to sort of set your declaration and the '600 patent just sort of to the side because we're going to be referring to them throughout the deposition, as you can imagine, but I'm going to introduce another exhibit here, which is Exhibit 1009.

(Previously marked Exhibit 1009 incorporated by reference.)

BY MR. LIU:

Q. And, Dr. Chan, do you recognize Exhibit 1009 in front of you as U.S. Patent Application Publication No. 2013/0266640?

A. Yes. It's -- U.S. 2013/0266640. The Schrum, et al., inventorship.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 54 of 375

Q. Do you recognize this as the reference referred to as Schrum in your declaration?
A. Yes.
Q. And you have reviewed this document before preparing your declaration, correct?
A. Yes.
Q. Do you understand -- can we just refer to this as the Schrum reference throughout this deposition?
A. Yes.
Q. You understand the Schrum reference is a Moderna patent application, right?
A. It says here "Moderna Therapeutics."
Q. Do you understand Moderna is a company that's focused on developing mRNA therapeutics -- let me rephrase.
Do you understand Moderna is a company that is focused on mRNA?
MR. DANFORD: Objection to form.
A. Moderna is a pharmaceutical company. That's my understanding.
Q. Do you have any understanding of what

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 55 of 375

their research focus is?

A. I really did not until COVID.

Q. What is your current understanding of what Moderna's research focus is?

A. Moderna is a pharmaceutical company.

Q. So you don't know if they're focused on mRNA technology?

A. The fact they had a vaccine, right, you know what is in there. But to me, Moderna is a pharmaceutical company, right. It's part of all the pharmaceutical companies that are out there.

Q. In your view -- well, let me rephrase.

So I think we've established this, but you reviewed Schrum in preparation for both your declaration and your deposition today, right?

A. Yes. I read through the patent.

Q. In your view, does Schrum disclose an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection.

A. So when I actually read this -- let me just go through.

So when I actually read through this

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 56 of 375

particular patent the first time, and even all the subsequent times afterwards, right -- I just want to go to the first page -- I had a certain impression of this particular -- this particular patent, right.

And my impression of this patent is actually a polymer PLGA nanoparticle, microparticle patent, right, that was focused on protein replacement therapy.

Q. So you understand my question is not what the patent is focused on, right?

A. I understand, right, but I'm just telling you, like, as a POSA, right, in this area, when I look at this particular patent, I am -- to me, it is a polymer -- PLGA polymer patent with little sprinkles of different things inside. But I would not look at these other things, right.

Q. Does Schrum, in your view, describe an mRNA vaccine against betacoronavirus?

A. The Schrum patent is focused on a controlled-release particle system or gel system

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 57 of 375

for protein replacement.

Q. So yes or no, does it describe an mRNA vaccine against betacoronavirus?

A. No. I'm just telling you what my impression of this particular patent is, right.

Q. I'm not asking you for what the overall impression is.

Does it contain a written disclosure of an mRNA vaccine against betacoronavirus?

A. Okay. If you can ask me that question -- can you define where within that framework does it provide this.

Q. So based on your review, is it your opinion that Schrum provides a written disclosure of an mRNA vaccine against betacoronavirus?

A. No. Schrum, to me, is a controlled-release particle patent that's for protein replacement.

Q. What information would need to be in Schrum in order for it to adequately describe an mRNA vaccine against betacoronavirus?

A. Well, it would probably need to have a

focus, the patent, on that particular topic, right. If it doesn't, it needs to relate to what it's trying to say, right.

The patent itself, if you just even go through the first page, right, it's on section -- the second part of page 5, as a delivery person, I'm reading this section, and this section says, "The formulations may be, but is not limited to, nanoparticles, polylactic-co-glycolic acid (PLGA), microspheres, lipidoids, lipoplexes, liposomes, polymers, carbohydrates, cationic lipids, fibrin gel, fibrin hydrogel, fibrin glue, fibrin sealant, fibrinogen, thrombin, rapidly eliminated lipid nanoparticle and combinations thereof."

And so if you continue to read it, it then starts to emphasize the PLGA component, after a long list of chemistry and then it really goes through lots of description of PLGA systems. That is on page 7 marked here, but it's 3 of the patent.

And then if you start to go through the

claims, it also focuses a lot on PLGA, right.

Q. Dr. Chan, is it your testimony today that in order for a patent application to adequately describe an mRNA vaccine against betacoronavirus, it would have to focus on an mRNA vaccine against betacoronavirus?

A. No. What I'm saying is that the context of the patent, right, as I read it, is a PLGA patent.

Q. So if the patent is not describing an mRNA vaccine against Beta- -- let me rephrase.

If the patent doesn't have an example of an mRNA vaccine against betacoronavirus, is it your opinion that the patent application doesn't adequately describe that vaccine?

MR. DANFORD: Objection to form.

A. No. What I'm saying without reading a patent, you have to understand the context of the patent, right. And the patent tells you what it's about.

And when I'm reading this patent, it's telling me about controlled-release,

particle-based system, it could be nano or micro, that is involved for protein replacement therapy.

Q. So are the opinions that you render in your declaration based on what you consider to be the focus of this patent application?

MR. DANFORD: Objection to form.

A. Well, when you read it, you have to understand what the patent is about, right. And when I read this patent, it is a PLGA sustained-release protein replacement therapy patent, right.

Q. Did you analyze any of the disclosure in Schrum that was not related to the PLGA embodiments?

A. Yes.

Q. And in those sections, is it your opinion that Schrum discloses an LNP encapsulating an mRNA vaccine against betacoronavirus?

A. So when I did the analysis beyond the PLGA, the next focus for me was about the fibrin. And they talk about gels a lot. I don't know how

many pages. I mean, I can sit there and identify all the pages about the fibrin gel system; right. And that is essentially the focus.

And then as a researcher, when you're looking at these particular topics, the polymer, the fibrin, they have a commonality associated with it, right.

Q. Dr. Chan, does Schrum disclose embodiments involving a lipid nanoparticle?

A. But what I'm trying to tell you is that when I read this, the contextual nature of this is in those two particular areas.

Q. Dr. Chan, does Schrum disclose examples using a lipid nanoparticle?

A. As I keep on saying, the context of this, as I'm going through this, is really a polymer-based --

Q. It's a yes or no question. Are there examples --

A. No.

Q. -- about lipid nanoparticles?

A. Nothing as simple as yes or no. It's

contextual. If I'm putting myself as an expert at that particular time and you're giving me this patent to read, that is essentially how I'm interpreting this particular patent, right.

It's a controlled-release system that is for protein replacement therapy. And it explicitly discusses the PLGA particle system, which is a polymer-based system. It also explicitly describes the fibrin system within this context, right.

Q. Dr. Chan, is it your testimony under oath before the PTAB that you cannot answer whether or not there are specific examples about lipid nanoparticles in Schrum?

MR. DANFORD: Objection to form.

A. No. I'm not saying that I cannot. I'm just saying that this is the contextual nature when I'm reading this, right.

You cannot -- what I'm saying is you cannot -- what I'm trying to tell you is whenever I read anything, it's always about the context, right. And you have to look at the context to

understand what this thing is about.

Q. Is it -- are you able to answer yes or no, are there examples of lipid nanoparticles in Schrum?

A. No. I'm answering your question based on the contextual nature of my understanding of the patent that's presented to me, right.

Q. So you're not able to answer yes or no to that question?

MR. DANFORD: Objection to form.

A. It is contextual nature of what is presented to me.

Q. Are there examples of lipid nanoparticles in Schrum?

A. There are contextual -- I'm providing an answer for you based on the contextual nature of what is the main focus of this particular patent, right.

The main focus of this particular patent is the polymer, fibrin, controlled-release system and for protein replacement therapy.

Q. Let's try this one more time. It's a

yes or no question. Are there examples of lipid nanoparticles in Schrum?

A. I'm explaining to you that -- what my interpretation of this particular patent is, right.

Q. Does Schrum disclose lipid nanoparticles encapsulating mRNA for a vaccine against the betacoronavirus?

A. The Schrum patent, as I mentioned, is focused on controlled-release systems, PLGA, fibrin and probably some of the other ones they listed, and they listed a ton of them, for protein replacement therapy.

Q. And so because it's focused on protein replacement therapy, is it your opinion that it does not describe a mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. No. I did not say that. What I'm trying to tell you is what this patent is about, right. If you ask me to write a thesis on this patent, that's essentially what I would write

about.

Q. So is it your opinion that this focus on what the patent -- so is your opinion as expressed in your declaration focused on what the patent is as a whole?

A. It is focused on the contextual nature of the patent, right.

Q. And so you didn't analyze the specific examples in the patent?

A. Again, when you read any kind of document, you understand what the document is about and then you focus on that and you also look in the details of things, but you essentially have to look at the contextual nature of what is presented to you.

Because if you don't do that, then you write -- any kind of document, this is -- I tell my students this all the time, you write things that are not relevant to what is really the main point of what is presented to you.

Q. So for a patent application to describe an mRNA vaccine against betacoronavirus, would

the patent application need to provide information about the S protein antigen?

MR. DANFORD: Objection to form.

A. Again, I have to read the patent that is presented to me to make that conclusion. You're asking me a generality at this particular point, right.

Q. For a patent application to describe an mRNA vaccine against betacoronavirus, would it need to describe an LNP formulation that is specifically designed for a vaccine?

MR. DANFORD: Objection to form.

A. Again, you're asking me to speculate, right. Unless you present me a specific document with specific examples to ask me to comment on it, and based on how it's written, that is essentially how I can comment.

Q. Well, does Schrum disclose any LNPs at all?

A. I mean, Schrum mentions lipid nanoparticles somewhere, but, again, it's a PLGA controlled-release patent, right. A fibrin

patent.

Q. Let's take a look at examples 16 and 17 in Schrum. Can you turn to page 135.

A. 135.

Q. Excuse me. Page 134.

A. 134. It says example 12.

Q. So on page 134 -- oh, I'm sorry. We should be -- are you looking at the page that says 134 out of 202 --

A. Out of 202, yeah.

Q. Can you turn to -- if you're looking at those page numbers -- well, let's do this, to be clear. Can we go to paragraph 995.

A. 995. Okay.

Q. Do you see on top of paragraph 995, it says, "Lipid Nanoparticle In Vivo Studies"?

A. Okay.

Q. And you would agree that example 16 discloses lipid nanoparticles, correct?

A. Well, it uses the words "lipid nanoparticle" in the title, right.

Q. You agree that example 16 discloses

formulations of lipid nanoparticles, correct?

A. Let me take a look at this again.

Okay. So we're referring to 995, right?

Q. Correct.

A. So 995 uses the word "Lipid Nanoparticles" in the title. It also, as the description, it says, "Modified mRNA were formulated as lipid nanoparticles using the syringe pump method. The lipid nanoparticles were formulated at a 20:1 ratio of total lipid to modified mRNA with a final lipid molar ratio of" -- whatever that number is.

Formulation listed in Table 27. Are we reading that differently? That's actually characteristics.

Were characterized by particle size --

THE COURT REPORTER: I'm sorry. I can't hear.

A. Oh, sorry. I just said it has formulations listed in Table 27 that were characterized by particle size, zeta potential, and encapsulation.

Q. So you would agree that in example 16, Schrum discloses lipid nanoparticles, correct?

A. Well, it lists the name lipid nanoparticles, right?

Q. And it describes a formulation that it contends to be a lipid nanoparticle, correct?

A. Well, it provides a molar ratio of the components of the final lipid molar ratio that is presented here.

Q. And so if you take a look at example 17, starting on paragraph 1000, as well as example 18, starting on paragraph 1002, you would agree that Schrum also discloses experiments using the lipid nanoparticles, correct?

A. In example -- what did you say, example 17 and --

Q. Example 18.

A. Let me take a look.

Okay. So 17. And the other one was 18?

Q. Correct.

A. Okay. What is your question?

Q. So do you agree that examples 17 and 18

describe examples using lipid nanoparticles?

A. It explains the lipid nanoparticles for protein replacement therapy.

Q. And if we go back to paragraph 995, do you contend that this disclosure describes a lipid nanoparticle?

A. Again, according to the writing, it mentions the word "lipid nanoparticle." It tells you about the composition of the lipid nanoparticle to have a molar ratio of 50, 10, 38.5, and 1.5. And then it characterized the particles after they synthesized it.

Q. Do you have any reason to believe -- to disagree with Schrum's characterization of the formulation in paragraph 995 as a lipid nanoparticle?

A. Again, the -- it writes out as lipid nanoparticles were formulated at a 20:1 ratio of total lipid to modified mRNA with a final lipid molar ratio.

So I'm just reading it directly at hand, what they describe as their final

characterization. And what they essentially described in the table is a characteristic of that formulation that is presented, right.

Q. Do you consider yourself an expert in the formulation of lipid nanoparticles?

A. If I'm looking at myself as a POSA, I would have an understanding of how to make lipid nanoparticles with the formulation at hand.

Q. Sorry. I'm not sure I understood that.

Do you consider yourself an expert in the formulation of lipid nanoparticles?

A. Again, if this formulation was presented to me, I can make this formulation.

Q. And if you made that formulation, would -- in your opinion, would it result in what you would consider a lipid nanoparticle?

A. Well, I have to make the formulation to see, right. Because you're asking me -- this is a two-sentence description, based on the characteristics of the lipid nanoparticle. And, again, it indicates that lipid nanoparticles were formulated at a 20:1 ratio of total lipid to

modified mRNA with a final lipid molar ratio of whatever, right.

So as a researcher, I would have -- I would then test that out, right.

Q. So do you have any reason to believe that example 16 would result in anything other than a lipid nanoparticle, sitting here today?

A. I can only judge based on what is written, right. And it describes the lipid nanoparticles were formulated using these weight ratios and these different compositions of the reagents to make the lipid nanoparticle.

The only second evaluation I have is the characteristics of the formulations, and it indicates that it's a modified mRNA for basically proteins, vector 9 and GCF -- G-CSF.

It only indicates the size and the power dispersity of the nanoparticles as well as the zeta potential of the nanoparticles, right.

Q. So let's take a look at examples 17 and 18 again.

Okay. Did you describe these -- let me

rephrase.

So is it right to describe examples 17 and 18 as the use of lipid nanoparticles for protein replacement therapy?

A. So according to what is written here, it says that lipid nanoparticle formulations shown in Table 31, which is the characteristic from the table that is above, right, were administered to rats intravenously, subcutaneous -- example 17, right.

It says "lipo nano formulations shown in Table 31..." -- so that's the characteristic of the nanoparticles -- "...were administered to rats intravenously, intramuscularly or subcutaneously in a single modified mRNA dose of .05 milligram per kilogram."

Q. So is this a description of what you would consider to be protein replacement therapy?

MR. DANFORD: Objection to form.

A. No. But you continue to read it, right. It says, "The rats were bled at 2 hours, 8 hours, 24 hours, 48 hours, and 96 hours. And

after, they were administered with G-CSF or EPO-modified mRNA formulations to determine protein expression using ELISA."

So they're measuring using ELISA, which is an immunoassay for probably for EPO or for CSF. And if you read the literature section, they describe those particular molecules.

Q. So examples 16 and 17, would you agree that those were directed towards protein replacement therapy?

MR. DANFORD: Objection to form.

A. Again, they indicated for the purpose of GCFF -- G-CSF and EPO, right.

Q. And the generation of G-CSF and EPO would both be for protein replacement therapy, right?

MR. DANFORD: Objection to form.

A. They are, again, specifically producing those particular molecules, right. That's what my interpretation of this is, right.

Q. So, for examples 17 and 18, do you believe that there is a description in example 17

and 18 of an mRNA vaccine?

MR. DANFORD: Objection to form.

A. Again, I can only interpret what I'm reading directly here, which is CSF and EPO. In 18, they continue to say, in example 18 they did a time-course study, and the time-course study states that lipid formulations shown in Table 31 -- again, the characteristics of the nanoparticle that was injected into the animal -- were administered to mice in IPOs of 5 intravenously at a single modified mRNA dose of whatever.

The mice were bled at 8 hours, 24 hours, 72 hours, and 6 days after they were administered with G-CSF or EPO-modified mRNA for formulations to determine protein expression using ELISA.

Again, there's a consistent theme here, which is the G-CSF or EPO.

Q. Dr. Chan, do you contend that examples 16 and 17 would enable a POSA to make an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. Again, I can only read and interpret what is here, right, and again just restate example 16. It states that the LNPs were formulated at a 20:1 ratio of total lipid to modified mRNA with a final lipid molar ratio of whatever it is listed here.

Example 17 then goes on and describes the rat study and, again, here they were administered at different times and they were -- they were administered with G-CSF or EPO-modified mRNA to determine protein expression using ELISA.

And then in example 18, they continued this theme that says mice were bled at 8 hours, 24 hours, 72 hours, and 6 days after they were administered with C -- G-CSF or EPO-modified mRNA formulations to determine protein expression using ELISA.

MR. DANFORD: When you reach a good breaking point, can we take a break? We've been going for a bit.

MR. LIU: Yeah. Why don't we finish this line of questioning.

BY MR. LIU:

Q. Dr. Chan, do you contend that examples 16 and 17 provide enough information for a POSA to make an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. Again, the specific -- I've repeated this a few times now, right? If you read this directly, it's specifically for lipid nanoparticles that has this combination of lipid-molar ratio that's described in example 16.

Example 17 then continues on to describe this as for administered with G-CSF or EPO-modified mRNA.

Example 18 now also continues that theme and talks about it for G-CSF or EPO-modified mRNA, right.

I mean, if you just read it literally, that's essentially what it's saying.

Q. Are you able to answer yes or no to my question?

A. What I'm answering for you is what is written down here and what my interpretation of

what is written down here, right.

Q. You're an expert in -- well, do you contend -- let me rephrase.

I understand what is on the page. Right. I don't dispute what is on the page with you. I'm asking, is that enough information, in your opinion, as an expert to make or use an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. As an expert, and as a scientist, as a researcher, at any level, you read what is given to you and you do what is given to you, right. You do not speculate because if you start to speculate beyond this, you create problems, right.

Here, what I'm trying to tell you is examples 16, 17, 18, that is what is written within this particular context. Here, there's no mention of vaccine. It just mentions G-CSF or EPO. That is the main context of 16, 17 and 18.

Q. So to go from examples 16, 17, and 18 -- let me rephrase.

To go from the disclosure in examples 16, 17, and 18 to an mRNA vaccine, is it your contention that would require speculation?

MR. DANFORD: Objection to form.

A. No. What I'm trying to tell you is this is what I'm reading at this particular point. What I'm saying about speculation is as a researcher, as a POSA at that time, you read what you have and you interpret what is written at that particular point. That's all it is.

Q. You would agree that what is written in examples 16 through 18 with respect to the mRNA vaccines that are disclosed, is that sufficient for a POSA to make an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. So as I said, what these three examples are providing are specifically LNP with the ratio of the reagents with a description of that particular LNP before G-CSF and EPO, right. It doesn't mention a vaccine. It doesn't mention that. That is what is written down, right.

Q. And is that enough information to make an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. As I said, I'm just giving you my interpretation based on what is written down, right. A POSA can only read what is given to them in terms of what is written, right.

Q. And a POSA, based on the description in examples 16, 17 and 18, is it your contention that they would not be able to make an mRNA vaccine based on that information?

MR. DANFORD: Objection to form.

A. I did not say that. What I'm trying to say is this is what is written down here, examples 16, 17 and 18, and I'm interpreting based on what is written down here, which is LNP with a certain molar ratio with reagents that are -- with the surratio reagents for that LNP.

What I'm trying to tell you is that 17 and 18 then describes that formulation for EPO, G-CSF and then it talks about the timeline, right. The mice were bled at 8 hours, 24 hours, 72 hours,

and 6 -- sorry. My eyes are not good. Oh, I'm sure you'll write that down -- and 6 days. That's example 18, right. So the line of sequence of this example 16, 17, 18 is just focused on those particular points.

MR. LIU: We can take a break now.

(A recess was taken.)

BY MR. LIU:

Q. Welcome back, Dr. Chan. Did you speak about the substance of your testimony with counsel during your break?

A. No.

Q. So can you turn to paragraph 83 of your declaration. Sorry, I promise I'll get the citations right before the end of this deposition. I'm actually referring to paragraph 81. Can you turn to paragraph 81 in your declaration?

A. Oh, paragraph 81. Oh, not page 30?

Q. That's right. So do you see in paragraph 81 it says, "Schrum contains only a generic section on vaccines and it does not

provide any working examples combining antigen-encoding mRNA in any specific formulations, let alone an mRNA vaccine formulated in an LNP"?

A. Mm-hmm.

Q. Is it your understanding that for the prior art to teach an mRNA vaccine, it must include a working example of an mRNA vaccine?

MR. DANFORD: Objection to form.

A. Can you repeat that in different ways?

Q. Sure. Is it your understanding for -- that for a prior art reference like Schrum to disclose an mRNA vaccine, it must include a working example of such a vaccine?

MR. DANFORD: Objection to form.

A. I'm just trying to figure out the framing of your sentence, right. Can you say it a different way again?

Q. Sure. So in paragraph 81, you say that Schrum doesn't provide any working examples, right?

A. According to what I wrote on

paragraph 81, it does not provide any working examples.

Q. So my question is: In order for Schrum to have disclosed an mRNA vaccine, is it your opinion that Schrum needed to include a working example of such a vaccine?

A. So I actually, when I referred back to the beginning of that -- that paragraph, right, which is "Schrum contains only a generic section on vaccines," the reason I wrote that at the beginning is to refer back to what I was saying earlier, right.

Because the Schrum patent emphasized and focused a lot on polymeric nanoparticles or microparticles. They emphasize a lot on fibrin-based -- fibrin-based systems. And because of that, the way they created context, a lot of context within that framework, I looked at the Schrum more from that particular direction.

So now coming to this, because when I was going through it -- and we can all agree it's a very long document. And it gives you the context

of those two particular themes. And it also lists other types of nanoparticle system, right. It was not just the polymer and not just the fibrin. That, to me, is the main emphasis of the Schrum or -- patent.

And then the other stuff that is included in the patent is generic, which is why that term was used, right. It was not explicit in terms of the level of contextual nature that it had for the other two topics, right, or categories.

Q. So when you say "explicit" in terms of the level of contextual nature, is it your opinion that in order for Schrum to disclose an mRNA vaccine, it must include an explicit example of such a vaccine?

A. No.

MR. DANFORD: Objection to form.

A. I did not say that, right. What I was saying is that in the Schrum patent, the contextual -- the feel of the patent, if you want to use that term, is very much a polymer, fibrin controlled-release system, right.

And so when you're reading it from that perspective, that is how the mindset is looking at that particular patent. Although they do use terminologies as you referred to in the examples in the previous questioning about lipid nanoparticles because he explicitly writes it that way. But, again, I would refer to those as a generic -- it provides a generic section on those things.

Q. So aside from the generic disclosure of vaccines, you also criticized Schrum for not providing any working examples combining antigen-encoding mRNA in any specific formulations, correct?

A. So in the declaration, it states that it does not provide any working examples combining antigen-encoding mRNA in any specific formulations.

Q. Did Schrum need to provide such an example, in your opinion, to disclose an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. I'm just stating in terms of what is presented in the Schrum patent, right. And what is presented is that it did not provide any working examples that combines antigen-encoding mRNA in any specific formulations.

Q. I'm just asking if it's your opinion that Schrum needed to provide such examples.

A. No. I'm stating what was stated in the Schrum patent, right.

Q. Did Schrum need to provide an example combining antigen-encoding mRNA in a specific formulation in order to disclose an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. What I'm saying is that when I -- when the declaration -- I put the declaration together, I'm just stating what was in the Schrum patent, right. And what I'm stating here is that it did not provide any working examples combining antigen-encoding mRNA in specific formulations.

Q. I understand it's your opinion that Schrum doesn't have any working examples. My

question is: Is it your opinion that Schrum was required to provide such working examples?

MR. DANFORD: Objection to form.

A. No. What I'm trying to say is this is my sentence here, look at the sentence, is referring to what is or not in the Schrum patent, right. That's it. That's all it was.

Q. So is it your understanding that in order to meet the disclosure requirement of an mRNA vaccine against betacoronavirus, Schrum needed to provide working examples of such a vaccine?

MR. DANFORD: Objection to form.

A. Again, we can break down this sentence further, right -- this section further, right.

Schrum contains only a generic section on vaccines. And within what is written within the patent, it does not provide any working examples combining antigen-encoded mRNA in any specific formulations, let alone an mRNA vaccine formulated in an LNP. So in this sentence or this paragraph, I'm just presenting what is in

here.

Q. So in the next paragraph -- do you see paragraph 82?

A. Yes.

Q. Do you see "Schrum does not teach mRNA encoding of betacoronavirus, S protein or S protein subunit as formulated in a lipid nanoparticle," correct?

A. I see the paragraph that says, "Therefore, Schrum does not teach mRNA encoding a betacoronavirus, S protein or S protein subunit that is formulated in a lipid nanoparticle."

Q. So in your opinion, in order for Schrum to teach an mRNA encoding a betacoronavirus, S protein or S protein subunit as formulated in a lipid nanoparticle, would Schrum have to provide a specific example of such an mRNA encoding a betacoronavirus, S protein or S protein subunit as formulated in the lipid nanoparticle?

MR. DANFORD: Objection to form.

A. So when I wrote this sentence, again, I'm giving you my contextual nature of what is in

the Schrum patent, right.

I know I've repeated this a bunch of times already. The contextual nature, as I'm reading the Schrum patent, is really, it's a PLGA particle, I'm not going to define it as nano or microparticle, fibrin and protein replacement therapy. That is the theme.

So when I'm reading through that particular patent, that is what is indicated in this particular patent to me.

Q. So in paragraph 82, you contend that Schrum does not teach mRNA encoding a betacoronavirus, S protein or S protein subunit as formulated in an LNP, correct?

A. So in the paragraph I wrote, "Therefore, Schrum does not teach mRNA encoding a betacoronavirus, S protein or S protein subunit that's formulated in a lipid nanoparticle," and that statement is based on my contextual interpretation of the Schrum patent, right.

My contextual interpretation of the patent is really that it's a protein replacement therapy

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 90 of 375

patent that is focused on a PLGA controlled-release system, fibrin, and it lists a bunch of different nanoparticle formulations and it mentions lipid nanoparticles. But it has headings that's in there that you've already indicated where in the patent that had the term "lipid nanoparticle" in there.

Q. So you used the term "contextual interpretation" of the patent a number of times during this deposition. What do you mean by "contextual interpretation"?

A. So for myself, when I read, for example, a book on whatever, right, when I read the book, the -- whatever is written down, that's telling me what is happening, right.

I don't make assumptions. I don't do -- I don't speculate. I don't do other stuff. I actually look at what is written down.

In the Schrum patent, when I'm going through it, I'm reading what the inventors are telling me what they're doing. And that's it. I can only interpret what they are writing and what they

specifically put in place, right.

And the things that -- you don't assume more than that. And when you look at what's written, the theme, the framework of what they're trying to say, it's written by the word of the inventors in this case, in the book example, it's written by the author. And then you just go through it from that perspective, right.

Q. You used the term "the theme" and "the framework" of what they're trying to say.

How did the theme and the framework of the Schrum application impact your opinion with respect to that application?

MR. DANFORD: Objection to form.

A. Okay. So when I read this invention, I take a look at the summaries, right. The Summary of the Invention, right. So let's start with that, right.

So usually in terms of writing these the way I do it is that you sort of bring in a little bit of a big picture, and they kind of do it in the Summary of the Invention.

The Summary of Invention states, "The present disclosure" -- I'm on page 5 of 202, left paragraph, paragraph 4.

It says, "The present disclosure provides, inter alia, formulation, composition comprising, modified nucleic acid molecules which may encode the protein, a protein precursor or a partially or fully processed form of the protein or a protein precursor. The formulation composition may further include a modified nucleic acid molecule and delivery agent.

"The present invention further provides nucleic acid useful for encoding polypeptides capable of modulating a cell's function and/or activity."

So when I read that, it gives a sort of a broader framework, right that it's -- this particular patent involves nucleic acids, encoding a protein, a protein precursor or a fully processed form of protein or protein precursor, right.

So then it sort of describes that part. But

then in the next paragraph, it now lists what these things are, right. And that essentially gives me a framework of the different types of delivery agent.

So in one aspect, a method of producing a polypeptide of interest in a mammalian cell or tissue is described. The method comprises contacting the mammalian cell or tissue with a formulation comprising a modified mRNA encoding a polypeptide of interest.

So the formulation may be, but is not limited to, nanoparticles, poly (lactic-co-glycolic acid), microspheres, lipidoids, lipoplexes, liposomes, polymers, carbohydrates, including simple sugars, cationic lipids, fibrin gel, fibrin hydrogel, fibrin glue, fibrin sealant, fibrinogen, thrombin, rapidly eliminated lipid nanoparticles and a combination thereof.

So, again, it lists a lot of different kinds of delivery agents. And so as you continue to read -- read this through, then what ends up

happening is then it starts to go through a very long section focused on PLGA systems. And then it continues on to really describe the PLGA systems along the way, right. So that's --

Q. So, Dr. Chan, did you look at paragraph 7 -- sorry, 6, 7, 8, of the summary?

A. Yes. I did.

Q. You would agree that those relate to lipid nanoparticles, correct?

MR. DANFORD: Objection to form.

A. It says in one embodiment, that is one type within that framework, the formulation comprising the modified mRNA is a nanoparticle which may comprise at least one lipid, the lipid may be selected from, but it's not limited to, whatever the case. There's a bunch of lists.

In another aspect, the lipid may be a cationic lipid, such as, but not limited to, the following. The lipid to modify mRNA ration in the -- ratio, that's a typo -- ratio in the formulation may be between .10 to 1 and 30 to 10. The mean size of this is -- whatever, right.

In section -- paragraph 8, it then describes the formulation of modified mRNA may comprise a fusogenic lipid, cholesterol, and so on.

So when I look at this whole section, it was just a listing of all different possibilities of everything that can be used to fit in with the general description in paragraph 4.

Q. So, Dr. Chan --

A. Yes.

Q. -- earlier again you had sort of used the term "contextual interpretation" of a patent during this deposition. Correct?

A. Yeah.

Q. Was that the standard that you were told to apply when you were -- in interpreting the Schrum application?

A. Nobody tells me to look at this from contextual. This is just from what I find as a normal human being in terms of trying to understand what you're reading. You have to understand the big picture. Then a lot of time when you understand the big picture, there's a

long list of stuff. When you look at the long list of stuff, you pay attention, but you don't fully pay attention.

What I mean by that is, when it's a long laundry list of stuff, you understand what the meaning of that is, but it's just a list of stuff.

Then what happens if you continue to write, you go and you write to create more description of things that you really want the reader to focus on, right.

And they have so much description about PLGA and polyglycolic acid. That was afterwards. We can go through it, if you like, in terms of the length. It's not just the description. It describes the function. It describes the advantage of the PLGA. It explains why I would want to use PLGA.

So once it starts to go into that category, it starts to frame what this -- you know, a big aspect of this particular patent.

Q. Sure. Dr. Chan, I just want to

understand how you reviewed this patent. You said that there's a long laundry list of stuff --

A. Yes.

Q. -- in the patent, right?

A. Yes.

Q. Okay. And then of that long laundry list of stuff, you contend that the patent focuses on certain delivery mechanisms, right?

A. No. The patent then continues and further describes the PLGA system. Again, there's sections here for that. It further describes the fibrin section.

Q. Was your opinion focused on those sections of the Schrum application?

MR. DANFORD: Objection to form.

A. No. I read the entire application, but, again, when you're essentially looking at what is presented here, as you start reading it, there are lots of paragraphs that describe aspects of a lot of aspects of the polymer-based system. It then provides aspects of the fibrin system. That essentially is where a lot of it

is. Then you understand the contextual nature of the other components, right.

Q. So, Dr. Chan, let's take a look at paragraph 340 of Schrum.

A. 340 of Schrum. Okay.

Q. So starting at paragraph 340, do you see there's a section header that says, "Activation of the Immune Response Vaccines"?

A. Okay.

Q. Do you see that?

A. Yes.

Q. So you would agree that from paragraphs 340 to paragraph 350, Schrum is discussing vaccines, correct?

A. He has the word "vaccine" in the title.

Q. And the section discusses vaccine applications of mRNA, correct?

A. Can you repeat the question.

Q. Sure. You would agree that under the subheading "Activation of the Immune Response Vaccines," Schrum is discussing vaccine applications of mRNA, correct?

A. Well, I mean, in the paragraph 340, it says, "In one embodiment of the present invention, mRNA molecules may be used to elicit or provoke an immune response in an organism."

Q. So when Schrum discusses the use of mRNA to elicit or provoke an immune response, it's referring to a vaccine, correct?

A. Again, it says it's eliciting or provoking an immune response of an organism.

Q. Would you agree that that is referring to a vaccine application for an mRNA?

A. Well, I'm reading it at hand, right. So...

Q. Do you agree that when Schrum says, "the use of mRNA to elicit or provoke an immune response in an organism," that that is referring to a vaccine?

A. Again, I'm just reading what is written down here, right. The embodiment of -- "in one embodiment of the present invention, mRNA molecules may be used to elicit or provoke an immune response in an organism."

Q. What does that sentence mean to you?
A. It provokes an immune response in an organism.
Q. Would you agree that that refers to a vaccine?
A. It says it provokes an immune response in an organism.
Q. Do you agree that the purpose of a vaccine is to provoke an immune response in an organism?
MR. DANFORD: Objection to form.
A. Again, it says "elicit or provoke an immune response in an organism," right?
Q. Do you agree that the purpose of a vaccine is to provoke an immune response?
MR. DANFORD: Objection to form.
A. So, again, I'm just reading what is presented here. I'm trying to read the other section. In certain embodiment, the activating molecules contain a translatable region which encodes for a polypeptide sequence useful as a vaccine, right?

Q. Dr. Chan, respectfully, you're not answering my question.

Setting aside what the application says, do you agree that a vaccine is something that elicits or provokes an immune response?

A. Again, what I'm just trying to tell you is what I'm reading here. Even, like, these interpretations, which is what you're trying to get me to indicate, I can only present what is written in this particular -- in this particular section, right, that you're referring to, right?

Q. Dr. Chan, do you know what a vaccine is?

A. I know what a vaccine does, but the specifics of the mechanism, the details, that is not my area of expertise, right.

My area of expertise is focused on the delivery system. And that's one part. The second part of my expertise is to be able to -- it's how the engineers do these things, which is you measure the outcome of it, right.

Q. Dr. Chan, it is a yes or no question.

Do you know what a vaccine is?

A. No. I'm just trying to tell you from an engineer's perspective what we know, right.

Q. I understand. Do you know what a vaccine is?

A. I know generally what a vaccine is.

Q. Do you agree that the purpose of a vaccine is to elicit or provoke an immune response?

MR. DANFORD: Objection to form.

A. Again, I'm just telling you what I'm reading here, right, in terms of this, right.

Q. Do you agree that the purpose of a vaccine is to elicit or provoke an immune response?

MR. DANFORD: Same objection.

A. What I'm telling you is that I know generally what a vaccine does.

Q. Okay. And, in general, does a vaccine elicit or provoke an immune response?

MR. DANFORD: Objection.

A. Again, I'm reading what is here, right,

which is that the invention, mRNA molecule may be used to elicit or provoke an immune response, right. And you're trying to link that terminology to a vaccine, right.

And what I'm telling you is that I can interpret what that is here, right. And when you ask me what a vaccine is, it's very broad, right, in that sense, right. And depending on what your education, background, what you're focused on, that is a different framework, unless you can narrow down what that means.

Q. Dr. Chan, what does a vaccine do?

A. Well, it provides a protective mechanism, right.

Q. How does it provide a protective mechanism?

A. Okay. So that's the part -- immunology part. So when I do analysis, when I interpret any kind of nanoparticle delivery system, right, if it's a functional-based delivery system, which is a -- design a particle delivery system for a certain intended medical purpose, what you do is

measure the outcome, right. And the outcome indicates whether your formulation works or not. That's what the delivery side works on, right.

Q. Dr. Chan, do you know how a vaccine provides a protective mechanism?

MR. DANFORD: Objection to form.

A. Again, what I'm telling you is that when I do experiments in a medical use of a nanoparticle, right, you measure the outcome. And then you measure the outcome to indicate whether the particle formulation works or not, right.

Q. It's a yes or no question. Dr. Chan, do you know how a vaccine provides a protective mechanism?

MR. DANFORD: Objection to form.

A. No. I'm trying to explain to you there's lots of different angles to these things, right. Unless you specify more specifically.

Q. How does a vaccine protect someone against disease?

A. Again, what I do is, for example, if

I'm looking at a nanoparticle that tries to elicit immune response, what I do is look at the blood and I measure certain proteins that are being produced from the formulation that you added into the system.

Q. So you said that you're looking at a nanoparticle that's trying to elicit a immune response. Do you agree a vaccine protects against disease by eliciting an immune response?

A. No. What I'm saying is that when you inject a nanoparticle into the system and the system is the host, to see if that delivery system elicits the function that you want, you remove certain fluid or you look at cells and you measure for certain markers of that.

Q. Do you agree that a vaccine protects against disease by eliciting an immune response?

A. Can you say that a different way?

Q. Do you agree that a vaccine protects against disease by eliciting an immune response in the host?

MR. DANFORD: Objection to form.

A. Can you say that a different way?
Q. What don't you understand about the question?
A. Because it's very broad.
Q. How does a vaccine protect against disease?
A. But "how" is also broad.
Q. So you're unable to answer the question of how a vaccine protects against disease.
A. No. I'm saying that you're asking, like, a general question, right. And what I'm trying to tell you is that from an engineer's perspective, a person who is developing delivery systems, what we do is very straightforward.
You develop the formulation. You inject it into the host. And then what you do is that you take the biological sample, it could be blood, it could be cells, and then you measure whether your formulation produced what you want.
The clinical side is a different ball game, right, whether the medical function works or not. That's a different side of the equation.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 107 of 375

So in my research program, just -- when I work on sort of multifaceted aspects, I collaborate with people to do multifaceted. But I am working on the delivery and the formulation aspect, right.

Q. So, Dr. Chan, you understand that your testimony in this case is public, right?

A. Yes.

Q. And you understand that's going to be available to your peers in the field, right?

A. Yes.

Q. You've used the word "vaccine" a number of times throughout your declaration, right?

A. Yes.

Q. And you cannot tell me how a vaccine elicits a protective mechanism -- let me rephrase.

Are you able to tell me how a vaccine protects against disease?

A. I'm just trying to tell you that when you essentially do these kind of experiments to test out a medical formulation for a delivery

agent, what you do is you measure the outcome of it, right. And that outcome, a lot of times we collaborate in terms of the interpretation of that outcome of measurement, right.

Q. Would you agree that one of the functions of a vaccine is to elicit an immune response?

MR. DANFORD: Objection to form.

A. Again, a vaccine has a certain purpose, but as the delivery person, which is what I'm focused on, if you ask me the chemistry of things and be specific, I can explain those things to you, right. But the vaccine part is the vaccine particle, right.

Q. Would you agree that one of the purposes of a vaccine is to elicit an immune response?

MR. DANFORD: Objection to form.

A. Again, I am going to say it again, when I do experiments, I make formulations. I measure outcome, right. And if it's used for immune application, and that's one part of the equation,

I collaborate with people who help interpret what that means. And if it's for other kind of clinical application, the same thing. You collaborate with other people for that, right.

But my area of expertise is nanoparticle formulation, nanoparticle design, the delivery aspect of things, and able to measure the outcome of the system you're designing.

Q. So I think I -- so do you not know whether the purpose -- one of the purposes of a vaccine is to elicit an immune response?

MR. DANFORD: Objection to form.

A. You can keep on asking me that, right. But, again, if you provide more specifics...

Q. So you're not able to answer the question of whether one of the purposes of a vaccine is to elicit an immune response?

MR. DANFORD: Objection to form.

A. No. I think your question is very general, right. And I'm asking you to clarify it and to narrow down your question. If you ask me specifically in a case, then we can talk about

that, right.

Q. Does the COVID-19 vaccine elicit an immune response?

A. The COVID-19 infection produced a certain amount of proteins in the blood.

Q. Dr. Chan, I'm not asking about the infection. I'm asking about the vaccine.

Does the COVID-19 vaccine elicit an immune response?

A. What I'm trying to tell you with COVID-19 is that it produced certain blood biomarkers by which people measure. That is my area of expertise.

Q. Does the COVID-19 vaccine elicit an immune response against the betacoronavirus -- let me rephrase. Let's try that again.

Does the COVID-19 vaccine elicit an immune response against SARS-CoV-2?

MR. DANFORD: Objection to form.

A. Again, when I look at the COVID-19, right, the SARS-CoV-2, if you've been infected with it, what we do is we measure the proteins

that your body is responding to the infection.

Q. Do you know whether the COVID-19 vaccine elicits an immune response against SARS-CoV?

MR. DANFORD: Objection to form.

A. Again, we can dance around this many, many times, right. So from an engineering perspective, from a delivery perspective, when we interpret these things, we're interpreting from looking at the biomarkers that are being produced, right. So it's input, output is what we look at.

Q. So in forming the opinions you express in this case, have you considered whether the COVID-19 vaccine elicits an immune response against SARS-CoV-2?

A. As I said, look, you can -- the way I look at COVID-19 is that you have SARS-CoV-2 in the system. There are markers that are produced at the end from that infection.

Q. So, a yes or no question. Have you considered whether the COVID-19 vaccine elicits

an immune response against SARS-CoV-2 in forming the opinions that you have expressed in this proceeding?

MR. DANFORD: Objection to form.

A. Yeah. But, again, what I'm telling you, when I look at SARS-CoV-2, I look at the markers that it generates after the SARS-CoV-2 is in your system.

Q. And does the COVID-19 vaccine elicit an immune response or not against SARS-CoV-2?

A. Again, let me ask you, does it produce the protein biomarkers when you've been infected?

Q. Respectfully, Dr. Chan, I'm the one asking the questions here.

Are you able to answer the question of whether or not the SARS-CoV-2 vaccine elicits an immune response against the virus?

A. I understand what you're asking me. What I'm just trying to tell you is from my expertise level, from my expertise, I look at the problem from measuring the biomarker, which is the blood proteins, after your infection.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 113 of 375

Q. And outside of the context of looking at the biomarkers, you're unable to give an opinion on whether the COVID-19 vaccine elicits an immune response against SARS-CoV-2?

MR. DANFORD: Objection to form.

A. So in order for me to answer that specifically, you have to present the data to me.

Q. So without seeing the data, you are unable to answer the question of whether the COVID-19 vaccines elicit an immune response against SARS-CoV-2?

A. No. That's not what I'm saying with that, right. What I'm saying is your question is very broad and very general.

Q. Let's try this again. When I say the COVID-19 vaccines, do you understand that I'm referring to the vaccines made by Moderna and Pfizer?

A. No, I'm not even looking at what -- the qualification of the vaccine, right. What I'm saying is you're trying to tell me a vaccine produces an immune response. What I'm saying is

you need to provide more specificity for me, right, with the specific case and specific details. Then I will be able to answer your question, right.

Q. Let's try this another way. You know what Spikevax is, right?

A. Yes.

Q. Does Spikevax elicit an immune response against the SARS-CoV-2 virus?

A. Again, the data -- I haven't looked at the data specifically, right.

Q. You understand what Comirnaty is, right?

A. Yes.

Q. Does Comirnaty, in your opinion, elicit an immune response against the SARS-CoV-2 virus?

A. Again, I haven't seen the data in front of me.

Q. So without seeing the data in front of you, you cannot opine on whether Spikevax or Comirnaty elicits an immune response against the SARS-CoV-2 virus?

A. I need the data at hand, right?
Q. Do you believe that the -- do you believe that Spikevax and Comirnaty protect against COVID-19 infection?
A. Again, that's a very general question, right? I need the data at hand.
Q. So you don't have an opinion today as to whether Spikevax or Comirnaty protect against COVID-19 vaccine [sic]?
A. Again, it's very broad.
Q. So in forming your opinions today, you did not consider whether the COVID-19 vaccines actually offer any protection against infection; is that right?
MR. DANFORD: Objection to form.
A. Again, I was interpreting with the declaration, information as to the particular patents, right. That's what I focused on, right.
Q. You're unable to answer the question of whether vaccines in general are designed to elicit an immune response, correct?
MR. DANFORD: Objection to the form.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 116 of 375

A. I'm looking at the interpretation from what is presented to me, and interpret that information, right.

Q. Based on the information that is presented to you, you are unable to answer the question today of whether a vaccine, as a general matter, functions to elicit or provoke an immune response; is that right?

MR. DANFORD: Objection to form.

A. Again, it's very general, right.

Q. So you don't know if a vaccine elicits or provokes an immune response; is that right?

A. Again, I'm focused on the delivery part. That is my expertise, right.

Q. So you don't know if a vaccine elicits or provokes an immune response, right?

MR. DANFORD: Objection. Asked and answered about 20 times.

A. So, again, I'm focused on the delivery technology, right.

Q. And because you're focused on delivery technology, you don't know if a vaccine elicits

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 117 of 375

or provokes an immune response, correct?

MR. DANFORD: Objection to form.

A. I have my expertise, right. This is really what it is. It's focused on the formulation designs and the purpose of formulation designs, right.

Q. Because you are focused on formulation and formulation designs, you are unable to answer the question of whether a vaccine elicits or provokes an immune response; is that right?

A. No. What I'm saying is you essentially -- when you make a formulation, you see what the markers, the output of this, right. And normally in an academic setting, you have collaborators, and they work on the interpretation of that, right.

Q. So your collaborators will determine whether a vaccine elicited or provoked an immune response?

A. They provide the expertise on a different topic.

Q. Because your expertise is not on

vaccines, you're unable to opine on whether a vaccine elicits or provokes an immune response?

A. That's not true. So what I'm saying is that when you essentially do your experiments, you have your formulation and you measure your outcome, right?

Q. What outcome are you measuring?

A. As I mentioned, you're measuring blood protein markers, right, or cell markers.

Q. Do those markers correlate to an immune response?

MR. DANFORD: Objection to form.

A. Again, the markers have lots of variability within the markers, right. And then patients could have various levels of those particular markers, right.

Q. So based on your research experience, do you know whether one function of a vaccine is to elicit or provoke an immune response?

A. Again, my point is that when I do my experiments, I measure the outcome, right.

Q. It's a yes or no.

A. You're asking me to define these things, right. What I'm trying to tell you is that the way I look at these things, right, rather than using nomenclature to define things, it has to be more specific in terms of what is presented. Then I can answer that question.

It's not whether I have expertise or not in vaccines, which is what you're assuming. What I'm trying to say is that your question to me now 20 -- I don't know, 20-plus times, is the same thing repeated over again. You're providing me a generality of context, right.

Q. So without additional context, you're unable to answer the question of whether a purpose of a vaccine is to elicit or provoke an immune response?

MR. DANFORD: Objection to form.

A. Again, I am focused on my declaration. If you ask me about the formulations and the formulation designs, we can talk about that in more detail, right.

Q. So I want you to take a look at

paragraphs 340 to 350. You would agree that mRNA is identified in those paragraphs, correct?

A. 340 and 350?

Q. Let me rephrase. Let's try again.

You agree that in paragraph 340, it specifically identifies mRNA, correct?

A. Okay. In 340, it says, "In one embodiment of the present invention, mRNA molecules may be used to elicit or provoke an immune response in an organism."

Q. So paragraph 340 references mRNA, correct?

A. Yes.

Q. And just to be clear, we're talking about paragraph 340 of Schrum, right?

A. Yes.

Q. Paragraph 340 doesn't mention RNAi-inducing agents, right?

A. Are you referring to interference RNA?

Q. Correct.

A. It mentions mRNA molecules.

Q. It doesn't talk about small interfering

RNA, right?
A. No.
Q. I just want to clarify.
A. It just mentions RNA.
Q. In fact, paragraph 340 to paragraph 350 of Schrum only discuss mRNA, correct?
MR. DANFORD: Objection. You can take your time to read that, if you need.
A. Okay.
Q. So in paragraphs 340 through 350, you would agree that mRNA is the only type of nucleic acid specifically identified, correct?
A. Let me look through. Let me read 350 since you mentioned that. Give me a few minutes.
Okay. So it describes two types of RNA.
Q. And it describes nonamplifying mRNA and saRNA, correct?
A. It describes mRNA and it describes self-replicating or self-amplifying RNA in paragraph 344.
Q. And there's no other types of nucleic acid specifically identified, right?

A. It does not appear so.
Q. So let's take a look at paragraph 903 of Schrum.
A. You're talking about the paragraph that starts with "The invention is further described in the following examples which do not limit the scope of the invention described in the claims"?
Q. Yeah. So paragraph 903 starts the section where Schrum provides examples of the invention, correct?
A. Okay.
Q. You agree with that, right?
A. Let me just -- well, it has example one, right.
Q. Did you review these examples in forming the opinions you expressed in your declaration?
A. Yes. In April. Or May.
Q. Do you agree that all of the examples use mRNA?
A. Let me take a look and just get a refresher. How many examples do you want me to

go through?

Q. What example are you on right now?

A. Thirteen.

Q. Thus far, have you seen any examples that discuss any type of nucleic acid other than mRNA?

A. From my quick scan -- and I apologize, my eyes are not so good -- it appears to be mRNA is the description.

Q. So why don't we do this. I can represent to you that all of the examples in Schrum relate to mRNA. Do you have any reason to disagree with that, sitting here today?

MR. DANFORD: Objection. If you need to review the rest of it to answer that, you can.

A. Yeah. As I said, it's been a couple of months since I've gone through. I did quickly review it before this, but to go through it -- I would need to take time to go through everything carefully to see where mRNA or other types of RNA may be described or presented.

Q. Are you -- do you recall in your review

any examples that use nucleic acid other than mRNA?

A. Let me go back to my review in my report.

Yeah. In my report, I indicated mRNA.

Q. So you agree that Schrum is focused on mRNA, correct?

MR. DANFORD: Objection to form.

A. Again, in my report -- and I'm going through the examples you provided -- it indicates mRNA.

Q. And you're not aware of any examples in which Schrum -- let me rephrase.

You're not aware of examples where Schrum uses small interfering RNA, correct?

A. Give me a few minutes to look over.

Yeah. So, again, just to present out, on page 6 -- or page 6 of 202, in the Schrum --

Q. Six of 202?

A. Yeah.

Q. Sorry. Just to be clear, I was referring specifically to the example section

starting on paragraph 903.

You're not aware of any examples starting on paragraph 903 that use small interfering RNA, right?

A. Example 903. Can you tell me the page again?

Q. Yeah. It's page 127 of 202.

A. 127. Are you just talking about example 1 through maybe 12?

Q. Well, I guess sitting here today, based on your review, can you recall any specific examples in Schrum that use small interfering RNA?

MR. DANFORD: Objection.

A. As I said, I would need to go through it as a refresher because it's a very dense patent. It's been a couple of months. But the reason I point out the other sections because they do -- in this patent, they do list all different types of RNAs in place.

Q. But you're not aware of any -- you have not identified any specific examples of small

interfering RNA that are disclosed in Schrum, correct?

MR. DANFORD: Objection to form.

A. Again, as I mentioned earlier, if I'm looking at this moment at example 1, it's a description of mRNA, as the title says, "Modified mRNA Production."

Then example 2, it says "cDNA," which is a complementary DNA. And then in 923, it mentions "poly-A T120 mRNA."

Example 3, it says in vitro transcription. It also mentions the mRNA is purified. Then it generically mentions 500 micrograms of RNA. Following the cleanup, the RNA is quantified using nanodrop. So it's just here uses generically ribonucleic acid.

Example 4, it talks about enzymatic capping of mRNA.

Example 5, it talks about poly-A tailing reaction.

So I'm just going through this, right, because as I'm quickly going through this, you

know, up to example 5, they use the abbreviations mRNA or RNA. And then at times, they, you know, put a little descriptor of the RNA, like, for example, in example 4, paragraph 928, it says to denature RNA. So then you can assume it's a denatured RNA from that, right, because of the description.

Do you want me to go beyond example 5?

Q. No. All the examples we just discussed involve mRNA, right?

A. That is what is listed here, it seems.

Q. So let's take a look at paragraph 22 of Schrum, then.

A. Okay. Twenty-two.

Okay. In one embodiment.

Q. So in paragraph 22, there's a number of different types of nucleic acid listed, correct?

A. Yeah.

Q. And do you see the first type of nucleic acid that's listed is DNA, right?

A. Yup.

Q. Do you agree that as of the priority

date, there was no approved DNA vaccine for any indication, despite many years of research, and a POSA would have understood that those vaccines, in fact, did not succeed?

A. Can you say that again?

Q. Sure. Why don't we break that down a little.

Do you agree that as of the priority date, there were no approved DNA vaccine for any indication, despite many years of research?

MR. DANFORD: To help me, what priority date are you talking about?

MR. LIU: Sure. Why don't we try this a third time, then.

Q. Do you agree that as of the priority of the '600 patent, there was no approved DNA vaccine for any indication, despite many years of research?

A. I mean, again, the reason I'm -- because I don't actually know how many commercial products were developed, right. This is what you're asking, right? I do know that there were

studies on DNA vaccines.

Q. Do you agree that as of the priority of the '600 patent, a POSA would have understood that DNA vaccines, in fact, did not succeed?

MR. DANFORD: Objection to form.

A. So a POSA would -- if, you know, you're looking at POSA, they would look at the literature to see what has been published on DNA vaccine.

Q. And do you agree that as of the priority date of the '600 patent, a POSA would have understood that DNA vaccine, in fact, did not succeed?

MR. DANFORD: Objection to form.

A. Again, a POSA would read the literature and interpret the results and would judge the DNA vaccine based on what is published, the animal model and the results that they measured.

Q. And based on the results, the literature that would have been available as of the priority date of the '600 patent, do you agree that a POSA would have understood that DNA

vaccine did not succeed?

MR. DANFORD: Objection to form.

A. No. A POSA would look at the paper and interpret the paper and understood within the system that was presented in the paper, would make a judgment of whether that particular topic -- whether that particular study that's -- with the data -- with the specifics that are laid out in the paper is successful enough with that paper, for that particular case.

Q. So as a general proposition, do you agree that as of the priority date of the 2000 -- of the '600 patent, that a POSA would have understood that DNA vaccines, in fact, did not succeed?

MR. DANFORD: Objection to form.

A. Again, from a researcher's perspective, from a POSA's perspective, they're looking at it from what is published and interpreting what is published, right.

Q. So if I said that as a general proposition, that a POSA would have understood

that DNA vaccines did not succeed as of 2015, that that statement would not be accurate from a POSA's perspective, as a general matter?

MR. DANFORD: Objection to form.

A. A POSA would not necessarily make those judgments because they have to read the paper at hand to understand the parameters that is presented in the paper to make that interpretation of the paper at hand, right.

Q. So you couldn't make that statement as a general matter, right?

MR. DANFORD: Objection to form.

A. You have to look at the paper at hand, right. And in -- I'm just going to bring this up. So in my deposition, I looked at the Yang paper, right. And that paper, you can interpret from what the results are presented.

Q. So as of 2015, are you aware of any small interfering RNA being used for vaccination against infectious diseases?

A. So what I know about the siRNA paper at that time is what was published in a couple of

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 132 of 375

papers in "Nature Biotech," and there's a couple of other papers elsewhere.

Q. Were any of those papers about vaccination against infectious diseases?

A. Well, I don't have the paper at hand. I focused on the formulation design and the siRNA, right. Because coming from that perspective, that's what I was very much interested in. So those things, I looked at.

Q. Are you able to identify any siRNA-based vaccines against infectious diseases?

A. Again, I was not focused on that. Right. If you give me, like, a month, I can look it up and study and see to answer that question. But I'm more interested in the siRNA and the formulation designs, right.

Q. What is shRNA?

A. That's -- I don't know what the H stands for.

Q. So you don't know what shRNA is?

A. Yeah. It's just a type of RNA, right.

Q. And you don't know what the "SH" stands

for in that?

A. I do not. There's a lot of acronyms for everything, and acronyms also change through time, right. Like, RNAi agents, right. You can -- you know, RNAi is an interference RNA, and siRNA is small interfering RNA. There's miRNA, microRNA, right.

Q. So do you know what micro -- miRNA, then?

A. Yes. It's a larger version of the siRNA.

Q. And as of 2015, are you aware of any microRNA being used for vaccination against infectious diseases?

A. Again, I did not pay attention to those papers at that particular time, right.

Q. And then the next one you see in that list is antisense RNA, right?

A. Mm-hmm.

Q. What is an antisense RNA?

A. It's an RNA that complements an RNA sequence that's in place or a nucleic acid

sequence in place.

Q. So as of 2015, are you aware of any antisense RNA being used in vaccination against infectious diseases?

A. Again, I cannot recall because I did not pay attention to that particular framework from the vaccine perspective, right.

Q. There's a number of other, I guess, nucleic acid molecules listed, including ribozymes, catalytic DNA, RNA, that induce triple helix formation, aptomers, vectors and combinations thereof, right?

A. Mm-hmm.

Q. Of those types of nucleic acids listed, are you aware of any of them being used in vaccines against infectious diseases as of 2015?

A. Again, as I said, I did not pay attention to that part of the equation, right.

Q. Does Schrum -- well, let me rephrase.

So in developing -- let me -- you've developed a number of nano-based delivery mechanisms for pharmaceuticals, correct?

MR. DANFORD: Objection to form.

A. Yeah. So my lab, we develop -- at one time, we synthesized nanoparticles. We synthesized in the past quantum dots in my lab. We have synthesized gold nanoparticles. We synthesized other families of nanoparticles, organic nanoparticles as well, POGA, lipid-based. And so we do a lot of formulations.

But when you synthesize them, it's broadly what that actually means because there's other things that -- you know, as part of the synthetic process, right.

Q. So in delivering -- in developing a delivery mechanism, does successful in vitro result always translate to successful in vivo results?

MR. DANFORD: Objection.

A. So whenever we do our experiments, it depends on what you're trying to do with it. We either run in vitro experiments and/or in vivo experiments, right. It's just part of what we do academically when we are just running experiments

in sort of the bio applications of nanoparticles.

Q. You would agree that a delivery mechanism that works in vitro may not necessarily work in vivo, right?

MR. DANFORD: Objection. Calls for speculation.

A. Again, we do those particular experiments as a way to inform us as to what to do with our formulation design. So that's a difference between how an expert in -- I will slow down -- in developing a nanoparticle delivery, right.

So we do in vitro cell culture experiments and we tend to do it in lots of different kind of cell cultures, cell systems. And the result informs us in terms of design, right.

The same thing with the in vivo. Experiments are very similar in development. You test it out and then it informs the design.

That's why when we went over my CV, that's why we study the interactions of nanoparticles with biological systems. It's an information

generation for design.

Q. So you would agree that before testing a drug delivery system in humans, you would need to test it in animals first, right?

MR. DANFORD: Objection to form.

A. I don't know what a pharma company does in that process. From an academic process, we focus on the cell culture experiments as well as animal experiments, right, to inform us.

Q. Why do you do animal testing?

MR. DANFORD: Objection.

A. Again, it informs us in terms of the design, right. Yeah. It's just -- that's all it is, right. Cells, you know, are one component of the system. Animals, there's a lot more parameters that is involved in that process, right.

Q. Do you agree that a delivery system that had been successfully tested in animals would be more promising than a delivery system that had only been tested in vitro?

MR. DANFORD: Objection.

A. Again, we just use it for information, right. Because the way you asked the question is very general. That -- it has to be more specified with a specific case associated with it for me to answer.

Q. Do you agree that if a delivery system had been tested both in vivo and in vitro, that that would give you more information about that delivery system than if it had only been tested in vitro?

MR. DANFORD: Objection. Calls for speculation.

A. So from that perspective, so sometimes -- sometimes in vitro cell experiments and in vivo cells go hand in hand. Sometimes they go separately, right.

So you don't necessarily do it from cell to animal to human. Sometimes you just go from animal to human. Sometimes you do cell and then go human. Like, there's lots of combinations of things depending on the specifics.

Q. Can we go back to Exhibit 17 of Schrum,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 139 of 375

starting paragraph 1000.

A. Exhibit 17. At what page?

Q. This is page 139 of 202.

A. 139. Okay.

Q. So example 17 is titled "Lipid Nanoparticle In Vivo Studies With Modified RNA," correct?

A. That is the title that I read.

Q. So example 17 describes an in vivo study using lipid nanoparticles, correct?

A. Let me see. So according to what is written here, it states that lipid nanoparticle formulations shown in Table 31 were administered to rats in IPOs of 5, so they did five rats, intravenously, intramuscularly or subcutaneously at a single modified mRNA dose of .05 milligram per kilogram.

Q. So you would agree, then, that example 17 relates to an in vivo study using lipid nanoparticles, right?

A. They injected it into the rats, right?

Q. So that makes it an in vivo study,

right?

A. It got injected into rats. "In vivo" is a funny term. I'll leave it at that.

Q. It's an animal study, right?

A. Yeah. But, again, it depends how you describe these things. But really it's administered to rats, right.

Q. Do you agree that a rat is an animal?

A. Rat is an animal, but the rat could be dead or alive, right. Not that this is -- I'm just saying. I've done experiments where the rats are not alive, right. So...

Q. I'm not sure we'll have time to explore that in this deposition. But you would agree that example 17 describes an animal experiment, right?

A. Yes.

Q. Example 18 also describes an animal experiment using LNPs, right?

A. Example 18, it says, "LNP formulations shown in Table 31 were administered to mice..." -- so it's a different animal --

"...intravenously at a single modified mRNA dose of..." whatever.

Q. And example 18 uses LNPs, right?

A. It states here that LNP formulations were administered to mice.

Q. Example 19 administered LNP formulations to mice too, right?

A. Let me see. The title for 1004 is LNP Formulations in Mice. So LNP -- yeah, the first sentence in 1005 states, "LNP formulations as shown in Table 31 were administered to mice," and it goes for intravenously at a single modified RNA dose of .05 milligrams per kilogram -- or .005 milligram per kilogram.

Q. Example 20 is also an example of administering LNPs to mammals, correct?

A. Yeah. LNP formulations shown in Table 31 are administered to mammals intravenously.

Q. And example 21 is an example of an LNP formulation being administered to nonhuman primates, correct?

A. Yes. It states that LNP formulations shown in Table 31 were administered to nonhuman primates. The usual. The studies as a bolus -- bolus intravenous injections.

Q. So example 22, then, is also an example of lipid nanoparticles being administered to nonhuman primates, correct?

A. Example 22, it says, "LNP formulations shown in Table 31 were administered to nonhuman primates as intravenous injection."

Q. So examples 17 through 22 all describe animal studies in which lipid nanoparticles were administered, correct?

A. According to the topic sentence, it was lipid nanoparticle formulations were administered to rats, mice, and monkeys through those examples.

Q. And it's at least three different animals that Schrum tested with the nanoparticles on, right?

A. I mean, they used three different subjects, right. Mice, rats, and monkeys.

Q. Can you identify any examples of in vivo testing using PLGA? Actually, before you answer that, I just want to make sure. It was your opinion that Schrum's focus is on PLGA, right?

A. Well, the main -- a lot of the descriptions from my reading, right, was PLGA, fibrin, and that family, right. They make -- I can go through, but they make arguments why certain controlled-release are useful for the purpose at hand.

Q. Can you identify any in vivo testing results using either PLGA or fibrin in Schrum?

A. Yes. I said I would need more time to go through it. There is an example on page 182 of using PLGA microspheres for in vivo studies.

Q. And can you identify the example you're referring to?

A. 1319.

Q. And based on your review, that's the only example that you saw that had in vivo studies of PLGA microspheres, correct?

A. I mean, I just quickly went through it, right. There's sections on, like, in vivo -- I mean in vitro, right.

Q. Right. But in terms of in vivo, paragraph 12- -- 1319 to 1320 is the only one that you saw?

A. I would have time to go through it carefully again, right, to map this out. Because I only took, what, 10 minutes, 15 minutes. It's just a quick run through, right.

Q. Are you aware -- now, during your review, did you see how many examples of lipid nanoparticles for delivery of mRNA were described?

A. Yeah. But some of those -- some of those examples that are described were just -- were -- so the ones that were described, like, some of them are just not that important, right.

What I mean by that is because they just list formulations and stuff and you skim over it because you kind of know that already, right.

The number of examples doesn't actually

matter in this particular -- for some of these things, right. It's actually the key ones that are important.

Q. You agree that most of the examples are directed towards lipid nanoparticles, right?

MR. DANFORD: Objection to form.

A. Again, there are lipid particles. There are, I think, liposomes. There are fibrin. There are lipoplexes. Again, I can't go through all of the nanoparticles. And it flips between all these different ones. They flip between whether it's mCherry, luciferase. There's a lot of repetition of that particular aspect as well, right.

There's also a lot of examples of modifications of the -- I think the mRNA, the encapsulation efficiencies. So there are just a lot of different things. It's not just solely lipid nanoparticles, right.

Q. You would agree that most of the examples are directed towards lipid nanoparticles, right?

MR. DANFORD: Objection to form.

A. As I stated, if you go through the example -- if I had time, I could map all of this for you in a nice table. But lipid nanoparticles is one of the -- one of the particles they essentially provide an example of the many that are listed.

Q. You would agree that Schrum discloses lipid nanoparticles for delivery of mRNA, correct?

A. Let me go through this again.

Q. So let's make this easier. You would agree that examples 17 through 22 describe the use of lipid nanoparticles for delivering mRNA, correct?

A. Seventeen through 22.

Q. Through 22. Just so we have a clear record. You would agree that examples 17 through 22 of Schrum disclose the use of lipid nanoparticles for delivering mRNA, correct?

A. What they indicate is that they formulate single modified mRNA in the lipid

nanoparticles, or the lipid nanoparticle formation has a single modified mRNA with a dose of .05 milligram per kilogram.

Q. That is lipid nanoparticle encapsulating mRNA, correct?

A. No. I'm just going to read this. I put that in. Lipid formulations shown in Table 31 intravenously, intramuscularly, or subcutaneously at a single modified mRNA dose of .05 milligram per kilogram.

It doesn't actually explicitly say encapsulating or nonencapsulating. It just says that the lipid nanoparticle formulations at a single modified mRNA dose.

MR. LIU: Why don't we take a 10-minute break.

(A recess was taken.)

BY MR. LIU:

Q. So, Dr. Chan, do you recall earlier in the deposition I asked you a number of questions about whether vaccines elicit an immune response?

A. Yes. You did, over 20 times.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 148 of 375

Q. Do you agree that the immunogenicity of every component of an mRNA vaccine contributes to the immunogenicity of the vaccine?

MR. DANFORD: Objection. Calls for speculation.

A. Do you -- yeah. That's a -- there's a lot there. Can you break it down?

Q. Sure. Do you agree that the immunogenicity of every component of the mRNA vaccine may contribute to the immunogenicity of the vaccine as a whole?

MR. DANFORD: Same objection.

A. Can you break it down?

Q. What don't you understand about that statement?

A. You used "immunogenicity" two times, and it's redundant in that sentence.

Q. Let me just try that statement again.

Do you agree that the immunogenicity of every component of an mRNA vaccine contributes to the immunogenicity of the vaccine as a whole?

MR. DANFORD: Objection. Calls for

speculation.

A. Again, repeat it differently. I will eventually get it. Just repeat it differently.

Q. Well, what don't you understand about that statement as phrased?

A. Well, you're being general, right, like, every component. Every component of what? Immunogenicity. What are you essentially measuring to indicate immunogenicity?

Q. So why don't -- I'm going to ask it again. And if you're unable to answer the question because you don't understand it or because it's too general, just let me know.

Do you agree that the immunogenicity of every component of an mRNA vaccine may contribute to the immunogenicity of the vaccine as a whole?

MR. DANFORD: Objection. Calls for speculation.

A. Again, it's not that I cannot answer the question. It's that you essentially -- the way you phrased the question with the terminology you used is very broad. And unless you specify

more specifically in your question with these terminologies, I will be able to answer once that happens.

Q. Try this again.

Do you agree that the immunogenicity of every component of the mRNA vaccine may contribute to the immunogenicity of the vaccine as a whole?

MR. DANFORD: Same objection.

A. Again, if you define more specifically, more in a narrow term what each of the part of your question is, I will be able to answer that.

Q. So do you understand what the immunogenicity -- do you understand what the term "immunogenicity" means?

A. So when I think about immunogenicity, it depends on what you're measuring to indicate that. It's a phrase, right.

Q. Do you agree that beyond the antigenetic protein translated from the mRNA, the immunogenicity of every component of the mRNA vaccine may contribute to the immunogenicity of

the vaccine as a whole?

MR. DANFORD: Objection. Calls for speculation. Vague.

A. Yes. It's -- so what I mean by that is that the question you're asking is very general, right. The term "immunogenicity," it's very -- every component is general, right. I can work on specificity. So if you provide more specific questions, then I can address that, right.

Q. So you're unable to answer that question, as phrased?

A. As you present it.

Q. Do you agree that the innate immune response evoked by the components of a vaccine can help prime the adaptive immune response elicited by the antigen expressed by the vaccine?

MR. DANFORD: Objection. Calls for speculation.

A. Again, if you shorten that, and more specific.

Q. Let me try that again.

Do you agree that the innate -- well, do you

understand that vaccines elicit an innate immune response?

MR. DANFORD: Objection to form.

A. Yeah. Again, you have to be more narrow.

Q. So you don't know if vaccines elicit an innate immune response?

MR. DANFORD: Objection to form.

A. Yes. You have to be more narrow.

Q. Well, do you know if vaccines elicit an innate immune response?

MR. DANFORD: Objection.

A. Again, you need to become more specific.

Q. What more information would you need?

A. What do you -- what are the numerical measurements of an innate immune response that you refer to?

Using terminology, if you define specifically what I am supposed to measure to indicate an event, then I can provide that.

Q. So have you ever used -- well, let me

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 153 of 375

rephrase.

Do you understand what an innate immune response is?

MR. DANFORD: Object to form.

A. Again, it's a broad terminology. I'm trying to get you to be more specific in terms of what you're defining.

As we discussed earlier, right, I work in measurement of function. And measurement of function, at times, refers to -- to specific markers.

Q. So do you agree that an innate immune response evoked by the components of a vaccine can help prime the adaptive immune response elicited by the antigen expressed by the vaccine?

MR. DANFORD: Objection. Calls for speculation. Vague.

A. Yeah. I mean, as I said in my report, I describe in page 26 the immune response. And I just want to read this. When basically potential pathogens enter the body after natural barriers are overcome or evaded, a multitude of components

in the body's defense system start to respond. And the response can include both an adaptive and an innate immune response.

And then the innate immune response or innate immune system that is within the host does not require adaptation. The innate immune system is immediately available to combat a wide range of pathogens and acts as the next-line defense right after the physical and chemical barriers.

Okay. But the unique thing about the innate immunity is it does not prevent reinfection. It's not specific for any individual pathogen.

Q. So in paragraph 26 of your report, you discuss the -- I'm sorry. What paragraph was that again? Excuse me.

A. Paragraph 67.

Q. Paragraph 67. So in paragraph 67 of your report, you discuss the innate immune response, right?

A. Well, I describe that there's two potential responses to a potential pathogen that enters the body, right. And those two responses

are adaptive and innate immune response.

Q. And do you agree that the innate immune response that is evoked by the components of a vaccine can help prime the adaptive immune response elicited by the vaccine's antigen?

A. Again, your question is very broad, right. And unless you clarify what the components are and then what is your measurement of an innate immune response specific to that, then I can answer.

Q. So as that question is phrased, you are unable to state whether you agree or disagree with that statement, correct?

A. No. Your statement to me, right, is very broad, right, and very general. Unless you specify -- it's actually not an appropriate question, right, unless you are more specific in what you're trying to ask me.

Q. So would --

A. Basically if you define things more explicitly. And as I stated earlier, right, from an engineering, chemistry and formulation and

delivery perspective, you look at measurement of outcome, and the measurement of outcome is an indication that the formulation you designed works as appropriately.

The measurements that you make on that part of the equation may relate to a certain medical outcome or function or response. Those parts, I have always depended on experts in that part to help interpret, right.

Q. So the question as I have phrased it, you believe that that is too general of a question to be answered?

A. No. The question you asked -- that you asked me, right, it's, like, it's not informative to allow me to ask the question as a delivery person in the way you're thinking about it as a delivery perspective, right.

Q. So as a delivery person, you're not able to answer the question as I phrased it. Is that right?

MR. DANFORD: Objection to form.

A. No. So because of the way you asked

the question, what it does is that it doesn't provide me enough information to provide specific answer that corresponds to what you want.

Q. And what additional information would you need?

A. Again, like, what are the markers for innate immunity, right, that you're asking for.

Q. Do you think that a POSA would have understood that expression of an antigen is required for an immune response?

MR. DANFORD: Objection.

A. Repeat that again, please.

Q. Is it your opinion that a POSA would have understood that expression of an antigen is required for an immune response?

MR. DANFORD: Objection. Calls for speculation. Incomplete hypothetical.

A. Yeah. This relates to the same issue that we discussed earlier, right, because you're using the generic term "immune response," right.

And depending on the specifics of what you're asking for, that provides me a more

specific answer for you.

Q. I'm sorry. Let me rephrase.

So as the question is phrased, you're unable to answer whether a POSA would have understood that expression of an antigen is required for an immune response?

MR. DANFORD: Objection. Incomplete hypothetical. Calls for speculation.

A. So what -- you're asking me a specific question with a specific phrasing and you're asking me to answer that question, but you do not provide enough specificity in your question for me to answer.

Q. So are you qualified to opine on how vaccines work?

MR. DANFORD: Objection to form.

A. Again, I'm a delivery expert, right. Designing particles, designing formulations, looking at the transport and delivery system, and measuring outcome and being able to evaluate that outcome. Then I essentially work with collaborators who can provide another part of the

equation, right. This is actually how a lot of academia works nowadays, right.

Q. Is it your opinion that the basis of vaccines is immunological memory?

MR. DANFORD: Objection to form.

A. Again, you need to define what -- "immunological memory." You're going through a line where my expertise is in the delivery and technology and formulation. Immunological memory are typically associated with people who are specialists in the immunology space.

Q. Right. Do you agree that immunological memory is the basis of vaccines?

MR. DANFORD: Objection. Asked and answered.

A. What I just repeat before, right. My expertise and my lane for most kind of work I do, if you look at my CV, relates to delivery and transport of nanoparticles. And now you're asking questions that are specifically to somebody who may have more of an immunology expertise, or immunologist.

Q. I'm sorry. It's a yes or no question.
Do you agree that immunological memory is the basis of vaccines?
MR. DANFORD: Same objection.
A. No. But, again, you're asking me things that are not in my area of purview -- or my expertise.
Q. Do you agree that the adaptive immune response produces antibodies that specifically recognize and bind the pathogen and is also responsible for immunological memory?
A. So on page 26 of my deposition [sic], I indicate the adaptive immune response is highly specific to the invading pathogen, but takes time to develop or adapt. The adaptive immune response produces antibodies that specifically recognize and bind the pathogen and is also responsible for immunological memory which protects the body from reinfection with the same pathogen, including some genetic variance.
Q. What is a nonviral-based vaccine, in your opinion?

MR. DANFORD: Objection. Vague.

A. That is vague. There's lots of categories of viral- and nonviral-based vaccines, right.

Q. Are you able to define what a nonviral-based vaccine is?

MR. DANFORD: Objection.

A. Again, if you look at the terminology, right, "non," if you look at Greek suffix as "non," "not," and "viral" means virus, right.

Q. Do you agree that nonviral-based vaccines often do not activate the innate immune system the way that a natural infection does?

A. On page 28, paragraph 73, it's written here as "nonviral-based vaccines often do not activate the innate immune system the same way as a natural infection does."

Q. Go to paragraph 114 of your declaration on the '600 patent.

A. Paragraph 114. On page 46?

Q. That's right. So in paragraph 114, you start a section where you say Schrum points to

PLGA microspheres as a carrier for mRNA, correct?

A. That's what the title on the page 46 states.

Q. Do you see in paragraph 119 --

A. Paragraph 119. So working examples.

Q. Yeah. And do you see in paragraph 119, you say, "Schrum includes five working examples that use PLGA to deliver mRNA"?

A. That is what is stated on page 48 on paragraph 119.

Q. Is it your opinion that Schrum points to PLGA microspheres as a carrier for mRNA because there are five working examples in Schrum that use PLGA microspheres?

MR. DANFORD: Objection to form.

A. I just want to specify in paragraph 120, I state the following: Example 15's title PLGA microsphere formulations using vector 9 mRNAs, example 15 details the process of PLGA microsphere synthesis. It also details the observed correlation between PLGA concentration, homogenization speed, the volume of the water

Phase II, and the filtration step on one hand, and the size of the formed PLGA microspheres on the other. Example 15 further describes the process to encapsulate mRNA and exemplary encapsulation deficiency.

Q. Respectfully, Dr. Chan, I can read what is in your report.

A. I know.

Q. My question is just, is it your opinion that Schrum discloses PLGA microspheres for the delivery of mRNA?

A. What I'm trying to essentially -- let me read the rest of the section, right.

It's a sequence of description that indicates the -- provides, for example, mRNA PLGA, right.

And so after I read this, then you can ask questions more specifically on this, okay?

So in paragraph 121, it says, "Example 15 provides a release study of mRNA, PLGA, which demonstrates that the mRNA was released gradually and only reached 96.4 percent release after 31

days at 37 degrees Celsius.

"Example 15 also demonstrates the protection the PLGA microspheres afforded the mRNA. PLGA microspheres protected vector 9 modified mRNA from degradation in 90 percent serum over two hours. The same mRNA completely degrades in 90 percent serum at the initial time point."

Paragraph 112 -- 122, excuse me, says: "Example 15 has another feature of PLGA microspheres. The PLGA microspheres can be lyophilized."

Q. I want to generally make sure that you have a chance to answer my questions in full. However, do you intend to do anything other than just read the words on the page here? Because we can all read what you've already put in your declaration, Dr. Chan.

A. I understand. But your question -- your line of questions need to be more specific, right.

So what I'm trying to present to you is the details of how I came to the conclusion about

mRNA PLGA, right.

Q. What I'm asking is just -- I see the examples that you point out in your declaration, right. I think we can all agree that's in the record.

What I'm asking is, are the examples that are disclosed in Schrum, in your opinion, sufficient to disclose -- to direct a POSA to PLGA as a delivery vehicle for mRNA?

MR. DANFORD: Objection to form.

A. So when a POSA reads this particular part of the equation, they can formulate the PLGA. They would also know why you use the PLGA for the intended purpose.

Q. So the five examples that you provided in your declaration, in your opinion, that's enough to direct a POSA to use PLGA as a delivery vehicle for mRNA, correct?

MR. DANFORD: Objection to form.

A. No. What a POSA would do is look at the example and understand how to formulate the PLGA with the mRNA. They would understand from

the examples that are provided some of the advantages of it, such as lyophilization, such as controlled-release of the system, because example 15, for example, provides very specific to indicate that the mRNA PLGA demonstrates that the mRNA was released gradually, right. So it's a controlled-release system.

So what that means is that if I was a POSA at that time -- you know, whenever you do science or any kind of project to understand what you use it for, you have to not only make something, which this demonstrates how you make the PLGA, but you also have to be convinced why this is a good system for use.

These examples clearly illustrate the properties, the physicochemical properties of a PLGA for their intended application, right.

Q. Do you know the difference, if any, between how vaccines for cancers perform as opposed to vaccines for infectious diseases?

MR. DANFORD: Objection. Vague.

A. Again, that is general, right. Lots of

different kinds of cancers, lots of different kinds of infectious disease. So it's not specific. Second thing is that there are different classes of diseases, and unless you can qualify that more specifically...

Q. So are you able to articulate any differences, sitting here today, between how vaccines for cancers perform as opposed to vaccines for infectious diseases?

MR. DANFORD: Objection. Vague.

A. Again, I have stated before, right, unless you narrow that particular down, right -- there's lots of cancers. There's lots of infectious disease. And please narrow that down.

Q. So you're unable to answer the question as phrased?

MR. DANFORD: Objection to form.

A. No. Your question is not clear, right.

Q. What's not clear about it?

A. Hmm?

Q. What is not clear about it?

A. Because the things that -- there's a

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 168 of 375

lot of different permutations of everything within those three words. Your three main words were "vaccine," "cancer," and "infectious disease."

There's so many subcategories under each of these, so many different conditions under each of these, and you're asking me to answer generically a statement, when each one of these could be lots of different subcategories, and there are subcategories under there and subcategories under there, right.

Q. Do you understand what a cancer vaccine is?

MR. DANFORD: Objection to form.

A. Again, it's very vague. Specify --

Q. Are you able to tell me today what a cancer vaccine is?

A. No. I would appreciate if you maybe specify it.

Q. So the answer is, you cannot tell me what a cancer vaccine is, as the question is phrased?

A. Because you're providing a generality in terms of what the "cancer" is, right?
Q. Do you know what cancer is?
A. Yes.
Q. Do you know what a vaccine is?
A. A vaccine, again, what are the specifics of that, right?
Q. So you don't know what a vaccine is?
A. No. I want to know the specific vaccine and specific cancer. Both of them are outcome-based.
That is why I keep trying to tell you, like, the way the engineers and delivery people think about it, it's an outcome-based measurement. The outcome-based measurement is based on the specificity of your question.
Q. So you drafted your declaration from the perspective of a POSA, right?
A. Yes.
Q. Okay. What would a POSA have understood a vaccine meant as of the priority date?

MR. DANFORD: Objection to form.

A. Again, a POSA -- any kind of POSA expertise would look at things not just in terminology. You look at the specific functional consequence, and that's how you answer things, right.

Q. So how would a POSA have understood the term "vaccine" as it was used as of the priority date?

A. Again, a POSA would not necessarily look at it from that particular direction, right. They would look at it from the direction of the outcome measurement, right.

Q. So does the '600 patent disclose an mRNA vaccine against betacoronavirus?

A. Does the '600 patent? I have to look at the '600 patent.

One of the important parts is actually Claim 1. And Claim 1 states that what is claimed is a composition comprising a messenger ribonucleic acid comprising an open reading frame encoding a betacoronavirus S protein or an S

protein subunit formulated in a lipid nanoparticle.

Q. Does Claim 1 of the '600 patent describe a vaccine?

A. The Claim 1 indicates a composition comprising a messenger RNA comprising an open reading frame encoding a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle. It's specific to the composition comprising.

Q. Does Claim 1 of the '600 patent claim a vaccine?

MR. DANFORD: Objection to form.

A. Again, I'm just reading the specific. It provides a lot of specificity.

The '600 patent indicates a messenger ribonucleic acid comprising an open reading frame encoding a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle.

Q. Does Claim 1 of the '600 patent recite a betacoronavirus mRNA vaccine?

MR. DANFORD: Objection to form.

A. It indicates a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle.

Q. Does Claim 1 of the '600 patent relate to a betacoronavirus mRNA vaccine?

MR. DANFORD: Objection to form.

A. Again, we can go back and forth, right. Because I can interpret based on what I'm reading here specifically, right, and what I'm reading here, as I've indicated, is a messenger RNA comprising an open reading frame encoding a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle.

Q. And when you read those words on the page, is it your understanding that that claim is directed to a betacoronavirus mRNA vaccine?

A. It indicates a lipid -- it's -- it indicates an mRNA comprising an open reading frame encoding a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle. It has the word "lipid nanoparticles" in it. It has the words "S

protein," "S protein subunit," "open reading frame." It has "messenger RNA" in there.

Q. And when you string those words together, is it your opinion that that describes a betacoronavirus vaccine?

MR. DANFORD: Objection to form.

A. When I string this together, it indicates a betacoronavirus S protein or S protein subunit in a lipid nanoparticle.

Q. Is that a vaccine?

A. I can only read what is written here. And that -- what I just indicated to you is what I'm reading here.

Q. So you don't know if that's a vaccine?

MR. DANFORD: Objection to form.

A. I did not say that. I'm just -- I read what is written.

Q. Is it a vaccine or not, in your opinion?

A. I am essentially telling you what I'm reading, right.

Q. As an expert, is it your expert opinion

that Claim 1 of the '600 patent relates to a vaccine?

A. No. What I'm reading here is what is indicated, right. It indicates that it's a messenger ribonucleic acid comprising an open reading frame encoding a betacoronavirus S protein or S protein subunit formulated in a lipid nanoparticle.

Q. And what lipid nanoparticle -- let me rephrase.

Is there a specific type of lipid nanoparticle that is described in Claim 1 of the '600 patent?

MR. DANFORD: Objection to form.

A. So, again, it says a lipid nanoparticle, and then in the other claims, 12, again, if you go through it, it now provides some composition of the lipid nanoparticles. You just need to read the sequence.

Q. Do you see a specific strain of betacoronavirus that's recited in Claim 1?

MR. DANFORD: Objection to form.

A. Can you clarify, please.
Q. Do you know what a -- well, let me rephrase.
Do you understand there's different types of betacoronaviruses?
MR. DANFORD: Objection to form.
A. Again, please be more specific.
Q. Do you understand that MERS is a different type of virus than SARS-CoV-2?
MR. DANFORD: Objection to form.
A. I mean, there's four genre of coronavirus.
Q. Does Claim 1 specify a genre of betacoronavirus?
A. It says a betacoronavirus, S protein or S protein subunit.
Q. Does it specify a genre?
A. It says it encodes a betacoronavirus, S protein or S protein subunit, right.
Q. So does the claim specify a genre of betacoronavirus?
A. It specifies a betacoronavirus,

right --

Q. But it doesn't specify a genre, right?

A. -- S protein.

MR. DANFORD: Objection to form.

A. Again, it says the betacoronavirus S protein, right.

Q. Have you ever seen the term "embodiment" appear in a patent?

A. I see it when I read these things.

Q. What does the term "embodiment" mean to you when you see it in a patent?

A. It means it incorporates things.

Q. And what --

A. Like one embodiment, it's in one thing. If it's in multiple embodiments, it's multiple things.

Q. What do you mean by "it incorporates things"?

A. Well, when I say it's in one embodiment, the way I interpret it is it's in one thing, one specific case, right. And if you say it's in another embodiment, it's in a different

case.

Q. So when you say "embodiment," do you think -- is it your interpretation that's the same thing as an example?

MR. DANFORD: Objection to form.

A. No.

Q. What is the difference between an embodiment and an example?

A. Oh, I'm not a lawyer. But the way I look at it is an embodiment is -- embodies the current event that is described in that particular sentence, right? It's a description, an example. It's an example. There probably is a legal term to this, but when I'm reading this, that's how I'm interpreting it.

Q. Are you familiar with the term "alternative embodiments"?

A. No.

Q. Do you know what "alternative embodiments" mean?

A. I'm guessing it's a different form, right. Just breaking down the terminology.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 178 of 375

Q. But that's not a term that you would use in your capacity as an expert, right?

A. Sometimes. Probably not. I mean, I would use a different form. But it probably means the same thing.

Q. Are you familiar with the term "preferred embodiments"?

A. Again, you're getting into all these legal terms, and they all probably mean something, right.

Q. But you're not familiar with what these terms mean, right?

A. Well, I'm not a lawyer, right.

Q. So how do you know when two embodiments are alternative embodiments or the same embodiment when they're described in a patent?

MR. DANFORD: Objection to form.

A. Again, you're asking me from a very, like, lawyer perspective. This is not my background, right.

Q. So you're not qualified to determine whether two embodiments are alternatives or, in

fact, the same embodiment when they're described in a patent, right?

MR. DANFORD: Objection.

A. Again, you're using legal terminology. This is not my background.

Q. So do you still have Schrum in front of you?

A. Yes. Yup.

Q. Can you turn to paragraph 397 of Schrum. It's on page 79 of 202.

A. What page again?

Q. It's on page 79 of 202.

A. Okay.

Q. And do you see paragraph 397 in Schrum?

A. Yes.

Q. And do you see the first sentence says, "In one embodiment, an immune response may be elicited by delivering a lipid nanoparticle," right?

A. Sure.

Q. So in the first sentence, Schrum is discussing the use of a lipid nanoparticle to

elicit an immune response, right?

MR. DANFORD: Objection to form.

A. It states that an immune response may be elicited by delivering a lipid nanoparticle. Blah, blah, blah.

Q. Now, do you understand the first sentence of Schrum to be describing the use of a lipid nanoparticle in a vaccine?

A. It says, "an immune response may be elicited by delivering a lipid nanoparticle."

Q. And you agree that in order to -- one reason why you would elicit an immune response is to make a vaccine, right?

MR. DANFORD: Objection to form.

A. Again, it just states an immune response may be elicited by delivering a lipid nanoparticle. Then it describes the lipid nanoparticle may include a nanospecies, polymer, or immunogen.

Q. So why else would you elicit an immune response other than to make a vaccine?

A. Again, I'm just reading what the word

choices are, right. I don't speculate more than that, right.

Q. So you don't know why --

A. Yeah. I'm not --

Q. -- you would make --

A. I'm not --

Q. Sorry. Let me -- I apologize. Let me finish my question.

So you're not aware of why a POSA would elicit an immune response using a lipid nanoparticle?

A. So, again, if I'm a POSA, I just read directly what is written down here, right. And what is written down is, you know, there's some words, right. Immune response may be elicited by delivering a lipid nanoparticle, right.

Q. So a POSA would not -- is it your opinion that a POSA would not understand why you would use a lipid nanoparticle to elicit an immune response?

A. A POSA would just read this and look at the sentence, right. And the sentence just says,

"An immune response may be elicited by delivering a lipid nanoparticle." And it essentially provides that lipid nanoparticle may include a nanospecies, a polymer, and an immunogen.

Q. So it's your opinion that a POSA would read the words on a page and not make any interpretations beyond what is in the words on the page, right?

MR. DANFORD: Objection. Mischaracterizes his testimony.

A. Yeah. They just read the words. A POSA, which I can tell you, I teach my students, is -- read the words, right. You need more context to it before you make conclusions, right.

Q. So in paragraph 397, do you see where it says, "An immune response may be elicited by delivering a lipid nanoparticle which may include a nanospecies, a polymer and an immunogen," correct?

A. That's what is written.

Q. So you'd agree that paragraph 397 discloses a lipid nanoparticle that includes an

immunogen, correct?

A. It says "a lipid nanoparticle which may include a nanospecies, a polymer and an immunogen."

Q. So one of the options for the payload of a lipid nanoparticle in paragraph 397 is an immunogen, correct?

A. It says it can include a nanospecies, a polymer and an immunogen.

Q. And if you go later down in paragraph 397, it says, "The immunogen may be a recombinant protein, a modified RNA described herein," correct?

A. It says, the third sentence, "The immunogen may be a recombinant protein, a modified RNA described herein."

Q. So in paragraph 397, you agree that Schrum discloses a lipid nanoparticle that can include a modified mRNA, correct?

A. No. It says the immunogen may be a recombinant protein. A modified RNA described herein, right.

Q. So it discloses two options for the immunogen, right?

A. So when I read that, it's a little bit unclear, right. Because it says may be a recombinant protein, right. A modified RNA described herein. So you can interpret that as the recombinant protein which comes from the modified RNA described herein or it's a modified RNA described herein.

Q. So in that sentence, Schrum is giving two options for the immunogen, a recombinant protein or a modified mRNA, correct?

MR. DANFORD: Objection.

A. I did not say that, right. It says the immunogen may be a recombinant protein, a modified RNA described herein.

Q. How do you interpret that sentence?

A. It's -- so that sentence could be of two combinations, right. Either a recombinant protein that is designed from a modified RNA or it could be a modified RNA, right. It could be a product or a precursor.

Q. So one option for the immunogen is a modified mRNA, correct?

A. No. Because if you look at this, it's a recombinant protein. There's different ways by which you can get to that point, right. That's why I was trying to -- I've been saying it's about the process of getting there. There's lots of different processes to get there, right.

Q. So do you see in the last sentence, it says, "In one embodiment, the lipid nanoparticle may be formulated for use in a vaccine"?

A. Yes. I see the -- that last sentence.

Q. You would agree that that last sentence discloses the use of a lipid nanoparticle for use in a vaccine, right?

A. Can you say that again?

Q. You would agree that the last sentence of paragraph 397 discloses the use of a lipid nanoparticle in a vaccine, correct?

A. Well, the last sentence states that the lipid nanoparticle may be formulated for use in a vaccine.

Q. Now, when it says "the lipid nanoparticle," which lipid nanoparticle is that referring to in your reading of paragraph 397?

A. So the lipid nanoparticles, the way I interpret this, they use the article "the" in front, right. It's "the formulation," the magic formulation that is involved in that process, right.

Q. Right. So because it's using "the," it's referring to a specific lipid nanoparticle, right?

A. The main one, right.

Q. When you say "the main one," are you referring to the lipid nanoparticles that are disclosed -- that are used in all of the examples as disclosed in example 16?

MR. DANFORD: Objection to form.

A. Again, if you just read by word, it just says "the lipid nanoparticle," right.

Q. And would it be a fair reading that "the lipid nanoparticle" in the last sentence is referring to the same lipid nanoparticle that is

in the first sentence of paragraph 397?

A. Again, from a semantics perspective, right, in the first one, it says "a lipid nanoparticle," which means it's not specific, it's a broad range. In the last sentence, it says "the." "The" means it's one. It's the main one. It's the magic one.

Q. So would you agree that "the lipid nanoparticle" is referring back to the lipid nanoparticle that is disclosed in the first sentence of paragraph 397?

MR. DANFORD: Objection.

A. No. As I said to you, the "a" refers to generally nanoparticles. "The" means "the." And my understanding of -- let's look at the word "embodiment." I know why, you know, you're asking. So it's, like, in one embodiment, in one case, then another one is in another case. And they're not necessarily related to each other, right. They don't have to be related to each other because of the way it's written, right.

Q. Do you understand these to be

alternative embodiments?

A. That, I don't know. I'm just saying if you combine with the article part, right, "the" and "a," I teach it all the time to my students, that article is very important in how it describes something. When I see something is "a" versus "the," it means very different things, right.

Q. I just want to be clear. It's your opinion that you don't know whether paragraph 397 discloses alternative embodiments, correct?

MR. DANFORD: Objection to form.

A. Again, you can use all the legal terms. I'm just saying that "a" lipid nanoparticle and "the" may not be linked because "the" just refers to a specific thing, right. It is like the magic formulation. We use that all the time, the term "magic formulation" when we design particle system. When you have "a," it's "a" something, right, doesn't mean it's "the" something.

Q. Beyond your interpretation of the terms "a" and "the," is there any other basis for you

to believe that example -- that paragraph 397 is disclosing two separate embodiments?

A. No. What I'm saying is it means, like, again, the "a lipid nanoparticle" refers to generally. And "the" means -- refers to a magic formulation, right. They may not be linked, right.

Q. So could the second sentence -- excuse me. Could the last sentence of paragraph 397 be referring to a specific lipid nanoparticle, whereas the first sentence is a more general description of a lipid nanoparticle?

MR. DANFORD: Objection. Form.

A. No. The first sentence states that an immune response may be elicited by delivering a lipid nanoparticle, right. It's a descriptor. And then the last sentence says the lipid nanoparticle may be formulated for use in a vaccine. So it refers to "the" nanoparticle, which is the magic lipid nanoparticle, may be used to formulate a vaccine. That's basically what it's saying --

Q. When you --
A. -- to me.
Q. When you say "the magic lipid nanoparticle," which lipid nanoparticle are you referring to?
A. I can't define it necessarily here. It just says "the," right. It's the magic formula, right.
Q. In order for a lipid nanoparticle to be used as a vaccine, would the lipid nanoparticle have to encapsulate a payload?
MR. DANFORD: Objection to form. Calls for speculation.
A. Can you ask the question in a different way?
Q. Sure. You agree that lipid nanoparticles are a delivery device, correct?
A. A lipid nanoparticle is a particle that contains lipid, lipid precursors.
Q. Would a lipid nanoparticle also have to contain something beyond the lipids themselves -- well, let me rephrase.

Do you agree that lipid nanoparticles are used to deliver drugs?

A. A lipid nanoparticle is just a particle that contains a lipid, right. It can be used to deliver drugs.

Q. What other uses are there for lipid nanoparticles?

A. People use lipid nanoparticles for research, right. They look at lipid bilayer structures. You look at how lipids form on a surface. So there's lots of different uses and applications, right.

Q. In the clinic, are you aware of any use for lipid nanoparticles other than to deliver drugs?

MR. DANFORD: Objection to form.

A. Again, I'm not a clinician, so I cannot comment on the broad utility of lipid-based systems, right.

Q. Suppose that you had a lipid nanoparticle that had no payload. Do you understand what I mean by that?

A. (Witness nodded.)
Q. Yes?
A. Yes. Sorry.
Q. Would a lipid nanoparticle that had no payload be useful as a vaccine?
MR. DANFORD: Objection. Calls for speculation.
A. Can you ask it a different way?
Q. Sure. Would a lipid nanoparticle that didn't encapsulate any payload be able to elicit an immune reaction against a pathogen?
MR. DANFORD: Objection. Calls for speculation.
A. Again, you need to be more specific.
Q. What other information would you need?
A. Rephrase the question, and I will tell you.
Q. Would a lipid nanoparticle that didn't encapsulate any payload be able to elicit an immune reaction against a pathogen?
MR. DANFORD: Objection. Calls for speculation.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 193 of 375

A. Again, you have to define more specifically the pathogen, the payload.

Q. Are you aware of any lipid nanoparticles that are used for a vaccine that did not carry any nucleic acid?

MR. DANFORD: Objection to form.

A. Say that again.

Q. You agree that lipid nanoparticles can be used as a carrier for nucleic acid, correct?

A. It's been demonstrated that nucleic acids can be loaded on the surface of lipid nanoparticles as well as inside as well.

Q. And you'd agree that Spikevax and Comirnaty are both -- both include lipid nanoparticles that encapsulate mRNA, right?

A. Both of those particular formulations has mRNA in them.

Q. Are you aware of a vaccine that uses lipid nanoparticles that didn't encapsulate mRNA?

MR. DANFORD: Objection to form.

A. Again, as I said, like, that's the immunology part. If you ask more specifically

from the formulation part, then I can describe that. That is my expertise, right.

Q. Do you understand what -- rephrase.

If I use the term "empty lipid nanoparticle," would you understand what I'm referring to?

A. Can you define what "empty" means?

Q. Sure. An empty lipid nanoparticle is a lipid nanoparticle that did not encapsulate any nucleic acid or protein.

A. Can it -- does it encapsulate other types of molecules?

Q. Sure. So you understand what "encapsulate" means, right?

A. Sure.

Q. Okay. Would you understand an empty lipid nanoparticle to be a lipid nanoparticle that didn't encapsulate anything?

A. What do you define as "empty"?

Q. How would you refer to a lipid nanoparticle that didn't encapsulate anything?

MR. DANFORD: Objection to form.

A. Again, it's the specificity of that, right. The reason I ask that question is because of the fact that when you have a hollow nanoparticle system, they still can contain things, right.

And the way we think about empty may be, like, a room, there's nothing in there. But in biology, in lipids, all these things for nanoparticle, there may be stuff that's still in there that you just can't see, right.

Q. Can you identify any vaccine that uses lipid nanoparticles that did not encapsulate any nucleic acid?

MR. DANFORD: Objection to form.

A. Can you say that again?

Q. Are you aware of any vaccines that use a lipid nanoparticle that do not encapsulate any nucleic acid?

MR. DANFORD: Objection to form.

A. Again, it's a very general question, right. And, you know, I would -- again, if we look at the formulation design, the chemistry

design, we can talk about it in more detail, right. Because this is a very general statement you're essentially asking me, right.

Q. So you can't identify any vaccines that use a lipid nanoparticle without a nucleic acid?

A. No. You're asking me a very general question in terms of that, right.

Q. Have you ever designed a vaccine before?

A. Again, what my lab works on, as I stated earlier, is we develop nanoparticles and we study the transport behavior of the nanoparticles, and that information gets published out. And how people use that information depends on them.

Q. Do you understand what I mean when I say "a lipid nanoparticle that doesn't encapsulate nucleic acid"?

MR. DANFORD: Objection to form.

A. Again, what is your definition of "encapsulation," right?

Q. Have you ever used the word

"encapsulation"?

A. I have used that word.

Q. Okay. So use the meaning that you apply to it.

Do you understand what I mean when I say "a lipid nanoparticle that does not encapsulate nucleic acid"?

MR. DANFORD: Objection to form.

A. Repeat it in a different way.

Q. So you don't understand what that means? You do not understand what the term -- a lipid nanoparticle that does not encapsulate nucleic acid?

A. Lipid nanoparticle that does not encapsulate -- does not encapsulate -- your word choices are bizarre. Like, "does not encapsulate" is a negative in there, right. Can you make it, like, not negative in there, and make it a positive?

Q. You understand what the term "encapsulate" means, right?

A. To put something in a system.

Q. Do you not understand what the terms "do not encapsulate" mean?

A. Why don't you ask does a lipid nanoparticle encapsulate something?

Q. Do you understand --

MR. LIU: Respectfully, if this continues, we are going to have to call the board because the witness is being extremely evasive and deliberately not answering questions.

MR. DANFORD: That is not true. You have not asked a straightforward question. You're asking him all these hypotheticals without any context. I think you need to ask better questions.

He is trying, trying with the questions that you're asking him. They're not appropriate questions. Ask him a focused question. He will answer you. He has been giving you answers when you have asked appropriate questions.

THE WITNESS: Counsel, I also want to mention in addition to that, I'm telling you my lane and my expertise is in a certain area,

right. And you're asking me questions that in this framework that is very general that doesn't allow me to answer my question from where my expertise is.

That's why I'm trying to get clarification for this. And, again, there's always two ways to ask the question, right. A positive and a negative mode, right.

MR. LIU: Counsel -- I'm sorry. Excuse me.

Q. Dr. Chan, I'm going to ask my questions however I choose.

A. I understand that, right. But if you want me to answer, and my interpretation of an answer that provides for you is depending on how you answer the questions.

Q. You understand that you have an obligation here to undertake a best effort to answer my questions truthfully, right?

A. That is correct.

Q. Now, do you understand what the term "does not encapsulate" means?

MR. DANFORD: Objection to form.

A. Again, can you ask that in a positive framework, right.

Q. You understand what "encapsulate" means, right?

A. Yes.

Q. You do not understand what "does not encapsulate" means.

A. It creates confusion. I tell my students not to write in confusion or ask questions in confusion framework, right.

Q. You understand what "encapsulate" means, but you don't understand what "not encapsulate" means?

A. It could mean a lot of things. Just putting "does not," right.

Q. So if I said to you this lipid nanoparticle does not encapsulate nucleic acid, you wouldn't know what that means?

MR. DANFORD: Objection to form.

A. I can explain why, right. Because encapsulation, the way the formulation scientist

looks at it, is defined by sometimes percentage and amount, right. The fact that you say "does not encapsulate," if you have .01 percent versus 1 percent, it does not mean it does not encapsulate nor encapsulate, right.

Because the way you ask the question -- and I'm not giving you a lesson on how to ask the question. You ask it however you want. But it is creating ambiguity. And because it's creating ambiguity without defining numerical numbers, which is what I've been trying to say. If you ask it where there's a specific number associated or activity associated, then I can provide a more specific answer. But by asking things in a general framework -- in science, it's defined by some of these parameters.

Q. So have you ever encountered a lipid nanoparticle that did not contain any nucleic acid in it?

MR. DANFORD: Objection to form.

A. So, again, when you make a lipid nanoparticle without any agents in it, you make a

lipid nanoparticle, right.

Q. Okay. So you understand -- so you used the term "a lipid nanoparticle without any agents in it" just now. I assume you understand what that means, right?

A. Generally.

Q. Would you agree that a lipid nanoparticle without any agents in it -- let me rephrase.

Are you aware of any lipid nanoparticles without any agents in it that have been used in a vaccine?

MR. DANFORD: Objection to form.

A. Again, as I stated, I don't look through the vaccine literature in detail. I understand, you know, a nanoparticle and what you measure as an outcome, and I understand the lipid nanoparticle literature and where that is at.

But you're asking me to be familiar with vaccines, when that is not my full field of activity. I understand what you measure, right, from the formulation side.

Q. You said you reviewed the literature, right? Or you're generally aware of the literature on lipid nanoparticles?

A. I know the lipid nanoparticle literature.

Q. So based on that -- and you believe -- contend -- let me rephrase.

And you contend that you are a POSA in the field as of the priority date, right?

A. Yes.

Q. So as a POSA in the field, are you aware of any lipid nanoparticles without any agents in it that have been used as a vaccine?

MR. DANFORD: Objection to form.

A. Okay. Let's break it down. If you can ask me that question in two different frameworks, right.

Q. I'm entitled to an answer to the question that I've asked.

Are you aware of any lipid nanoparticles without any agents in it that have been used as a vaccine?

MR. DANFORD: Objection to form.

A. Again, as I said this before, right, break it down into -- if you want me to answer it, to be -- to get clearer so I understand what you're trying to ask, then you break it down to two questions, right.

Q. Are you able to answer the question, as phrased?

A. No. Because your question is ambiguous to me.

Q. So let's try this again before we go to the board.

Are you aware of any lipid nanoparticles without any agents in that have been used as a vaccine?

A. Again, as I said, you need to break down the question, right?

Q. So you understand lipid nanoparticles without any agents in it. That's a phrase you used, right?

A. So a lipid nanoparticle can -- when you make it, it will contain water inside, so that's

an agent. And so when you make it, that's essentially what we have.

Q. Dr. Chan, you used the term "lipid nanoparticle without any agents in it," right?

A. Okay. Lipid nanoparticle with water inside.

Q. And you would consider that's not a pharmaceutically active agent, right?

MR. DANFORD: Objection to form.

A. Again, I don't know what that part is used for. It's just when I synthesize lipid nanoparticles, if I don't put any agent, it still contains water molecule.

Q. Again, you used the term "lipid nanoparticle without an agent," correct?

A. Again, when we make the lipid nanoparticle using the normal method, right, inside the lipid nanoparticle will contain water because it's hydrated in water. It's just the way it's designed.

Q. Would you characterize that as a lipid nanoparticle without an agent inside of it?

MR. DANFORD: Objection to form.

A. Depending on if water is considered an agent or not, right. And it depends on maybe different applications.

Q. Sitting here today, Doctor -- sitting here today, can you identify a lipid nanoparticle without an agent in it that has ever been used as a vaccine?

A. As I said, I don't look at the vaccine literature, right, or the vaccine clinical trials or what companies develop in terms of that.

As an academic, I understand how to make a lipid nanoparticle. I understand when you are using it for a medical purpose that you need to measure something as an outcome, and the outcome indicates whether that lipid nanoparticle has achieved what you're trying to achieve, right.

And then we work with collaborators who becomes the other part, which is their expertise to help us interpret that part of the equation.

Q. Dr. Chan, do you understand what the term "divisional application" means in the

context of a patent?

A. Again, legal terminologies, I'm not a lawyer or a patent agent.

Q. Do you know how to determine whether two patents are in the same family?

A. Again, those are legal questions and patent agents, and I'm neither one, right.

Q. So you don't know how to determine whether two patents are in the same family, right?

A. Again, that's for the -- I pay lawyers and patent agents. They tell me what to put in those things and -- or they explain things.

Q. So if I told you to find all the patents that are in the same family as Schrum, you wouldn't be able to do that, right?

A. I would look up the category of the topic and able to see the relationship.

Q. But you wouldn't be able to identify all the patents that are in the same family as Schrum, right?

A. If I go Google Patents, they link

enough relationship of patents that you can figure this out, right.

Q. So how would you find all the patents that are in the same family as Schrum?

A. I use Google Patents when I've done it.

Q. And using Google Patents, how do you find all the same patents that are in the same family as Schrum?

A. What I usually do, this is just how I do my literature search, and probably do the same thing for patent, is that when I read the main paper, I read the paper through, figure out what is interesting or what the relationships are. Then I look up those papers, right. And I read those papers, and then if there is something interesting there, you then look up those papers.

Eventually, someone who is educated would know that there is a relationship, references from one paper to the next paper. So when you do that, you start to understand the relationship between the two.

Also in the academic literature, in terms of

the same topic, a lot of times they come from the same family of -- from the same family of PIs, so you can also map those out, right. And then that gives you a very complete picture of how everything is related.

Q. So in the context of two patents, how do you know whether those two patents are in the same family?

A. You look to see how they are referring to each other. And then sometimes they mention and then, based on that, you can look at that. Sometimes you contact the inventors. I've done that for papers as well if I'm not sure.

Q. So if two patents have related subject matter, would you consider them to be in the same family?

MR. DANFORD: Objection to form.

A. That is, for me, very difficult to answer because, again, I'm not a patent agent or legal person, right. If I think that there is a relationship, I would contact the inventor. It's very common in academia to contact the authors of

things.

Q. Can you turn to paragraph 130 of your declaration. Do you see in paragraph 130 you say "other patents in the same family as Schrum"?

A. Mm-hmm.

Q. Okay. And when you use the term "family," on top of paragraph 130, what did you mean by that?

A. So these are patents that are related to each other.

Q. You see the '720 -- what do you mean by "related to each other"?

A. The themes and the topics, right.

Q. So you believe that two patents are in the same family if the themes and the topics are similar to each other?

MR. DANFORD: Objection to form.

A. No. I mean, you have a history here, right. I mean, look at the Schrum on the first page, right. It says provisional patent application 61/576, filed on whatever, provisional application, provisional application,

right.

Q. Okay. Now, you don't see the '720 application that is listed in any of these provisional applications, right?

I'm sorry. Excuse me. You don't see the '458 application listed anywhere in these provisional applications, right?

A. I have to look at what the '458 is.

MR. DANFORD: You mean the one that is listed on the face of this --

A. It says "Division of Application Number 13/714,458, filed on December 14, 2012."

Q. How do you know that's a divisional application?

A. I mean, you look up the application, right. It's divisional provisional. It's the same thing as looking at a research paper, right.

Q. What does "divisional application" mean?

A. I don't know exactly.

Q. Do you know if there's other divisional applications that were based on the same parent

application?

A. Well, I don't know. It just -- there is specific applications here. You look the applications up.

Q. So you don't know if there's other divisional applications that might have issued from the '458 application, right?

A. Yeah. I just look up what is presented, right. You look up the patents, right.

Q. You also opine in paragraph 130 that there's two granted U.S. Patent applications originally from the '458 application, right?

A. On which page?

Q. On paragraph 130 of your declaration.

A. Okay.

Q. Do you see there's two granted U.S. applications originally -- originating from the '458 application?

A. Mm-hmm.

Q. How did you find that?

A. You can look up all these patents,

right.

Q. Is it your testimony under oath that you yourself looked up these two patent applications that issued from the '458 application?

A. I mean, in the discussions with the lawyer, the patents were up, and I looked up individual patents on Google Patent, right, as I need references.

Q. So did you personally find the two issued applications that are here?

A. So I don't remember which ones I found and which ones were provided, but I did Google searches, Google Patent searches on these things, right.

Q. Can you describe the process in which you discovered that the '996 and the '689 patents originated from the '458 application?

A. Yeah. I don't recall. As I was preparing for this case the last couple of months, I was on Google Patent all the time, right, as things were interesting as I was

reading through the patents, right.

I mean, that's what I usually do when I read anything, right. Google is always in front of me. I look things up. I don't remember numbers or specifics. Sometimes when I write a report, it essentially provides that information, but I don't recall all the details and steps along the way, right.

Q. What does "divisional application" mean to you?

A. We already covered it, right. I don't know exactly the meaning of that.

Q. Right. Did you write this paragraph, Dr. Chan?

A. So as I said, when we worked on these things together, the science, I contributed to that and the sort of the discussions about how patents are related, and then the lawyers at WilmerHale draft the legal language and legal relationships on these things, right. Because I don't have a legal background.

Q. So some portions of the declaration

were drafted by your lawyers?

A. The legal stuff, right.

Q. Now, did your lawyers identify the applications that are discussed in -- starting at paragraph 130?

A. I don't recall. They provided some patents. I had some patents. I looked up patents along the way as I was preparing these things. And I usually do that for context, right. Because as you start reading the patents, there are things that they refer to, and then you look up those particular information.

MR. LIU: Why don't we break for lunch.

(Lunch recess was taken.)

BY MR. LIU:

Q. Welcome back, Dr. Chan.

A. Thank you.

Q. Over lunch, did you speak with your attorneys about the content of your testimony today?

A. No, I have not.

Q. Can we turn to paragraph 37 of your

declaration.

A. Okay.

Q. And do you see on the last sentence of paragraph 37 you say that "I agree with Dr. Moon, the technology overview section of Dr. Moon's declaration is indeed far from comprehensive"?

A. Talking about the last sentence in paragraph 37?

"I agree with Dr. Moon, the technology overview section in Dr. Moon's declaration is indeed far from comprehensive."

Q. You have your own technology background section in your declaration, right?

A. Yes.

Q. Do you contend the technology background section of your own declaration to be comprehensive?

MR. DANFORD: Objection to form.

A. I think that the technology section here is pretty comprehensive.

Q. And off the top of your head, you're not aware of any relevant technology that you've

excluded from the technology background section?

MR. DANFORD: Objection to form.

A. I guess that's -- to me, that's -- can you repeat the question in different ways?

Q. Sure. Are you aware of any relevant technology -- let me rephrase.

Are you aware of any technology relevant to the validity of the '600 and '127 patents that you've excluded from the technology background section of your declaration?

MR. DANFORD: Objection to form.

A. So can you be more specific in terms of what technology that you consider me to exclude from the document?

Q. Sure. Did you include every -- did you include the entire technical background that you would consider to be relevant for the validity of the '600 and '127 patent?

A. Again, I don't mean to be difficult, right. I'm trying to get more specificity, right, because "technology" is broad, right.

Q. So you discuss a number of delivery

vehicles for nucleic acids in the background section of your declaration, right?

A. That's correct.

Q. Can we go to paragraph 43 of your declaration. You refer to protamine, right?

A. That is correct.

Q. Earlier we had looked at all the examples that were disclosed in Schrum, right?

A. We looked at the Schrum patent and looked at the description of the different types of nanoparticle, microparticle delivery systems.

Q. Do you recall looking through the working examples in Schrum?

A. Yes. We discussed that earlier.

Q. When you reviewed those examples, there were no working examples of using protamine to deliver mRNA in Schrum; right?

MR. DANFORD: Objection to the form.

A. Within the Schrum patent, they -- I do not believe they discuss protamine.

Q. And if we go to paragraph 51, you also talk about the use of polysaccharides, including

cytosine, to deliver mRNA, correct?

A. Yes. The section informs about polysaccharide, and cytosine polymers were discussed in this section.

Q. And let me rephrase.

The section in which you are discussing polysaccharide refers to the delivery of nucleic acids generally, correct?

MR. DANFORD: Objection to form.

A. Can you rephrase that?

Q. Sure.

So you say in paragraph 51 that cytosine synthesized vectors had been investigated and developed to deliver nucleic acids for nearly two decades, right?

A. It states it was shown to be particular promising for synchronizing nine viral vectors for successful nucleotide delivery of a nucleotide in vivo.

Q. Now, the examples in paragraph 53 of the use of cytosine to deliver nucleic acids are of DNA vaccines, correct?

A. Yes. Here the topic sentence is the cytosine was used to deliver DNA vaccines.

Q. So is it your opinion that the use of cytosine to deliver DNA vaccines would have been relevant to a POSA who was attempting to develop an mRNA vaccine?

MR. DANFORD: Objection to form.

A. Can you please state that question in a different way?

Q. Sure.

MR. LIU: If you don't mind, can we go off the record for just a second.

(Discussion off the record.)

BY MR. LIU:

Q. So if we take a look at paragraph 53, you're discussing the use of cytosine to deliver DNA vaccines, right?

A. Yes. The topic sentence states cytosine was used to deliver DNA vaccines.

Q. Would you agree that the use of cytosine to deliver DNA vaccines would have been relevant to a POSA who was trying to develop an

mRNA vaccine?

MR. DANFORD: Objection to form.

A. Maybe I can explain a little bit of how this section was structured, right.

This section was focused on developing and -- providing examples of different delivery technologies, and it presented an example of a cytosine polysaccharide delivery system.

And each of the paragraphs, the way they're structured is that to provide some examples of -- 52 just explains some of the advantages in the structure, but then 53 provides one example of how cytosine has been used as a delivery strategy, right.

And if you look at the other sections as well, you know, 55 is another example where now we present another example of a delivery strategy using cytosine, right.

So it -- in lots of documents, when we write papers, we essentially provide history of something. And this is what the -- how this is written in this particular context, right.

Q. So let's say a POSA was trying to develop an mRNA vaccine in 2015. Would a POSA have looked to the literature in cytosine delivery of DNA vaccines?

MR. DANFORD: Objection to form.

A. Yeah. A POSA, if they're essentially trying to deliver -- to develop a delivery technology, what they do is they look at the literature to see what the possibilities are, right.

So you look at the literature to see what is available just for your own knowledge base, right. You can look at the patent literature. You can look at the academic published literature. You can go to conferences. And so you just want to see examples of delivery technology.

Q. So then the technology that was being -- let me rephrase.

So the research into DNA vaccines that was available as of the priority date would have been relevant to a POSA who was trying to develop an

mRNA vaccine, correct?

MR. DANFORD: Objection to form.

A. No. So the way a POSA would look at it is that -- if you have a POSA would look at it, from my perspective, right, as a delivery person, is what are the delivery technologies out there, what are the possibility of the delivery technologies for you to understand the scope of the field, right.

Q. When they look at the delivery technologies that are out there, would they look at the delivery technologies that had been developed for DNA vaccines?

MR. DANFORD: Objection to form.

A. Sometimes when you look at the delivery technology, just -- it's just delivery technologies, in general, right.

Q. So would the POSA have looked at delivery technology that had been specifically developed for DNA vaccines?

MR. DANFORD: Objection to form.

A. So the bigger picture is that in terms

of -- it's, like, the main focus is the nanoparticle system. That's what you look at first, right.

Q. So when you -- in the section in which you discuss cytosine, you don't refer -- you don't provide any examples in which cytosine is used to deliver mRNA, correct?

A. Well, I think the example that I provided was cytosine to deliver DNA vaccine, cytosine plasma DNA nanoparticles for oral administration, and then another example in number 55 is cytosine-based delivery system used to successfully deliver siRNA in several contexts. So it's basically for cytosine delivery systems for siRNA.

Q. Just to be clear, none of the examples you just discussed relate to the use of cytosine to deliver mRNA, correct?

A. Can you say that in a different way?

Q. The examples that you just discussed that are in your declaration, none of them relate to the use of cytosine to deliver mRNA, correct?

A. The examples I provided were cytokine for delivering DNA vaccine, cytosine for plasma DNA systems, and then the other one was cytosine-based delivery systems to successfully deliver siRNA.

Q. Now, the next system you discuss is PLGA, correct?

A. Yes.

Q. Now, do you remember earlier when we were discussing PLGA, I believe you explained that this was a delivery system that would have been particularly interesting to a POSA as of the priority date based on Schrum.

Do you recall that?

A. Yes.

Q. So -- and do you contend that Schrum discloses examples of PLGA delivery systems?

A. Yeah. So I want to go back to refer to page 46 of my declaration because Schrum points to PLGA microspheres as a carrier for mRNA.

The reason I mention this is because in these sections, I sort of took it out to explain

why PLGA was a good carrier for formulating mRNA.

And so I'm just going to read one section, which is "the formulation of modified mRNA may be a PLGA microsphere which may be between 4 to 20 micrometers in size. So the modified mRNA may be released from the formation at least -- at less than 50 percent in a 48-hour time period."

So release, again, as I stated earlier, was sustained release. And so that's a property of PLGA.

The second property is that the PLGA microsphere formations may be stable in serum, which is quite important.

And then I can't find it, so I'm not going to continue on, but the other one is that PLGA could be lyophilized, which is another advantage for transport and -- it's actually on page 49. It's important in terms of -- in terms of storage and transport.

Q. So in contrast to PLGA, is it your opinion that the lipid nanoparticles disclosed in Schrum are not good carriers for a vaccine?

MR. DANFORD: Objection to form.

A. I did not say that. If I was a POSA at that time, when I design a carrier system, I particularly may want to design the carrier system with a certain property.

And so when you look at PLGA microspheres as stated on page 46 and continuing on 49 that PLGA can release mRNA, so it has sustained-release properties. It's also very stable in serum, which is the second aspect here. And the third aspect is that it can be lyophilized. And as I mentioned, lyophilized allows storage and potentially transport.

Q. So those are the benefits of a PLGA system, in your opinion, correct?

A. For this particular context for delivering modified mRNA.

Q. Now, in your opinion, are the LNPs that are disclosed in Schrum also suitable for use in a vaccine?

MR. DANFORD: Objection to form.

A. Okay. So the way I look at it as a

POSA, right, because you have a certain amount of time in terms of developing something, you need to rationalize why you picked that particular delivery technology.

As indicated in Schrum, and what was known at that time, is that polymer-based particle system, specifically PLGA, has the three advantages I mentioned before, right. It has sustained release, it's stable, and because of lyophilization, it can be good for transport.

Q. I understand that you contend the PLGA has advantages. I understand. You've testified to that a few times.

What I want to know is, is it your opinion that the lipid nanoparticles disclosed in Schrum are not suitable for use in a vaccine?

MR. DANFORD: Objection to form.

A. What I'm trying to present to you, right, is that if I was a POSA at that particular time, and if I'm trying to think of what is the best delivery formulation, you have to look in the literature, you look at patents to see which

is the best formulation for you to go after, right.

Q. I'm not asking which is the best formulation. I'm asking you whether it's your opinion that the lipid nanoparticles disclosed in Schrum would have been suitable for use in a vaccine.

MR. DANFORD: Objection to form.

A. Yeah. But what I'm trying to tell you, a POSA, when they're essentially deciding whether they spend their resources, to work on a delivery technology, you have to rationalize it before you work on something, right. Because if you -- you know, if you can't rationalize it, then you're just essentially randomly picking a delivery technology and there's a lot of delivery technologies out there.

Q. Dr. Chan, respectfully, I don't believe you're answering my question.

Are the lipid nanoparticles disclosed in Schrum suitable for use in a vaccine?

MR. DANFORD: Objection to form.

A. Again, we're going to come back to the earlier discussion, right, about lipid nanoparticles and for vaccine, right, again, depending on the metrics by which you're using to determine whether something is suitable or not.

So if I'm a POSA at that particular time, I look at the literature and I have to make a rational argument for myself why I go after a certain formulation, because if you go into a certain delivery design, you're going to waste a lot of time, right.

Q. So is it your opinion that a POSA would not have rationalized the use of lipid nanoparticles to deliver a vaccine based on the disclosure in Schrum?

MR. DANFORD: Objection to form.

A. Again, like, can you state this in a different way? I don't like the "nots." That's why I keep on bringing that up. Can you say that in a different way?

Q. Would a POSA have rationalized the use of lipid nanoparticles to deliver a vaccine based

on the disclosure in Schrum?

MR. DANFORD: Objection to form.

A. Again, a POSA would select the best candidate for them to invest their time and resources. And given that PLGA microspheres have the properties I mentioned earlier, the sustained release, the stability, and the ability to transport, that's what I would have gone with.

Q. Are those the only parameters that a POSA would have considered in determining whether a delivery system is suitable for a vaccine?

MR. DANFORD: Objection to form.

A. At that particular time, these particular properties were attractive to a POSA for this particular intended purposes.

Q. Are there other parameters that a POSA would have considered in determining whether a delivery system is suitable for a vaccine?

A. So, of course, one parameter would be that it has to be delivered to the target, right. I mean, that's -- that is a general framework.

But aside from that, that's a generality,

then you look at properties, right. Stability -- I'm just going to go into a little bit more detail about stability and lyophilization.

Q. Respectfully, Dr. Chan, that's not my question.

Are there other parameters other than stability, lyophilization, and the parameters that you discussed in your report that would -- that a POSA would consider in determining whether a delivery system is suitable for a vaccine?

MR. DANFORD: Objection to form.

A. So the reason I'm explaining this way to you is because whenever you design the system, there is a certain priority of properties that you want to go after, right.

Those priorities of properties become very important in terms of how you do your first set of efforts. Those things are, again, sustained release, stability, and transport, right. The ability to do storage and transport.

I'll give you another example. If -- even if you develop a technology and it works

perfectly, right, but you cannot store it or transport it, then it may not be broadly useful, right. So you look at these properties as the key properties at the beginning.

Q. As of the priority date, is it your opinion that a POSA would have used LNPs as a delivery vehicle for an mRNA vaccine?

A. I keep on saying as a POSA, I have to pick the winners, and the winners are based on what I read in the literature, I read in the patent landscape potentially, and then you have these properties.

It's very well argued in the Schrum patent about PLGA microspheres, why are they useful for protein replacement therapy.

Q. And is it your opinion that a POSA would not have used LNPs because PLGA was better?

MR. DANFORD: Objection to form.

A. No. When you do experiments, you have only a certain amount of time and resources. You go to the literature, figure out which of these particular delivery technologies will have the

properties that you desire, and that's what you start to go after.

Q. Is protein expression a parameter that a POSA would consider in determining whether a given delivery system is suitable for use in a vaccine?

MR. DANFORD: Objection to form.

A. So protein expression refers to the ability to generate an agent, right. So in some sense, again, if you're looking from a delivery technology perspective, you need to be able to release the agent so you can actually produce the product at the end, right.

Q. So you agree that protein expression would be a relevant parameter for a POSA to consider in determining whether a delivery system is suitable for a vaccine?

MR. DANFORD: Objection to form.

A. Again, it depends on the quantification of protein expression, right.

Q. So in terms of quantification of protein expression, you would agree that a higher

level of protein expression is generally desirable for a delivery system, correct?

MR. DANFORD: Objection to form. Calls for speculation.

A. Yeah. That's -- so can you repeat that question.

Q. Sure. Do you agree that it's -- a higher level of protein expression is generally desirable for a delivery system for nucleic acids?

MR. DANFORD: Same objection.

A. Again, for that particular question, yes and no.

Q. So you're unable to answer the question, as posed?

MR. DANFORD: Objection to form.

A. No. I'm just giving you a response in terms of -- it depends on, again, the context of it, right. What the application and what you're trying to apply it to.

Q. Do you still have Schrum in front of you?

A. Yes.

Q. Can you turn to paragraph 406 of Schrum.

A. Okay.

Q. And paragraph 406 starts with the sentence, "Liposomes, lipoplexes or lipid nanoparticles may be used to improve the efficacy of modified nucleic acid molecules or mmRNA-directed protein production," correct?

A. It says -- yeah. Okay.

Q. And the last sentence of that paragraph says, "The liposomes, lipoplexes or lipid nanoparticles may also be used to increase the stability of the modified nucleic acid molecules or mmRNA," correct?

A. It states that "the liposomes, lipoplexes or lipid nanoparticles may also be used to increase the stability of the modified nucleic acid molecules or mmRNA."

Q. So Schrum teaches that lipid nanoparticles can be used to improve the stability of mmRNA, correct?

MR. DANFORD: Objection to form.

A. No. But the thing is, what I was saying is that PLGA microsphere formation may be available in serum.

Here, in the -- Schrum says the liposome lipoplexes or lipid nanoparticles may be used to increase the stability of the modified nucleic acid. So this one is referring to -- based on how it's written, it says the stability of the modified nucleic acid.

The PLGA microsphere form may be stable in serum. They're referring to the microspheres in that sentence.

Q. So I want you to turn back to your discussion of PLGA in the background section of your report. That's paragraph 57.

Okay. So in the paragraph in which you discuss PLGA, you just referred to the section of your discussion on Schrum, right?

A. Fifty-seven? Says to the extent a POSA would have been applying Schrum in the context -- I'm just reading the first sentence.

Q. I think we're on a different -- paragraph 57.

A. Oh, paragraph 57. Okay.

Q. And in paragraph 57, when you're talking about PLGA in the background section, you're just referring to your discussion with respect to Schrum's disclosure of PLGA, right?

A. Yeah. So the -- Schrum goes through the detail to describe the sustained release, the stability, and the lyophilization.

Q. After 2015, are you aware -- let me rephrase.

You don't describe any vaccines that use PLGA as a delivery mechanism, right?

MR. DANFORD: Objection to form.

A. Again, when we're looking at delivery systems, you look at all the possibility of a nano- or microparticle system, right.

Q. Dr. Chan, in your declaration, you do not identify any vaccines that use PLGA as a delivery mechanism for a vaccine, correct?

MR. DANFORD: Objection to form.

A. So within my declaration, I'm focused on the section in terms of the different types of delivery technologies out there.

Q. Do you or do you not identify a vaccine that uses PLGA as a delivery mechanism in your declaration?

MR. DANFORD: Objection to form.

A. So in my declaration, what I have here is in the description on page 18 about protamine, right. So protamine complex mRNAs tested as vaccines against influenza in animal models.

Q. Protamine is not PLGA, right?

A. No. But I essentially provide that as an example because of the fact that CureVac was developing protamine for the purpose of delivering mRNA, right, as a vaccine.

Q. So in your declaration, you do not identify a vaccine that uses PLGA as a delivery mechanism in a vaccine, right?

MR. DANFORD: Objection to form.

A. No. But I'm describing PLGA is -- at that particular time, it was a very popular

polymer delivery technology, right. And it was a popular delivery technology with lots of appealing features for different kinds of delivery purposes.

Q. And you don't identify a single example in which PLGA was used in a vaccine, right?

A. Here, I provide examples of this particular polymer -- I focus on the -- sort of the properties of the PLGA delivery system, right.

Q. Sitting here today, are you able to identify a single vaccine that uses PLGA as a delivery mechanism?

MR. DANFORD: Objection to form.

A. Again, if you're a POSA at that particular time, the way I look at it is I'm looking for a delivery technology as to which is the best delivery technology to be able to deliver mRNA to a targeted site, right.

Q. Dr. Chan, I'm entitled to an answer to my question. I'm reminding you again that you're under oath. If the answer is I don't know,

that's fine. If you don't know the answer to my question, you can say that.

But my question is, sitting here today, are you able to identify an example of a vaccine that uses PLGA as a delivery mechanism?

A. So the way I'm responding to you is I'm putting myself in the mindset of a POSA at that particular time. When you have an agent you want for a specific purpose, you look in the literature to figure out what is out there in terms of delivery technologies. And you look at certain properties that you want in those particular delivery technologies. And that is what I'm saying with this, right.

Q. Let's try this again. It's a yes or no question. Why don't we start with: Are you able to identify an example of a vaccine that uses PLGA as a delivery mechanism?

MR. DANFORD: Objection to form.

A. Again, I'm trying to tell you what -- the context of where I would be if I was starting a project to work on vaccine delivery, right.

Q. Are you able to answer the question yes or no?
A. I'm just providing context, right.
Q. Can you answer yes or no to the question?
A. I am providing context.
Q. So are you refusing to answer yes or no to the question?
A. I'm not refusing. I'm providing context, right.
Q. So are you able, yes or no, sitting here today, to identify an example of a vaccine that uses PLGA as a delivery mechanism?
MR. DANFORD: Objection to form.
A. Again, I'm just providing context as I'm thinking, right.
Q. So let's go to paragraph 25 of your declaration. I'm sorry, excuse me. Let's go to paragraph 65 of your declaration.
A. Paragraph 65.
Q. And in paragraph 65 of your declaration, you discuss the use of a gene gun,

correct?

A. Yes.

Q. Just to be clear, a gene gun is a helium-powered gun that propels gold beads loaded with mRNA; is that right?

A. Yup.

Q. Okay. Have you ever seen a gene gun used clinically to deliver a vaccine?

MR. DANFORD: Objection to form.

A. Can you rephrase the question differently?

Q. Sure.

Have you ever seen -- are you aware of a gene gun ever being used to deliver a vaccine in the clinic?

A. So, again, I'm not a clinician. I'm not working for a pharma. And so what I know about gene guns lies with what is done academically. And a gene gun is very commonly used at that time for delivering mRNA as well as other agents into a target site.

Q. How would this work if I was to use a

gene gun to receive an mRNA vaccine against COVID, right? Well, why don't I turn that into a question.

If I was to receive an mRNA vaccine against COVID in a clinic using a gene gun, how would that work?

MR. DANFORD: Objection. Calls for speculation.

A. So at that particular time or currently?

Q. As of the priority date.

A. Scientists do funny things, right, in terms of how to get things to work, right. So gene guns can potentially still introduce agents into the bloodstream, right.

Q. Are you aware of a single instance in which a gene gun has been used to deliver a vaccine in humans?

MR. DANFORD: Objection to form.

A. Again, a gene gun using gold nanoparticles has been used for delivering agents into the bloodstream, right -- or into cells,

actually. People use that --

Q. You understand my question was directed to vaccines, right?

A. I understand. But what I'm trying to say is from the clinical side, that's not my forte. I don't pay attention to that part. I focus on the sort of delivery technology, which is a gene gun.

What I'm trying to tell you is that what the gene gun has been used for, right. If I was -- my expertise was more in the clinical part or the pharmaceutical part in terms of the translation part, then I would have all that in place, right.

What I'm trying to address to you is at that time, gold particles gene gun was used for delivering nucleic acids. They've been used for proteins, they were done -- people have done it in different types of biological systems, right.

Q. You would agree as of the priority date, LNPs were also used to deliver nucleic acids, right?

A. So in 2000 -- in the early 2000s,

right, LNPs was demonstrated -- let me see. I think I list it here, just for me to recall. So here, in page 22 or so, I sort of highlighted lipid-based delivery technologies, cationic nanoemulsions.

The Brito paper describes cationic emulsion systems to bind self-amplifying RNA for enhanced delivery of saRNA and increased the potency for saRNA vaccine.

Q. So by 2015, LNPs had been used to deliver nucleic acids, right?

MR. DANFORD: Objection to form.

A. So in -- this particular example that I'm trying to provide you with said it's cationic nanoemulsion, right.

Q. So cationic nanoemulsions are not LNPs, right?

A. Yep.

Q. Had LNPs been used to deliver nucleic acid as of 2015?

A. Yeah. So in the published literature, as I indicate here, cationic liposomes, they

were -- so cationic liposomes were used for delivering mRNA before 2015, as Dr. Moon summarized. But the thing is that this particular category of nanoparticle system, right, was part of hundreds and thousands of permutations of designs, right.

Q. Let's go back to the gene gun. Are you aware of an instance in which a gene gun has been used to deliver a vaccine in a human, ever?

A. Again, that's the clinical side of the equation, right. As I mentioned, I know the gene gun has been applied for delivering nucleic acids and other agents in cells and in animals.

Q. Is a lipoplex another term for a cationic liposome?

A. Lipoplex is an interesting definition, right. Lipoplex is a -- it's a lipid system that serves kind of like a micromolecule, right.

Q. So what is a lipoplex, in your view?

A. A lipoplex is an agent that contains a lipid.

Q. So would a lipid nanoparticle be a type

of lipoplex, in your definition?

A. So, at the time when the POSA was looking at all the different nomenclature, lipoplex, lipid nanoparticles, liposomes, they -- at that time, they were just looking at the terminologies, right. But the commonality of all those things were really that they had a lipid inside them, right.

Q. So as of the priority date, would the term "liposome" and "lipid nanoparticle" have been used interchangeably under certain circumstances?

MR. DANFORD: Objection to form.

A. So at that particular time -- so there is a specific definition, right, of lipid particles generally at that time, which is essentially a system that contains a lipid that carries a payload, right.

And then they define some of the categories of agents within that particular lipid particle system or formulations, right.

Q. Is there a difference between a

lipoplex and a cationic liposome?

MR. DANFORD: Objection to form.

A. Cationic liposome. The reason it's -- this maybe needs to go to another level of detail, right, to be able to address that. These are general names.

At that particular time, when we look at sort of lipid-based systems, it's looking at the formulation side and the components within it, as they define things.

Q. So are you not able to determine what a cationic liposome is today?

MR. DANFORD: Objection.

Q. Let me rephrase.

Are you not able to define a cationic liposome today?

MR. DANFORD: Objection to form.

A. On page 24, it essentially indicates how the cationic liposomes were used, and I just want to say that. And I'll read this and I'll explain why I'm reading it.

It says in paragraph 63, "Cationic liposomes

were used for delivering mRNA before 2015, as Dr. Moon summarized in his reviews, citing studies of mRNA therapeutics and mRNA tumor vaccines, Dr. Moon stated that while they employed transfection agent lipofectamine composed of..." -- long chemical names I won't name -- "...DOSPA and DOPE, was used to deliver the therapeutic protein EPO and vascular endothelial growth factor..." --

Q. Dr. --

A. No. I'm getting to it.

So "cationic liposomes containing DOTMA and DOTAP were used to deliver mRNA vaccines encoding tumor, associated antigens, and granulocyte-macrophages colony stimulating factor."

The reason I read this out is because liposomes, it's a lipid-based system, and it consists of the DOTMA or the DOTAP, which makes it cationic.

Q. So is there a difference between cationic liposome and lipid nanoparticles?

MR. DANFORD: Objection to form.

A. So at that particular time, there was still lots of discussions about those, right. And they were nanoparticle systems out of thousands of different combinations of nanoparticle formulations that was still being developed or that were case -- that were case or potentially used for different type of biomedical applications.

Q. Do you agree that if a POSA was looking to construct an mRNA vaccine before October 2015, cationic liposomes would have been a more attractive option than lipid nanoparticles to deliver the mRNA vaccine?

A. Okay. Can you state that shorter but in a different framework?

Q. Sure.

Do you agree that if a POSA was looking to construct an mRNA vaccine before October 2015, cationic liposomes would have been a more attractive option than lipid nanoparticles to deliver the mRNA vaccine?

MR. DANFORD: Objection to form.

A. Again, as I stated earlier when we discussed the polymer particle system, right, so the PLGA system with sustained release, stability in serum as well as lyophilization are important traits within the design of these systems, right.

And the reason I was asking -- answering earlier is that there's lots and lots of choices at that particular time because there's lots of choices and lots of combination of choices. You look at certain properties that you feel are winners in your delivery technology, right.

Q. So it's a yes or no question. Again, do you agree that if a POSA was looking to construct an mRNA vaccine before 2015, cationic liposomes would have been a more attractive option than lipid nanoparticles to deliver the mRNA vaccine?

MR. DANFORD: Objection.

A. As I mentioned earlier, right, there's a sea of nanoparticles or microparticles that is available.

Q. Are you able to answer yes or no to that question?

A. I'm just providing context as to what I was thinking as I -- if I'm a POSA at that particular time, and why I would pick certain formulations in terms of testing out.

Q. So as of October 2005 [sic], would a POSA have selected cationic liposomes over lipid nanoparticles to deliver an mRNA vaccine?

MR. DANFORD: Objection to form.

A. Are you referring to 2005 or 2015?

Q. 2015.

A. Thank you. So, again, as I said, I'm just putting contextual. There's a huge sea of nanoparticle systems, and you pick the one that is specifically for your application based on your specifications.

I'll give you another example that is part of this. My lab -- I will discuss it, right.

When -- I was looking at some of these processes of identifying the best delivery technologies, right. But what I do is focus on a

model system. So I picked gold nanoparticles in most of my research projects earlier on, right, because the intended application, the specifics of what I want to use for the biological perspectives led me to think about that being the best system.

Now, coming back to this, right, the fact that there are thousands or millions of combinations of particle formulations, then you have to think about which ones you feel is going to be most comfortable for you to do what you need.

And the PLGA particle -- that's why I keep on repeating those three things. Those are very attractive properties for these particular applications, right.

Q. So I'm going to ask you one more time. I'm just going to ask you if this is a true statement or not. Okay?

A. Okay.

Q. If a POSA was looking to construct an mRNA vaccine before October 2015, cationic

liposomes would have been a more attractive option than lipid nanoparticles to deliver that mRNA vaccine?

MR. DANFORD: Objection. Incomplete hypothetical. Calls for speculation.

A. Again, it's not specific enough, right, for me to be able to address that particular question, considering that there's a huge sea of nanoparticle formulation designs, right. And there's also lots of permutations of the cationic as well as the lipid nanoparticles, right.

Q. So you would need more information in order to evaluate whether that statement was accurate?

A. I would need more information in terms of what you're actually looking for in terms of the final outcome and the degree of outcome, right.

Q. And can you just identify what additional information you would need in order to assess whether that statement was accurate?

A. Again, you know, you would need some

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 256 of 375

quantification, efficiency, in terms of what you need to deliver to the target and how much you need to deliver to the target. And then there's a bunch of other parameters as well, right.

Q. So without that information, you would not say that if a POSA was looking to construct an mRNA vaccine before October 2015, cationic liposomes would have been a more attractive option than lipid nanoparticles to deliver that mRNA vaccine, correct?

MR. DANFORD: Objection. Incomplete hypothetical. Calls for speculation.

A. And as I've said before, no -- I don't know how many times we've gone through this, right -- is that the PLGA had these three properties. And I -- if I was a POSA at that time, those three properties were quite important, and that would probably be the first thing I would try.

Q. So would you say that if a POSA was looking to construct an mRNA vaccine before 2015, cationic liposomes would have been a more

attractive option than lipid nanoparticles to deliver that mRNA vaccine?

MR. DANFORD: Same objections.

A. Let me think about different ways to say it, right.

Q. I'm not asking for different. I'm just asking, would you say that if a POSA was looking to construct an mRNA vaccine before October of 2015, cationic liposomes would have been a more attractive option than lipid nanoparticles to deliver that mRNA vaccine?

MR. DANFORD: Same objections.

A. I understand what you're saying, right. But what I'm trying to say is I'm trying to put a context, because whenever you design or pick something, it's always contextual in nature. And it's sometimes not as clear as being black and white as what you're asking.

Q. So you can't make that statement without additional context, right?

A. I'm just saying that the PLGA particle based on those particular properties at that

particular time and based on even the arguments in Schrum, right, that is -- that is the reason, right.

Q. Are cationic liposomes permanently charged, positively charged?

MR. DANFORD: Objection to form.

A. So there are two types of -- well, the way we categorize it sometimes is there's cationic lipids, and cationic lipids have potential to be positive charged in some conditions.

And there's also ionizable cationic lipids. It typically has a tertiary amine, and the tertiary amine can acquire charge because that can bind onto protons.

Q. So in your view of cationic liposomes, the cationic lipid can be either ionizable or permanently charged?

A. No. There's lots of different permutation of design. As I mentioned, they can contain cationic lipids in the construct and the cationic lipids can be -- would be positive

charged in certain conditions -- at least in certain conditions.

And the ionizable has the capability to usually have a tertiary amine that has the capability of acquiring protons.

Q. So can you turn to paragraphs 46 and 47 of your declaration.

A. The Petsch.

Q. Correct. So in paragraphs 46 and 47, you discuss mRNA vaccines conducted by CureVac -- trials conducted by CureVac, correct?

A. Mm-hmm.

Q. This work was based on protamine, right?

A. That is correct.

Q. Do you believe that CureVac and Novartis's research provide a rationale from which an investigator can understand that an mRNA vaccine would be worth testing in humans in a Phase I clinical trial?

A. Can you break your question down because that's very loaded with many components

to it.

Q. Sure. You understand what a Phase I clinical trial is, right?

A. Again, I'm not a clinician. I've never done a Phase I clinical trial.

Q. Do you know what that term means?

A. Yes.

Q. Now, do you believe that the CureVac and Novartis research that you describe -- let me rephrase.

Do you agree that CureVac's research, as you've described in paragraphs 46 and 47, provide a rationale from which an investigator can understand that an mRNA vaccine would be worthwhile testing in humans in a Phase I clinical trial?

MR. DANFORD: Objection. Outside the scope.

A. Again, so when I'm looking at the Petsch paper and the CureVac, the paper essentially demonstrated the use of the protamine complex mRNA as a vaccine against influenza in --

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 261 of 375

I think they use, like, different animal models, right.

Q. And do you believe that the results in Petsch would have demonstrated that an mRNA vaccine would be worth testing in humans in a Phase I clinical trial?

MR. DANFORD: Objection. Calls for speculation. Outside the scope.

A. Yeah. Again, that decision is based on the company. It's not based on my decision, right. So that's why it's, like -- there's no point for me to answer because I don't know what the decision point is, right.

MR. LIU: So, Dr. Chan, I'm going to hand you what has been premarked as Exhibit 2021.

(Previously marked Exhibit 2021 incorporated by reference.)

BY MR. LIU:

Q. Dr. Chan, do you recognize Exhibit 2021 as a paper titled "Nonviral delivery of self-amplifying RNA vaccines"?

A. The paper you presented me is the Geall

PNS paper that is titled "Nonviral delivery of self-amplifying RNA vaccines."

Q. This was a paper that you considered in forming the opinions expressed in your declaration, right?

A. I looked at -- I read this paper.

Q. And this paper is directed to self-amplifying RNA, correct?

A. That is correct.

Q. And if you look at the first page, do you see where under the bold text, about halfway down the first paragraph, it says, "We show that nonviral delivery of a 9-kilobyte self-amplifying RNA encapsulated within an LNP substantially increased immunogenicity compared with delivery of unformulated RNA," correct?

A. Can you -- which line is that?

Q. So it's about halfway down the paragraph. Do you see where it says "here we"?

A. Oh, in the abstract.

Q. Correct.

A. Okay. So "Here we show that nonviral

delivery of a 9-kilobyte self-amplifying RNA encapsulated within an LNP substantially increased" -- wait, "substantially increased immunogenicity compared with delivery of unformulated..." Okay.

Q. So what Schrum shows -- excuse me, what the Geall reference in Exhibit 2021 shows is that when self-amplifying RNA is encapsulated in an LNP, it substantially increases immunogenicity compared to the unformulated RNA, correct?

MR. DANFORD: Objection to form.

A. Okay. So here in the abstract, it is stated, "We show that nonviral delivery of a 9-kilobyte self-amplifying RNA encapsulated within an LNP substantially increased immunogenicity compared with delivery of unformulated RNA."

Q. And if we turn to page 14605 of Exhibit 2021, do you see on the right column on the first paragraph, it says, "LNPs protected the RNA from degradation by RNase A"?

A. Oh, in contrast, the nature -- wait.

Which line?

Q. It's about six lines down.

A. On the right?

Q. On the right column.

A. That the LNP protected the RNA from degradation by RNase. Okay.

Q. Do you see that sentence?

A. Yes.

Q. So nonreplicating mRNA is also degraded by RNase, correct?

A. RNAs in general can be degraded by enzymes. And RNase is an enzyme.

Q. So both self-replicating RNA and nonamplifying mRNA can be degraded by RNase, correct?

A. Well, RNase's function is to degrade RNA.

Q. So you would agree that regardless of whether you're delivering nonamplifying mRNA or self-amplifying RNA, it is important to protect the RNA from degradation by RNase, correct?

MR. DANFORD: Objection to form.

A. Again, it depends on the particular application, right.

Q. Well, if the RNA was degraded by RNase, it would not express protein, right?

MR. DANFORD: Objection to form. Calls for speculation.

A. No, it depends on, again, the more specifics of your question, right.

Q. Would you agree that in order to -- would you agree that if you're interested in expressing a protein in the RNA, you would want to protect it from degradation?

MR. DANFORD: Objection. Incomplete hypothetical. Calls for speculation.

A. Yeah. Define the protein.

Q. Would your answer depend on what type of protein you're trying to express?

A. No. It depends on the functional component of the protein.

Q. So do you see in the next sentence it says, "Encapsulation was also required for efficient delivery of functional RNA into

muscle"?

A. Let me see. Which way now?

Q. Same paragraph.

A. I have to get reading glasses. I have computer glasses. Don't put that in. Sorry. Just my bad eyes.

Wait. Where is that again?

Q. So if we go to the same paragraph --

A. Okay.

Q. -- in the next sentence, full sentence, it says, "Encapsulation was also required for efficient delivery of functional RNA into muscle," right?

A. Okay. "Encapsulation was also required for efficient delivery of functional RNA into muscle."

Q. And do you agree that delivering nonamplifying mRNA also requires efficient delivery into muscles?

MR. DANFORD: Objection. Calls for speculation. Incomplete hypothetical.

A. Yeah. So when I read that sentence,

right, to me, that sentence is not fully complete, right. Again, it's very broad in terms of a statement because it has the term "efficient delivery," right. And it needs to be quantified for me to be able to answer that particular question.

Q. So do you disagree with the statement that encapsulation was also required for efficient delivery of functional RNA to muscle?

MR. DANFORD: Objection.

A. So my opinion is that Geall, in this particular paper, in this particular sentence, "encapsulation was also required for efficient delivery of functional RNA into muscle" is not specific enough for me to make a -- for me to make an opinion of that particular meaning of that particular sentence.

Q. So in order for mRNA to express a protein in the cell, the mRNA has to escape the endosome, right?

MR. DANFORD: Objection. Calls for speculation.

A. Can you ask that question in a different way?
Q. Do you understand my question?
A. There's lots of different ways to answer your question. That's why I'm asking for specificity.
Q. Do you know what endosomal escape means?
A. Endosomal escape refers to something that leaves an endosome.
Q. Do you agree that in order for mRNA to express a protein, it needs to escape the endosome?
MR. DANFORD: Objection. Calls for speculation.
A. That's why I need more clarification what you mean by that.
Q. What other clarification do you need?
A. Definition of percentage of endosomal escape as an example.
Q. Do you agree that the mRNA or saRNA payload must escape the endosome and enter the

cell cytoplasm to exert its intended function?

MR. DANFORD: Objection. Incomplete hypothetical.

A. Again, you need to be more specific with that, right.

Q. So would you write the sentence that the mRNA or saRNA payload must escape the endosome and enter the cell cytoplasm to exert its intended function?

MR. DANFORD: Objection.

A. To answer your question, I would be more specific to that.

Q. That's not a sentence that you would write, because it's too general, right?

A. For me, again, to answer your question, I need more specificity in terms of endosomal escape.

Q. So you would not say that the mRNA or saRNA payload must subsequently escape the endosome and enter the cell cytoplasm to exert its intended function?

MR. DANFORD: Objection. To give him

the context, you can show him where you're reading from, perhaps.

MR. LIU: I would appreciate, Counsel, if you stop coaching the witness.

A. He's not coaching me. I'm asking this question because what I'm trying to tell you is I'm a very specific guy, right. So you're asking me this question, if you ask me, does 1 percent of endosomal escape lead to an expression of 5 micrograms of proteins, then I can answer that question, right. That's what I'm asking, right. So...

Q. So without more context, you're unable to determine whether that sentence is true or not; is that right?

MR. DANFORD: Objection.

A. I did not say that. What I'm saying is for me to answer the question that you're asking me, if you provide me more specific detail and a context to it, right. So if it's one sentence, I can answer it out of context. But if it's part of a paragraph that explains the point of it,

then I can answer that question.

Q. Okay. Do you agree that mRNA or saRNA payload must subsequently escape the endosome and enter the cell cytoplasm to exert its intended function? Is that an accurate statement or not?

MR. DANFORD: Objection.

A. Ask the question a different way.

Q. Is it an accurate statement that the mRNA or saRNA payload must subsequently escape the endosome and enter the cell cytoplasm to exert its intended function?

MR. DANFORD: Objection.

A. Again, could you please be more specific?

Q. What more information do you need to determine whether that's an accurate statement?

A. What function? What specific function? What's specifically the amount of endosomal escape?

Q. So you would need the specific function of the protein and then you would also need the amount of endosomal escape, correct?

MR. DANFORD: Objection.

Q. What other information would you need?

A. Function of -- it's not about the function of the protein. It's the expression level of the protein. And then there's the functional aspect of it, right. Just because something is expressed doesn't mean it's functional.

Q. What other information would you need?

A. Endosome escape number. If you're going to use the term "endosomal escape," you need to define for me what that means, right. What is considered a threshold for endosomal escape.

Q. So --

A. And then for function, you need to provide me information to context of what that function actually means. And then you need to also provide me at the end the function and the qualification of what that function means, right. And the value system and the threshold of that.

Q. Is there any other information that you

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 273 of 375

would need to evaluate whether that sentence is complete?

A. Those are the main comments.

Q. So can you turn to paragraph 203 of your declaration.

A. Page 203.

Q. Paragraph 203. Can you just read that first sentence of paragraph 203 to yourself?

A. "The mRNA and saRNA payload must escape the enzyme and enter cell cytoplasm to exert its intended function."

Q. Now, you said in order to evaluate the accuracy of that statement, you would need to know the expression level of the protein, right?

I'm asking about your earlier testimony. You testified that in order to assess the accuracy of that statement, you need to know the expression level of the protein, right?

A. Yeah. But here if you follow the next sentence, it states that it was estimated that, for saRNA, the escape of saRNA from endosomes into the cytosol occurs at 1 -- at low

efficiency, which is 1 to 2 percent. That is a specific number that defines that parameter.

Q. Where do you see the expression level of a protein in this paragraph?

A. Efficiency can relate back to the expression level, so you can actually back-calculate this.

Q. And you don't explain any specific protein expression level, right?

A. No. But a POSA would be able to take that number and understand that. It basically creates a parameter, right?

The reason I was asking you that question is because it has -- you have to qualify this. If you just say generally "endosomal escape," it becomes hard to be able to answer that accurately.

Q. You also said that you need to know the function of the protein, right?

A. The expression of the protein and whether the function -- whether the protein can potentially be useful or not, right.

Q. Okay. Where do you see the description of the protein's function in paragraph 203?

Dr. Chan, would you agree that paragraph 203 makes no mention of a protein's function, right?

A. No. But it's implied from this, right. Because if you look at the data, there is a functional nature in the example, Figure 2A, Figure 3 in terms of utility, right.

Q. Sorry. What figures are you referring to?

A. On page 80 and 81, right.

Q. So, Dr. Chan, where does paragraph 203 cite to the figures in page 80 and 81?

A. I did not cite it, but --

Q. You're not talking about the Geall reference in paragraph 203, are you?

Dr. Chan --

A. Yes.

Q. -- paragraph 203 does not provide any context about the function of the protein. You would agree with that, right?

MR. DANFORD: Objection to form.

Q. Dr. Chan, if it's easier -- we've been here for five, ten minutes -- we can go through paragraph 203 sentence by sentence.

A. I would appreciate you give me a few minutes to go through this. Okay?

I mean, you can clearly see here that there are correlations between these behaviors, right. So we've looked at the fact that there's a discussion in Section 204 because at the bottom, low rate of endosomal escape, the ability to self-amplify after escape can be decisive regarding whether there will be significant reduction of antigen.

Q. When you say "Section 204," do you mean paragraph 204?

A. Paragraph 204.

Q. Paragraph 204 doesn't identify specific proteins, right?

MR. DANFORD: Objection to form.

A. But it indicates the relationship. And what I was asked -- you're asking the question broadly, right.

What I was trying to tell you is in order for me to answer this question, I need the specifics because there's a correlation between the endosomal escape, the production of antigen.

And then if you look at paragraph 205, when we talk about from the James Moon's acknowledgment, it states that, in general, mRNA needs to escape endosomes to go to the cytosol to function properly.

Q. Dr. --

A. So what I'm saying, there's a correlation between endosomal escape, sufficient production antigen, and the function properly.

Q. Dr. Chan, in paragraph 204, 205, there's no specific proteins identified, right?

MR. DANFORD: Objection to form.

A. But an antigen is a protein, right? And that's a specific -- that's a specific name of a category of protein, right? It doesn't have to say a protein. That's what I mean by "specificity." The relation of function properly.

Now, if you look at the Geall paper or the citations we put for Geall, we've got two -- let me -- okay. So now look at Figure 3 on page 81.

I'm trying to tell you how to piece this together. There's a sequence of events that happens, right. There's multiple events that has to happen for the function to be created, right. An endosomal escape, expression of antigen, and the function of that, right.

And if you look at the Geall paper as an example, it essentially describes the specific serum IgG in the titer. So that's the markers by which you're measuring these impacts.

And, again, if you're looking at this -- at the data that is presented here -- I'm just going to read it, just so I can take some time to think about it and explain what the meaning of these specific captions, right.

So "comparative mouse immunogenicity studies of a lipid nanoparticle formulated self-amplifying RNA vaccine candidate encoding RSV-F. Groups of eight mice were vaccinated

intramuscularly on days zero and 21 with viral replicon particles, plasmid DNA delivery using electroporation, pDNA formulated with LNP, naked self-amplifying RNA or self-amplifying RNA formulated in LNP. Sera were collected on day 35 and F-specific IgG titers were determined by ELISA. ELISA data are from individual mice and the geometric mean titers are solid lines. Dotted line indicates the limit of titer quantification. To calculate GMTs," so "titers less than 25 were assigned a value of 5. F-specific CD4+ and CD8+. T cell frequencies can be found" --

Q. Dr. Chan, respectfully, we can all read what is the caption in Figure 3 --

A. I understand. But I --

Q. -- and, frankly, this is entirely nonresponsive to my question.

A. No, no, no. Because what I'm saying is because you were asking a general question earlier and was trying to explain to you that in order for you -- for me to answer that particular

question, you had to be very specific in terms of each of the levels in the sequence of process that goes all the way -- that goes all the way from the endosomal escape to the protein production and to the function, which is the aftereffect.

Q. So why don't we try a more basic question, then.

In order for mRNA to express a protein, does the mRNA have to escape the endosome?

MR. DANFORD: Objection to form.

A. Again, when I'm asking you about escape the endosome, the thing I'm asking is you need to define that in terms of what is the percentage of escape, right. Because is 0 percent considered escape? Is it .1 percent considered escape? Is 1 percent considered escape? Is it 2 percent considered escape?

Q. In your opinion, for a vaccine, what would be the level of endosomal escape that would be required?

MR. DANFORD: Objection. Calls for

speculation.

A. So what I can indicate is what I wrote in my declaration, which -- give me two seconds, I can find it again.

Here in the declaration on page 85, paragraph 203, it was estimated that for saRNA, the escape of siRNAs from endosomes into the cytosol occurs at low efficiency, 1 to 2 percent, and only during a limited window of time when the LNP reside in a specific compartment, sharing early and late endosomal characterization.

The reason I mention the 1 to 2 percent is because a POSA at that time, some may consider that as escape. Some do not consider that escape because of the percentages at a certain low level.

Q. So where in paragraph 203 do you define the endosomal escape percentage that is required for mRNA?

A. So here I focus on what was available in the literature at that time, which is for siRNA, right, which is the 1 to 2 percent.

Q. So do you know what percentage of mRNA would need to escape the endosome in order to express an antigen for a vaccine?

MR. DANFORD: Objection. Calls for speculation. Incomplete hypothetical.

A. Again, that's why I'm asking for specificity, right. How much antigen do you need to express?

Q. So if a POSA was trying to make a vaccine against betacoronavirus in 2015, do you have an opinion as to what percentage of the mRNA would need to escape the endosome?

A. At that particular time, I would not know what that percentage would be, right.

MR. DANFORD: If you reach a breaking point, I'd welcome one.

MR. LIU: Why don't we take five minutes off the record.

(A recess was taken.)

MR. LIU: So, Dr. Chan, I'm going to hand you what has been marked as Exhibit 1010.

(Previously marked Exhibit 1010

incorporated by reference.)

THE WITNESS: Okay.

BY MR. LIU:

Q. And, Dr. Chan, do you recognize this document as the Geall reference that is discussed in your declaration?

A. Referring to the front page, it has Andrew Geall as the inventor.

Q. And is this the same document that you opined on in your declaration, which you referred to as Geall?

A. Yes.

Q. Are you aware -- have you ever heard the term "preferred embodiment"?

A. Again, we talked about this earlier about the terminology, right. They're legal terminologies. I'm not a lawyer.

Q. So can you turn to page 12 of Geall. Excuse me, if you're looking at the page number on the bottom, left-hand corner is page 13 of 57.

And do you see on page 13 of 57 at the very top it says, "The invention involves in vivo

delivery of RNA which encodes an immunogen," correct?

A. I see the title.

Q. And it says, "The RNA can trigger innate immunity pathways and is also translated, leading to expression of the immunogen." Correct?

A. The sentence states what you just said.

Q. And do you understand the RNA that is discussed here to be mRNA?

A. The -- so Geall was focused on saRNA. So it's stated in the next paragraph that it's a -- preferred positive stranded RNA are self-replicating.

Q. What is your definition of messenger RNA?

A. So in this definition, it's -- let me just see --

Q. And just to clarify my question, if I can.

A. Yup.

Q. I'm not asking for the definition. I

understand there is a definition of mRNA that you contend to be in the '600 patent. I'm just asking, as a scientific matter, what does the term "mRNA" mean to you?

MR. DANFORD: Objection to form.

A. So mRNA is a messenger RNA.

Q. Would you agree that a messenger RNA is an RNA that translates into a protein?

MR. DANFORD: Objection to form.

A. So messenger RNA is a type of RNA.

Q. Are you able to offer a more specific definition for mRNA?

A. Give me two seconds. Sorry. It's just long in the day.

Q. Dr. Chan, is there anything specific that you're searching for in your declaration?

A. Yeah. Just I'm mentally a little tired because it's late Singaporean time. And so I just want to be accurate in terms of how I describe it. A messenger RNA is a type of an RNA, right.

Q. Would you agree that messenger RNA is a

type of RNA that can be translated into a protein?

MR. DANFORD: Objection to the form.

A. Again, messenger RNA is a type of RNA, right.

Q. What is the function of mRNA?

A. The function of mRNA is to produce proteins out of it. It provides a sequence that indicates a certain immunoassay sequence for a protein.

Q. So do you see in Geall it says the RNA "is also translated, leading to expression of the immunogen."

That's referring to mRNA, right?

MR. DANFORD: Objection.

A. Can you please indicate where?

Q. Sure. On page 13 of 57 in Geall, at the very top where it states, "RNA."

A. It says the --

Q. "The invention involves in vivo delivery."

Do you see that?

A. The invention -- on page -- oh, that's 14. Oh, "The invention involves in vivo delivery of RNA which encodes an immunogen. The RNA can trigger innate immunity pathways," right?

Q. Yeah. And that sentence says that the "RNA leads to expression of the immunogen," correct?

A. According to this, it says "the in vivo delivery of RNA which encodes an immunogen."

Q. So that's referring to mRNA, correct?

MR. DANFORD: Objection.

A. No. The Geall patent here, the way I read it, it's all about self-replicating RNA, which is a type of RNA.

Q. And self-replicating RNA also encodes for a protein, right?

MR. DANFORD: Objection to form.

A. Again, it's a type of RNA, right. So mRNA is a different type of RNA.

Q. Would you consider yourself an expert in self-replicating RNA?

MR. DANFORD: Objection to form.

A. I'm aware of self-replicating RNA. I understand the premise of RNA.

Q. Do you consider yourself an expert in self-replicating RNA?

A. Yes.

Q. Okay. And so did you review the literature in -- with respect to self-replicating RNA that existed as of 2015?

MR. DANFORD: Objection to form.

A. So when I looked at the literature on self-replicating mRNA, I looked at it from the perspective of the delivery technology.

Q. Have you encountered any references in which self-replicating RNA is referred to as a type of mRNA?

MR. DANFORD: Objection to form.

A. Well -- can you please repeat your question again?

Q. Sure.

Sitting here today, can you recall reviewing any literature in which self-replicating RNA is referred to as a type of mRNA?

MR. DANFORD: Objection to form.

A. So there are different categories of RNA. And self-replicating is one. And mRNA is a different one.

Q. And I'm asking you, have you ever seen literature that refers to self-replicating mRNA -- I'm sorry. Let me rephrase the question.

Have you ever reviewed literature that refers to self-amplifying RNA as a type of messenger RNA?

MR. DANFORD: Objection to form.

A. Again, as I indicated, right, my understanding is that there are two -- at least two types of RNA, right. There are different categories.

Q. Have you ever seen literature that refers to self-amplifying RNA as a subtype of mRNA?

MR. DANFORD: Objection to form.

A. Can you repeat that?

Q. Have you ever reviewed literature that refers to self-amplifying RNA as a subtype of

messenger RNA?

A. Can you define what "subtype" means?

Q. Do you understand what I mean by "type of mRNA"?

A. So there are categories of mRNA. But you're using the word "subtype."

Q. Okay. Let me rephrase the question.

Have you ever reviewed literature that refers to self-amplifying RNA as a type of messenger RNA?

MR. DANFORD: Objection to form.

A. MRNA and saRNA are two categories of RNA.

Q. I understand that's your testimony today. I'm asking you if you've seen literature that refers to self-amplifying RNA as a type of mRNA.

A. I understand what you're saying, but I'm trying to tell you that they are two categories of RNA.

Q. Have you ever seen literature that refers to self-amplifying RNA as a type of mRNA?

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 291 of 375

MR. DANFORD: Objection to form.
A. Again, there are two types of RNA.
Q. Are you unable to answer the question of whether you've seen such literature?
A. I can tell you within the literature, my interpretation is there's two types of RNA, right.
Q. So have you ever seen literature that refers to self-amplifying RNA as a type of mRNA?
MR. DANFORD: Objection to form.
A. Again, there are two categories of RNA, and the reason there are two categories of RNA is because there's a different mechanism of action.
Q. So if you -- so if there was a literature -- let me rephrase.
So if a reference referred to self-amplifying RNA as a type of messenger RNA, would you disagree with that reference?
MR. DANFORD: Objection to form.
A. No. When I read the terminology if it's mentioned, I have to read it from the context that's presented. And from the context

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 292 of 375

that's presented, relates to the mechanism by which it can potentially produce a product. And that mechanism is different. So, therefore, there's different categories of RNA.

Q. So let me try this again. Would you agree that self-amplifying RNA can be considered a type of messenger RNA?

MR. DANFORD: Objection to form.

A. There are two categories, right.

Q. So if the literature referred to messenger -- let me rephrase.

So if the literature referred to self-amplifying RNA as a type of mRNA, would you agree with that characterization?

MR. DANFORD: Objection to form.

A. As I said, when I read the paper, I read the context of that paper. And my interpretation from that context is that there are two different types of RNA.

Q. And have you ever seen literature that, in fact, refers to self-amplifying RNA as the same type of RNA as mRNA?

MR. DANFORD: Objection to form.

A. So, again, you have to read the context of what you're referring to. And the context suggests that there are two types of RNA.

Q. And that is true for every reference that you've seen that discusses self-amplifying RNA?

A. You have to read it from the context of what is presented.

Q. So can you turn to page 41 of 57 in Geall.

A. Forty-one. Okay. There's page 41.

Q. Do you see there's a large mammal study that's discussed on page -- starting at page 41 of 57?

A. Halfway through. Yes. It says large mammal study.

Q. So this is an in vivo study that Geall conducted, correct?

A. Let me just read it.

Okay. Can you repeat your question?

Q. So what is described in Geall is an in

vivo study using large mammals, specifically calves, correct?

A. They indicated that a large animal study was performed in cattle.

Q. And as a part of this test, Geall tested both lipid nanoparticles and cationic nanoemulsions, correct?

MR. DANFORD: Objection to form.

A. So in this sentence, the second sentence stated, "The replicons were formulated either inside liposomes or with the CNE17 emulsion."

Q. Now, the liposomes that are referenced in Geall, you would agree that those used the four lipid components that are typically associated with lipid nanoparticles, correct?

MR. DANFORD: Objection to form.

A. So on page 31, they provide an indication of a liposome made of 10 percent DSPC, 40 percent DlinDMA, 48 percent cholesterol and 2 percent PEG conjugated.

Q. Those are the same components that

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 295 of 375

would be used in what you would consider a lipid nanoparticle, correct?

MR. DANFORD: Objection to form.

A. Again, it's just listed in terms of these liposomes contain these four components, right.

Q. So in Geall, with respect to the large mammal study, Geall tested both what it calls a liposome as well as cationic nanoemulsion, correct?

A. They tested liposome or with the CNE17 emulsion.

Q. Now, if you go to page 43 of 57 in Geall --

A. Page 43 of 57.

Q. I want you to just read the last paragraph.

A. The one that starts "when assayed"?

Q. Correct.

A. "When assayed with complement, neutralizing antibodies were detected in all vaccinated cows." "When assayed with complement,

neutralizing antibodies were detected in all vaccinated cows. In this assay, all vaccinated cows had good neutralizing antibody titers after the second RNA vaccination, regardless of the formulation."

Q. So when -- pause there.

In discussing these results, this would include what Geall characterizes as the liposome formulation, correct?

A. So I just want to point out specifically in this particular set of experiments, they're essentially using RNA replicon, right?

Q. So --

A. And they're using a self-amplifying RNA system in terms of this particular large animal study.

Q. So how is that responsive to the question of whether these results used a liposome?

A. Well, I mean, the thing is that the main system here that is being discussed or shown

is really -- is this RNA replicon in the system, right.

Q. And that RNA replicon was delivered in a liposome, right?

A. Again, can you repeat that?

Q. Sure.

On page 43 of 57 of Geall in the last paragraph when they discuss the results of the experiment, those results are applicable to Geall's formulation to the liposome formulation, correct?

A. So, again, it's contextual in nature, right. Because if you look at page 43 of that same section, but the paragraph before, it explained that "Although the emulsion-adjuvanted vaccines appeared to be more immunogenic than the liposome-adjuvanted vaccines, one complicating factor is that the material used for the second liposome dose was not freshly prepared and the same lot of RNA showed a decrease in potency in a mouse immunogenicity study."

Q. So do you agree with the statement that

neutralizing antibodies were detected in all vaccinated cows, regardless of the formulation?

A. So what that statement suggests to me is that with the liposome-adjuvanted vaccines is that one complicating factor is that the material used for the second liposome dose was not freshly prepared. So it's multiple doses in terms of that particular set of experiments, based on that.

Q. So do you agree that -- do you have any reason to disagree with the statement that neutralizing antibodies were detected in all vaccinated cows, regardless of formulation?

A. Again, your question is in regards to formulation. But it's more than that, right. The fact that you look at the sentence from Geall, it clearly indicates that it's one complicating factor. So that complicating makes it a complex system, is that the second liposome dose was not freshly prepared.

Q. Okay. So I'm asking you with respect to the last paragraph, do you agree with the

sentence that "All vaccinated cows had good neutralizing antibody titers after the second RNA vaccination, regardless of the formulation"? You see that sentence, right?

A. Yes. I see that sentence.

Q. Do you agree with that sentence?

MR. DANFORD: Objection.

A. Yes. But, again, you have to put it in context. In the paragraph before, it affects the interpretation when it says, "The second liposome dose was not freshly prepared, and the same lot of RNA showed a decrease in potency in a mouse immunogenicity study."

They then, from that sentence, made another conclusion from their own interpretation that, therefore, it is possible that the liposome-adjuvanted vaccine would have been more immunogenic if fresh material had been used for all vaccinations.

So there's a new parameter or variable that's within their results. And that parameter or variable, according to them, is indicated by

freshly prepared versus not freshly prepared.

Q. So if the liposome formulation, as Geall refers to it, was freshly prepared, it would be even more immunogenic, correct?

MR. DANFORD: Objection.

A. I cannot make that conclusion because then they also have the fact they don't -- in some sense, they're making speculation at this particular point.

Q. Do you see the last sentence in Geall where it says, "Both RNA vaccines elicited F-specific serum IgG titers that were detected in a few calves after the second vaccination and in all calves after the third"?

A. Yes, I see that sentence.

Q. Do you have any reason to disagree with that sentence, based on the results in Geall?

A. No. It creates uncertainty because it uses the word "few."

Q. Do you have any reason to disagree with the characterization that all calves exhibited F-specific serum IgG titers after three

administrations of both vaccines?

A. Can I ask where you're asking the three administration of vaccines come from?

Q. If you see the last sentence, it says, "all calves after the third..."

A. Oh, yeah, the third. Yes, but because, again, all these are contextual. The fact that in the paragraph before, it clearly indicated that -- you know, that the liposome dose was not freshly prepared, and the same lot of RNA showed a decrease in potency in a mouse immunogenicity study.

Then the next sentence follows up with a speculation that states, "Therefore, it is possible that the liposome-adjuvanted vaccine would have been more immunogenic if fresh material had been used for all vaccinations."

Then they follow that last sentence with the descriptor or adjective a "few." And so all these things, from a POSA's perspective, creates uncertainty.

Q. Now, the data is disclosed -- Geall

discloses the actual F-specific serum IgG titer data, right?

A. Sure.

Q. Now, based on that data, do you have any reason to disagree with Geall's statement that all calves exhibited F-specific serum IgG titers after the third vaccination, regardless of formulation?

A. Okay. But present data, but you have to read what Geall, the inventor, is stating in the contextual nature of what they're putting here.

They stated that one complicating factor -- they used the word "complicating factor" -- is that the material used for the second liposome dose was not freshly prepared, right.

And then they follow up with the following sentence that is speculative that says, "It is possible that the liposome-adjuvanted vaccine would have been more immunogenic if fresh material had been used for all vaccinations."

Then they follow with another terminology

that creates uncertainty, which is that they were detected in a few calves. They are the best to make their interpretation of their own data. And they put those language in this particular patent.

Q. In your opinion -- you've identified a number of what you contend to be uncertainties in Geall's experiment, right?

A. It is their interpretation from their own experiments.

Q. In your opinion, would a POSA have disregarded this experiment based on those uncertainties?

MR. DANFORD: Objection to form.

A. So a POSA would read those statements, right, would understand in some sense what the inventor is thinking, right.

And the inventor is thinking that there's complicating factors that -- you know, freshly prepared versus not prepared, and then few calves.

Q. You can set aside that reference for

now.

A. Okay.

Q. So, Dr. Chan, as of 2015, you were working on nanostructures for drug delivery, correct?

A. Yeah. I started working in that particular -- well, all the stuff we worked on since I was a Ph.D. student is probably relevant to drug delivery.

Q. So do you agree that around 2015, there were at least hundreds of ionizable cationic lipids, both univalent and multivalent, known?

A. Can you reframe the question, please.

Q. Do you understand my question?

A. I want you to reframe it, please.

Q. Are you able to answer my question?

A. I can if you reframe it.

Q. Are you able to answer my question as posed?

A. I would like for you to reframe the question.

Q. Respectfully --

A. There's hundreds -- what does -- like, hundreds of formulations. I want that to be qualified.

Q. Are you able to answer my question as posed?

A. Can you repeat your question.

MR. LIU: Let's go off the record for a second.

(A recess was taken.)

BY MR. LIU:

Q. Dr. Chan, you understand that in this proceeding, you are under oath and you have an obligation to answer any questions that you understand, correct?

A. That is correct.

Q. And you understand that you have an obligation not just to answer the questions that you like or that you have, you know, worded in a way that you prefer? You understand that, right?

A. I understand that.

Q. So let me try this again.

Do you agree that around 2015, there were at

least hundreds of ionizable cationic lipids, both univalent and multivalent, that would have been known?

MR. DANFORD: Objection to form.

A. Again, can you please ask that question a different way?

Q. Are you able to answer the question as phrased?

A. The question is still very general.

Q. So you're unable to answer that question as phrased?

A. I feel like your question is not specific enough to answer -- to give you a specific answer.

Q. So if you're not able to answer the question, you can tell me that. That's fine. But if you are able to answer the question, you must answer the question.

Do you understand that?

A. I understand that. Right. But what I've been trying to get you to do all day, right, is when ask you a question, I'm trying to

interpret your question, right, and if your question is more specific, it allows me to give a more accurate answer.

Q. Are you able to answer the question of whether or not, as of 2015, there were at least hundreds of ionizable cationic lipids, both univalent and multivalent, known?

MR. DANFORD: Objection to form.

A. Again, I would ask that you clarify your question or ask the question in a different way, with more specificity.

Q. So you're unable to answer that question as posed?

A. No. I'm asking you to provide more specificity in your question.

Q. Do you agree that variations in the proportions of noncationic lipids in a lipid nanoparticle would impact their ability to deliver nucleic acid payloads?

MR. DANFORD: Objection. Calls for speculation. Incomplete hypothetical.

A. Can you repeat that question again?

Q. Do you agree that variations in the proportions of noncationic lipids would impact the ability of an LNP to deliver their nucleic acid payload?

MR. DANFORD: Same objections.

A. Yeah. To me, that question is very speculative, right.

Q. So you're not able to answer that question?

A. Well, that's speculation, right?

Q. And because it's speculation, you're not able to answer it?

MR. DANFORD: Objection to form.

A. No. I don't want to answer a question that is not specific enough for me to provide a specific answer to you.

Q. Can you take a look at the '600 patent. And this is Exhibit 1001, the '600 patent. And, specifically, can you go to Column 109.

A. Column 109. Column 109. This one.

Q. Dr. Chan, do you see in Column 109, starting at Column 109 and going on for many

pages, there are lipids that have been disclosed in the '600 patent, correct?

A. Yes. So from page -- Column 109 to Column -- this may take a while --

Q. Just to help you out here, it goes all the way to Column 182, right?

A. To column -- to Column 180. Yeah.

Q. These are cationic lipids, correct?

A. Let me take a look at the chemical structure.

Sorry. I'm just going through to make sure they all have the same...

Yes. I believe so.

Q. Now, Dr. Chan, is it your opinion that all of the cationic lipids that are disclosed in the columns we just looked at would be suitable for use in an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection.

A. Again, it seems that the purpose here is to just list the different types of cationic -- cationic lipids.

Q. Is it your opinion that all of the cationic lipids that are listed here would be suitable for use in an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. Again, what this, to me -- I'll need to go to the beginning of the section to see the context of the listing.

So I just want to read the paragraph before they go into all the chemical structures. That paragraph, to me, provides some context. It just says at least one of the nanoparticles -- in Column 100, it indicates, "At least one of the nanoparticles of the present disclosure may be embedded in the core of a nanostructure or coated with a low-density, porous 3D structure or coating which is capable of carrying or associating with at least one payload within or on the surface of the nanostructure. Non-limiting examples of the nanostructure" -- I'm going to read the paragraph again.

"At least one of the nanoparticles of the

present disclosure may be embedded in the core of a nanostructure or coated with a low-density, porous 3D structure or coating which is capable of carrying or associating with at least one payload within or on the surface of the nanostructure. Non-limiting examples of the nanostructures comprising at least one nanoparticle are described in international patent" blah, blah, blah, "the contents of which are herein incorporated by reference in their entirety."

Q. So, again, Dr. Chan, we can read what is in the patent.

A. No. I understand.

Q. Is it your opinion that all the cationic lipids listed in the '600 patent would be suitable for use in an mRNA vaccine against betacoronavirus?

MR. DANFORD: Objection to form.

A. Again, what they're doing here is listing the chemical structures. They started on Column 100, 103, 104, 105, with different kinds

of chemical structure for formulation and design.

Then on 109, so they're shown examples of chemical structures to create clarity or provide examples of these kind of long list of variable chemical structures.

MR. LIU: So, Dr. Chan, I have no further questions for you today. However, I do want to note for the record that throughout the deposition, the witness has been evasive, nonresponsive, and oftentimes has flatly refused to answer the question altogether.

So with that, we reserve our right to raise this issue before the PTAB, and we reserve all rights otherwise with respect to the witness's conduct during this deposition.

MR. DANFORD: And I disagree with the characterization of the witness's conduct. I think the record will reflect that your questions were often unclear, vague, calling for speculation, lacking any context, and far outside the scope of the issues addressed in his declaration in these proceedings.

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 313 of 375

And so I think that his conduct was appropriate, and there's no basis for you to raise anything further with him.

I think if you just give me a minute, I'd like to confer with my colleagues, and we can then wrap this up.

MR. LIU: Sure.

(A recess was taken.)

MR. DANFORD: I don't have any questions.

THE COURT REPORTER: I have standing orders for everything except for WilmerHale's delivery of the final. Do you want expedited or regular?

MR. DANFORD: We'll take what they're getting.

THE COURT REPORTER: So three-day expedite?

MR. DANFORD: Yes.

(Deposition concluded at 3:03 p.m.)

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 314 of 375

CERTIFICATE OF SHORTHAND REPORTER - NOTARY PUBLIC

I, Janet McHugh, Registered Merit Reporter and Notary Public within and for the Commonwealth of Massachusetts do hereby certify:

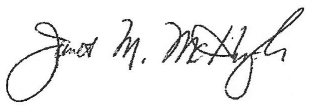
That WARREN C.W. CHAN, Ph.D., the witness whose deposition is hereinbefore set forth, was duly sworn by me before the commencement of such deposition and that such deposition was taken before me and is a true record of the testimony given by such witness.

I further certify that the adverse party, ModernaTX, was represented by counsel at the deposition.

I further certify that the deposition of WARREN C.W. CHAN, Ph.D. occurred at the offices of WilmerHale, 60 State Street, Boston, Massachusetts, on Tuesday, July 30, 2024, commencing at 7:13 a.m. to 3:03 p.m.

I further certify that I am not related to any of the parties to this action by blood or marriage, I am not employed by or an attorney to any of the parties to this action, and that I am in no way interested, financially or otherwise, in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 1st day of August, 2024.
My commission expires:
July 16, 2028



NOTARY PUBLIC IN AND FOR THE COMMONWEALTH OF MASSACHUSETTS

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 315 of 375

A
abbreviations
127:1
ability
231:7, 232:20, 234:9, 276:10, 307:18, 308:3
able
40:21, 51:11, 63:2, 63:8, 77:19, 80:10, 101:19, 107:18, 109:7, 109:15, 112:15, 114:3, 132:10, 150:2, 150:12, 156:19, 158:20, 161:5, 167:6, 168:16, 192:10, 192:19, 204:7, 207:16, 207:18, 207:19, 234:11, 240:11, 240:18, 241:4, 241:16, 242:1, 242:11, 249:5, 249:11, 249:15, 253:1, 255:7, 267:5, 274:10, 274:16, 285:11, 304:16, 304:18, 305:4, 306:7, 306:15, 306:17, 307:4, 308:8, 308:12
about
10:21, 17:13, 17:16, 26:9, 26:14, 26:19, 27:16, 28:20, 30:17, 30:20, 33:4, 33:11, 35:3, 38:2, 39:18, 49:10, 59:20, 59:22, 60:8, 60:21, 60:22, 61:2, 61:21, 62:13, 62:21, 63:1, 64:20, 65:1, 65:12, 66:2, 70:9, 77:15, 79:7, 80:21, 81:10, 85:5, 96:12, 106:2, 109:22, 110:6, 110:7, 116:18, 119:19, 119:20, 120:15, 120:22, 122:4, 125:8, 126:17, 126:19, 128:12, 131:21, 132:3, 138:8, 147:21, 148:14, 149:4, 150:16, 154:10, 156:16, 164:22, 167:19, 167:21, 169:14, 185:7, 195:6, 196:1, 214:17, 215:19, 216:7, 218:22, 219:2, 230:2, 232:3, 233:14, 238:5, 239:9, 243:18, 251:3, 254:5, 254:10, 257:4, 262:11, 262:18, 264:2, 272:3, 273:15, 275:15, 275:20, 277:6, 278:17, 280:12, 283:15, 283:16, 287:13
above
73:8
abstract
262:20, 263:12
academia
159:2, 209:22
academic
15:18, 22:11, 34:22, 117:14, 137:7, 206:12, 208:22, 222:14
academically
135:22, 243:19
according
70:7, 73:5, 82:22, 139:11, 142:14, 287:8, 299:22
accuracy
273:13, 273:17
accurate
16:18, 16:19, 131:2, 255:14, 255:21, 271:5, 271:8, 271:16, 285:19, 307:3
accurately
274:17
achieve
206:17
achieved
206:17
acid
40:15, 42:16, 43:17, 46:11, 47:10, 47:13, 48:7, 48:10, 49:18, 49:19, 58:9, 92:6, 92:10, 92:13, 93:13, 96:13, 121:12, 121:22, 123:5, 124:1, 126:16, 127:17, 127:20, 133:22, 134:9, 170:21, 171:17, 174:5, 193:5, 193:9, 194:10, 195:13, 195:18, 196:5, 196:18, 197:7, 197:13, 200:18, 201:19, 236:8, 236:14, 236:19, 237:8, 237:10, 246:20, 307:19, 308:4
acids
24:21, 25:2, 25:14, 25:20, 26:1, 26:22, 27:13, 27:19, 39:4, 39:12, 39:13, 39:17, 42:21, 43:13, 44:21, 44:22, 45:22, 47:20, 92:18, 134:14, 193:11, 218:1, 219:8, 219:14, 219:21, 235:10, 245:16, 245:21, 246:11, 247:12
acknowledgment
277:7
acquire
258:14
acquiring
259:5
acronyms
133:2, 133:3
acs
35:6
action
291:13, 314:20, 314:22
activate
161:12, 161:16
activating
100:19
activation
98:8, 98:20
active
205:8
activities
21:8, 31:4
activity
92:15, 201:13, 202:21
acts
154:8
actual
10:14, 302:1
actually
9:15, 23:1, 30:2, 40:8, 40:14, 41:6, 42:17, 46:17, 55:20, 55:22,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 316 of 375

56:6, 68:14, 81:16, 83:7, 90:18, 115:13, 128:20, 135:10, 143:2, 144:22, 145:2, 147:11, 155:16, 159:1, 170:18, 226:17, 234:12, 245:1, 255:16, 272:18, 274:6
adapt
160:15
adaptation
154:6
adaptive
151:15, 153:14, 154:2, 155:1, 155:4, 160:8, 160:13, 160:15
added
105:5
adding
21:7
addition
198:21
additional
119:13, 157:4, 255:20, 257:20
address
151:9, 245:14, 249:5, 255:7
addressed
312:21
addressing
34:5
adequately
57:20, 59:4, 59:15
adjective
301:19
administered
42:1, 73:9, 73:13, 74:1, 75:10, 75:14, 76:8, 76:10, 76:15, 77:12, 139:13, 140:7, 140:21, 141:5, 141:6, 141:11, 141:18, 141:21, 142:2, 142:6, 142:9, 142:13, 142:15
administering
141:16
administration
224:11, 301:3
administrations
301:1
administrative
16:3
advanced
24:20
advantage
96:17, 226:16
advantages
166:2, 221:11, 228:8, 228:12
adverse
314:12
affects
299:9
afforded
164:3
after
6:3, 18:7, 58:17, 70:12, 74:1, 75:14, 76:14, 112:7, 112:22, 153:21, 154:9, 163:17, 163:22, 229:1, 230:8, 232:15, 234:2, 238:11, 276:11, 296:3, 299:2, 300:13, 300:14, 300:22, 301:5, 302:7
aftereffect
280:6
afterwards
56:2, 96:13
against
11:18, 55:18, 56:20, 57:3, 57:9, 57:15, 57:21, 59:4, 59:6, 59:11, 59:13, 60:18, 64:8, 64:16, 65:22, 66:9, 75:21, 77:4, 78:8, 79:14, 80:2, 85:21, 86:13, 87:10, 104:21, 105:9, 105:17, 105:20, 106:5, 106:9, 107:19, 110:15, 110:18, 111:3, 111:16, 112:1, 112:10, 112:17, 113:4, 113:11, 114:9, 114:16, 114:21, 115:4, 115:8, 115:13, 131:20, 132:4, 132:11, 133:13, 134:3, 134:16, 170:15, 192:11, 192:20, 239:11, 244:1, 244:4, 260:22, 282:10, 309:17, 310:3, 311:17
agent
92:11, 93:4, 108:1, 205:1, 205:8, 205:12, 205:15, 205:22, 206:3, 206:7, 207:3, 209:19, 234:9, 234:12, 241:8, 247:20, 250:5
agents
93:21, 120:18, 133:4, 201:22, 202:3, 202:8, 202:11, 203:13, 203:21, 204:14, 204:19, 205:4, 207:7, 207:12, 243:21, 244:14, 244:21, 247:13, 248:20
agreement
2:12
aim
19:13
al
46:22, 53:22
alia
92:5
alive
140:10, 140:12
all
28:6, 28:20, 31:2, 47:4, 48:21, 51:7, 55:10, 56:1, 61:2, 65:18, 66:19, 79:10, 83:21, 87:7, 95:5, 122:19, 123:11, 125:19, 127:9, 137:13, 142:11, 145:10, 145:11, 146:3, 164:16, 165:4, 178:8, 178:9, 186:15, 188:4, 188:13, 188:17, 195:8, 198:12, 207:14, 207:20, 208:3, 208:7, 212:22, 213:21, 214:7, 218:7, 238:17, 245:13, 248:3, 248:6, 279:14, 280:3, 287:13, 295:21, 296:1, 296:2, 298:1, 298:12, 299:1, 299:19, 300:14, 300:21, 301:5, 301:7, 301:17, 301:19, 302:6, 302:21, 304:7, 306:21, 309:5, 309:12,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 317 of 375

309:15, 310:1, 310:10, 311:15, 312:14
allow 156:15, 199:3
allows 227:12, 307:2
alone 82:3, 87:20
along 94:4, 214:7, 215:8
already 17:18, 49:22, 89:3, 90:5, 144:21, 164:16, 214:11
also 4:11, 9:12, 10:22, 12:7, 15:8, 17:6, 17:8, 18:15, 18:19, 21:6, 25:11, 26:3, 26:15, 28:17, 29:5, 30:13, 35:5, 39:18, 40:11, 42:4, 44:22, 45:15, 46:14, 52:7, 52:22, 59:1, 62:8, 65:12, 68:6, 69:13, 77:14, 84:1, 85:11, 106:7, 126:12, 133:3, 140:18, 141:15, 142:5, 145:15, 160:10, 160:17, 162:20, 164:2, 165:13, 166:13, 190:20, 198:20, 208:22, 209:3, 212:11, 218:21, 227:9, 227:19, 236:13, 236:17, 245:20, 255:10, 258:12, 264:9, 265:21, 266:11, 266:14, 266:18, 267:8, 267:13, 271:21, 272:19, 274:18, 284:5, 286:12, 287:15, 300:7
alternative 177:17, 177:19, 178:15, 188:1, 188:11
alternatives 178:22
although 85:3, 297:15
altogether 312:11
always 62:21, 135:15, 156:8, 199:7, 214:3, 257:16
ambiguity 201:9, 201:10
ambiguous 204:9
amine 258:13, 258:14, 259:4
amount 110:5, 201:2, 228:1, 233:20, 271:18, 271:22
amplification 39:19, 42:16, 42:19, 43:2, 43:7, 43:16, 43:22, 44:1, 44:8, 44:10, 44:21, 45:1, 45:6, 45:14, 45:22, 46:1, 46:10, 46:19, 46:21, 47:1, 47:7, 47:15, 47:19, 48:15, 49:2, 49:6, 49:13
amplifications 48:21
amplified 40:17, 42:3
amplifies 41:22, 43:17
amplify 40:11, 40:12, 40:14, 42:22, 43:13, 48:6, 48:9
analysis 20:20, 60:20, 103:18
analytical 24:19
analyze 60:12, 65:8
andrew 3:14, 3:19, 283:8
angles 104:18
animal 75:9, 129:17, 137:9, 137:10, 138:18, 138:19, 140:4, 140:8, 140:9, 140:15, 140:18, 140:22, 142:12, 239:11, 261:1, 294:3, 296:16
animals 137:4, 137:15, 137:19, 142:19, 247:13
another 18:14, 18:19, 53:14, 94:17, 114:5, 158:22, 164:9, 176:22, 187:18, 221:16, 221:17, 224:11, 226:16, 232:21, 247:14, 249:4, 253:18, 299:14, 302:22
answer 7:17, 8:1, 20:14, 27:4, 39:20, 40:22, 41:3, 62:12, 63:2, 63:8, 63:16, 77:19, 106:8, 109:15, 112:15, 113:6, 113:9, 114:3, 115:19, 116:5, 117:8, 119:6, 119:14, 123:15, 132:14, 138:5, 143:3, 149:11, 149:19, 150:2, 150:12, 151:10, 155:10, 156:19, 157:3, 158:1, 158:4, 158:11, 158:13, 164:13, 167:15, 168:7, 168:20, 170:5, 198:18, 199:3, 199:14, 199:15, 199:16, 199:19, 201:14, 203:18, 204:3, 204:7, 209:19, 235:14, 240:20, 240:22, 241:1, 242:1, 242:4, 242:7, 253:1, 261:12, 265:16, 267:5, 268:5, 269:11, 269:15, 270:10, 270:18, 270:21, 271:1, 274:16, 277:2, 279:22, 291:3, 304:16, 304:18, 305:4, 305:13, 305:17, 306:7, 306:10, 306:13, 306:14, 306:15, 306:17, 306:18, 307:3, 307:4, 307:12, 308:8, 308:12, 308:14, 308:16, 312:11

answered
116:18, 156:12, 159:15
answering
29:4, 63:5, 77:21, 101:2, 198:9, 229:19, 252:7
answers
7:8, 198:18
antibodies
160:9, 160:16, 295:21, 296:1, 298:1, 298:12
antibody
296:3, 299:2
antigen
66:2, 151:16, 153:15, 155:5, 157:9, 157:14, 158:5, 276:13, 277:4, 277:13, 277:17, 278:8, 282:3, 282:7
antigen-encoded
87:19
antigen-encoding
82:2, 85:13, 85:17, 86:4, 86:11, 86:20
antigenetic
150:20
antigenic
42:7
antigens
250:14
antisense
133:18, 133:20, 134:3
anyone
14:3, 39:7
anything
62:21, 72:6, 164:14, 194:18, 194:21, 214:3, 285:15, 313:3
anywhere
53:2, 211:6
apologize
9:16, 123:7, 181:7
appeal
1:2
appealing
240:3
appear
122:1, 176:8
appearances
3:1, 4:1
appeared
297:16
appears
123:8
appendix
16:13
applicable
297:9
application
22:18, 23:3, 27:16, 42:20, 43:4, 53:20, 54:12, 59:3, 59:14, 60:5, 65:21, 66:1, 66:8, 91:12, 91:13, 95:16, 97:14, 97:16, 99:11, 101:3, 108:22, 109:3, 166:17, 206:22, 210:21, 210:22, 211:3, 211:6, 211:11, 211:14, 211:15, 211:18, 212:1, 212:7, 212:13, 212:19, 213:5, 213:18, 214:9, 235:19, 253:16, 254:3, 265:2
applications
20:1, 20:5, 20:11, 22:9, 25:11, 27:17, 98:17, 98:22, 136:1, 191:12, 206:4, 211:4, 211:7, 211:22, 212:3, 212:4, 212:6, 212:12, 212:18, 213:4, 213:11, 215:4, 251:9, 254:16
applied
247:12
applies
10:22
apply
21:21, 22:21, 95:15, 197:4, 235:20
applying
42:8, 237:21
appreciate
168:18, 270:3, 276:4
appropriate
155:16, 198:16, 198:19, 313:2
appropriately
156:4
approved
128:1, 128:9, 128:16
april
122:18
aptomers
134:11
area
20:21, 56:14, 101:16, 101:17, 109:5, 110:13, 160:6, 198:22
areas
15:16, 61:12
argued
233:13
argument
230:8
arguments
143:9, 258:1
around
27:20, 34:15, 34:16, 34:22, 35:5, 35:10, 37:4, 37:9, 37:10, 46:21, 111:6, 304:10, 305:22
art
82:7, 82:12
article
36:10, 186:5, 188:3, 188:5
articles
36:16, 37:15
articulate
167:6
aside
13:6, 17:5, 45:1, 45:7, 45:10, 85:10, 101:3, 231:22, 303:22
asked
30:18, 40:20, 116:17, 138:2, 147:20, 156:13, 156:14, 156:22, 159:14, 198:11, 198:19, 203:19, 276:21
asking
22:15, 32:22, 33:11, 39:17, 51:17, 57:6, 66:6, 66:13, 71:18, 78:6, 86:6, 106:10, 109:13, 109:20, 110:6, 110:7, 112:14, 112:18, 119:1, 128:22, 151:5, 157:7, 157:22, 158:9, 158:11, 159:20, 160:5, 165:2, 165:6, 168:7, 178:18, 187:17, 196:3, 196:6, 198:12, 198:16, 199:1, 201:14,

202:19, 229:3, 229:4, 252:7, 257:6, 257:7, 257:18, 268:5, 270:5, 270:7, 270:11, 270:18, 273:15, 274:13, 276:21, 279:20, 280:12, 280:13, 282:6, 284:22, 285:3, 289:5, 290:15, 298:21, 301:2, 307:14
aspect
24:12, 93:5, 94:17, 96:21, 107:5, 109:7, 145:13, 227:10, 227:11, 272:6
aspects
29:19, 97:20, 97:21, 107:2
assay
296:2
assayed
295:18, 295:20, 295:22
assemble
34:8
assess
255:21, 273:16
assigned
279:11
associated
14:12, 31:15, 49:12, 61:6, 138:4, 159:10, 201:12, 201:13, 250:14, 294:16
associating
310:18, 311:4
assume
7:17, 12:7, 15:2, 23:10, 91:2, 127:5, 202:4
assuming
119:8
assumptions
90:16
attach
25:15
attempting
220:5
attention
96:2, 96:3, 133:15, 134:6, 134:18, 245:6
attorney
314:21
attorneys
13:22, 14:4, 215:19
attractive
231:14, 251:13, 251:21, 252:16, 254:15, 255:1, 256:8, 257:1, 257:10
august
314:27
author
91:7
authors
209:22
available
107:10, 129:20, 154:7, 222:12, 222:21, 237:4, 252:22, 281:20
avenue
3:6, 4:5
aware
124:12, 124:14, 125:2, 125:21, 131:18, 133:12, 134:2, 134:15, 144:11, 181:9, 191:13, 193:3, 193:18, 195:16, 202:10, 203:2, 203:12, 203:20, 204:13, 216:22, 217:5, 217:7, 238:11, 243:13, 244:16, 247:8, 283:13, 288:1

B

bachelor's
24:15
back
31:10, 70:4, 81:9, 83:7, 83:11, 124:3, 138:22, 172:7, 187:9, 215:16, 225:18, 230:1, 237:14, 247:7, 254:7, 274:5
back-calculate
274:7
background
103:9, 178:20, 179:5, 214:21, 216:12, 216:16, 217:1, 217:9, 217:16, 218:1, 237:15, 238:5
backward
40:9
bad
266:6
ball
106:20
barriers
153:21, 154:9
base
52:7, 222:12
based
57:13, 60:4, 63:5, 63:16, 66:16, 71:19, 72:8, 80:5, 80:8, 80:11, 80:16, 89:19, 116:4, 118:17, 125:10, 129:17, 129:19, 143:20, 169:15, 172:8, 203:6, 209:11, 211:22, 225:13, 230:14, 230:22, 233:9, 237:8, 253:16, 257:22, 258:1, 259:13, 261:9, 261:10, 298:8, 300:17, 302:4, 303:12
basic
23:6, 24:8, 280:7
basically
72:15, 153:20, 155:20, 189:21, 224:14, 274:11
basis
159:3, 159:13, 160:3, 188:22, 313:2
beads
243:4
became
34:15, 35:2, 35:5, 37:11
become
34:15, 34:17, 34:21, 152:13, 232:16
becomes
206:19, 274:16
becoming
35:9
been
6:3, 6:21, 13:1, 18:6, 20:12, 21:6, 21:9, 46:15, 51:5, 51:13, 76:19, 110:21, 112:12, 123:16, 125:17, 129:8, 129:20, 137:19, 137:21, 138:7, 138:9, 185:6, 193:10, 198:18, 201:11, 202:11, 203:13, 203:21, 204:14, 206:7, 219:13, 220:4, 220:21, 221:13, 222:21, 223:12,

223:19, 225:12, 229:6, 237:21, 244:17, 244:21, 245:10, 245:16, 246:10, 246:19, 247:8, 247:12, 248:11, 251:12, 251:20, 252:16, 255:1, 256:8, 256:22, 257:9, 261:15, 276:1, 282:21, 299:17, 299:18, 301:16, 301:17, 302:20, 302:21, 306:2, 306:21, 309:1, 312:9
before
1:2, 2:13, 6:14, 6:19, 6:22, 7:3, 8:2, 8:10, 10:5, 21:2, 23:8, 23:11, 41:3, 51:5, 51:13, 54:5, 62:12, 79:20, 81:15, 123:18, 137:2, 143:2, 159:16, 167:11, 182:14, 196:9, 204:2, 204:11, 228:8, 229:12, 247:2, 250:1, 251:11, 251:19, 252:15, 254:22, 256:7, 256:13, 256:21, 257:8, 297:14, 299:9, 301:8, 310:9, 312:13, 314:7, 314:8
beginning
83:8, 83:11, 233:4, 310:7
behavior
196:12
behaviors
276:7
behind
24:8
being
95:19, 105:4, 111:10, 131:19, 133:13, 134:3, 134:15, 141:21, 142:6, 149:6, 158:20, 198:8, 222:19, 243:14, 251:6, 254:5, 257:17, 296:22
believe
50:1, 70:13, 72:5, 74:22, 115:2, 115:3, 156:11, 189:1, 203:6, 210:14, 218:20, 225:10, 229:18, 259:16, 260:8, 261:3, 309:13
below
30:6
benefits
227:14
best
7:15, 51:10, 199:18, 228:21, 229:1, 229:3, 231:3, 240:18, 253:21, 254:6, 303:2
beta
59:11
betacoronavirus
55:18, 56:20, 57:3, 57:9, 57:15, 57:21, 59:5, 59:6, 59:13, 60:19, 64:8, 64:17, 65:22, 66:9, 75:21, 77:4, 78:8, 79:15, 80:2, 85:21, 86:13, 87:10, 88:6, 88:11, 88:14, 88:18, 89:13, 89:17, 110:15, 170:15, 170:22, 171:7, 171:18, 171:21, 172:1, 172:5, 172:12, 172:16, 172:19, 173:5, 173:8, 174:6, 174:21, 175:14, 175:15, 175:18, 175:21, 175:22, 176:5, 282:10, 309:18, 310:4, 311:18
betacoronaviruses
175:5
better
198:13, 233:17
between
10:10, 14:17, 36:6, 36:17, 44:12, 44:17, 94:21, 136:10, 145:10, 145:11, 162:21, 166:19, 167:7, 177:7, 208:21, 226:4, 248:22, 250:21, 276:7, 277:3, 277:12
beyond
42:3, 60:20, 78:14, 127:8, 150:19, 182:7, 188:21, 190:21
big
91:21, 95:21, 95:22, 96:20
bigger
223:22
bilayer
191:9
bind
160:10, 160:17, 246:7, 258:15
bio
136:1
bioimaging
25:10
biological
19:16, 21:17, 21:19, 24:11, 106:17, 136:22, 245:18, 254:4
biology
195:8
biomarker
112:21
biomarkers
110:12, 111:10, 112:12, 113:2
biomedical
14:12, 19:21, 20:4, 20:15, 26:17, 251:8
biontech
1:4, 4:9, 4:12, 6:18
biotech
132:1
bit
29:17, 31:6, 76:20, 91:20, 184:3, 221:3, 232:2
bizarre
197:16
black
257:17
blah
180:5, 311:9
bled
73:21, 75:13, 76:13, 80:22
blood
18:9, 18:17, 22:6, 105:3, 106:17, 110:5, 110:11, 112:22, 118:8, 314:20
bloodstream
244:15, 244:22
board
1:2, 198:7, 204:12

body
111:1, 153:21, 154:22, 160:19
body's
154:1
bold
262:11
bolus
142:3, 142:4
book
90:13, 90:14, 91:6
boston
1:19, 2:12, 3:17, 314:16
both
8:14, 8:21, 11:11, 11:12, 12:1, 14:21, 32:8, 55:14, 74:15, 138:7, 154:2, 169:10, 193:14, 193:16, 264:13, 294:6, 295:8, 300:11, 301:1, 304:12, 306:1, 307:6
bottom
276:9, 283:20
break
7:20, 8:2, 76:19, 81:6, 81:11, 87:14, 128:6, 147:16, 148:7, 148:13, 203:15, 204:3, 204:5, 204:16, 215:13, 259:21
breaking
76:19, 177:22, 282:15
bring
91:20, 131:14
bringing
230:19
brito
246:6
broad
103:7, 106:4, 106:7, 113:14, 115:10, 149:22, 153:5, 155:6, 155:15, 187:5, 191:18, 217:21, 267:2
broader
34:20, 92:17
broadly
12:15, 52:14, 135:9, 233:2, 276:22
broken
31:21
build
16:4
bunch
89:2, 90:3, 94:16, 256:4
buy
39:8, 43:22, 44:7, 44:20, 45:5, 45:14
buying
47:15

C

calculate
279:10
call
25:5, 198:7
called
25:11, 47:17
calling
312:19
calls
136:5, 138:11, 148:4, 148:22, 149:17, 151:2, 151:17, 153:16, 157:16, 158:8, 190:12, 192:6, 192:12, 192:21, 235:3, 244:7, 255:5, 256:12, 261:7, 265:5, 265:14, 266:20, 267:21, 268:14, 280:22, 282:4, 295:8, 307:20
calves
294:2, 300:13, 300:14, 300:21, 301:5, 302:6, 303:2, 303:21
came
164:22
can't
8:5, 18:4, 31:1, 36:19, 43:3, 43:10, 52:5, 68:18, 145:9, 190:6, 195:10, 196:4, 226:14, 229:14, 257:19
cancer
19:22, 168:3, 168:12, 168:17, 168:21, 169:2, 169:3, 169:10
cancers
166:19, 167:1, 167:8, 167:13
candidate
231:4, 278:21
cannot
36:8, 62:12, 62:16, 62:19, 62:20, 107:15, 114:20, 134:5, 149:19, 168:20, 191:17, 233:1, 300:6
capability
259:3, 259:5
capable
92:14, 310:17, 311:3
capacity
178:2
capping
126:17
caption
279:15
captions
278:18
carbohydrates
26:3, 27:20, 58:11, 93:15
carefully
46:16, 47:3, 123:20, 144:8
carrier
162:1, 162:12, 193:9, 225:20, 226:1, 227:3, 227:4
carriers
226:22
carries
248:18
carry
193:5
carrying
310:17, 311:4
case
1:10, 32:8, 40:19, 41:5, 91:6, 94:16, 107:7, 109:22, 111:14, 114:2, 130:10, 138:4, 176:21, 177:1, 187:18, 213:20, 251:7
cases
48:21
catalytic
134:10
categories
30:9, 84:10, 161:3, 248:19, 289:2, 289:15, 290:5, 290:12, 290:20, 291:11, 291:12, 292:4, 292:9
categorize
258:8
category
34:20, 53:3, 96:19, 207:17, 247:4, 277:19
cationic
58:11, 93:15,

94:18, 246:4, 246:6, 246:14, 246:16, 246:22, 247:1, 247:15, 249:1, 249:3, 249:12, 249:15, 249:19, 249:22, 250:12, 250:20, 250:22, 251:12, 251:20, 252:15, 253:8, 254:22, 255:10, 256:7, 256:22, 257:9, 258:4, 258:9, 258:12, 258:16, 258:17, 258:21, 258:22, 294:6, 295:9, 304:11, 306:1, 307:6, 309:8, 309:15, 309:22, 310:2, 311:16
cattle
294:4
cd4+
279:12
cd8+
279:12
cdna
126:8
cell
42:2, 48:12, 93:6, 93:8, 118:9, 136:13, 136:15, 137:8, 138:14, 138:17, 138:19, 267:19, 269:1, 269:8, 269:20, 271:4, 271:10, 273:10, 279:12
cell's
92:14
cells
22:3, 26:22, 27:14, 38:3, 38:4, 48:14, 105:14, 106:18, 137:14, 138:15, 244:22, 247:13
celsius
164:1
certain
15:19, 32:1, 47:1, 49:12, 56:3, 80:17, 97:8, 100:19, 103:22, 105:3, 105:14, 105:15, 108:9, 110:5, 110:11, 143:10, 156:6, 198:22, 227:5, 228:1, 230:9, 230:10, 232:14, 233:20, 241:12, 248:11, 252:11, 253:5, 259:1, 259:2, 281:15, 286:9
certificate
314:1
certified
2:14
certify
314:4, 314:12, 314:14, 314:19
chan
1:16, 2:10, 5:3, 6:2, 6:8, 6:12, 6:13, 6:16, 6:21, 8:8, 8:20, 11:10, 11:13, 12:10, 14:7, 19:13, 24:14, 31:5, 32:7, 53:9, 53:18, 59:2, 61:8, 61:13, 62:11, 75:19, 77:2, 81:9, 94:5, 95:8, 96:22, 98:3, 101:1, 101:12, 101:22, 103:12, 104:4, 104:13, 107:6, 110:6, 112:13, 147:19, 163:6, 164:17, 199:11, 205:3, 206:21, 214:14, 215:16, 229:18, 232:4, 238:19, 240:20, 261:14, 261:19, 275:3, 275:12, 275:17, 276:1, 277:14, 279:14, 282:20, 283:4, 285:15, 304:3, 305:11, 308:21, 309:14, 311:12, 312:6, 314:5, 314:15
chance
164:13
change
17:5, 133:3
characteristic
71:2, 73:7, 73:12
characteristics
68:15, 71:20, 72:14, 75:8
characterization
70:14, 71:1, 281:11, 292:14, 300:21, 312:17
characterize
19:14, 25:17, 25:19, 205:21
characterized
68:16, 68:21, 70:11
characterizes
296:8
charge
258:14
charged
258:5, 258:10, 258:18, 259:1
chee
6:12
chemical
22:7, 154:9, 250:6, 309:9, 310:10, 311:21, 312:1, 312:3, 312:5
chemistries
33:10
chemistry
24:15, 24:16, 24:18, 24:19, 26:18, 58:18, 108:11, 155:22, 195:22
chen
46:22
choices
181:1, 197:16, 252:8, 252:10
cholesterol
95:3, 294:20
choose
199:12
circumstances
248:12
citations
10:19, 10:20, 81:15, 278:2
cite
275:13, 275:14
cited
13:13, 13:16
citing
250:2
claim
170:19, 171:3, 171:5, 171:11, 171:20, 172:4, 172:15, 174:1, 174:12, 174:21, 175:13, 175:20
claimed
170:19
claims
10:5, 10:12, 13:9, 59:1, 122:7, 174:16
clarification
199:6, 268:16, 268:18
clarify
7:15, 12:14,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 323 of 375

32:21, 38:17, 39:12, 50:18, 109:20, 121:3, 155:7, 175:1, 284:19, 307:9
clarity 312:3
classes 167:4
cleanup 126:14
clear 11:22, 28:8, 40:21, 67:13, 120:14, 124:21, 146:17, 167:18, 167:19, 167:21, 188:9, 224:16, 243:3, 257:17
clearer 204:4
clearly 166:15, 276:6, 298:17, 301:8
clinic 23:8, 191:13, 243:15, 244:5
clinical 20:19, 20:20, 23:11, 23:12, 106:20, 109:3, 206:10, 245:5, 245:11, 247:10, 259:20, 260:3, 260:5, 260:16, 261:6
clinically 243:8
clinician 191:17, 243:16, 260:4
clr 1:21
cne 294:11, 295:11
coaching 270:4, 270:5
coated 310:15, 311:2
coating 310:17, 311:3
collaborate 20:18, 107:3, 108:3, 109:1, 109:4
collaborators 117:15, 117:17, 158:22, 206:18
colleagues 313:5
collected 279:5
colony 250:15
column 263:19, 264:4, 308:19, 308:20, 308:21, 308:22, 309:3, 309:4, 309:6, 309:7, 310:13, 311:22
columns 309:16
com 3:9, 3:10, 3:19, 3:20, 4:8
combat 154:7
combination 77:9, 93:18, 252:10
combinations 58:14, 134:12, 138:20, 184:19, 251:5, 254:9
combine 188:3
combines 86:4
combining 82:1, 85:12, 85:17, 86:11, 86:19, 87:19
come 49:21, 209:1, 230:1, 301:3
comes 184:7
comfortable 254:11
coming 83:20, 132:7, 254:7
comirnaty 114:12, 114:15, 114:21, 115:3, 115:8, 193:14
commencement 314:7
commencing 314:18
comment 36:8, 66:15, 66:17, 191:18
commenting 30:17
comments 273:3
commercial 128:20
commission 314:28
common 209:22
commonality 61:6, 248:6
commonly 243:19
commonwealth 2:16, 314:3, 314:33
companies 39:8, 55:11, 206:11
company 43:5, 54:14, 54:17, 54:20, 55:5, 55:10, 137:6, 261:10
comparative 278:19
compared 262:15, 263:4, 263:10, 263:16
compartment 281:10
complement 295:20, 295:22
complementary 126:9
complements 133:21
complete 209:4, 267:2, 273:2
completed 14:22
completely 164:6
complex 239:10, 260:22, 298:19
complicating 297:17, 298:5, 298:18, 302:13, 302:14, 303:19
component 31:13, 48:22, 58:17, 137:14, 148:2, 148:9, 148:20, 149:7, 149:15, 150:6, 150:21, 151:7, 265:19
components 30:15, 69:8, 98:2, 151:14, 153:13, 153:22, 155:3, 155:8, 249:9, 259:22, 294:15, 294:22, 295:5
composed 250:6
composition 70:9, 92:5, 92:9, 170:20, 171:5, 171:10, 174:18
compositions 72:11
comprehensive 216:6, 216:11, 216:17, 216:20

comprise
94:14, 95:2
comprises
93:7
comprising
92:5, 93:9, 94:13, 170:20, 170:21, 171:6, 171:10, 171:17, 172:11, 172:18, 174:5, 311:7
computer
266:5
concentration
162:21
concept
30:19
concluded
313:20
conclusion
66:5, 164:22, 299:15, 300:6
conclusions
182:14
conditions
168:6, 258:11, 259:1, 259:2
conduct
312:15, 312:17, 313:1
conducted
38:6, 44:11, 44:16, 45:2, 45:10, 259:10, 259:11, 293:19
confer
313:5
conferences
222:15
confusing
29:17
confusion
200:9, 200:10, 200:11
conjugated
294:21
connolly
3:3
consequence
170:5
consider
60:4, 71:4, 71:10, 71:16, 73:18, 115:12, 205:7, 209:15, 217:13, 217:17, 232:9, 234:4, 234:16, 281:13, 281:14, 287:20, 288:3, 295:1
considered
111:14, 111:22, 206:2, 231:10, 231:17, 262:3, 272:13, 280:15, 280:16, 280:17, 280:18, 292:6
considering
255:8
consistent
75:17
consists
250:19
construct
251:11, 251:19, 252:15, 254:21, 256:6, 256:21, 257:8, 258:21
contact
209:12, 209:21, 209:22
contacting
93:8
contain
49:14, 49:17, 57:8, 100:20, 190:21, 195:4, 201:18, 204:22, 205:18, 258:21, 295:5
containing
250:12
contains
31:14, 81:21, 83:9, 87:16, 190:19, 191:4, 205:13, 247:20, 248:17
contemplating
21:7
contend
45:18, 70:5, 75:19, 77:2, 78:3, 89:11, 97:7, 203:7, 203:8, 216:15, 225:16, 228:11, 285:2, 303:7
contends
69:6
content
215:19
contention
79:3, 80:9
contents
311:9
context
25:13, 34:10, 34:17, 40:10, 41:3, 41:14, 47:7, 50:20, 59:8, 59:18, 61:15, 62:9, 62:21, 62:22, 78:18, 78:20, 83:17, 83:18, 83:22, 113:1, 119:12, 119:13, 182:14, 198:13, 207:1, 209:6, 215:9, 221:22, 227:16, 235:18, 237:21, 241:21, 242:3, 242:6, 242:10, 242:15, 253:3, 257:15, 257:20, 270:1, 270:13, 270:20, 270:21, 272:17, 275:20, 291:22, 292:17, 292:18, 293:2, 293:3, 293:8, 299:9, 310:8, 310:11, 312:20
contexts
224:14
contextual
61:11, 62:1, 62:17, 63:6, 63:11, 63:15, 63:16, 65:6, 65:14, 84:9, 84:12, 84:20, 88:22, 89:3, 89:19, 89:21, 90:8, 90:11, 95:11, 95:18, 98:1, 253:14, 257:16, 297:12, 301:7, 302:11
continuation
15:13
continue
15:20, 16:4, 58:16, 73:20, 75:5, 93:21, 96:8, 226:15
continued
4:1, 76:12
continues
77:11, 77:14, 94:3, 97:9, 198:7
continuing
227:7
contrast
226:20, 263:22
contribute
148:10, 149:15, 150:7, 150:22
contributed
214:16
contributes
148:2, 148:20
controlled-release
56:22, 57:17, 59:22, 62:5, 63:20, 64:10, 66:22, 84:22, 90:2, 143:10,

166:3, 166:7
convenience
10:18
convinced
166:13
copy
16:18, 16:19
core
310:15, 311:1
corner
283:20
coronavirus
175:12
correlate
118:10
correlation
162:21, 277:3, 277:12
correlations
276:7
corresponds
157:3
could
12:15, 26:22, 32:19, 48:13, 60:1, 106:17, 106:18, 118:15, 140:9, 146:3, 168:8, 184:18, 184:21, 189:8, 189:9, 200:15, 226:16, 271:13
couldn't
23:20, 131:10
counsel
3:11, 3:21, 4:9, 4:12, 4:13, 81:11, 198:20, 199:9, 270:3, 314:13
couple
13:1, 13:2, 13:5, 21:6, 123:16, 125:17, 131:22, 132:1, 213:20
course
15:20, 26:1, 30:19, 31:1, 33:1, 35:2, 45:14, 231:19
court
7:5, 68:17, 313:11, 313:17
covered
214:11
covid
55:2, 110:2, 110:4, 110:8, 110:11, 110:14, 110:17, 110:20, 111:2, 111:15, 111:18, 111:22, 112:9, 113:3, 113:10, 113:16, 115:4, 115:9, 115:12, 244:2, 244:5
cows
295:22, 296:2, 296:3, 298:2, 298:13, 299:1
create
47:17, 78:14, 96:9, 312:3
created
18:11, 83:17, 278:7
creates
200:9, 274:12, 300:18, 301:20, 303:1
creating
201:9
creation
19:21
criticized
85:11
cross
5:2
crr
1:21
crystal
30:2, 30:12, 30:14, 32:4, 33:18
crystals
30:1, 32:12
csf
74:5, 75:4
culture
136:13, 137:8
cultures
136:15
curevac
239:14, 259:10, 259:11, 259:16, 260:8, 260:20
curevac's
260:11
current
14:7, 55:3, 177:11
currently
244:10
cv
16:18, 16:19, 17:3, 17:14, 17:22, 18:3, 45:19, 46:4, 46:6, 46:15, 136:20, 159:18
cytokine
225:1
cytoplasm
269:1, 269:8, 269:20, 271:4, 271:10, 273:10
cytosine
219:1, 219:3, 219:12, 219:21, 220:2, 220:4, 220:16, 220:19, 220:21, 221:8, 221:13, 221:18, 222:3, 224:5, 224:6, 224:9, 224:10, 224:14, 224:17, 224:22, 225:2
cytosine-based
224:12, 225:4
cytosol
273:22, 277:8, 281:8

D

dance
111:6
danford@wilmerhale
3:19
data
113:7, 113:8, 114:10, 114:11, 114:17, 114:19, 115:1, 115:6, 130:8, 275:6, 278:15, 279:7, 301:22, 302:2, 302:4, 302:9, 303:3
date
128:1, 128:8, 128:12, 129:11, 129:21, 130:12, 169:22, 170:9, 203:9, 222:21, 225:13, 233:5, 244:11, 245:20, 248:9
day
279:5, 285:14, 306:21, 314:27
days
13:2, 14:1, 75:14, 76:14, 81:2, 164:1, 279:1
dc
3:7
dead
140:10
dealt
53:7
dean
15:8
decades
219:15
december
211:12
deciding
229:10

decision
261:9, 261:10, 261:13
decisive
276:11
declaration
11:12, 12:3, 12:4, 12:21, 13:5, 13:7, 13:11, 13:14, 13:17, 16:11, 16:17, 19:6, 41:8, 41:11, 41:12, 41:15, 53:10, 54:2, 54:5, 55:15, 60:4, 65:4, 81:14, 81:18, 85:15, 86:16, 107:13, 115:17, 119:18, 122:17, 161:18, 164:17, 165:3, 165:16, 169:17, 210:3, 212:15, 214:22, 216:1, 216:6, 216:10, 216:13, 216:16, 217:10, 218:2, 218:5, 224:21, 225:19, 238:19, 239:1, 239:6, 239:8, 239:17, 242:18, 242:19, 242:22, 259:7, 262:5, 273:5, 281:3, 281:5, 283:6, 283:10, 285:16, 312:22
declarations
8:9, 11:4, 11:17
decrease
297:20, 299:12, 301:11
defense
26:16, 154:1, 154:8
deficiency
163:5
define
28:10, 40:4, 40:6, 57:11, 89:5, 119:1, 119:4, 150:10, 152:19, 155:20, 159:6, 161:5, 190:6, 193:1, 194:7, 194:19, 248:19, 249:10, 249:15, 265:15, 272:12, 280:14, 281:17, 290:2
defined
28:7, 30:5, 31:22, 32:2, 41:13, 201:1, 201:15
defines
31:13, 32:5, 274:2
defining
153:7, 201:10
definitely
46:20
definition
30:8, 30:14, 40:10, 40:16, 42:8, 196:20, 247:16, 248:1, 248:15, 268:19, 284:15, 284:17, 284:22, 285:1, 285:12
degradation
164:5, 263:21, 264:6, 264:21, 265:12
degrade
264:16
degraded
264:9, 264:11, 264:14, 265:3
degrades
164:6
degree
24:20, 25:3, 26:12, 26:13, 26:16, 26:19, 255:17
degrees
164:1
deliberately
198:9
deliver
162:8, 191:2, 191:5, 191:14, 218:17, 219:1, 219:14, 219:21, 220:2, 220:4, 220:16, 220:19, 220:21, 222:7, 224:7, 224:9, 224:13, 224:18, 224:22, 225:5, 230:14, 230:22, 240:19, 243:8, 243:14, 244:17, 245:20, 246:11, 246:19, 247:9, 250:7, 250:13, 251:14, 251:22, 252:17, 253:9, 255:2, 256:2, 256:3, 256:9, 257:2, 257:11, 307:19, 308:3
delivered
231:20, 297:3
delivering
135:13, 146:14, 146:20, 179:18, 180:4, 180:10, 180:16, 181:16, 182:1, 182:17, 189:15, 225:2, 227:17, 239:16, 243:20, 244:21, 245:16, 247:2, 247:12, 250:1, 264:19, 266:17
demonstrated
193:10, 246:1, 260:21, 261:4
demonstrates
163:21, 164:2, 166:5, 166:12
denature
127:5
denatured
127:6
dense
125:16
departments
14:13
depend
265:16
depended
156:8
depending
34:7, 103:8, 138:21, 157:21, 199:15, 206:2, 230:4
depends
29:6, 34:10, 135:19, 140:5, 150:17, 196:15, 206:3, 234:19, 235:18, 265:1, 265:7, 265:18
deposed
6:21
deposes
6:5
deposition
1:16, 2:10, 6:14, 6:17, 7:21, 8:13, 10:19, 12:17, 12:19, 13:18, 14:5, 53:12, 54:9, 55:15, 81:16, 90:10, 95:12, 131:15, 140:14, 147:20, 160:12, 312:9, 312:15, 313:20, 314:6, 314:7, 314:8, 314:13, 314:14
derived
41:19
describe
56:19, 57:2,

57:20, 59:4, 59:15, 64:16, 65:21, 66:8, 66:10, 70:1, 70:22, 72:22, 73:2, 74:7, 77:11, 94:3, 97:19, 140:6, 142:11, 146:13, 153:19, 154:20, 171:4, 194:1, 213:16, 238:9, 238:13, 260:9, 285:20
described
51:5, 51:13, 71:2, 77:10, 93:7, 122:5, 122:7, 123:21, 144:14, 144:16, 144:17, 174:12, 177:11, 178:16, 179:1, 183:12, 183:16, 183:21, 184:6, 184:8, 184:9, 184:16, 260:12, 293:22, 311:8
describes
62:9, 69:5, 70:5, 72:9, 76:7, 80:20, 92:22, 95:1, 96:16, 97:10, 97:12, 121:15, 121:16, 121:18, 139:9, 140:15, 140:18, 163:3, 173:4, 180:17, 188:6, 246:6, 278:11
describing
59:10, 180:7, 239:21
description
58:19, 68:7, 71:19, 73:17, 74:22, 79:19, 80:8, 95:7, 96:9, 96:12, 96:15, 123:9, 126:6, 127:7, 163:14, 177:12, 189:12, 218:10, 239:9, 275:1
descriptions
143:7
descriptor
31:18, 127:3, 189:16, 301:19
design
21:15, 21:18, 22:13, 103:21, 109:6, 132:6, 136:9, 136:16, 136:19, 137:1, 137:13, 188:18, 195:22, 196:1, 227:3, 227:4, 230:10, 232:13, 252:6, 257:15, 258:20, 312:1
designed
23:2, 23:10, 23:12, 66:11, 115:20, 156:3, 184:20, 196:8, 205:20
designing
109:8, 158:18
designs
117:5, 117:6, 117:8, 119:20, 132:16, 247:6, 255:9
desirable
235:2, 235:9
desire
234:1
despite
128:2, 128:10, 128:17
detail
119:21, 196:1, 202:15, 232:3, 238:9, 249:5, 270:19
details
65:13, 101:15, 114:3, 162:19, 162:20, 164:22, 214:7
detected
295:21, 296:1, 298:1, 298:12, 300:12, 303:2
detecting
20:8
detection
18:21, 18:22, 20:18
determine
74:2, 75:16, 76:11, 76:16, 117:17, 178:21, 207:4, 207:8, 230:5, 249:11, 270:14, 271:16
determined
279:6
determining
231:10, 231:17, 232:9, 234:4, 234:16
develop
21:20, 50:4, 106:15, 135:2, 160:15, 196:11, 206:11, 220:5, 220:22, 222:2, 222:7, 222:22, 232:22
developed
21:1, 21:3, 22:2, 22:8, 22:17, 23:1, 23:13, 23:22, 50:7, 51:12, 128:21, 134:21, 219:14, 223:13, 223:20, 251:7
developing
18:20, 20:17, 21:10, 25:10, 54:15, 106:13, 134:20, 135:13, 136:11, 221:5, 228:2, 239:15
development
23:17, 23:19, 136:18
developments
19:20, 37:3, 37:19
device
18:21, 190:17
devices
15:17, 19:22, 20:4, 20:8, 20:16, 20:18
diagnosing
20:16
diagnostic
15:17, 18:20, 20:8, 39:18, 40:13
diagnostics
20:12, 46:2, 46:14, 46:18
difference
44:12, 44:17, 136:10, 166:18, 177:7, 248:22, 250:21
differences
10:12, 167:7
different
15:21, 17:10, 28:3, 28:20, 29:19, 31:6, 33:10, 35:13, 37:1, 49:8, 50:19, 51:22, 56:16, 72:11, 76:9, 82:10, 82:18, 90:3, 93:3, 93:20, 95:5, 103:10, 104:18, 105:18, 106:1, 106:20, 106:22, 117:21, 125:20, 127:17,

136:14, 140:22, 142:18, 142:21, 145:11, 145:18, 167:1, 167:4, 168:1, 168:6, 168:9, 175:4, 175:9, 176:22, 177:21, 178:4, 185:4, 185:8, 188:7, 190:14, 191:11, 192:8, 197:9, 203:16, 206:4, 217:4, 218:10, 220:9, 221:6, 224:19, 230:18, 230:20, 238:1, 239:2, 240:3, 245:18, 248:3, 251:5, 251:8, 251:16, 257:4, 257:6, 258:19, 261:1, 268:2, 268:4, 271:7, 287:19, 289:2, 289:4, 289:14, 291:13, 292:3, 292:4, 292:19, 306:6, 307:10, 309:21, 311:22
differently
68:14, 149:2, 149:3, 243:11
difficult
209:18, 217:19
dimension
30:7, 30:10
dimensions
18:12, 32:1
direct
5:2, 6:6, 165:8, 165:17
directed
44:12, 44:17, 45:3, 45:11, 45:18, 46:5, 46:7, 74:9, 145:5, 145:21, 172:16, 245:2, 262:7
direction
83:19, 170:11, 170:12
directly
23:9, 29:5, 32:16, 42:18, 70:21, 75:4, 77:8, 181:13
disagree
70:14, 123:13, 155:12, 267:7, 291:18, 298:11, 300:16, 300:20, 302:5, 312:16
disclose
55:17, 61:8, 61:13, 64:6, 66:18, 82:13, 84:13, 85:20, 86:12, 146:19, 165:8, 170:14
disclosed
79:13, 83:4, 126:1, 165:7, 186:15, 186:16, 187:10, 218:8, 226:21, 227:19, 228:15, 229:5, 229:20, 301:22, 309:1, 309:15
discloses
60:17, 67:19, 67:22, 69:2, 69:13, 146:8, 163:10, 182:22, 183:18, 184:1, 185:14, 185:18, 188:11, 225:17, 302:1
disclosing
189:2
disclosure
10:15, 10:21, 57:8, 57:14, 60:12, 70:5, 79:1, 85:10, 87:9, 92:2, 92:4, 230:15, 231:1, 238:7, 310:14, 311:1
discovered
213:17
discuss
121:6, 123:5, 154:14, 154:18, 217:22, 218:20, 224:5, 225:6, 237:18, 242:22, 253:19, 259:10, 297:8
discussed
29:19, 127:9, 153:8, 157:19, 215:4, 218:14, 219:4, 224:17, 224:20, 232:8, 252:3, 283:5, 284:10, 293:14, 296:22
discusses
62:7, 98:16, 99:5, 293:6
discussing
44:4, 98:14, 98:21, 179:22, 219:6, 220:16, 225:10, 296:7
discussion
10:21, 30:22, 220:13, 230:2, 237:15, 237:19, 238:6, 276:9
discussions
30:20, 33:3, 213:6, 214:17, 251:3
disease
18:21, 19:22, 20:5, 20:11, 23:21, 104:21, 105:9, 105:17, 105:20, 106:6, 106:9, 107:19, 167:2, 167:14, 168:4
diseases
20:16, 131:20, 132:4, 132:11, 133:14, 134:4, 134:16, 166:20, 167:4, 167:9
dispersity
72:18
dispute
78:5
disregarded
303:12
division
211:11
divisional
206:22, 211:13, 211:16, 211:18, 211:21, 212:6, 214:9
dlindma
294:20
dna
48:3, 48:5, 48:6, 48:9, 48:15, 49:3, 49:7, 126:9, 127:20, 128:1, 128:9, 128:16, 129:1, 129:4, 129:8, 129:12, 129:16, 129:22, 130:14, 131:1, 134:10, 219:22, 220:2, 220:4, 220:17, 220:19, 220:21, 222:4, 222:20, 223:13, 223:20, 224:9, 224:10, 225:2, 225:3, 279:2
dnazymes
47:17
doctor
206:5
document
16:16, 17:4, 54:4, 65:11,

65:17, 66:14, 83:22, 217:14, 283:5, 283:9
documents 11:11, 12:1, 12:22, 13:6, 13:16, 221:19
doing 12:8, 39:3, 90:21, 311:20
done 15:14, 33:7, 52:9, 140:11, 208:5, 209:12, 243:18, 245:17, 260:5
dope 250:7
dose 73:15, 75:11, 139:16, 141:1, 141:13, 147:2, 147:9, 147:14, 297:19, 298:6, 298:20, 299:11, 301:9, 302:16
doses 298:7
dospa 250:7
dot 25:16
dotap 250:13, 250:19
dotma 250:12, 250:19
dots 25:10, 25:11, 27:11, 27:12, 135:4
dotted 279:9
down 7:6, 15:20, 77:22, 78:1, 79:22, 80:5, 80:14, 80:16, 81:2, 87:14, 90:14, 90:18, 99:19, 103:11, 109:21, 128:6, 136:11, 148:7, 148:13, 167:12, 167:14, 177:22, 181:13, 181:14, 183:10, 203:15, 204:3, 204:5, 204:17, 259:21, 262:12, 262:18, 264:2
dr 6:8, 6:13, 6:16, 6:21, 8:8, 8:20, 11:10, 12:10, 14:7, 24:14, 31:5, 32:7, 53:9, 53:18, 59:2, 61:8, 61:13, 62:11, 75:19, 77:2, 81:9, 94:5, 95:8, 96:22, 98:3, 101:1, 101:12, 101:22, 103:12, 104:4, 104:13, 107:6, 110:6, 112:13, 147:19, 163:6, 164:17, 199:11, 205:3, 206:21, 214:14, 215:16, 216:4, 216:5, 216:9, 216:10, 229:18, 232:4, 238:19, 240:20, 247:2, 250:2, 250:4, 250:10, 261:14, 261:19, 275:3, 275:12, 275:17, 276:1, 277:10, 277:14, 279:14, 282:20, 283:4, 285:15, 304:3, 305:11, 308:21, 309:14, 311:12, 312:6
draft 214:19
drafted 169:17, 215:1
driver's 6:4
drug 137:3, 304:4, 304:9
drugs 191:2, 191:5, 191:15
dspc 294:19
duly 6:3, 314:6
during 7:21, 25:7, 25:9, 25:19, 26:9, 26:15, 27:5, 28:14, 28:19, 29:1, 29:9, 30:19, 31:1, 33:1, 33:12, 34:13, 81:11, 90:10, 95:12, 144:11, 281:9, 312:15
dynamic 17:11

E

each 33:3, 150:11, 168:5, 168:6, 168:8, 187:19, 187:20, 209:10, 210:10, 210:12, 210:16, 221:9, 280:2
earlier 11:3, 83:12, 95:10, 126:4, 147:19, 153:8, 155:21, 157:19, 196:11, 218:7, 218:14, 225:9, 226:8, 230:2, 231:6, 252:2, 252:8, 252:20, 254:2, 273:15, 279:21, 283:15
early 245:22, 281:11
easier 146:12, 276:1
editor 35:5
educated 208:17
education 25:5, 31:3, 33:5, 103:9
educational 28:19
educations 33:3
efficacy 236:7
efficiencies 145:17
efficiency 256:1, 274:1, 274:5, 281:8
efficient 265:22, 266:12, 266:15, 266:18, 267:3, 267:9, 267:13
effort 199:18
efforts 232:18
eight 278:22
either 17:17, 47:9, 49:2, 49:6, 135:20, 143:13, 184:19, 258:17, 294:11
electron 18:8
electroporation 279:3

elicit
99:3, 99:6, 99:15, 99:21, 100:12, 102:8, 102:14, 102:20, 103:2, 105:2, 105:7, 108:6, 108:16, 109:11, 109:17, 110:2, 110:8, 110:14, 110:17, 112:9, 113:10, 114:8, 114:15, 115:21, 116:7, 118:19, 119:15, 120:9, 147:21, 152:1, 152:6, 152:10, 180:1, 180:12, 180:20, 181:10, 181:19, 192:10, 192:19
elicited
117:18, 151:16, 153:15, 155:5, 179:18, 180:4, 180:10, 180:16, 181:15, 182:1, 182:16, 189:15, 300:11
eliciting
99:8, 105:9, 105:17, 105:20
elicits
101:5, 105:13, 107:16, 111:3, 111:15, 111:22, 112:16, 113:3, 114:21, 116:11, 116:15, 116:22, 117:9, 118:2
eliminated
58:14, 93:18
elisa
74:3, 74:4, 75:16, 76:11, 76:17, 279:7
else
180:20
elsewhere
132:2
elucidate
19:15, 24:10
elucidating
21:16
embedded
310:15, 311:1
embodies
177:10
embodiment
94:11, 99:2, 99:19, 99:20, 100:19, 120:8, 127:15, 176:8, 176:10, 176:14, 176:20, 176:22, 177:2, 177:8, 177:10, 178:16, 179:1, 179:17, 185:10, 187:16, 187:17, 283:14
embodiments
60:14, 61:9, 176:15, 177:17, 177:20, 178:7, 178:14, 178:15, 178:22, 188:1, 188:11, 189:2
emphasis
84:4
emphasize
58:17, 83:15
emphasized
83:13
employed
250:5, 314:21
employment
14:8, 17:5
empty
194:4, 194:7, 194:8, 194:16, 194:19, 195:6
emulsion
246:6, 294:12, 295:12
emulsion-adjuvanted
297:15
enable
75:20
encapsulate
29:20, 163:4, 190:11, 192:10, 192:19, 193:15, 193:19, 194:9, 194:11, 194:14, 194:18, 194:21, 195:12, 195:17, 196:18, 197:6, 197:12, 197:15, 197:17, 197:21, 198:2, 198:4, 199:22, 200:4, 200:8, 200:12, 200:14, 200:18, 201:3, 201:5
encapsulated
262:14, 263:2, 263:8, 263:14
encapsulating
60:18, 64:7, 147:5, 147:12
encapsulation
68:22, 145:17, 163:5, 196:21, 197:1, 200:22, 265:21, 266:11, 266:14, 267:8, 267:13
encode
92:6
encodes
42:6, 48:17, 49:1, 49:5, 49:14, 100:21, 175:18, 284:1, 287:3, 287:9, 287:15
encoding
88:6, 88:10, 88:14, 88:17, 89:12, 89:16, 92:13, 92:19, 93:9, 170:22, 171:7, 171:18, 172:11, 172:19, 174:6, 250:13, 278:21
encompass
52:18
encountered
201:17, 288:13
end
14:15, 25:3, 81:15, 111:20, 234:13, 272:19
ended
17:16
endosomal
268:7, 268:9, 268:19, 269:16, 270:9, 271:18, 271:22, 272:11, 272:13, 274:15, 276:10, 277:4, 277:12, 278:8, 280:4, 280:20, 281:11, 281:18
endosome
267:20, 268:10, 268:13, 268:22, 269:8, 269:20, 271:3, 271:10, 272:10, 280:10, 280:13, 282:2, 282:12
endosomes
273:21, 277:8, 281:7
endothelial
250:9
ends
93:22
energy
31:16
engineer's
102:3, 106:12
engineered
41:19
engineering
14:12, 15:8, 20:22, 26:17, 111:7, 155:22
engineers
101:20, 169:13

enhanced
246:7
enough
33:7, 33:9, 77:3, 78:6, 80:1, 130:9, 157:2, 158:12, 165:17, 208:1, 255:6, 267:15, 306:13, 308:15
enter
153:21, 268:22, 269:8, 269:20, 271:4, 271:10, 273:10
enters
154:22
entire
53:6, 97:16, 217:16
entirely
27:3, 279:17
entirety
311:11
entitled
203:18, 240:20
enzymatic
126:17
enzyme
48:7, 48:22, 49:18, 264:12, 273:10
enzymes
47:21, 47:22, 48:3, 48:5, 48:16, 48:20, 49:3, 49:7, 49:17, 49:21, 264:12
epo
74:5, 74:13, 74:14, 75:4, 75:18, 78:20, 79:20, 80:20, 250:8
epo-modified
74:2, 75:15, 76:10, 76:15, 77:13, 77:15
equation
20:22, 21:14, 22:1, 22:7, 31:13, 106:22, 108:22, 134:18, 156:6, 159:1, 165:12, 206:20, 247:11
escape
267:19, 268:7, 268:9, 268:12, 268:20, 268:22, 269:7, 269:17, 269:19, 270:9, 271:3, 271:9, 271:19, 271:22, 272:10, 272:11, 272:14, 273:9, 273:21, 274:15, 276:10, 276:11, 277:4, 277:8, 277:12, 278:8, 280:4, 280:10, 280:12, 280:15, 280:16, 280:17, 280:18, 280:20, 281:7, 281:14, 281:18, 282:2, 282:12
esquire
3:4, 3:5, 3:14, 3:15, 4:4
essentially
24:4, 27:1, 27:15, 45:21, 46:9, 61:3, 62:3, 64:22, 65:14, 66:17, 71:1, 77:18, 93:2, 97:17, 97:22, 107:21, 117:12, 118:4, 146:6, 149:8, 149:20, 158:21, 163:12, 173:20, 182:2, 196:3, 205:2, 214:6, 221:20, 222:6, 229:10, 229:15, 239:13, 248:17, 249:18, 260:21, 278:11, 296:12
established
11:3, 55:13
estimated
273:20, 281:6
et
46:22, 53:22
evaded
153:22
evaluate
158:20, 255:13, 273:1, 273:12
evaluation
72:13
evasive
198:8, 312:9
even
56:1, 58:4, 101:7, 113:19, 232:21, 258:1, 300:4
event
152:21, 177:11
events
278:5, 278:6
eventually
149:3, 208:17
ever
6:21, 7:2, 21:1, 22:8, 22:16, 23:7, 23:13, 38:14, 38:22, 39:5, 39:9, 39:14, 39:22, 42:9, 42:13, 44:3, 44:11, 45:2, 50:7, 50:21, 51:3, 152:22, 176:7, 196:8, 196:22, 201:17, 206:7, 243:7, 243:13, 243:14, 247:9, 283:13, 289:5, 289:8, 289:16, 289:21, 290:8, 290:21, 291:8, 292:20
every
148:2, 148:9, 148:20, 149:7, 149:15, 150:6, 150:21, 151:7, 217:15, 293:5
everything
95:6, 123:19, 133:3, 168:1, 209:5, 313:12
evoked
151:14, 153:13, 155:3
evolved
30:8, 30:12, 32:3
exactly
43:11, 47:7, 211:20, 214:12
examination
6:6
example
18:8, 23:20, 26:6, 51:21, 59:12, 67:6, 67:18, 67:22, 69:1, 69:10, 69:12, 69:15, 69:17, 72:6, 73:10, 74:22, 75:5, 76:3, 76:7, 76:12, 77:10, 77:11, 77:14, 81:3, 81:4, 82:8, 82:14, 83:6, 84:14, 85:20, 86:10, 88:17, 90:13, 91:6, 104:22, 122:13, 123:2, 124:22, 125:5, 125:9, 126:5, 126:8, 126:11, 126:17,

126:19, 127:1, 127:4, 127:8, 139:5, 139:9, 139:19, 140:15, 140:18, 140:20, 141:3, 141:6, 141:15, 141:20, 142:5, 142:8, 143:15, 143:17, 143:21, 146:3, 146:6, 162:17, 162:19, 163:3, 163:15, 163:19, 164:2, 164:9, 165:21, 166:4, 177:4, 177:8, 177:13, 186:16, 189:1, 221:7, 221:12, 221:16, 221:17, 224:8, 224:11, 232:21, 239:14, 240:5, 241:4, 241:17, 242:12, 246:13, 253:18, 268:20, 275:7, 278:11
examples
21:19, 61:13, 61:19, 62:13, 63:3, 63:13, 64:1, 65:9, 66:15, 67:2, 69:22, 70:1, 72:20, 73:2, 74:8, 74:21, 75:19, 77:2, 78:17, 78:21, 79:1, 79:12, 79:17, 80:9, 80:15, 82:1, 82:20, 83:2, 85:4, 85:12, 85:16, 86:4, 86:7, 86:19, 86:22, 87:2, 87:11, 87:18, 122:6, 122:9, 122:15, 122:19, 122:22, 123:4, 123:11, 124:1, 124:10, 124:12, 124:14, 125:2, 125:12, 125:22, 127:9, 142:11, 142:17, 143:1, 144:12, 144:16, 144:22, 145:4, 145:15, 145:21, 146:13, 146:18, 162:5, 162:7, 162:13, 165:3, 165:6, 165:15, 166:1, 166:15, 186:15, 218:8, 218:13, 218:15, 218:16, 219:20, 221:6, 221:10, 222:16, 224:6, 224:16, 224:20, 225:1, 225:17, 240:7, 310:20, 311:6, 312:2, 312:4
except
313:12
exclude
217:13
excluded
217:1, 217:9
excuse
16:14, 67:5, 154:15, 164:8, 189:8, 199:9, 211:5, 242:18, 263:6, 283:19
exemplary
163:4
exert
269:1, 269:8, 269:20, 271:4, 271:11, 273:10
exhibit
5:7, 5:8, 5:9, 5:10, 5:11, 8:22, 9:1, 9:6, 9:12, 11:7, 11:11, 12:1, 12:3, 53:14, 53:15, 53:19, 138:22, 139:2, 261:15, 261:16, 261:19, 263:7, 263:19, 282:21, 282:22, 308:18
exhibited
300:21, 302:6
exhibits
5:5, 8:21, 9:5
existed
288:8
expedite
313:18
expedited
313:13
experience
118:17
experiment
140:15, 140:19, 297:9, 303:8, 303:12
experiments
33:8, 33:9, 38:22, 45:16, 69:13, 104:8, 107:21, 108:20, 118:4, 118:21, 135:18, 135:20, 135:21, 135:22, 136:8, 136:13, 136:18, 137:8, 137:9, 138:14, 140:11, 233:19, 296:12, 298:8, 303:10
expert
8:9, 62:1, 71:4, 71:10, 78:2, 78:7, 78:10, 136:10, 158:17, 173:22, 178:2, 287:20, 288:3
expertise
20:21, 25:6, 101:16, 101:17, 101:19, 109:5, 110:13, 112:20, 116:14, 117:3, 117:20, 117:22, 119:7, 159:8, 159:17, 159:22, 160:7, 170:3, 194:2, 198:22, 199:4, 206:19, 245:11
experts
156:8
expires
314:28
explain
104:17, 108:12, 200:21, 207:13, 221:3, 225:22, 249:21, 274:8, 278:17, 279:21
explained
225:10, 297:15
explaining
64:3, 232:12
explains
70:2, 96:17, 221:11, 270:22
explicit
84:8, 84:11, 84:14
explicitly
31:2, 62:6, 62:8, 85:6, 147:11, 155:21
explore
140:13
express
111:13, 265:4, 265:17, 267:18, 268:12, 280:9, 282:3, 282:8
expressed
65:4, 112:2, 122:16, 151:16, 153:15, 262:4, 272:7
expresses
43:19, 44:5

expressing
265:11
expression
74:3, 75:16, 76:11, 76:16, 157:9, 157:14, 158:5, 234:3, 234:8, 234:14, 234:20, 234:22, 235:1, 235:8, 270:9, 272:4, 273:14, 273:18, 274:3, 274:6, 274:9, 274:20, 278:8, 284:6, 286:12, 287:6
extent
237:20
extremely
198:8
eyes
81:1, 123:8, 266:6

F

f-specific
279:6, 279:12, 300:12, 300:22, 302:1, 302:6
face
211:10
fact
26:15, 55:8, 121:5, 128:4, 129:4, 129:12, 130:14, 179:1, 195:3, 201:2, 239:14, 254:8, 276:8, 292:21, 298:16, 300:7, 301:7
factor
250:9, 250:16, 297:18, 298:5, 298:18, 302:13, 302:14
factors
303:19
faculty
37:21
fair
20:10, 186:20
fall
16:13
familiar
34:15, 34:18, 35:7, 177:16, 178:6, 178:11, 202:19
families
135:6
family
28:5, 28:12, 143:8, 207:5, 207:9, 207:15, 207:20, 208:4, 208:8, 209:2, 209:8, 209:16, 210:4, 210:7, 210:15
far
123:4, 216:6, 216:11, 312:20
feature
164:9
features
240:3
feel
84:20, 252:11, 254:10, 306:12
few
52:8, 77:7, 121:14, 124:16, 228:13, 276:4, 300:13, 300:19, 301:19, 303:2, 303:20
fibrin
58:12, 58:13, 60:21, 61:2, 61:6, 62:9, 63:20, 64:11, 66:22, 84:4, 84:21, 89:6, 90:2, 93:16, 93:17, 97:12, 97:21, 143:8, 143:13, 145:8
fibrin-based
83:16
fibrinogen
58:13, 93:17
field
34:22, 35:7, 107:10, 202:20, 203:9, 203:11, 223:9
fifty-seven
237:20
figure
82:16, 208:2, 208:12, 233:21, 241:10, 275:7, 275:8, 278:3, 279:15
figures
10:9, 275:9, 275:13
filed
210:21, 211:12
filtration
163:1
final
68:11, 69:8, 70:19, 70:22, 72:1, 76:5, 255:17, 313:13
financially
314:23
find
52:5, 95:18, 207:14, 208:3, 208:7, 212:21, 213:10, 226:14, 281:4
findings
19:20
fine
7:11, 241:1, 306:16
finish
76:21, 181:8
first
19:18, 31:12, 56:1, 56:3, 58:5, 127:19, 137:4, 141:9, 179:16, 179:21, 180:6, 187:1, 187:3, 187:10, 189:11, 189:14, 210:19, 224:3, 232:17, 237:22, 256:18, 262:10, 262:12, 263:20, 273:8
fit
95:6
five
139:14, 162:7, 162:13, 165:15, 276:2, 282:17
flatly
312:10
flip
36:20, 145:11
flipped
37:15
flipping
36:9, 36:13, 36:22
flips
145:10
fluid
105:14
focus
15:10, 15:15, 20:17, 22:6, 22:20, 23:5, 24:2, 25:7, 27:9, 29:1, 29:9, 55:1, 55:4, 58:1, 59:5, 60:5, 60:21, 61:3, 63:17, 63:19, 65:2, 65:12, 96:11, 137:8, 143:4, 224:1, 240:8, 245:7, 253:22, 281:20
focused
18:20, 19:2,

20:12, 20:22, 24:18, 24:21, 25:9, 25:18, 25:20, 26:13, 28:2, 28:3, 28:16, 29:11, 54:15, 54:18, 55:6, 56:8, 56:11, 56:21, 64:10, 64:14, 65:4, 65:6, 81:5, 83:14, 90:1, 94:2, 97:13, 101:17, 103:9, 108:11, 115:18, 116:13, 116:19, 116:21, 117:4, 117:7, 119:18, 124:6, 132:6, 132:12, 198:17, 221:5, 239:1, 284:11
focuses
59:1, 97:8
focusing
28:15
follow
273:19, 301:18, 302:17, 302:22
following
94:19, 122:6, 126:14, 162:17, 302:17
follows
6:5, 301:13
formation
134:11, 147:2, 226:6, 237:3
formations
226:12
formed
163:2
forming
111:13, 112:1, 115:11, 122:16, 262:4
formula
190:7
formulate
146:22, 165:12, 165:21, 189:21
formulated
68:8, 68:10, 70:18, 71:22, 72:10, 76:4, 82:4, 87:21, 88:7, 88:12, 88:15, 88:19, 89:14, 89:18, 171:1, 171:8, 171:19, 172:2, 172:13, 172:20, 174:7, 185:11, 185:21, 189:18, 278:20, 279:3, 279:5, 294:10
formulating
226:1
formulation
43:3, 50:8, 50:16, 66:10, 68:13, 69:5, 70:15, 71:3, 71:5, 71:8, 71:11, 71:12, 71:13, 71:14, 71:17, 80:20, 86:12, 92:5, 92:9, 93:9, 93:11, 94:12, 94:21, 95:2, 104:2, 104:11, 105:4, 106:15, 106:19, 107:4, 107:22, 109:6, 117:5, 117:6, 117:7, 117:8, 117:12, 118:5, 119:20, 132:6, 132:16, 136:9, 141:21, 155:22, 156:3, 159:9, 186:6, 186:7, 188:17, 188:18, 189:6, 194:1, 195:22, 200:22, 202:22, 226:3, 228:21, 229:1, 229:4, 230:9, 249:9, 255:9, 296:5, 296:9, 297:10, 298:2, 298:13, 298:15, 299:3, 300:2, 302:8, 312:1
formulations
58:8, 68:1, 68:20, 72:14, 73:6, 73:11, 74:2, 75:7, 75:15, 76:16, 82:3, 85:14, 85:18, 86:5, 86:20, 87:20, 90:3, 108:20, 119:19, 135:8, 139:13, 140:20, 141:4, 141:7, 141:9, 141:10, 141:17, 142:1, 142:8, 142:15, 144:20, 147:7, 147:13, 158:18, 162:18, 193:16, 248:21, 251:6, 253:6, 254:9, 305:2
forte
245:6
forth
172:7, 314:6
forty-one
293:12
found
213:12, 279:13
four
17:17, 18:3, 175:11, 294:15, 295:5
frame
34:16, 37:4, 37:10, 96:20, 170:21, 171:7, 171:17, 172:11, 172:19, 173:2, 174:6
framed
33:14
framework
15:19, 24:4, 27:2, 28:19, 30:11, 57:12, 83:18, 91:4, 91:10, 91:11, 92:17, 93:3, 94:12, 103:10, 134:6, 199:2, 200:3, 200:11, 201:15, 231:21, 251:16
frameworks
203:16
framing
82:17
frankly
279:17
frequencies
279:12
fresh
299:18, 301:16, 302:20
freshly
297:19, 298:6, 298:20, 299:11, 300:1, 300:3, 301:10, 302:16, 303:19
front
9:11, 53:19, 114:17, 114:19, 179:6, 186:6, 214:3, 235:21, 283:7
full
6:10, 6:12, 164:13, 202:20, 266:10
fully
92:8, 92:20, 96:3, 267:1
function
31:18, 92:14,

96:16, 105:13, 106:21, 118:18, 153:9, 153:10, 156:7, 264:16, 269:1, 269:9, 269:21, 271:5, 271:11, 271:17, 271:20, 272:3, 272:4, 272:16, 272:18, 272:19, 272:20, 273:11, 274:19, 274:21, 275:2, 275:4, 275:20, 277:9, 277:13, 277:21, 278:7, 278:9, 280:5, 286:6, 286:7
functional 170:4, 265:18, 265:22, 266:12, 266:15, 267:9, 267:14, 272:6, 272:8, 275:7
functional-based 103:20
functions 108:6, 116:7
fundamental 15:19, 24:12
fundamentals 22:20, 24:3, 24:7, 24:9
funny 140:3, 244:12
further 87:15, 92:10, 92:12, 97:10, 97:11, 122:5, 163:3, 312:7, 313:3, 314:12, 314:14, 314:19
fusogenic 95:3

G

g-csf 72:16, 74:1, 74:13, 74:14, 75:15, 75:18, 76:10, 76:15, 77:12, 77:15, 78:19, 79:20, 80:20
game 106:20
gaps 31:17
gcf 72:16
gcff 74:13
geall 261:22, 263:7, 267:11, 275:15, 278:1, 278:2, 278:10, 283:5, 283:8, 283:11, 283:18, 284:11, 286:11, 286:17, 287:12, 293:11, 293:18, 293:22, 294:5, 294:14, 295:7, 295:8, 295:14, 296:8, 297:7, 298:17, 300:3, 300:10, 300:17, 301:22, 302:10
geall's 297:10, 302:5, 303:8
gel 56:22, 58:12, 61:2, 93:16
gels 60:22
gene 242:22, 243:3, 243:7, 243:14, 243:18, 243:19, 244:1, 244:5, 244:14, 244:17, 244:20, 245:8, 245:10, 245:15, 247:7, 247:8, 247:11
general 18:2, 26:18, 30:19, 51:16, 95:7, 102:19, 106:11, 109:20, 113:14, 115:5, 115:20, 116:6, 116:10, 130:11, 130:21, 131:3, 131:11, 138:3, 149:6, 149:13, 151:5, 151:7, 155:15, 156:11, 166:22, 189:11, 195:20, 196:2, 196:6, 199:2, 201:15, 223:17, 231:21, 249:6, 264:11, 269:14, 277:7, 279:20, 306:9
generality 66:6, 119:12, 169:1, 231:22
generally 102:6, 102:18, 164:12, 187:14, 189:5, 202:6, 203:2, 219:8, 235:1, 235:8, 248:16, 274:15
generate 234:9
generates 112:7
generation 74:14, 137:1
generic 31:21, 32:4, 81:22, 83:9, 84:7, 85:8, 85:10, 87:16, 157:20
generically 126:13, 126:16, 168:7
genetic 160:20
genetically 41:18
genre 175:11, 175:13, 175:17, 175:20, 176:2
geometric 279:8
gesture 7:9
getting 178:8, 185:7, 250:11, 313:16
giu 3:15
giu@wilmerhale 3:20
give 7:8, 11:19, 52:9, 113:2, 121:14, 124:16, 132:13, 138:8, 232:21, 253:18, 269:22, 276:4, 281:3, 285:13, 306:13, 307:2, 313:4
given 78:11, 78:12, 80:6, 231:5, 234:5, 314:9
gives 25:6, 83:22, 92:16, 93:3, 209:4
giving 62:2, 80:4, 88:22, 184:10, 198:18, 201:7, 235:17
glasses 266:4, 266:5
glue 58:12, 93:16
gmts 279:10
go 8:2, 11:19,

19:5, 31:10, 40:8, 55:21, 56:3, 58:4, 58:22, 67:13, 70:4, 78:21, 79:1, 91:7, 94:1, 96:9, 96:14, 96:19, 123:1, 123:18, 123:19, 124:3, 125:15, 127:8, 138:15, 138:16, 138:18, 138:20, 138:22, 143:9, 143:15, 144:7, 145:9, 146:2, 146:11, 161:18, 172:7, 174:17, 183:10, 204:11, 207:22, 218:4, 218:21, 220:11, 222:15, 225:18, 229:1, 230:8, 230:9, 232:2, 232:15, 233:21, 234:2, 242:17, 242:18, 247:7, 249:4, 266:8, 276:2, 276:5, 277:8, 295:13, 305:7, 308:19, 310:7, 310:10
goes
34:6, 58:18, 76:7, 141:12, 238:8, 280:3, 309:5
going
7:8, 8:20, 8:21, 10:19, 15:10, 37:13, 53:9, 53:11, 53:13, 61:16, 76:20, 83:21, 89:5, 90:19, 107:9, 108:19, 124:9, 126:21, 126:22, 131:14, 147:6, 149:10, 159:7, 198:7, 199:11, 226:2, 226:14, 230:1, 230:10, 232:2, 254:10, 254:17, 254:18, 261:14, 272:11, 278:15, 282:20, 308:22, 309:11, 310:21
gold
135:5, 243:4, 244:20, 245:15, 254:1
gone
123:17, 231:8, 256:14
good
6:8, 6:9, 76:18, 81:1, 123:8, 166:14, 226:1, 226:22, 228:10, 296:3, 299:1
google
207:22, 208:5, 208:6, 213:8, 213:13, 213:14, 213:21, 214:3
gradually
163:21, 166:6
graduate
17:10
granted
212:12, 212:17
grants
17:8
granulocyte-macrophages
250:15
great
8:4, 9:18, 10:14
greater
41:2
greek
161:9
group
19:14
groups
278:22
growth
250:9
guess
22:15, 125:10, 134:8, 217:3
guessing
177:21
gun
242:22, 243:3, 243:4, 243:7, 243:14, 243:19, 244:1, 244:5, 244:17, 244:20, 245:8, 245:10, 245:15, 247:7, 247:8, 247:12
guns
243:18, 244:14
guy
270:7

H

half
31:22
halfway
262:11, 262:18, 293:16
halves
31:22
hand
8:20, 70:21, 71:8, 99:12, 115:1, 115:6, 131:7, 131:9, 131:13, 132:5, 138:15, 143:11, 163:1, 261:15, 282:21, 314:27
handed
9:5, 11:10
handle
35:6
happen
278:7
happened
36:12
happening
90:15, 94:1
happens
22:5, 48:8, 96:8, 150:3, 278:6
hard
274:16
hastings
4:3
head
7:9, 216:21
header
98:7
headings
90:5
hear
68:18
heard
6:14, 283:13
held
2:10
helium-powered
243:4
helix
134:11
help
22:12, 109:1, 128:11, 151:15, 153:14, 155:4, 156:9, 206:20, 309:5
here
6:17, 11:15, 12:17, 18:1, 24:10, 41:13, 46:4, 51:11, 52:6, 53:14, 54:13, 58:20, 69:9, 72:7, 73:5, 75:4, 75:17, 76:2, 76:6, 76:8, 77:22, 78:1, 78:16, 78:18, 80:14, 80:16, 86:18, 87:5, 88:1, 97:11,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 337 of 375

97:18, 99:19, 100:18, 101:7, 102:12, 102:22, 103:6, 112:14, 123:13, 125:10, 126:15, 127:11, 139:12, 141:4, 161:15, 164:15, 167:7, 172:9, 172:10, 173:11, 173:13, 174:3, 181:13, 190:6, 199:18, 206:5, 206:6, 210:18, 212:3, 213:11, 216:20, 220:1, 227:10, 237:5, 239:8, 240:7, 240:11, 241:3, 242:12, 246:2, 246:3, 246:22, 262:19, 262:22, 263:12, 273:19, 276:2, 276:6, 278:15, 281:5, 281:20, 284:10, 287:12, 288:20, 296:22, 302:12, 309:5, 309:20, 310:2, 311:20
hereby
314:4
herein
183:13, 183:16, 183:22, 184:6, 184:8, 184:9, 184:16, 311:10
hereinbefore
314:6
hereunto
314:26
higher
234:22, 235:8
highlighted
246:3
highly
160:13
hilgar
4:12
hire
17:10
history
210:18, 221:20
hmm
167:20
hoi
6:12
hollow
195:3
homogenization
162:22
host
105:12, 105:21, 106:16, 154:5
hour
226:7
hours
73:21, 73:22, 75:13, 75:14, 76:13, 76:14, 80:22, 164:6
housekeeping
11:2
however
164:14, 199:12, 201:8, 312:7
huge
253:14, 255:8
human
95:19, 138:18, 138:19, 138:20, 247:9
humans
137:3, 244:18, 259:19, 260:15, 261:5
hundreds
247:5, 304:11, 305:1, 305:2, 306:1, 307:6
hydrated
205:19
hydrogel
58:12, 93:16
hypothetical
157:17, 158:8, 255:5, 256:12, 265:14, 266:21, 269:3, 282:5, 307:21
hypotheticals
198:12

I

idea
21:7
identical
10:2, 10:9, 10:15
identification
6:4
identified
120:2, 121:12, 121:22, 125:22, 277:15, 303:6
identifies
120:6
identify
38:10, 45:8, 45:17, 46:1, 46:3, 46:6, 46:10, 46:12, 50:2, 51:11, 52:2, 52:11, 61:1, 132:10, 143:1, 143:12, 143:17, 195:11, 196:4, 206:6, 207:19, 215:3, 238:20, 239:4, 239:18, 240:5, 240:12, 241:4, 241:17, 242:12, 255:19, 276:17
identifying
253:21
igg
278:12, 279:6, 300:12, 300:22, 302:1, 302:6
ii
163:1
illinois
24:17
illustrate
166:15
image
18:9
imagine
53:13
imaging
18:12
immediately
154:7
immune
26:7, 27:6, 98:8, 98:20, 99:4, 99:6, 99:9, 99:15, 99:22, 100:2, 100:6, 100:9, 100:13, 100:15, 101:5, 102:8, 102:14, 102:20, 103:2, 105:2, 105:7, 105:9, 105:17, 105:20, 108:6, 108:16, 108:21, 109:11, 109:17, 110:3, 110:8, 110:15, 110:17, 111:3, 111:15, 112:1, 112:10, 112:17, 113:4, 113:10, 113:22, 114:8, 114:16, 114:21, 115:21, 116:7, 116:12, 116:16, 117:1, 117:10, 117:18, 118:2, 118:10, 118:19, 119:16, 120:10, 147:21, 151:13, 151:15, 152:1, 152:7, 152:11, 152:17, 153:2, 153:12, 153:14, 153:19, 154:3, 154:4, 154:5, 154:6, 154:18, 155:1, 155:2, 155:4, 155:9, 157:10, 157:15,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 338 of 375

157:20, 158:6, 160:8, 160:13, 160:15, 161:12, 161:16, 179:17, 180:1, 180:3, 180:9, 180:12, 180:15, 180:20, 181:10, 181:15, 181:20, 182:1, 182:16, 189:15, 192:11, 192:20
immunity 154:11, 157:7, 284:5, 287:4
immunoassay 74:5, 286:9
immunogen 180:19, 182:4, 182:18, 183:1, 183:4, 183:7, 183:9, 183:11, 183:15, 183:20, 184:2, 184:11, 184:15, 185:1, 284:1, 284:6, 286:13, 287:3, 287:6, 287:9
immunogenic 297:16, 299:18, 300:4, 301:16, 302:20
immunogenicity 148:1, 148:3, 148:9, 148:10, 148:16, 148:19, 148:21, 149:8, 149:9, 149:14, 149:16, 150:5, 150:7, 150:14, 150:15, 150:16, 150:21, 150:22, 151:6, 262:15, 263:4, 263:9, 263:16, 278:19, 297:21, 299:13, 301:11
immunological 159:4, 159:7, 159:9, 159:12, 160:2, 160:11, 160:18
immunologist 159:22
immunology 103:17, 159:11, 159:21, 193:22
impact 91:12, 307:18, 308:2
impacts 278:13
implied 275:5
important 30:3, 30:4, 144:18, 145:3, 170:18, 188:5, 226:13, 226:18, 232:17, 252:5, 256:18, 264:20
impression 56:4, 56:6, 57:5, 57:7
improve 236:7, 236:21
in-house 4:12, 4:13
inc 1:4, 1:7
incidence 39:22
include 17:22, 18:1, 82:8, 82:13, 83:5, 84:14, 92:10, 154:2, 180:18, 182:3, 182:17, 183:3, 183:8, 183:19, 193:14, 217:15, 217:16, 296:8
included 84:6
includes 41:18, 51:8, 162:7, 182:22
including 93:15, 134:9, 160:20, 218:22
incomplete 157:17, 158:7, 255:4, 256:11, 265:13, 266:21, 269:2, 282:5, 307:21
incorporated 9:2, 11:8, 32:19, 53:16, 261:17, 283:1, 311:10
incorporates 176:12, 176:17
increase 47:9, 47:10, 47:12, 47:19, 47:22, 236:13, 236:18, 237:7
increased 246:8, 262:15, 263:3, 263:15
increases 263:9
indeed 216:6, 216:11
indicate 101:9, 104:10, 146:21, 149:9, 150:17, 152:21, 160:13, 166:5, 246:22, 281:2, 286:16
indicated 17:19, 74:12, 89:9, 90:6, 124:5, 172:10, 173:12, 174:4, 228:5, 289:12, 294:3, 299:22, 301:8
indicates 71:21, 72:15, 72:17, 104:2, 124:10, 163:15, 171:5, 171:16, 172:1, 172:17, 172:18, 173:8, 174:4, 206:16, 249:18, 276:20, 279:9, 286:9, 298:17, 310:13
indication 128:2, 128:10, 128:17, 156:3, 294:19
individual 154:12, 213:8, 279:7
induce 134:10
infected 110:21, 112:12
infection 110:4, 110:7, 111:1, 111:20, 112:22, 115:4, 115:13, 161:13, 161:17
infectious 18:21, 19:22, 20:5, 20:8, 20:11, 20:16, 23:21, 131:20, 132:4, 132:11, 133:14, 134:4, 134:16, 166:20, 167:2, 167:9, 167:14, 168:3
influenza 239:11, 260:22
inform 136:8, 137:9
information 22:22, 23:18, 24:6, 57:19, 66:2, 77:3, 78:6, 80:1, 80:11, 115:17, 116:3, 116:4, 136:22, 138:1, 138:8, 152:15, 157:2, 157:4, 192:15, 196:13,

196:15, 214:6, 215:12, 255:12, 255:15, 255:20, 256:5, 271:15, 272:2, 272:9, 272:17, 272:22
informative 156:14
informs 21:20, 136:16, 136:19, 137:12, 219:2
initial 164:7
inject 105:11, 106:15
injected 22:5, 75:9, 139:21, 140:2
injection 142:10
injections 142:4
innate 26:7, 27:6, 151:13, 151:22, 152:1, 152:7, 152:11, 152:17, 153:2, 153:12, 154:3, 154:4, 154:5, 154:6, 154:10, 154:18, 155:1, 155:2, 155:9, 157:7, 161:12, 161:16, 284:5, 287:4
input 111:11
inside 48:13, 56:17, 193:12, 204:22, 205:6, 205:18, 205:22, 248:8, 294:11
instance 244:16, 247:8
instead 7:9
institute 14:11
integrate 27:18
intend 164:14
intended 103:22, 165:14, 166:17, 231:15, 254:3, 269:1, 269:9, 269:21, 271:4, 271:11, 273:11
inter 92:5
interact 22:2, 27:18
interacting 49:19
interaction 26:6, 27:6
interactions 19:16, 21:17, 22:12, 22:15, 24:11, 136:21
interacts 21:19
interchangeably 248:11
interest 19:12, 37:19, 42:7, 93:6, 93:10
interested 36:1, 36:2, 37:11, 38:9, 132:9, 132:15, 265:10, 314:23
interesting 34:7, 36:11, 36:21, 37:2, 37:16, 38:5, 208:13, 208:16, 213:22, 225:12, 247:16
interests 19:9
interference 120:19, 133:5
interfering 120:22, 124:15, 125:3, 125:12, 126:1, 131:19, 133:6
international 311:8
interpret 75:3, 76:1, 79:9, 90:22, 103:6, 103:18, 109:1, 111:9, 116:2, 129:16, 130:4, 131:16, 156:9, 172:8, 176:20, 184:6, 184:17, 186:5, 206:20, 307:1
interpretation 64:4, 74:20, 77:22, 80:5, 89:20, 89:21, 90:9, 90:11, 95:11, 108:3, 116:1, 117:16, 131:9, 177:3, 188:21, 199:14, 291:6, 292:18, 299:10, 299:15, 303:3, 303:9
interpretations 101:8, 182:7
interpreting 62:4, 80:15, 95:15, 111:9, 115:16, 130:19, 177:15
intramuscularly 73:14, 139:15, 147:8, 279:1
intravenous 142:4, 142:10
intravenously 73:9, 73:14, 75:11, 139:15, 141:1, 141:12, 141:19, 147:8
introduce 53:13, 244:14
invading 160:14
invention 91:15, 91:17, 91:22, 92:1, 92:12, 99:3, 99:20, 103:1, 120:8, 122:5, 122:7, 122:10, 283:22, 286:20, 287:1, 287:2
inventor 209:21, 283:8, 302:10, 303:17, 303:18
inventors 90:20, 91:5, 209:12
inventorship 53:22
invest 231:4
investigated 219:13
investigator 259:18, 260:13
involve 26:22, 27:22, 48:17, 48:20, 127:10
involved 18:16, 21:10, 23:16, 33:10, 60:2, 137:16, 186:7
involves 92:18, 283:22, 286:20, 287:2
involving 61:9
ionizable 258:12, 258:17, 259:3, 304:11, 306:1, 307:6
ipos 75:10, 139:14
ipr 1:10, 1:11,

6:17
iprs
11:18
isothermal
42:15, 42:20, 47:15, 47:18, 47:21
issue
9:8, 9:19, 157:18, 312:13
issued
212:6, 213:4, 213:11
issues
312:21
itself
23:14, 31:20, 43:8, 58:4

J

jacob
4:13
jake
13:2
james
277:6
janet
1:21, 2:13, 314:2
job
1:22
journal
35:18
journals
35:13, 35:14, 35:15, 35:19, 36:6, 36:10, 37:14, 37:15
judge
72:8, 129:16
judgment
130:6
judgments
131:6
july
1:17, 2:5, 14:10, 14:15, 15:1, 15:2, 314:17, 314:29
june
14:16

K

kathryn
3:5
kayali
3:5
keep
24:3, 28:15, 61:15, 109:13, 169:12, 230:19, 233:8, 254:14
key
145:2, 233:4
kilogram
73:16, 139:17, 141:13, 141:14, 147:3, 147:10
kind
14:21, 21:12, 32:2, 45:15, 65:10, 65:17, 91:21, 103:19, 107:21, 109:2, 136:14, 144:21, 159:17, 166:10, 170:2, 247:18, 312:4
kinds
93:20, 167:1, 167:2, 240:3, 311:22
kit
43:8, 43:10, 43:11, 49:2, 49:6
kits
42:19, 43:2, 43:4, 43:12, 43:14, 43:15, 43:22, 44:8, 44:10, 44:21, 45:2, 45:5, 45:7, 45:10, 45:15, 47:16, 47:19, 48:15, 49:11, 49:13, 49:21
kkayali@wc
3:10
knowledge
51:4, 222:12
known
228:5, 304:12, 306:3, 307:7

L

lab
16:4, 39:4, 39:10, 45:16, 50:8, 50:22, 51:1, 51:4, 51:7, 51:12, 51:18, 135:2, 135:4, 196:10, 253:19
laboratory
38:15, 38:20, 39:1, 40:1, 42:10, 42:12, 42:14, 42:18
labs
15:15
lacking
312:20
lactic-co-glycol-ic
93:13
laid
130:8
landscape
233:11
lane
159:17, 198:22
language
214:19, 303:4
large
293:13, 293:16, 294:1, 294:3, 295:7, 296:16
larger
133:10
last
13:2, 14:1, 21:6, 53:8, 185:9, 185:12, 185:13, 185:17, 185:20, 186:21, 187:5, 189:9, 189:17, 213:20, 216:3, 216:7, 236:11, 295:16, 297:7, 298:22, 300:10, 301:4, 301:18
late
281:11, 285:18
later
183:10
laundry
96:5, 97:2, 97:6
lawyer
177:9, 178:13, 178:19, 207:3, 213:7, 283:17
lawyers
207:11, 214:18, 215:1, 215:3
lead
270:9
leading
284:6, 286:12
leads
287:6
learn
26:20, 28:20
least
30:7, 94:14, 142:18, 226:6, 259:1, 289:13, 304:11, 306:1, 307:5, 310:12, 310:13, 310:18, 310:22, 311:4, 311:7
leave
15:4, 140:3
leaves
268:10
led
254:5

left
92:2
left-hand
283:20
legal
177:14, 178:9, 179:4, 188:13, 207:2, 207:6, 209:20, 214:19, 214:21, 215:2, 283:16
length
96:15
less
226:6, 279:11
lesson
201:7
let's
17:16, 31:10, 63:22, 67:2, 67:12, 72:20, 91:17, 98:3, 110:16, 113:15, 114:5, 120:4, 122:2, 127:12, 146:12, 187:15, 203:15, 204:11, 222:1, 241:15, 242:17, 242:18, 247:7, 305:7
level
15:21, 78:11, 84:9, 84:12, 112:20, 235:1, 235:8, 249:4, 272:5, 273:14, 273:18, 274:3, 274:6, 274:9, 280:20, 281:16
levels
118:15, 280:2
library
35:19
license
6:4
lies
243:18
liked
37:21
limit
122:6, 279:9
limited
58:8, 93:12, 94:15, 94:18, 281:9
line
76:22, 81:3, 159:8, 164:19, 262:17, 264:1, 279:9
lines
264:2, 279:8
link
103:3, 207:22
linked
188:15, 189:6
lipid-based
28:13, 29:1, 32:18, 52:10, 52:13, 52:18, 53:1, 53:3, 135:7, 191:18, 246:4, 249:8, 250:18
lipid-molar
77:10
lipidoids
58:10, 93:14
lipids
58:12, 93:16, 190:21, 191:10, 195:8, 258:9, 258:12, 258:21, 258:22, 304:12, 306:1, 307:6, 307:17, 308:2, 309:1, 309:8, 309:15, 309:22, 310:2, 311:16
lipo
73:11
lipofectamine
250:5
lipoplex
247:14, 247:16, 247:17, 247:19, 247:20, 248:1, 248:4, 249:1
lipoplexes
58:10, 93:14, 145:9, 236:6, 236:12, 236:17, 237:6
liposome
237:5, 247:15, 248:10, 249:1, 249:3, 249:12, 249:16, 250:22, 294:19, 295:9, 295:11, 296:8, 296:20, 297:4, 297:10, 297:19, 298:6, 298:19, 299:10, 300:2, 301:9, 302:15
liposome-adjuvanted
297:17, 298:4, 299:17, 301:15, 302:19
liposomes
53:3, 58:11, 93:14, 145:8, 236:6, 236:12, 236:16, 246:22, 247:1, 248:4, 249:19, 249:22, 250:12, 250:18, 251:12, 251:20, 252:16, 253:8, 255:1, 256:8, 256:22, 257:9, 258:4, 258:16, 294:11, 294:13, 295:5
list
17:9, 17:19, 58:18, 96:1, 96:2, 96:5, 96:6, 97:2, 97:7, 125:19, 133:18, 144:20, 246:2, 309:21, 312:4
listed
64:12, 68:13, 68:20, 76:6, 127:11, 127:17, 127:20, 134:9, 134:14, 146:7, 211:3, 211:6, 211:10, 295:4, 310:2, 311:16
listing
95:5, 310:8, 311:21
lists
69:3, 84:2, 90:2, 93:1, 93:20, 94:16
literally
77:17
literature
74:6, 129:8, 129:15, 129:20, 202:15, 202:18, 203:1, 203:3, 203:5, 206:10, 208:10, 208:22, 222:3, 222:9, 222:11, 222:13, 222:15, 228:22, 230:7, 233:10, 233:21, 241:10, 246:21, 281:21, 288:7, 288:10, 288:21, 289:6, 289:8, 289:16, 289:21, 290:8, 290:15, 290:21, 291:4, 291:5, 291:8, 291:15, 292:10, 292:12, 292:20
little
29:17, 31:6, 56:16, 91:20, 127:3, 128:7, 184:3, 221:3, 232:2, 285:17
liu
3:4, 5:4, 6:7, 6:15, 9:4, 11:9, 53:17, 76:21,

77:1, 81:6, 81:8, 128:13, 147:15, 147:18, 198:6, 199:9, 215:13, 215:15, 220:11, 220:14, 261:14, 261:18, 270:3, 282:17, 282:20, 283:3, 305:7, 305:10, 312:6, 313:7
livenote
2:14
llp
3:3, 4:3
lnp
60:17, 66:10, 79:18, 79:20, 80:16, 80:18, 82:4, 87:21, 89:14, 140:20, 141:4, 141:6, 141:8, 141:9, 141:10, 141:17, 141:20, 142:1, 142:8, 262:14, 263:2, 263:9, 263:15, 264:5, 279:3, 279:5, 281:10, 308:3
lnps
66:18, 76:3, 140:19, 141:3, 141:16, 227:18, 233:6, 233:17, 245:20, 246:1, 246:10, 246:16, 246:19, 263:20
loaded
193:11, 243:4, 259:22
located
18:13
long
13:22, 58:18, 83:22, 94:2, 96:1, 96:4, 97:2, 97:6, 250:6, 285:14, 312:4
looked
13:8, 27:17, 46:15, 83:18, 114:10, 131:15, 132:9, 213:3, 213:7, 215:7, 218:7, 218:9, 218:10, 222:3, 223:18, 262:6, 276:8, 288:10, 288:11, 309:16
looking
18:15, 61:5, 67:8, 67:11, 71:6, 85:2, 97:17, 105:1, 105:6, 111:10, 113:1, 113:19, 116:1, 126:5, 129:7, 130:18, 158:19, 211:17, 218:12, 234:10, 238:16, 240:17, 248:3, 248:5, 249:8, 251:10, 251:18, 252:14, 253:20, 254:21, 255:16, 256:6, 256:21, 257:7, 260:19, 278:14, 283:19
looks
201:1
lot
18:22, 27:20, 35:14, 37:20, 38:2, 39:3, 39:13, 39:16, 39:18, 40:13, 43:14, 50:19, 59:1, 60:22, 83:14, 83:15, 83:18, 93:20, 95:21, 97:20, 97:22, 108:2, 133:2, 135:8, 137:15, 143:6, 145:12, 145:15, 145:18, 148:7, 159:1, 168:1, 171:15, 200:15, 209:1, 229:16, 230:11, 297:20, 299:11, 301:10
lots
58:19, 97:19, 104:18, 118:13, 136:14, 138:20, 161:2, 166:22, 167:1, 167:13, 168:8, 185:7, 191:11, 221:19, 240:2, 251:3, 252:8, 252:9, 252:10, 255:10, 258:19, 268:4
low
273:22, 276:10, 281:8, 281:15
low-density
310:16, 311:2
luciferase
145:12
lunch
215:13, 215:14, 215:18
lymph
21:5
lyophilization
166:2, 228:10, 232:3, 232:7, 238:10, 252:5
lyophilized
164:11, 226:16, 227:11, 227:12

M

ma
1:19
macropinocytosis
18:16
made
17:14, 51:18, 53:2, 71:14, 113:17, 294:19, 299:14
magic
186:6, 187:7, 188:16, 188:18, 189:5, 189:20, 190:3, 190:7
main
28:17, 29:12, 63:17, 63:19, 65:19, 78:20, 84:4, 143:6, 168:2, 186:12, 186:13, 187:6, 208:11, 224:1, 273:3, 296:22
maine
3:6
make
11:20, 29:21, 66:5, 71:7, 71:13, 71:17, 72:12, 75:20, 77:4, 78:7, 79:14, 80:1, 80:10, 90:16, 108:20, 117:12, 130:6, 131:5, 131:8, 131:10, 143:3, 143:8, 143:9, 146:12, 156:5, 164:12, 166:11, 166:12, 180:13, 180:21, 181:5, 182:6, 182:14, 197:18, 197:19, 201:21, 201:22, 204:22, 205:1, 205:16, 206:12, 230:7, 257:19, 267:15, 267:16, 282:9, 300:6, 303:3, 309:11
makes
139:22, 250:19, 275:4, 298:18
making
300:8

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 343 of 375

mammal
293:13, 293:17, 295:8
mammalian
93:6, 93:8
mammals
141:16, 141:18, 294:1
mandate
33:5
many
17:13, 32:18, 51:22, 61:1, 111:6, 111:7, 122:22, 128:2, 128:10, 128:17, 128:20, 144:12, 146:6, 168:5, 168:6, 256:14, 259:22, 308:22
map
144:8, 146:3, 209:3
marked
5:5, 8:21, 9:1, 9:6, 9:12, 11:7, 11:11, 53:15, 58:20, 261:16, 282:21, 282:22
markers
105:15, 111:19, 112:7, 117:13, 118:9, 118:10, 118:13, 118:14, 118:16, 153:11, 157:6, 278:12
marriage
314:21
massachusetts
2:12, 2:16, 3:17, 314:4, 314:17, 314:33
material
13:18, 31:17, 297:18, 298:5, 299:18, 301:17, 302:15, 302:21
materials
30:9
matter
6:15, 31:7, 32:11, 33:18, 33:22, 116:7, 131:3, 131:11, 145:1, 209:15, 285:3, 314:24
maybe
15:21, 125:9, 168:18, 206:3, 221:3, 249:4
mcherry
145:12
mchugh
1:21, 2:13, 314:2
mean
10:3, 13:13, 15:2, 24:8, 29:6, 38:3, 40:5, 41:11, 47:8, 50:6, 50:15, 50:19, 61:1, 66:20, 77:17, 90:10, 94:22, 96:4, 99:1, 100:1, 128:19, 142:21, 144:1, 144:3, 144:19, 151:4, 153:18, 175:11, 176:10, 176:17, 177:20, 178:3, 178:9, 178:12, 188:20, 191:22, 196:16, 197:5, 198:2, 200:15, 201:4, 210:8, 210:11, 210:18, 210:19, 211:9, 211:15, 211:19, 213:6, 214:2, 214:9, 217:19, 231:21, 268:17, 272:7, 276:6, 276:14, 277:20, 279:8, 285:4, 290:3, 296:21
meaning
96:6, 197:3, 214:12, 267:16, 278:17
means
38:18, 50:11, 50:19, 103:11, 109:2, 135:10, 150:15, 161:10, 166:8, 176:12, 178:5, 187:4, 187:6, 187:14, 188:7, 189:3, 189:5, 194:7, 194:14, 197:11, 197:21, 199:22, 200:5, 200:8, 200:13, 200:14, 200:19, 202:5, 206:22, 260:6, 268:8, 272:12, 272:18, 272:20, 290:2
meant
169:21
measure
101:21, 104:1, 104:9, 104:10, 105:3, 105:15, 106:18, 108:1, 108:20, 109:7, 110:12, 110:22, 118:5, 118:21, 152:20, 202:17, 202:21, 206:15
measured
129:18
measurement
108:4, 153:9, 155:8, 156:1, 156:2, 169:14, 169:15, 170:13
measurements
152:17, 156:5
measuring
74:4, 112:21, 118:7, 118:8, 149:9, 150:17, 158:20, 278:13
mechanism
43:19, 44:4, 101:15, 103:14, 103:16, 104:5, 104:15, 107:16, 135:14, 136:3, 238:14, 238:21, 239:5, 239:19, 240:13, 241:5, 241:18, 242:13, 291:13, 292:1, 292:3
mechanisms
97:8, 134:22
mechanistic
21:14, 21:22
medical
103:22, 104:8, 106:21, 107:22, 156:6, 206:14
meet
13:22, 87:9
memory
159:4, 159:7, 159:9, 159:13, 160:2, 160:11, 160:18
mentally
285:17
mention
78:19, 79:21, 120:17, 198:21, 209:10, 225:21, 275:4, 281:12
mentioned
44:20, 64:9, 118:8, 121:14, 126:4, 227:12, 228:8, 231:6, 247:11, 252:20, 258:20, 291:21
mentions
66:20, 70:8, 78:19, 90:4, 120:21, 121:4, 126:9, 126:12, 126:13

merit
2:13, 314:2
mers
175:8
messenger
170:20, 171:6, 171:16, 172:10, 173:2, 174:5, 284:15, 285:6, 285:7, 285:10, 285:20, 285:22, 286:4, 289:10, 290:1, 290:10, 291:17, 292:7, 292:11
met
13:1, 13:21
method
68:9, 93:5, 93:7, 205:17
metrics
230:4
meuth
4:4
mice
75:10, 75:13, 76:13, 80:22, 140:22, 141:5, 141:7, 141:9, 141:11, 142:16, 142:22, 278:22, 279:7
michael
3:4, 6:14
micro
60:1, 133:8
microenvironment
18:18
micrograms
126:13, 270:10
micrometers
226:5
micromolecule
247:18
microparticle
56:7, 89:6, 218:11, 238:18
microparticles
83:15, 252:21
microrna
133:7, 133:13
microscopy
18:9
microsphere
162:18, 162:20, 226:4, 226:12, 237:3, 237:11
microspheres
58:10, 93:13, 143:16, 143:22, 162:1, 162:12, 162:14, 163:2, 163:10, 164:3, 164:4, 164:10, 225:20, 227:6, 231:5, 233:14, 237:12
might
17:18, 212:6
milligram
73:16, 139:16, 141:14, 147:3, 147:10
milligrams
141:13
millions
254:8
mind
220:11
mindset
85:2, 241:7
minute
147:15, 313:4
minutes
121:14, 124:16, 144:9, 276:2, 276:5, 282:18
mirna
133:6, 133:8
mischaracterizes
182:10
mliu@wc
3:9
mm-hmm
82:5, 133:19, 134:13, 210:5, 212:20, 259:12
mmrna
236:15, 236:19, 236:22
mmrna-directed
236:9
mode
199:8
model
129:18, 254:1
models
239:11, 261:1
moderna
1:7, 6:18, 9:19, 14:4, 54:12, 54:13, 54:14, 54:17, 54:20, 55:5, 55:9, 113:17
moderna's
8:17, 55:4
modernatx
4:13, 314:12
modifications
145:16
modified
68:7, 68:11, 70:19, 72:1, 72:15, 73:15, 75:11, 76:5, 92:6, 92:10, 93:9, 94:13, 95:2, 126:6, 139:6, 139:16, 141:1, 141:12, 146:22, 147:2, 147:9, 147:14, 164:4, 183:12, 183:16, 183:19, 183:21, 184:5, 184:8, 184:12, 184:16, 184:20, 184:21, 185:2, 226:3, 226:5, 227:17, 236:8, 236:14, 236:18, 237:7, 237:10
modify
94:19
modulating
92:14
molar
68:11, 69:7, 69:8, 70:10, 70:20, 72:1, 76:5, 80:17
molecule
92:11, 103:1, 205:13
molecules
25:14, 26:3, 27:12, 28:4, 74:7, 74:19, 92:6, 99:3, 99:21, 100:20, 120:9, 120:21, 134:9, 194:12, 236:8, 236:14, 236:19
moment
126:5
monkeys
142:16, 142:22
month
132:13
months
13:1, 123:17, 125:17, 213:21
moon
216:4, 216:9, 247:2, 250:2, 250:4
moon's
216:5, 216:10, 277:6
moore
4:13
more
11:2, 17:6, 17:8, 17:17, 22:15, 32:21, 34:15, 35:9, 36:5, 36:15, 36:19, 37:7, 38:8, 50:10, 52:14, 52:18, 63:22, 83:19,

91:2, 96:9, 104:19, 109:14, 114:1, 119:5, 119:21, 132:15, 137:15, 137:20, 138:3, 138:8, 143:14, 150:1, 150:10, 150:11, 151:8, 151:19, 152:4, 152:9, 152:13, 152:15, 153:6, 155:17, 155:20, 157:22, 159:21, 163:18, 164:19, 167:5, 175:7, 181:1, 182:13, 189:11, 192:14, 193:1, 193:22, 196:1, 201:13, 217:12, 217:20, 232:2, 245:11, 251:12, 251:20, 252:16, 254:17, 255:1, 255:12, 255:15, 256:8, 256:22, 257:9, 265:7, 268:16, 269:4, 269:12, 269:16, 270:13, 270:19, 271:13, 271:15, 280:7, 285:11, 297:16, 298:15, 299:17, 300:4, 301:16, 302:20, 307:2, 307:3, 307:11, 307:14

morning
6:8, 6:9

most
145:4, 145:20, 159:17, 254:2, 254:11

mostly
20:21

mouse
278:19, 297:21, 299:12, 301:11

move
15:7

moved
14:14, 14:16, 16:21

movie
18:11

mrnas
162:19, 239:10

much
22:7, 84:21, 96:12, 132:8, 256:2, 282:7

multifaceted
107:2, 107:3

multiple
176:15, 278:6, 298:7

multitude
153:22

multivalent
304:12, 306:2, 307:7

muscle
266:1, 266:13, 266:16, 267:9, 267:14

muscles
266:19

must
82:7, 82:13, 84:14, 268:22, 269:7, 269:19, 271:3, 271:9, 273:9, 306:18

myself
21:12, 23:9, 35:16, 62:1, 71:6, 90:12, 230:8, 241:7

N

naked
279:3

name
6:10, 6:12, 6:14, 23:20, 69:3, 250:7, 277:18

names
249:6, 250:6

nano
28:5, 28:11, 30:3, 30:5, 31:22, 35:6, 60:1, 73:11, 89:5, 238:18

nano-based
134:21

nanocrystal
25:16, 30:11, 31:20

nanocrystals
25:12, 27:16, 27:18, 28:3, 28:4, 28:5, 28:8, 28:11, 28:16, 29:12, 29:20, 30:20, 31:7, 31:11, 31:19, 32:19, 33:18, 34:1

nanodrop
126:15

nanoemulsion
246:15, 295:9

nanoemulsions
246:5, 246:16, 294:7

nanomedicine
35:7

nanometers
30:6

nanospecies
180:18, 182:4, 182:18, 183:3, 183:8

nanostructure
30:15, 310:15, 310:19, 310:20, 311:2, 311:6

nanostructures
19:15, 304:4, 311:7

nanosystem
52:18

nanosystems
52:10, 52:13, 53:1

nanyang
14:14

narrow
103:11, 109:21, 150:11, 152:5, 152:9, 167:12, 167:14

natural
153:21, 161:13, 161:17

nature
35:15, 61:11, 62:17, 63:6, 63:11, 63:16, 65:6, 65:14, 84:9, 84:12, 88:22, 89:3, 98:1, 132:1, 257:16, 263:22, 275:7, 297:12, 302:11

nearly
219:14

necessarily
131:5, 136:3, 138:17, 170:10, 187:19, 190:6

need
7:20, 47:2, 57:19, 57:22, 66:1, 66:10, 85:19, 86:10, 114:1, 115:1, 115:6, 121:8, 123:14, 123:19, 125:15, 137:3, 143:14, 152:13, 152:15, 157:5, 159:6, 164:19, 174:19, 182:13, 192:14, 192:15, 198:13, 204:16, 206:14, 213:9, 228:2, 234:11, 254:12, 255:12,

255:15, 255:20, 255:22, 256:2, 256:3, 268:16, 268:18, 269:4, 269:16, 271:15, 271:20, 271:21, 272:2, 272:9, 272:12, 272:16, 272:18, 273:1, 273:13, 273:17, 274:18, 277:2, 280:13, 282:2, 282:7, 282:12, 310:6
needed
83:5, 86:7, 87:11
needs
58:2, 249:4, 267:4, 268:12, 277:8
negative
197:17, 197:18, 199:8
neither
207:7
neutralizing
295:21, 296:1, 296:3, 298:1, 298:12, 299:2
never
21:9, 23:1, 23:10, 42:17, 260:4
new
4:6, 15:7, 17:10, 37:20, 42:1, 50:7, 299:20
next
19:19, 60:21, 88:2, 93:1, 133:17, 208:19, 225:6, 265:20, 266:10, 273:19, 284:12, 301:13
next-line
154:8
nice
146:4
nine
219:17
ninety-two
16:15
nobody
95:17
nod
7:9
nodded
192:1
nodes
21:5
nomenclature
119:4, 248:3
non
161:9, 161:10
non-limiting
310:20, 311:6
nonamplified
44:22
nonamplifying
121:16, 264:14, 264:19, 266:18
noncationic
307:17, 308:2
none
224:16, 224:21
nonencapsulating
147:12
nonhuman
141:21, 142:2, 142:7, 142:9
nonreplicating
264:9
nonresponsive
279:18, 312:10
nonself-amplifying
44:13, 44:18
nonviral
261:20, 262:1, 262:13, 262:22, 263:13
nonviral-based
160:21, 161:3, 161:6, 161:11, 161:15
normal
95:19, 205:17
normally
17:22, 117:14
nos
1:12
notary
2:15, 314:1, 314:3, 314:32
note
312:8
nothing
61:22, 195:7
notice
37:14
nots
230:18
novartis
260:9
novartis's
259:17
novel
50:4, 50:6
novelty
50:19
nowadays
39:7, 159:2
ntu
14:15, 14:16, 14:18, 15:6, 15:11, 15:22, 16:22
nucleic
24:21, 25:2, 25:14, 25:20, 25:22, 26:22, 27:12, 27:13, 27:19, 39:4, 39:12, 39:13, 39:16, 40:15, 42:16, 42:20, 43:13, 43:17, 44:21, 44:22, 45:22, 46:11, 47:10, 47:13, 47:19, 48:7, 48:10, 49:18, 49:19, 92:6, 92:10, 92:13, 92:18, 121:11, 121:21, 123:5, 124:1, 127:17, 127:20, 133:22, 134:9, 134:14, 193:5, 193:9, 193:10, 194:10, 195:13, 195:18, 196:5, 196:18, 197:7, 197:13, 200:18, 201:18, 218:1, 219:7, 219:14, 219:21, 235:9, 236:8, 236:14, 236:19, 237:7, 237:10, 245:16, 245:20, 246:11, 246:19, 247:12, 307:19, 308:3
nucleotide
219:18, 219:19
number
5:6, 14:13, 17:21, 35:21, 46:13, 47:10, 47:12, 47:19, 47:22, 48:10, 68:12, 90:9, 107:12, 127:16, 134:8, 134:21, 144:22, 147:20, 201:12, 211:11, 217:22, 224:12, 272:10, 274:2, 274:11, 283:19, 303:7
numbers
67:12, 201:10, 214:4
numerical
152:16, 201:10
ny
4:6

O

oath
32:8, 62:12,

213:2, 240:22, 305:12
object
43:9, 153:4
objection
20:13, 21:11, 22:10, 22:19, 23:4, 23:15, 24:1, 24:22, 25:21, 26:8, 27:8, 29:3, 31:9, 32:14, 33:20, 34:3, 34:19, 35:11, 36:7, 36:18, 37:6, 38:16, 39:2, 40:3, 40:18, 43:21, 44:6, 44:14, 44:19, 45:13, 45:20, 48:19, 49:16, 50:5, 50:9, 51:6, 51:14, 52:21, 54:19, 55:19, 59:16, 60:6, 62:15, 63:10, 64:18, 66:3, 66:12, 73:19, 74:11, 74:17, 75:2, 75:22, 77:5, 78:9, 79:4, 79:16, 80:3, 80:12, 82:9, 82:15, 84:17, 85:22, 86:14, 87:3, 87:13, 88:20, 91:14, 94:10, 97:15, 100:11, 100:16, 102:10, 102:16, 102:21, 104:6, 104:16, 105:22, 108:8, 108:18, 109:12, 109:18, 110:19, 111:5, 112:4, 113:5, 115:15, 115:22, 116:9, 116:17, 117:2, 118:12, 119:17, 121:7, 123:14, 124:8, 125:14, 126:3, 129:5, 129:14, 130:2, 130:16, 131:4, 131:12, 135:1, 135:17, 136:5, 137:5, 137:11, 137:22, 138:11, 145:6, 146:1, 148:4, 148:12, 148:22, 149:17, 150:9, 151:2, 151:17, 152:3, 152:8, 152:12, 153:16, 156:21, 157:11, 157:16, 158:7, 158:16, 159:5, 159:14, 160:4, 161:1, 161:7, 162:15, 165:10, 165:19, 166:21, 167:10, 167:17, 168:14, 170:1, 171:13, 171:22, 172:6, 173:6, 173:15, 174:14, 174:22, 175:6, 175:10, 176:4, 177:5, 178:17, 179:3, 180:2, 180:14, 182:9, 184:13, 186:17, 187:12, 188:12, 189:13, 190:12, 191:16, 192:6, 192:12, 192:21, 193:6, 193:20, 194:22, 195:14, 195:19, 196:19, 197:8, 200:1, 200:20, 201:20, 202:13, 203:14, 204:1, 205:9, 206:1, 209:17, 210:17, 216:18, 217:2, 217:11, 218:18, 219:9, 220:7, 221:2, 222:5, 223:2, 223:14, 223:21, 227:1, 227:21, 228:17, 229:8, 229:22, 230:16, 231:2, 231:12, 232:11, 233:18, 234:7, 234:18, 235:3, 235:11, 235:16, 237:1, 238:15, 238:22, 239:7, 239:20, 240:14, 241:19, 242:14, 243:9, 244:7, 244:19, 246:12, 248:13, 249:2, 249:13, 249:17, 251:1, 252:1, 252:19, 253:10, 255:4, 256:11, 258:6, 260:17, 261:7, 263:11, 264:22, 265:5, 265:13, 266:20, 267:10, 267:21, 268:14, 269:2, 269:10, 269:22, 270:16, 271:6, 271:12, 272:1, 275:22, 276:19, 277:16, 280:11, 280:22, 282:4, 285:5, 285:9, 286:3, 286:15, 287:11, 287:17, 287:22, 288:9, 288:16, 289:1, 289:11, 289:19, 290:11, 291:1, 291:10, 291:19, 292:8, 292:15, 293:1, 294:8, 294:17, 295:3, 299:7, 300:5, 303:14, 306:4, 307:8, 307:20, 308:13, 309:19, 310:5, 311:19
objections
257:3, 257:12, 308:5
objective
10:13
obligation
199:18, 305:13, 305:17
observed
162:21
obviously
16:21
occur
48:21
occurred
314:15
occurs
48:11, 273:22, 281:8
october
251:11, 251:19, 253:7, 254:22, 256:7, 257:8
offer
115:13, 285:11
office
1:1, 6:19, 8:11
offices
2:11, 314:15
officially
14:19
often
161:12, 161:15, 312:19
oftentimes
312:10
oh
36:11, 37:1, 67:7, 68:19, 81:1, 81:19, 177:9, 238:3, 262:20, 263:22, 287:1, 287:2,

301:6
okay
7:10, 8:3, 8:16, 9:16, 11:21, 12:6, 12:10, 16:15, 19:8, 20:15, 40:4, 47:5, 50:15, 57:10, 67:14, 67:17, 68:3, 69:19, 69:21, 72:22, 91:15, 97:6, 98:5, 98:9, 102:19, 103:17, 120:7, 121:9, 121:15, 122:11, 127:14, 127:15, 139:4, 154:10, 163:18, 169:20, 179:13, 194:16, 197:3, 202:2, 203:15, 205:5, 210:6, 211:2, 212:16, 216:2, 227:22, 236:4, 236:10, 237:17, 238:3, 243:7, 251:15, 254:19, 254:20, 262:22, 263:5, 263:12, 264:6, 266:9, 266:14, 271:2, 275:1, 276:5, 278:3, 283:2, 288:6, 290:7, 293:12, 293:21, 298:21, 302:9, 304:2
once
22:5, 96:19, 150:2
one
9:7, 9:8, 9:10, 15:16, 15:17, 17:8, 18:7, 19:8, 27:14, 30:7, 30:10, 31:22, 32:1, 35:20, 37:1, 40:10, 46:13, 46:14, 46:19, 47:14, 47:16, 48:8, 52:5, 63:22, 69:19, 93:5, 94:11, 94:14, 99:2, 99:19, 101:18, 108:5, 108:15, 108:22, 109:10, 109:16, 112:13, 118:18, 120:7, 122:14, 127:15, 133:17, 135:2, 137:14, 144:5, 146:5, 163:1, 168:8, 170:18, 176:14, 176:19, 176:20, 176:21, 179:17, 180:11, 183:5, 185:1, 185:10, 186:12, 186:13, 187:3, 187:6, 187:7, 187:17, 187:18, 207:7, 208:19, 211:9, 221:12, 225:3, 226:2, 226:15, 231:19, 237:8, 253:15, 254:17, 270:20, 282:16, 289:3, 289:4, 295:18, 297:17, 298:5, 298:17, 302:13, 308:20, 310:12, 310:13, 310:18, 310:22, 311:4, 311:7
ones
52:8, 64:11, 144:17, 145:2, 145:11, 213:12, 213:13, 254:10
ongoing
19:1
only
7:22, 34:4, 34:14, 48:4, 72:8, 72:13, 72:17, 75:3, 76:1, 80:6, 81:21, 83:9, 87:16, 90:21, 101:9, 121:6, 121:11, 137:21, 138:9, 143:21, 144:5, 144:9, 163:22, 166:11, 173:11, 231:9, 233:20, 281:9
open
170:21, 171:6, 171:17, 172:11, 172:18, 173:1, 174:5
opine
114:20, 118:1, 158:14, 212:11
opined
283:10
opinion
57:14, 59:14, 60:17, 64:15, 65:2, 65:3, 71:15, 78:7, 83:5, 84:13, 85:20, 86:6, 86:21, 87:1, 88:13, 91:12, 97:13, 113:3, 114:15, 115:7, 143:4, 157:13, 159:3, 160:22, 162:11, 163:9, 165:7, 165:16, 173:4, 173:19, 173:22, 181:18, 182:5, 188:10, 220:3, 226:21, 227:15, 227:18, 228:14, 229:5, 230:12, 233:6, 233:16, 267:11, 267:16, 280:19, 282:11, 303:6, 303:11, 309:14, 310:1, 311:15
opinions
60:3, 111:13, 112:2, 115:11, 122:16, 262:4
opposed
166:20, 167:8
optimization
45:15
option
185:1, 251:13, 251:21, 252:17, 255:2, 256:9, 257:1, 257:10
options
183:5, 184:1, 184:11
oral
7:8, 224:10
order
57:20, 59:3, 83:3, 84:13, 86:12, 87:9, 88:13, 113:6, 180:11, 190:9, 255:13, 255:20, 265:9, 267:18, 268:11, 273:12, 273:16, 277:1, 279:22, 280:9, 282:2
orders
313:12
organic
135:7
organism
99:4, 99:9, 99:16, 99:22, 100:3, 100:7, 100:10, 100:13, 120:10
original
42:4
originally
212:13, 212:18

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358

originated
213:18
originating
212:18
other
9:11, 13:4, 13:16, 13:17, 14:3, 14:13, 15:17, 17:2, 17:3, 18:22, 22:21, 23:17, 24:5, 26:2, 28:18, 30:20, 32:18, 33:4, 45:8, 45:15, 46:14, 47:16, 52:5, 52:8, 53:3, 56:17, 64:11, 69:19, 72:6, 84:2, 84:6, 84:10, 90:17, 98:2, 100:18, 109:2, 109:4, 121:21, 123:5, 123:20, 124:1, 125:18, 132:2, 134:8, 135:6, 135:10, 163:3, 164:14, 174:16, 180:21, 187:19, 187:21, 188:22, 191:6, 191:14, 192:15, 194:11, 206:19, 209:10, 210:4, 210:10, 210:12, 210:16, 211:21, 212:5, 221:15, 225:3, 226:15, 231:16, 232:6, 243:21, 247:13, 256:4, 268:18, 272:2, 272:9, 272:22
otherwise
12:8, 312:14, 314:23
out
11:3, 31:21, 46:17, 51:21, 55:11, 67:9, 67:10, 70:17, 72:4, 82:16, 107:22, 124:17, 125:18, 130:9, 136:19, 144:8, 165:3, 196:14, 208:2, 208:12, 209:3, 223:6, 223:11, 225:22, 229:17, 233:21, 239:3, 241:10, 250:17, 251:4, 253:6, 270:21, 286:8, 296:10, 309:5
outcome
101:21, 104:1, 104:9, 104:10, 108:1, 108:2, 108:4, 108:21, 109:7, 118:6, 118:7, 118:21, 156:2, 156:7, 158:20, 158:21, 170:13, 202:17, 206:15, 255:17, 314:24
outcome-based
169:11, 169:14, 169:15
output
111:11, 117:13
outside
40:12, 48:12, 48:13, 113:1, 260:17, 261:8, 312:20
over
9:5, 119:11, 124:16, 136:20, 144:20, 147:22, 164:5, 215:18, 253:8
overall
19:13, 57:6
overcome
153:22
overview
19:9, 19:13, 216:5, 216:10
own
28:22, 216:12, 216:16, 222:12, 299:15, 303:3, 303:10
owner
1:8, 3:21

P

page
5:6, 16:11, 16:17, 19:5, 41:15, 56:3, 58:5, 58:6, 58:20, 67:3, 67:5, 67:7, 67:8, 67:12, 78:4, 78:5, 81:19, 92:2, 124:18, 125:5, 125:7, 139:2, 139:3, 143:15, 153:19, 160:12, 161:14, 161:20, 162:2, 162:9, 164:15, 172:15, 179:10, 179:11, 179:12, 182:6, 182:8, 210:20, 212:14, 225:19, 226:17, 227:7, 239:9, 246:3, 249:18, 262:10, 263:18, 273:6, 275:11, 275:13, 278:3, 281:5, 283:7, 283:18, 283:19, 283:20, 283:21, 286:17, 287:1, 293:10, 293:12, 293:14, 294:18, 295:13, 295:15, 297:7, 297:13, 309:3
pages
61:1, 61:2, 309:1
paper
18:11, 18:14, 18:19, 18:20, 27:14, 46:22, 52:4, 52:5, 52:7, 52:11, 130:3, 130:4, 130:5, 130:9, 130:10, 131:6, 131:8, 131:9, 131:13, 131:16, 131:21, 132:5, 208:12, 208:19, 211:17, 246:6, 260:20, 261:20, 261:22, 262:1, 262:3, 262:6, 262:7, 267:12, 278:1, 278:10, 292:16, 292:17
papers
17:17, 17:21, 18:3, 18:6, 19:2, 35:6, 35:21, 37:20, 37:22, 38:10, 38:12, 43:18, 44:2, 44:3, 44:9, 45:17, 46:1, 46:3, 46:6, 46:10, 46:12, 46:17, 50:3, 51:20, 52:2, 132:1, 132:2, 132:3, 133:16, 208:14, 208:15, 208:16, 209:13, 221:20
paragraphs
97:19, 98:13, 120:1, 120:2, 121:10, 221:9, 259:6, 259:9, 260:12
parameter
231:19, 234:3, 234:15, 274:2,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 350 of 375

274:12, 299:20, 299:21
parameters
131:7, 137:16, 201:16, 231:9, 231:16, 232:6, 232:7, 256:4
parent
211:22
park
4:5
part
28:5, 28:10, 28:11, 30:21, 31:2, 31:12, 33:4, 46:2, 53:6, 55:10, 58:6, 92:22, 101:18, 101:19, 103:17, 103:18, 108:13, 108:22, 116:14, 134:18, 135:11, 135:21, 150:11, 156:5, 156:8, 158:22, 165:12, 188:3, 193:22, 194:1, 205:10, 206:19, 206:20, 245:6, 245:11, 245:12, 245:13, 247:5, 253:18, 270:21, 294:5
partially
92:7
particle
18:13, 52:7, 56:22, 57:17, 62:7, 68:16, 68:21, 89:5, 103:21, 104:11, 108:14, 188:18, 190:18, 191:3, 228:6, 248:20, 252:3, 254:9, 254:13, 257:21
particle-based
60:1
particles
28:13, 29:1, 70:12, 145:7, 146:5, 158:18, 245:15, 248:16, 279:2
particular
15:20, 20:7, 28:18, 31:18, 35:16, 37:18, 44:9, 56:1, 56:4, 56:14, 57:5, 58:1, 61:5, 61:12, 62:2, 62:4, 63:17, 63:19, 64:4, 66:6, 74:7, 74:19, 78:18, 79:6, 79:10, 79:20, 81:5, 83:19, 84:1, 85:3, 89:8, 89:10, 92:18, 96:21, 101:10, 115:17, 118:16, 130:6, 130:7, 130:10, 133:16, 134:6, 136:7, 145:1, 145:13, 165:11, 167:12, 170:11, 177:12, 193:16, 215:12, 219:16, 221:22, 227:16, 228:3, 228:19, 230:6, 231:13, 231:14, 231:15, 233:22, 235:12, 239:22, 240:8, 240:16, 241:8, 241:13, 244:9, 246:13, 247:4, 248:14, 248:20, 249:7, 251:2, 252:9, 253:5, 254:15, 255:7, 257:22, 258:1, 265:1, 267:5, 267:12, 267:16, 267:17, 279:22, 282:13, 296:11, 296:16, 298:8, 300:9, 303:4, 304:7
particularly
225:12, 227:4
parties
314:20, 314:22
parts
156:7, 170:18
party
314:12
past
135:4
patents
9:8, 9:10, 9:19, 10:1, 10:5, 10:15, 11:18, 115:18, 207:5, 207:9, 207:15, 207:20, 207:22, 208:1, 208:3, 208:5, 208:6, 208:7, 209:6, 209:7, 209:14, 210:4, 210:9, 210:14, 212:9, 212:22, 213:7, 213:8, 213:17, 214:1, 214:18, 215:7, 215:8, 215:10, 217:8, 228:22
pathogen
18:22, 154:12, 154:21, 160:10, 160:14, 160:17, 160:20, 192:11, 192:20, 193:2
pathogens
20:9, 153:21, 154:8
pathways
284:5, 287:4
patients
118:15
paul
4:3
pause
296:6
pay
96:2, 96:3, 133:15, 134:6, 134:17, 207:11, 245:6
payload
183:5, 190:11, 191:21, 192:5, 192:10, 192:19, 193:2, 248:18, 268:22, 269:7, 269:19, 271:3, 271:9, 273:9, 308:4, 310:18, 311:5
payloads
307:19
pcr
48:1
pdna
279:3
peers
107:10
peg
294:21
pending
7:22, 8:1
people
17:9, 17:10, 17:11, 21:20, 22:21, 23:18, 24:5, 28:10, 28:18, 35:15, 48:13, 107:3, 109:1, 109:4, 110:12, 159:10, 169:13, 191:8, 196:14, 245:1, 245:17
percent
163:22, 164:5, 164:7, 201:3, 201:4, 226:7, 270:8, 274:1,

280:15, 280:16, 280:17, 281:8, 281:12, 281:22, 294:19, 294:20, 294:21
percentage 201:1, 268:19, 280:14, 281:18, 282:1, 282:11, 282:14
percentages 281:15
perfectly 233:1
perform 166:19, 167:8
performed 38:22, 294:4
perhaps 270:2
period 226:7
permanently 258:4, 258:18
permutation 258:20
permutations 33:9, 168:1, 247:6, 255:10
person 58:6, 106:13, 108:10, 156:16, 156:18, 209:20, 223:5
personally 21:9, 213:10
perspective 35:17, 85:2, 91:8, 102:3, 106:13, 111:8, 130:17, 130:18, 131:3, 132:8, 134:7, 138:13, 156:1, 156:17, 169:18, 178:19, 187:2, 223:5, 234:11, 288:12, 301:20
perspectives 254:5
petitioner 3:11, 4:9
petitioners 1:5
petsch 259:8, 260:20, 261:4
pfizer 1:4, 6:15, 6:18, 113:18
ph 1:16, 2:10, 5:3, 6:2, 24:15, 24:18, 25:2, 25:3, 25:8, 25:9, 25:17, 25:20, 26:9, 26:12, 26:16, 26:17, 27:5, 27:22, 28:14, 28:17, 29:2, 29:10, 33:1, 33:13, 34:13, 304:8, 314:5, 314:15
pharma 137:6, 243:17
pharmaceutical 54:20, 55:5, 55:10, 55:11, 245:12
pharmaceutically 205:8
pharmaceuticals 134:22
phase 163:1, 259:20, 260:2, 260:5, 260:15, 261:6
philosophizing 26:14
philosophy 25:3, 25:4, 26:12, 26:13, 26:19, 26:20
phrase 150:18, 204:19
phrased 149:5, 149:21, 151:11, 155:11, 156:10, 156:19, 158:3, 167:16, 168:22, 204:8, 306:8, 306:11
phrasing 158:10
physical 154:9
physicochemical 166:16
pick 233:9, 253:5, 253:15, 257:15
picked 228:3, 254:1
picking 229:15
picture 91:21, 95:21, 95:22, 209:4, 223:22
piece 278:4
pis 209:2
place 91:1, 125:20, 133:22, 134:1, 245:13
plasma 224:10, 225:2
plasmid 279:2
played 27:19
playing 46:21
please 7:21, 157:12, 167:14, 175:1, 175:7, 220:8, 271:13, 286:16, 288:17, 304:13, 304:15, 306:5
plga 56:7, 56:15, 58:10, 58:17, 58:19, 59:1, 59:9, 60:9, 60:13, 60:21, 62:7, 64:10, 66:21, 89:4, 90:1, 94:2, 94:3, 96:12, 96:17, 96:18, 97:10, 143:2, 143:4, 143:7, 143:13, 143:16, 143:22, 162:1, 162:8, 162:12, 162:14, 162:18, 162:19, 162:21, 163:2, 163:10, 163:16, 163:20, 164:3, 164:9, 164:10, 165:1, 165:9, 165:13, 165:17, 165:22, 166:5, 166:12, 166:17, 225:7, 225:10, 225:17, 225:20, 226:1, 226:4, 226:10, 226:11, 226:15, 226:20, 227:6, 227:7, 227:14, 228:7, 228:11, 231:5, 233:14, 233:17, 237:3, 237:11, 237:15, 237:18, 238:5, 238:7, 238:14, 238:20, 239:5, 239:12, 239:18, 239:21, 240:6, 240:9, 240:12, 241:5, 241:18, 242:13, 252:4, 254:13, 256:15, 257:21
plus 119:10
pns 262:1

poga
135:7
point
7:20, 18:7, 33:12, 65:20, 66:7, 76:19, 79:7, 79:10, 118:20, 125:18, 164:7, 165:3, 185:5, 261:12, 261:13, 270:22, 282:16, 296:10, 300:9
points
81:5, 161:22, 162:11, 225:19
poly
93:12
poly-a
126:10, 126:19
polyglycolic
96:13
polylactic-co-glycolic
58:9
polymer
56:7, 56:15, 61:5, 63:20, 84:3, 84:21, 180:18, 182:4, 182:18, 183:3, 183:9, 240:1, 240:8, 252:3
polymer-based
61:17, 62:8, 97:20, 228:6
polymeric
83:14
polymers
58:11, 93:14, 219:3
polypeptide
93:6, 93:10, 100:21
polypeptides
92:13
polysaccharide
219:3, 219:7, 221:8
polysaccharides
218:22
popping
36:13
popular
34:21, 35:2, 35:9, 239:22, 240:2
porous
310:16, 311:3
portions
214:22
posa
56:13, 71:6, 75:20, 77:3, 79:8, 79:14, 80:6, 80:8, 128:3, 129:3, 129:6, 129:7, 129:11, 129:15, 129:22, 130:3, 130:13, 130:22, 131:5, 157:8, 157:13, 158:4, 165:8, 165:11, 165:17, 165:20, 166:8, 169:18, 169:20, 170:2, 170:7, 170:10, 181:9, 181:12, 181:17, 181:18, 181:21, 182:5, 182:12, 203:8, 203:11, 220:5, 220:22, 222:1, 222:2, 222:6, 222:22, 223:3, 223:4, 223:18, 225:12, 227:2, 228:1, 228:19, 229:10, 230:6, 230:12, 230:21, 231:3, 231:10, 231:14, 231:16, 232:9, 233:6, 233:8, 233:16, 234:4, 234:15, 237:20, 240:15, 241:7, 248:2, 251:10, 251:18, 252:14, 253:4, 253:8, 254:21, 256:6, 256:16, 256:20, 257:7, 274:10, 281:13, 282:9, 303:11, 303:15
posa's
130:18, 131:3, 301:20
posed
235:15, 304:19, 305:5, 307:13
position
16:3
positive
197:19, 199:8, 200:2, 258:10, 258:22, 284:13
positively
258:5
possibilities
95:5, 222:9
possibility
223:7, 238:17
possible
299:16, 301:15, 302:19
potency
246:8, 297:20, 299:12, 301:11
potential
68:21, 72:19, 153:20, 154:21, 258:10
potentially
227:13, 233:11, 244:14, 251:8, 274:22, 292:2
power
72:17
precursor
92:7, 92:9, 92:19, 92:21, 184:22
precursors
190:19
prefer
305:19
preferred
178:7, 283:14, 284:13
premarked
261:15
premise
288:2
preparation
13:18, 14:5, 55:14
prepare
12:11, 12:12, 12:19
prepared
13:3, 297:19, 298:7, 298:20, 299:11, 300:1, 300:3, 301:10, 302:16, 303:20
preparing
54:5, 213:20, 215:8
present
4:11, 44:1, 44:8, 66:14, 92:2, 92:4, 92:12, 99:2, 99:20, 101:9, 113:7, 120:8, 124:17, 151:12, 164:21, 221:17, 228:18, 302:9, 310:14, 311:1
presentations
17:7
presented
27:10, 63:7, 63:12, 65:15, 65:20, 66:5, 69:9, 71:3, 71:13, 86:2, 86:3, 97:18, 100:18, 116:2, 116:5, 119:6,

123:21, 130:5, 131:8, 131:17, 212:9, 221:7, 261:22, 278:15, 291:22, 292:1, 293:9
presenting 6:3, 87:22
presumably 38:19
pretty 216:20
prevent 154:11
previous 85:5
previously 5:5, 9:1, 11:7, 53:15, 261:16, 282:22
primates 141:22, 142:3, 142:7, 142:10
prime 151:15, 153:14, 155:4
principles 23:6
prior 21:4, 82:7, 82:12
priorities 232:16
priority 43:5, 127:22, 128:8, 128:11, 128:15, 129:2, 129:11, 129:21, 130:12, 169:21, 170:8, 203:9, 222:21, 225:13, 232:14, 233:5, 244:11, 245:19, 248:9
private 43:5
probably 6:13, 7:5, 17:16, 57:22, 64:11, 74:5, 177:13, 178:3, 178:4, 178:9, 208:10, 256:18, 304:8
problem 112:21
problems 26:14, 26:21, 78:14
proceeding 9:9, 112:3, 305:12
proceedings 6:18, 8:10, 8:14, 8:17, 9:20, 11:5, 312:22
process 18:16, 33:10, 135:12, 137:7, 137:16, 162:19, 163:4, 185:7, 186:7, 213:16, 280:2
processed 92:8, 92:20
processes 39:19, 185:8, 253:21
produce 41:22, 42:4, 112:11, 234:12, 286:7, 292:2
produced 105:4, 106:19, 110:4, 110:11, 111:11, 111:19
produces 42:1, 113:22, 160:9, 160:16
producing 74:18, 93:5
product 43:16, 43:17, 47:11, 184:22, 234:13, 292:2
production 126:7, 236:9, 277:4, 277:13, 280:5
products 47:13, 47:20, 48:1, 128:21
professor 14:10, 15:8
program 107:1
project 26:1, 166:10, 241:22
projects 254:2
promise 81:14
promising 137:20, 219:17
propels 243:4
properly 277:9, 277:13, 277:22
properties 34:7, 49:12, 166:16, 227:9, 231:6, 231:14, 232:1, 232:14, 232:16, 233:3, 233:4, 233:12, 234:1, 240:9, 241:12, 252:11, 254:15, 256:16, 256:17, 257:22
property 31:15, 226:9, 226:11, 227:5
proportions 307:17, 308:2
proposition 130:11, 130:22
proprietary 43:14
protamine 218:5, 218:16, 218:20, 239:9, 239:10, 239:12, 239:15, 259:13, 260:21
protect 104:20, 106:5, 115:3, 115:8, 264:20, 265:12
protected 164:4, 263:20, 264:5
protection 115:13, 164:2
protective 103:13, 103:15, 104:5, 104:14, 107:16
protects 105:8, 105:16, 105:19, 106:9, 107:19, 160:19
protein's 275:2, 275:4
proteins 25:14, 26:2, 26:22, 27:13, 27:19, 72:16, 105:3, 110:5, 110:22, 112:22, 245:17, 270:10, 276:18, 277:15, 286:8
protons 258:15, 259:5
provide 41:2, 57:12, 66:1, 77:3, 82:1, 82:20, 83:1, 85:16, 85:19, 86:3, 86:7, 86:10, 86:19, 87:2, 87:11, 87:18, 88:16, 103:15, 109:14, 114:1, 117:20, 146:6, 151:8, 152:21, 157:2, 158:12, 158:22, 201:13,

221:10, 221:20, 224:6, 239:13, 240:7, 246:14, 259:17, 260:12, 270:19, 272:17, 272:19, 275:19, 294:18, 307:14, 308:15, 312:3
provided 124:10, 165:15, 166:1, 213:13, 215:6, 224:9, 225:1
provides 57:14, 69:7, 85:8, 92:4, 92:12, 97:21, 103:13, 104:5, 104:14, 122:9, 157:22, 163:15, 163:20, 166:4, 171:15, 174:17, 182:3, 199:15, 214:6, 221:12, 286:8, 310:11
providing 63:15, 79:18, 85:12, 119:11, 169:1, 221:6, 242:3, 242:6, 242:9, 242:15, 253:3
provisional 210:20, 210:22, 211:4, 211:7, 211:16
provoke 99:4, 99:6, 99:15, 99:21, 100:9, 100:12, 100:15, 102:8, 102:14, 102:20, 103:2, 116:7, 118:19, 119:15, 120:9
provoked 117:18
provokes 100:2, 100:6, 101:5, 116:12, 116:16, 117:1, 117:10, 118:2
provoking 99:9
ptab 62:12, 312:13
public 2:15, 32:9, 107:7, 314:1, 314:3, 314:32
publication 53:20
publications 17:6, 17:13, 19:7, 36:5, 36:16
published 17:18, 18:3, 18:5, 27:14, 27:21, 35:14, 35:22, 38:11, 43:18, 44:3, 50:3, 51:5, 51:13, 53:5, 129:8, 129:17, 130:19, 130:20, 131:22, 196:14, 222:14, 246:21
pull 46:17
pump 68:9
purchase 39:11, 39:12, 39:13, 39:16, 43:11, 43:13
purchased 39:9, 39:14, 40:1, 42:13, 42:15, 42:17, 42:19
purified 126:12
purpose 21:16, 43:12, 45:6, 74:12, 100:8, 100:14, 102:7, 102:13, 103:22, 108:9, 109:10, 117:5, 119:15, 143:11, 165:14, 206:14, 239:15, 241:9, 309:20
purposes 21:5, 108:16, 109:10, 109:16, 231:15, 240:4
pursuant 2:12
purview 160:6
put 23:7, 28:4, 33:5, 86:16, 91:1, 127:3, 147:7, 164:16, 197:22, 205:12, 207:12, 257:14, 266:5, 278:2, 299:8, 303:4
putting 34:11, 62:1, 200:16, 241:7, 253:14, 302:11

Q

qualification 113:20, 272:20
qualified 158:14, 178:21, 305:3
qualify 167:5, 274:14
quantification 234:19, 234:21, 256:1, 279:10
quantified 126:14, 267:4
quantum 25:10, 25:11, 25:16, 27:11, 27:12, 135:4
questioning 76:22, 85:5
questions 7:9, 7:13, 7:16, 112:14, 147:20, 151:9, 159:20, 163:18, 164:13, 164:19, 198:9, 198:14, 198:15, 198:17, 198:19, 199:1, 199:11, 199:16, 199:19, 200:11, 204:6, 207:6, 305:13, 305:17, 312:7, 312:18, 313:10
quick 123:7, 144:10
quickly 123:17, 126:22, 144:1
quite 226:13, 256:17

R

raise 312:13, 313:3
randomly 229:15
range 30:10, 32:2, 154:7, 187:5
rapidly 58:13, 93:17
rat 76:8, 140:8, 140:9
rate 276:10
rather 119:4
ratio 68:10, 68:11, 69:7, 69:8, 70:10, 70:18, 70:20, 71:22, 72:1, 76:4, 76:5, 77:10, 79:18, 80:17,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 355 of 375

94:20
ration
94:19
rational
230:8
rationale
259:17, 260:13
rationalize
228:3, 229:12, 229:14
rationalized
230:13, 230:21
ratios
72:11
rats
73:9, 73:14, 73:21, 139:14, 139:21, 140:2, 140:7, 140:12, 142:16, 142:22
reach
76:18, 282:15
reached
163:22
reaction
126:20, 192:11, 192:20
read
35:3, 35:15, 35:16, 36:12, 37:20, 38:5, 55:16, 55:20, 55:22, 58:16, 59:8, 60:7, 60:9, 61:11, 62:3, 62:21, 65:10, 66:4, 73:20, 74:6, 76:1, 77:7, 77:17, 78:11, 79:8, 80:6, 90:12, 90:13, 91:15, 92:16, 93:22, 97:16, 100:18, 121:8, 121:13, 129:15, 131:6, 139:8, 147:6, 153:20, 163:6, 163:13, 163:17, 164:15, 164:16, 172:14, 173:11, 173:16, 174:19, 176:9, 181:12, 181:21, 182:6, 182:11, 182:13, 184:3, 186:18, 208:11, 208:12, 208:14, 214:2, 226:2, 233:10, 249:20, 250:17, 262:6, 266:22, 273:7, 278:16, 279:14, 287:13, 291:20, 291:21, 292:16, 292:17, 293:2, 293:8, 293:20, 295:16, 302:10, 303:15, 310:9, 310:21, 311:12
reader
96:10
reading
36:1, 36:9, 37:17, 37:21, 38:2, 58:7, 59:17, 59:21, 62:18, 68:14, 70:21, 75:4, 79:6, 85:1, 89:3, 89:8, 90:20, 95:20, 97:18, 99:12, 99:18, 100:17, 101:7, 102:12, 102:22, 143:7, 170:21, 171:7, 171:14, 171:17, 172:8, 172:9, 172:11, 172:18, 173:1, 173:13, 173:21, 174:3, 174:6, 177:14, 180:22, 186:3, 186:20, 214:1, 215:10, 237:22, 249:21, 266:4, 270:2
reads
165:11
reagents
72:12, 79:19, 80:17, 80:18
realize
33:8
really
51:15, 55:2, 58:18, 61:16, 65:19, 89:4, 89:22, 94:3, 96:10, 117:4, 140:6, 248:7, 297:1
realtime
2:14
reason
7:13, 8:5, 24:3, 28:15, 29:4, 29:16, 29:18, 30:17, 31:10, 32:15, 34:4, 39:17, 51:15, 70:13, 72:5, 83:10, 123:12, 125:18, 128:19, 180:12, 195:2, 225:21, 232:12, 249:3, 250:17, 252:7, 258:2, 274:13, 281:12, 291:12, 298:11, 300:16, 300:20, 302:5
rebecca
4:12
recall
18:4, 31:1, 37:5, 39:22, 123:22, 125:11, 134:5, 147:19, 213:19, 214:7, 215:6, 218:12, 225:14, 246:2, 288:20
receive
244:1, 244:4
received
24:14, 24:16, 24:17
recent
44:4
recess
81:7, 147:17, 215:14, 282:19, 305:9, 313:8
recite
171:20
recited
174:21
recognize
53:18, 54:1, 160:10, 160:17, 261:19, 283:4
recombinant
183:12, 183:15, 183:21, 184:5, 184:7, 184:11, 184:15, 184:19, 185:4
record
6:11, 11:22, 146:18, 165:5, 220:12, 220:13, 282:18, 305:7, 312:8, 312:18, 314:9
recross
5:2
recruited
15:6, 15:7, 15:22, 16:2
redirect
5:2
reduction
276:13
redundant
148:17
refer
10:19, 54:7, 83:11, 85:7, 152:18, 194:20, 215:11, 218:5,

224:5, 225:18
reference
9:2, 11:8, 46:22, 47:2, 53:16, 54:1, 54:8, 54:11, 82:12, 261:17, 263:7, 275:16, 283:1, 283:5, 291:16, 291:18, 293:5, 303:22, 311:10
referenced
294:13
references
13:10, 13:12, 13:13, 120:11, 208:18, 213:9, 288:13
referred
54:2, 83:7, 85:4, 237:18, 283:10, 288:14, 288:22, 291:16, 292:10, 292:12
referring
12:2, 12:4, 20:5, 20:15, 22:1, 30:14, 48:4, 48:5, 48:16, 49:3, 49:7, 49:14, 53:12, 68:3, 81:16, 87:6, 99:7, 99:10, 99:16, 101:11, 113:17, 120:19, 124:22, 143:18, 186:3, 186:10, 186:14, 186:22, 187:9, 189:10, 190:5, 194:6, 209:9, 237:8, 237:12, 238:6, 253:11, 275:9, 283:7, 286:14, 287:10, 293:3
refers
20:7, 32:1, 100:4, 153:10, 187:13, 188:15, 189:4, 189:5, 189:19, 219:7, 234:8, 268:9, 289:6, 289:9, 289:17, 289:22, 290:9, 290:16, 290:22, 291:9, 292:21, 300:3
reflect
52:3, 312:18
reframe
304:13, 304:15, 304:17, 304:20
refresher
122:22, 125:16
refused
312:10
refusing
242:7, 242:9
regarding
276:12
regardless
33:5, 37:22, 264:18, 296:4, 298:2, 298:13, 299:3, 302:7
regards
298:14
region
100:20
registered
2:13, 314:2
regular
313:14
reinfection
154:11, 160:19
relate
8:17, 58:2, 94:8, 123:12, 156:6, 172:4, 224:17, 224:21, 274:5
related
29:8, 31:16, 60:13, 187:19, 187:20, 209:5, 209:14, 210:9, 210:12, 214:18, 314:19
relates
21:18, 41:5, 139:19, 157:18, 159:18, 174:1, 292:1
relation
277:21
relationship
207:18, 208:1, 208:18, 208:20, 209:21, 276:20
relationships
208:13, 214:20
relatively
34:21
release
163:20, 163:22, 226:8, 226:9, 227:8, 228:9, 231:7, 232:19, 234:12, 238:9, 252:4
released
163:21, 166:6, 226:6
relevant
65:19, 216:22, 217:5, 217:7, 217:17, 220:5, 220:22, 222:22, 234:15, 304:8
remember
213:12, 214:4, 225:9
reminder
12:22
reminding
240:21
remove
105:14
render
60:3
repeat
33:21, 44:15, 49:4, 82:10, 98:18, 149:2, 149:3, 157:12, 159:16, 197:9, 217:4, 235:5, 288:17, 289:20, 293:21, 297:5, 305:6, 307:22
repeated
30:14, 32:5, 77:6, 89:2, 119:11
repeating
24:3, 254:14
repertoire
21:8, 31:3
repetition
145:13
rephrase
25:18, 36:4, 37:8, 41:5, 45:9, 46:5, 48:4, 52:12, 52:17, 54:16, 55:12, 59:11, 73:1, 78:3, 78:22, 107:17, 110:16, 120:4, 124:13, 134:19, 153:1, 158:2, 174:10, 175:3, 190:22, 192:16, 194:3, 202:9, 203:7, 217:6, 219:5, 219:10, 222:19, 238:12, 243:10, 249:14, 260:10, 289:7, 290:7, 291:15, 292:11
replacement
56:9, 57:1, 57:18, 60:2, 60:10, 62:6, 63:21, 64:13, 64:15, 70:3, 73:4, 73:18, 74:10, 74:15, 89:6, 89:22,

BioNTech-Pfizer Exhibit 1152
BioNTech SE and Pfizer Inc. v. ModernaTX, Inc. IPR2023-01358
Page 357 of 375

233:15
replicase
41:22, 42:4, 48:17, 49:2, 49:6, 49:15
replicases
42:3
replicon
41:19, 279:2, 296:13, 297:1, 297:3
replicons
294:10
report
124:4, 124:5, 124:9, 153:18, 154:13, 154:18, 163:7, 214:5, 232:8, 237:16
reported
1:20
reporter
2:13, 2:14, 2:15, 7:6, 68:17, 313:11, 313:17, 314:1, 314:2
represent
6:15, 123:11
represented
314:13
request
7:8, 7:22
require
79:3, 154:6
required
87:2, 157:10, 157:15, 158:5, 265:21, 266:11, 266:14, 267:8, 267:13, 280:21, 281:18
requirement
87:9
requires
266:18
research
15:10, 16:1, 19:8, 19:12, 20:11, 21:8, 22:21, 23:16, 25:19, 26:5, 27:5, 27:22, 29:1, 29:8, 31:3, 33:1, 37:4, 37:11, 37:18, 38:7, 38:8, 44:4, 44:11, 44:16, 45:2, 45:8, 45:11, 46:5, 55:1, 55:4, 107:1, 118:17, 128:2, 128:10, 128:18, 191:9, 211:17, 222:20, 254:2, 259:17, 260:9, 260:11
researcher
33:2, 61:4, 72:3, 78:11, 79:8
researcher's
130:17
researchers
20:19
reserve
312:12, 312:13
reside
281:10
resigned
14:19
resources
229:11, 231:5, 233:20
respect
8:14, 12:4, 20:10, 52:13, 79:12, 91:13, 238:7, 288:7, 295:7, 298:21, 312:14
respectfully
101:1, 112:13, 163:6, 198:6, 229:18, 232:4, 279:14, 304:22
respond
154:1
responding
111:1, 241:6
response
98:8, 98:20, 99:4, 99:6, 99:9, 99:16, 99:22, 100:2, 100:6, 100:9, 100:13, 100:15, 101:5, 102:9, 102:15, 102:20, 103:2, 105:2, 105:8, 105:9, 105:17, 105:20, 108:7, 108:17, 109:11, 109:17, 110:3, 110:9, 110:15, 110:18, 111:3, 111:15, 112:1, 112:10, 112:17, 113:4, 113:10, 113:22, 114:8, 114:16, 114:21, 115:21, 116:8, 116:12, 116:16, 117:1, 117:10, 117:19, 118:2, 118:11, 118:19, 119:16, 120:10, 147:21, 151:14, 151:15, 152:2, 152:7, 152:11, 152:17, 153:3, 153:13, 153:14, 153:19, 154:2, 154:3, 154:4, 154:19, 155:1, 155:3, 155:5, 155:9, 156:7, 157:10, 157:15, 157:20, 158:6, 160:9, 160:13, 160:16, 179:17, 180:1, 180:3, 180:9, 180:12, 180:16, 180:21, 181:10, 181:15, 181:20, 182:1, 182:16, 189:15, 235:17
responses
154:21, 154:22
responsible
160:11, 160:18
responsive
296:18
rest
123:15, 163:13
restate
76:2
result
71:15, 72:6, 135:15, 136:15
results
21:20, 44:1, 129:16, 129:18, 129:19, 131:17, 135:16, 143:13, 261:3, 296:7, 296:19, 297:8, 297:9, 299:21, 300:17
review
13:6, 57:13, 122:15, 123:15, 123:18, 123:22, 124:3, 125:11, 143:20, 144:12, 288:6
reviewed
13:5, 54:4, 55:14, 97:1, 203:1, 218:15, 289:8, 289:21, 290:8
reviewing
288:20
reviews
250:2
revision
18:7, 18:14
ribonucleic
126:16, 170:21,

171:17, 174:5
ribozymes
134:10
rights
312:14
rmr
1:21
rna-based
38:1
rnai
133:4, 133:5
rnai-inducing
120:18
rnas
125:20, 264:11
rnase
263:21, 264:6, 264:10, 264:12, 264:14, 264:21, 265:3
rnase's
264:16
room
195:7
roughly
17:13
rsv-f
278:22
run
135:20, 144:10
running
135:22
ryan
4:4
ryanmeuth@paulhastings
4:8

S

s
162:17, 172:22, 173:1
said
9:14, 13:4, 22:11, 23:5, 25:22, 26:11, 28:2, 37:9, 37:13, 44:7, 45:5, 45:21, 46:9, 68:19, 79:17, 80:4, 97:2, 105:6, 111:17, 123:16, 125:15, 130:21, 134:17, 143:14, 153:18, 187:13, 193:21, 200:17, 203:1, 204:2, 204:16, 206:9, 214:15, 246:14, 253:13, 256:13, 273:12, 274:18, 284:8, 292:16
same
10:11, 12:8, 15:11, 34:3, 40:13, 102:16, 109:3, 119:10, 136:17, 148:12, 150:9, 157:18, 160:4, 160:19, 161:16, 164:6, 177:4, 178:5, 178:15, 179:1, 186:22, 207:5, 207:9, 207:15, 207:20, 208:4, 208:7, 208:10, 209:1, 209:2, 209:8, 209:15, 210:4, 210:15, 211:17, 211:22, 235:11, 257:3, 257:12, 266:3, 266:8, 283:9, 292:22, 294:22, 297:14, 297:20, 299:11, 301:10, 308:5, 309:12
sample
20:20, 106:17
sarna
35:20, 38:13, 40:5, 40:6, 40:16, 41:4, 41:7, 41:13, 42:1, 42:4, 42:8, 42:9, 42:13, 42:18, 121:17, 246:8, 246:9, 268:21, 269:7, 269:19, 271:2, 271:9, 273:9, 273:21, 281:6, 284:11, 290:12
sars-cov
111:4
sars-cov-2
110:18, 110:21, 111:16, 111:18, 112:1, 112:6, 112:7, 112:10, 112:16, 113:4, 113:11, 114:9, 114:16, 114:22, 175:9
saw
143:21, 144:6
say
13:12, 13:21, 15:1, 19:19, 20:10, 21:22, 24:7, 24:9, 31:11, 32:16, 36:11, 36:19, 47:7, 48:11, 51:18, 52:16, 58:3, 64:19, 69:15, 75:5, 80:13, 80:14, 82:17, 82:19, 84:11, 84:18, 87:4, 91:5, 91:10, 105:18, 106:1, 108:19, 113:15, 119:9, 128:5, 147:11, 161:22, 162:7, 173:16, 176:19, 176:21, 177:2, 184:14, 185:16, 186:13, 190:3, 193:7, 195:15, 196:17, 197:5, 201:2, 201:11, 210:3, 216:4, 219:12, 222:1, 224:19, 227:2, 230:19, 241:2, 245:5, 249:20, 256:6, 256:20, 257:5, 257:7, 257:14, 269:18, 270:17, 274:15, 276:14, 277:20
saying
7:7, 59:7, 59:17, 61:15, 62:16, 62:17, 62:19, 77:18, 79:7, 83:11, 84:19, 86:15, 105:10, 106:10, 113:12, 113:13, 113:21, 113:22, 117:11, 118:3, 140:11, 185:6, 188:2, 188:14, 189:3, 189:22, 233:8, 237:3, 241:14, 257:13, 257:21, 270:17, 277:11, 279:19, 290:18
says
6:5, 41:17, 54:13, 58:7, 67:6, 67:9, 67:16, 68:7, 73:6, 73:11, 73:21, 76:13, 81:21, 88:9, 92:4, 94:11, 98:7, 99:2, 99:8, 99:14, 100:6, 100:12, 101:3, 120:7, 126:6, 126:8, 126:11, 127:4, 140:20, 142:8, 147:12, 163:19,

164:8, 174:15, 175:15, 175:18, 176:5, 179:16, 180:9, 181:22, 182:16, 183:2, 183:8, 183:11, 183:14, 183:20, 184:4, 184:14, 185:10, 186:1, 186:19, 187:3, 187:6, 189:17, 190:7, 210:20, 211:11, 236:10, 236:12, 237:5, 237:9, 237:20, 249:22, 262:12, 262:19, 263:20, 265:21, 266:11, 283:22, 284:4, 286:11, 286:19, 287:5, 287:8, 293:16, 299:10, 300:11, 301:4, 302:18, 310:12
scan
123:7
schrum's
70:14, 143:4, 238:7
science
24:8, 37:22, 50:20, 166:9, 201:15, 214:16
scientific
31:7, 32:11, 33:17, 33:22, 36:6, 36:16, 285:3
scientist
78:10, 200:22
scientists
244:12
scope
122:7, 223:8, 260:18, 261:8, 312:21
se
1:4
sea
252:21, 253:14, 255:8
sealant
58:13, 93:17
search
208:10
searches
213:14
searching
285:16
second
58:6, 72:13, 101:19, 167:3, 189:8, 220:12, 226:11, 227:10, 294:9, 296:4, 297:18, 298:6, 298:19, 299:2, 299:10, 300:13, 302:15, 305:8
seconds
11:19, 281:3, 285:13
section
19:7, 58:5, 58:7, 74:6, 81:22, 83:9, 85:8, 87:15, 87:16, 94:2, 95:1, 95:4, 97:12, 98:7, 98:16, 100:19, 101:11, 122:9, 124:22, 161:22, 163:13, 216:5, 216:10, 216:13, 216:16, 216:19, 217:1, 217:10, 218:2, 219:2, 219:4, 219:6, 221:4, 221:5, 224:4, 226:2, 237:15, 237:18, 238:5, 239:2, 276:9, 276:14, 297:14, 310:7
sections
60:16, 97:11, 97:14, 125:18, 144:2, 221:15, 225:22
see
11:14, 17:16, 19:12, 19:17, 19:18, 35:17, 36:10, 51:20, 67:15, 71:18, 81:20, 88:2, 88:5, 88:9, 98:7, 98:10, 105:12, 117:13, 123:20, 127:19, 129:8, 132:14, 133:17, 139:11, 141:8, 144:12, 162:4, 162:6, 165:2, 174:20, 176:9, 176:11, 179:14, 179:16, 182:15, 185:9, 185:12, 188:6, 195:10, 207:18, 209:9, 210:3, 210:11, 211:2, 211:5, 212:17, 216:3, 222:9, 222:11, 222:16, 228:22, 246:1, 262:11, 262:19, 263:19, 264:7, 265:20, 266:2, 274:3, 275:1, 276:6, 283:21, 284:3, 284:18, 286:11, 286:22, 293:13, 299:4, 299:5, 300:10, 300:15, 301:4, 308:21, 310:7
seeing
36:15, 113:8, 114:19
seems
127:11, 309:20
seen
114:17, 123:4, 176:7, 243:7, 243:13, 289:5, 289:16, 290:15, 290:21, 291:4, 291:8, 292:20, 293:6
select
231:3
selected
94:15, 253:8
self-amplify
276:11
self-amplifying
34:12, 34:14, 34:18, 38:7, 38:11, 38:14, 39:1, 39:6, 39:9, 39:14, 40:2, 41:18, 41:21, 42:6, 43:1, 43:19, 44:5, 44:13, 44:18, 45:3, 45:12, 45:19, 46:7, 121:19, 246:7, 261:21, 262:2, 262:8, 262:13, 263:1, 263:8, 263:14, 264:20, 278:21, 279:4, 289:9, 289:17, 289:22, 290:9, 290:16, 290:22, 291:9, 291:17, 292:6, 292:13, 292:21, 293:6, 296:15
self-replicating
41:20, 121:19, 264:13, 284:14, 287:13, 287:15, 287:21, 288:1, 288:4, 288:7, 288:11, 288:14, 288:21, 289:3, 289:6
semantics
187:2

semiconductor
25:12, 29:11, 29:22, 31:7, 31:11, 31:12, 31:14, 32:12, 33:18, 34:1, 34:5
sense
14:20, 34:9, 38:4, 48:1, 52:9, 103:8, 234:10, 300:8, 303:16
sentence
19:18, 19:19, 82:17, 87:5, 87:14, 87:21, 88:21, 100:1, 141:10, 142:14, 148:17, 177:12, 179:16, 179:21, 180:7, 181:22, 183:14, 184:10, 184:17, 184:18, 185:9, 185:12, 185:13, 185:17, 185:20, 186:21, 187:1, 187:5, 187:11, 189:8, 189:9, 189:11, 189:14, 189:17, 216:3, 216:7, 220:1, 220:18, 236:6, 236:11, 237:13, 237:22, 264:7, 265:20, 266:10, 266:22, 267:1, 267:12, 267:17, 269:6, 269:13, 270:14, 270:20, 273:1, 273:8, 273:20, 276:3, 284:8, 287:5, 294:9, 294:10, 298:16, 299:1, 299:4, 299:5, 299:6, 299:14, 300:10, 300:15, 300:17, 301:4, 301:13, 301:18, 302:18
separate
6:17, 189:2
separately
138:16
sequence
81:4, 100:21, 133:22, 134:1, 163:14, 174:19, 278:5, 280:2, 286:8, 286:9
sera
279:5
serum
164:5, 164:7, 226:12, 227:9, 237:4, 237:12, 252:5, 278:12, 300:12, 300:22, 302:1, 302:6
serve
15:7, 16:3
serves
247:18
set
53:10, 232:17, 296:11, 298:8, 303:22, 314:6, 314:26
setting
45:1, 45:7, 45:10, 101:3, 117:14
seventeen
146:16
several
224:13
sh
132:22
sharing
281:10
shorten
151:19
shorter
251:15
shorthand
314:1
should
16:13, 19:6, 50:17, 67:8
show
262:12, 262:22, 263:13, 270:1
showed
297:20, 299:12, 301:10
shown
73:7, 73:11, 75:7, 139:13, 140:21, 141:11, 141:17, 142:2, 142:9, 147:7, 219:16, 296:22, 312:2
shows
36:22, 37:1, 263:6, 263:7
shrna
132:17, 132:20
sic
115:9, 160:12, 253:7
side
20:22, 21:14, 21:22, 22:7, 29:5, 53:11, 104:3, 106:20, 106:22, 202:22, 245:5, 247:10, 249:9
signal
47:10
signature-p1kal
314:30
significant
276:12
similar
136:18, 210:16
simple
61:22, 93:15
since
16:21, 17:3, 17:11, 17:14, 18:3, 46:15, 121:14, 123:17, 304:8
singapore
14:15
singaporean
285:18
single
73:15, 75:11, 139:16, 141:1, 141:12, 146:22, 147:2, 147:9, 147:14, 240:5, 240:12, 244:16
single-stranded
41:20
sirna
38:1, 131:21, 132:7, 132:15, 133:6, 133:11, 224:13, 224:15, 225:5, 281:22
sirna-based
132:11
sirnas
281:7
sit
61:1
site
240:19, 243:21
sitting
46:3, 51:10, 72:7, 123:13, 125:10, 167:7, 206:5, 240:11, 241:3, 242:11, 288:20
six
124:19, 264:2
sixty-two
16:12
size
30:10, 32:2, 68:16, 68:21, 72:17, 94:22, 163:2, 226:5
skim
144:20
slow
136:11

small
120:22, 124:15, 125:3, 125:12, 125:22, 131:19, 133:6
smaller
42:5
solely
145:18
solid
279:8
solution
47:11, 47:13, 47:20, 48:10, 48:11
solve
26:20
solving
26:14, 26:21
some
11:2, 12:22, 13:10, 14:19, 18:5, 28:10, 34:9, 35:14, 38:4, 46:18, 46:19, 48:1, 49:11, 49:19, 51:20, 64:11, 144:15, 144:18, 145:1, 160:20, 166:1, 174:17, 181:14, 201:16, 214:22, 215:6, 215:7, 221:10, 221:11, 234:9, 248:19, 253:20, 255:22, 258:10, 278:16, 281:13, 281:14, 300:8, 303:16, 310:11
somebody
159:21
someone
104:20, 208:17
something
31:14, 32:6, 101:4, 166:11, 178:10, 188:6, 188:19, 188:20, 190:21, 197:22, 198:4, 206:15, 208:15, 221:21, 228:2, 229:13, 230:5, 257:16, 268:9, 272:7
sometimes
138:14, 138:15, 138:18, 138:19, 178:3, 201:1, 209:10, 209:12, 214:5, 223:15, 257:17, 258:8
somewhere
66:21
sorry
16:14, 46:15, 67:7, 68:17, 68:19, 71:9, 81:1, 81:14, 94:6, 124:21, 154:14, 158:2, 160:1, 181:7, 192:3, 199:9, 211:5, 242:18, 266:5, 275:9, 285:13, 289:7, 309:11
sort
21:13, 53:9, 53:11, 91:20, 92:16, 92:22, 95:10, 107:2, 136:1, 214:17, 225:22, 240:8, 245:7, 246:3, 249:8
sounds
37:1
space
18:13, 28:19, 33:2, 159:11
speak
14:3, 81:9, 215:18
specialists
159:11
specific
16:1, 22:9, 22:16, 23:21, 37:7, 40:19, 50:10, 62:13, 65:8, 66:14, 66:15, 77:6, 82:2, 85:13, 85:17, 86:5, 86:11, 86:20, 87:19, 88:17, 108:12, 114:2, 119:5, 125:11, 125:22, 138:4, 151:8, 151:20, 152:14, 153:6, 153:10, 154:12, 155:9, 155:17, 157:2, 158:1, 158:9, 158:10, 160:14, 164:19, 166:4, 167:3, 169:9, 169:10, 170:4, 171:9, 171:14, 174:11, 174:20, 175:7, 176:21, 186:10, 187:4, 188:16, 189:10, 192:14, 201:12, 201:14, 212:3, 217:12, 241:9, 248:15, 255:6, 267:15, 269:4, 269:12, 270:7, 270:19, 271:14, 271:17, 271:20, 274:2, 274:8, 276:17, 277:15, 277:18, 278:11, 278:18, 280:1, 281:10, 285:11, 285:15, 306:13, 306:14, 307:2, 308:15, 308:16
specifically
20:17, 22:17, 23:2, 24:18, 32:21, 44:12, 44:17, 45:3, 45:11, 45:18, 46:4, 46:7, 66:11, 74:18, 77:8, 79:18, 91:1, 104:19, 109:22, 113:7, 114:11, 120:6, 121:12, 121:22, 124:22, 150:1, 150:10, 152:20, 159:20, 160:9, 160:16, 163:18, 167:5, 172:9, 193:2, 193:22, 223:19, 228:7, 253:16, 271:18, 294:1, 296:11, 308:19
specification
10:1
specifications
10:3, 253:17
specificity
40:21, 114:1, 151:8, 158:12, 169:16, 171:15, 195:1, 217:20, 268:6, 269:16, 277:21, 282:7, 307:11, 307:15
specifics
101:15, 109:14, 130:8, 138:21, 157:21, 169:7, 214:5, 254:3, 265:8, 277:3
specified
138:4
specifies
175:22
specify
12:8, 104:19, 149:22, 155:16, 162:16, 168:15, 168:19, 175:13, 175:17, 175:20,

176:2
speculate
66:13, 78:13, 78:14, 90:17, 181:1
speculation
79:3, 79:7, 136:6, 138:12, 148:5, 149:1, 149:18, 151:3, 151:18, 153:17, 157:17, 158:8, 190:13, 192:7, 192:13, 192:22, 235:4, 244:8, 255:5, 256:12, 261:8, 265:6, 265:14, 266:21, 267:22, 268:15, 281:1, 282:5, 300:8, 301:14, 307:21, 308:10, 308:11, 312:20
speculative
302:18, 308:7
speed
162:22
spend
39:3, 229:11
spent
38:2
spikevax
114:6, 114:8, 114:20, 115:3, 115:8, 193:13
sprinkles
56:16
spurred
37:19
stability
231:7, 232:1, 232:3, 232:7, 232:19, 236:14, 236:18, 236:22, 237:7, 237:9, 238:10, 252:4
stable
226:12, 227:9, 228:9, 237:11
stage
15:21
standard
95:14
standing
313:11
stands
132:19, 132:22
start
15:18, 33:8, 35:3, 35:7, 35:22, 41:3, 46:21, 58:22, 78:13, 91:17, 97:18, 154:1, 161:22, 208:20, 215:10, 234:2, 241:16
started
34:14, 36:15, 37:13, 37:14, 37:17, 304:6, 311:21
starting
16:17, 28:6, 34:21, 69:11, 69:12, 98:6, 125:1, 125:2, 139:1, 215:4, 241:21, 293:14, 308:22
starts
58:17, 94:1, 96:19, 96:20, 122:5, 122:8, 236:5, 295:18
state
1:19, 2:11, 3:16, 6:10, 19:13, 155:12, 162:17, 220:8, 230:17, 251:15, 314:16
stated
24:10, 86:8, 146:2, 155:21, 162:9, 167:11, 196:11, 202:14, 226:8, 227:7, 250:4, 252:2, 263:13, 284:12, 294:10, 302:13
statement
20:7, 89:19, 131:2, 131:10, 148:15, 148:18, 149:5, 155:13, 155:14, 168:8, 196:2, 254:19, 255:13, 255:21, 257:19, 267:3, 267:7, 271:5, 271:8, 271:16, 273:13, 273:17, 297:22, 298:3, 298:11, 302:5
statements
303:15
states
1:1, 75:7, 76:3, 85:15, 92:1, 139:12, 141:4, 141:10, 142:1, 162:3, 170:19, 180:3, 180:15, 185:20, 189:14, 219:16, 220:18, 236:16, 273:20, 277:7, 284:8, 286:18, 301:14
stating
86:1, 86:8, 86:17, 86:18, 302:10
stem
38:3, 38:4
step
163:1
steps
214:7
still
20:14, 179:6, 195:4, 195:9, 205:12, 235:21, 244:14, 251:3, 251:6, 306:9
stimulating
250:15
stop
270:4
storage
226:18, 227:12, 232:20
store
233:1
straddling
14:21
straightforward
106:14, 198:11
strain
174:20
stranded
284:13
strategy
221:14, 221:17
street
1:19, 2:11, 3:16, 314:16
string
173:3, 173:7
structurally
40:12
structure
48:9, 221:12, 309:10, 310:16, 311:3, 312:1
structured
221:4, 221:10
structures
30:6, 191:10, 310:10, 311:21, 312:3, 312:5
student
304:8
students
26:15, 65:18, 182:12, 188:4, 200:10
studied
21:4
studies
19:20, 67:16,

129:1, 139:6, 142:3, 142:12, 143:16, 143:22, 250:3, 278:19
study 21:18, 22:4, 75:6, 76:8, 130:7, 132:14, 136:21, 139:10, 139:19, 139:22, 140:4, 163:20, 196:12, 293:13, 293:17, 293:18, 294:1, 294:4, 295:8, 296:17, 297:21, 299:13, 301:12
studying 22:12, 22:14, 24:12, 26:6
stuff 11:3, 84:6, 90:17, 96:1, 96:2, 96:5, 96:7, 97:2, 97:7, 144:20, 195:9, 215:2, 304:7
subcategories 168:5, 168:9, 168:10
subcutaneous 73:10
subcutaneously 73:15, 139:15, 147:9
subgenomic 42:5
subheading 98:20
subject 209:14
subjects 142:22
submitted 8:9, 11:4, 11:17, 16:20, 17:4, 17:14, 17:17, 17:19, 17:21, 18:5, 18:6, 18:15, 18:19
subscribe 35:18
subscribes 35:19
subsequent 56:2
subsequently 269:19, 271:3, 271:9
substance 81:10
substantially 262:14, 263:2, 263:3, 263:9, 263:15
substantive 17:3
subtype 289:17, 289:22, 290:2, 290:6
subunit 88:7, 88:11, 88:15, 88:18, 89:13, 89:17, 171:1, 171:8, 171:19, 172:2, 172:12, 172:20, 173:1, 173:9, 174:7, 175:16, 175:19
succeed 128:4, 129:4, 129:13, 130:1, 130:15, 131:1
successful 130:9, 135:14, 135:15, 219:18
successfully 137:19, 224:13, 225:4
sufficient 79:13, 165:8, 277:12
suffix 161:9
sugars 93:15
suggests 293:4, 298:3
suitable 227:19, 228:16, 229:6, 229:21, 230:5, 231:11, 231:18, 232:10, 234:5, 234:17, 309:16, 310:3, 311:17
summaries 91:16
summarized 247:3, 250:2
summary 91:16, 91:22, 92:1, 94:6
sunday 14:1, 14:2
super 36:11
suppose 191:20
supposed 152:20
sure 10:4, 11:20, 12:16, 27:3, 29:8, 29:21, 31:5, 37:8, 38:19, 39:20, 40:6, 44:16, 49:5, 49:13, 52:17, 71:9, 81:2, 82:11, 82:19, 96:22, 98:19, 128:6, 128:13, 140:13, 143:3, 148:8, 164:12, 179:20, 190:16, 192:9, 194:8, 194:13, 194:15, 209:13, 217:5, 217:15, 219:11, 220:10, 235:7, 243:12, 251:17, 260:2, 286:17, 288:19, 297:6, 302:3, 309:11, 313:7
surface 25:15, 191:11, 193:11, 310:19, 311:5
surratio 80:18
sustained 226:9, 228:9, 231:6, 232:18, 238:9, 252:4
sustained-release 60:10, 227:8
sw 3:6
sworn 6:3, 314:6
synchronizing 219:17
synthesis 162:20
synthesize 19:14, 42:11, 135:9, 205:11
synthesized 39:5, 40:1, 42:9, 50:21, 51:3, 52:12, 70:12, 135:3, 135:4, 135:5, 135:6, 219:13
synthesizes 39:8, 51:1
synthetic 135:11
syringe 68:9
system 17:12, 22:6, 26:7, 27:7, 32:20, 48:8, 53:4, 56:22, 60:1, 61:2, 62:5, 62:7, 62:8, 62:9,

63:20, 84:2, 84:22, 90:2, 97:10, 97:21, 97:22, 101:18, 103:19, 103:20, 103:21, 105:5, 105:11, 105:12, 105:13, 109:8, 111:19, 112:8, 130:5, 137:3, 137:15, 137:18, 137:20, 138:6, 138:9, 154:1, 154:5, 154:6, 158:19, 161:13, 161:16, 166:3, 166:7, 166:14, 188:19, 195:4, 197:22, 221:8, 224:2, 224:12, 225:6, 225:11, 227:3, 227:5, 227:15, 228:7, 231:11, 231:18, 232:10, 232:13, 234:5, 234:16, 235:2, 235:9, 238:18, 240:9, 247:4, 247:17, 248:17, 248:21, 250:18, 252:3, 252:4, 254:1, 254:6, 272:21, 296:16, 296:22, 297:1, 298:19
systems
19:16, 21:17, 24:11, 32:18, 34:6, 40:14, 42:16, 51:2, 53:6, 53:7, 58:19, 64:10, 83:16, 94:2, 94:4, 106:14, 136:15, 136:22, 191:19, 218:11, 224:15, 225:3, 225:4, 225:17, 238:17, 245:18, 246:7, 249:8, 251:4, 252:6, 253:15

T

table
68:13, 68:20, 71:2, 73:7, 73:8, 73:12, 75:8, 139:13, 140:21, 141:11, 141:18, 142:2, 142:9, 146:4, 147:8
tailing
126:19
tailored
22:18
take
67:2, 68:2, 69:10, 69:18, 72:20, 76:19, 81:6, 91:16, 98:3, 106:17, 119:22, 121:7, 122:2, 122:21, 123:19, 127:12, 147:15, 220:15, 274:10, 278:16, 282:17, 308:17, 309:4, 309:9, 313:15
taken
81:7, 147:17, 215:14, 282:19, 305:9, 313:8, 314:8
takes
160:14
taking
7:6
talk
33:3, 60:22, 109:22, 119:20, 120:22, 196:1, 218:22, 277:6
talked
283:15
talking
26:9, 120:14, 122:4, 125:8, 128:12, 216:7, 238:5, 275:15
talks
26:19, 27:15, 77:15, 80:21, 126:17, 126:19
target
231:20, 243:21, 256:2, 256:3
targeted
240:19
teach
16:4, 82:7, 88:5, 88:10, 88:14, 89:12, 89:16, 182:12, 188:4
teaches
236:20
technical
217:16
technological
14:14
technologies
22:13, 28:20, 221:7, 223:6, 223:8, 223:11, 223:12, 223:17, 229:17, 233:22, 239:3, 241:11, 241:13, 246:4, 253:22
technology
55:7, 116:20, 116:22, 159:9, 216:5, 216:9, 216:12, 216:15, 216:19, 216:22, 217:1, 217:6, 217:7, 217:9, 217:13, 217:21, 222:8, 222:17, 222:18, 223:16, 223:19, 228:4, 229:12, 229:16, 232:22, 234:11, 240:1, 240:2, 240:17, 240:18, 245:7, 252:12, 288:12
telephone
3:5
tell
7:5, 43:3, 43:10, 61:10, 62:20, 64:20, 65:17, 78:16, 79:5, 80:19, 101:6, 102:2, 106:12, 107:15, 107:18, 107:20, 110:10, 112:19, 113:21, 119:2, 125:5, 168:16, 168:20, 169:12, 182:12, 192:16, 200:9, 207:12, 229:9, 241:20, 245:9, 270:6, 277:1, 278:4, 290:19, 291:5, 306:16
telling
56:13, 57:4, 59:22, 90:15, 90:20, 102:11, 102:17, 103:5, 104:7, 112:5, 173:20, 198:21
tells
59:19, 70:8, 95:17
ten
276:2
tend
136:14
tenured
16:6, 16:8
term
30:12, 31:12, 31:20, 32:4, 41:7, 41:10, 52:14, 52:22,

84:7, 84:21, 90:6, 90:8, 91:9, 95:11, 140:3, 150:11, 150:14, 151:6, 157:20, 170:8, 176:7, 176:10, 177:14, 177:16, 178:1, 178:6, 188:17, 194:4, 197:11, 197:20, 199:21, 202:3, 205:3, 205:14, 206:22, 210:6, 247:14, 248:10, 260:6, 267:3, 272:11, 283:14, 285:4
terminologies
85:4, 150:2, 207:2, 248:6, 283:17
terminology
31:21, 103:4, 149:21, 152:19, 153:5, 161:8, 170:4, 177:22, 179:4, 283:16, 291:20, 302:22
terms
10:12, 44:9, 80:7, 84:8, 84:11, 86:1, 91:19, 95:19, 96:14, 102:12, 108:3, 119:5, 136:16, 137:12, 144:4, 153:6, 169:2, 178:9, 178:12, 188:13, 188:21, 196:7, 198:1, 206:11, 208:22, 217:12, 223:22, 226:18, 228:2, 232:17, 234:21, 235:18, 239:2, 241:11, 244:13, 245:12, 253:6, 255:15, 255:16, 256:1, 267:2, 269:16, 275:8, 280:1, 280:14, 285:19, 295:4, 296:16, 298:7
tertiary
258:13, 258:14, 259:4
test
72:4, 107:22, 136:19, 137:4, 294:5
tested
137:19, 137:21, 138:7, 138:9, 142:19, 239:10, 294:6, 295:8, 295:11
testified
7:2, 228:12, 273:16
testify
8:6, 12:11, 12:12
testimony
29:22, 32:8, 59:2, 62:11, 81:10, 107:7, 182:10, 213:2, 215:19, 273:15, 290:14, 314:9
testing
137:2, 137:10, 143:2, 143:12, 253:6, 259:19, 260:15, 261:5
text
10:5, 10:8, 262:11
thank
9:3, 215:17, 253:13
theme
29:12, 29:15, 75:17, 76:13, 77:14, 89:7, 91:4, 91:9, 91:11
themes
84:1, 210:13, 210:15
themselves
190:21
therapeutic
250:8
therapeutics
54:13, 54:15, 250:3
therapy
56:9, 60:2, 60:10, 62:6, 63:21, 64:13, 64:15, 70:3, 73:4, 73:18, 74:10, 74:15, 89:7, 89:22, 233:15
therefore
88:10, 89:16, 292:3, 299:16, 301:14
thereof
58:15, 93:19, 134:12
thesis
28:17, 29:9, 29:11, 29:17, 33:6, 64:21
thing
25:1, 32:17, 63:1, 109:3, 119:11, 136:17, 154:10, 167:3, 176:14, 176:21, 177:4, 178:5, 188:16, 208:11, 211:17, 237:2, 247:3, 256:19, 280:13, 296:21
things
19:1, 27:21, 28:6, 29:5, 32:5, 33:4, 39:19, 50:20, 56:16, 56:18, 65:13, 65:18, 85:9, 91:2, 93:2, 96:10, 101:20, 104:18, 108:11, 108:12, 109:7, 111:9, 119:2, 119:3, 119:4, 132:9, 135:11, 138:21, 140:6, 145:2, 145:18, 155:20, 160:6, 167:22, 170:3, 170:5, 176:9, 176:12, 176:16, 176:18, 188:7, 195:5, 195:8, 200:15, 201:14, 207:13, 210:1, 213:14, 213:22, 214:4, 214:16, 214:20, 215:9, 215:11, 232:18, 244:12, 244:13, 248:7, 249:10, 254:14, 301:20
think
10:11, 31:5, 39:7, 55:13, 109:9, 109:19, 145:8, 145:16, 150:16, 157:8, 165:4, 169:13, 177:3, 195:6, 198:13, 209:20, 216:19, 224:8, 228:20, 238:1, 246:2, 254:5, 254:10, 257:4, 261:1, 278:16, 312:18, 313:1, 313:4
thinking
156:16, 242:16, 253:4, 303:17, 303:18
third
128:14, 183:14,

227:10, 300:14, 301:5, 301:6, 302:7
thirteen
123:3
thought
37:16
thousands
247:5, 251:5, 254:8
three
17:16, 18:2, 18:12, 79:17, 142:18, 142:21, 168:2, 228:7, 254:14, 256:15, 256:17, 300:22, 301:2
three-day
313:17
threshold
272:13, 272:21
thrombin
58:13, 93:17
through
11:20, 12:21, 13:8, 13:10, 30:13, 34:11, 36:10, 36:13, 36:20, 36:22, 37:14, 37:15, 55:16, 55:21, 55:22, 58:5, 58:19, 58:22, 61:16, 79:12, 83:21, 89:8, 90:19, 91:7, 93:22, 94:1, 96:14, 121:10, 121:13, 123:1, 123:17, 123:18, 123:19, 124:10, 125:9, 125:15, 126:21, 126:22, 133:3, 142:11, 142:16, 143:9, 143:15, 144:1, 144:7, 144:10, 145:9, 146:2, 146:11, 146:13, 146:16, 146:17, 146:18, 159:7, 174:17, 202:15, 208:12, 214:1, 218:12, 238:8, 256:14, 276:2, 276:5, 293:16, 309:11
throughout
10:18, 53:12, 54:8, 107:13, 312:8
time
16:20, 27:15, 28:6, 29:18, 30:5, 30:13, 30:19, 32:2, 34:6, 34:16, 35:22, 37:4, 37:10, 38:2, 38:3, 39:3, 56:1, 62:2, 63:22, 65:18, 79:8, 95:21, 121:8, 123:19, 128:14, 131:22, 133:4, 133:16, 135:3, 140:13, 143:14, 144:7, 146:3, 160:14, 164:7, 166:9, 188:4, 188:17, 213:21, 226:7, 227:3, 228:2, 228:6, 228:20, 230:6, 230:11, 231:4, 231:13, 233:20, 239:22, 240:16, 241:8, 243:20, 244:9, 245:15, 248:2, 248:5, 248:14, 248:16, 249:7, 251:2, 252:9, 253:5, 254:17, 256:17, 258:1, 278:16, 281:9, 281:13, 281:21, 282:13, 285:18
time-course
75:6
timeline
80:21
times
32:18, 56:2, 76:9, 77:7, 89:2, 90:9, 107:13, 108:2, 111:7, 116:18, 119:10, 127:2, 147:22, 148:16, 153:10, 209:1, 228:13, 256:14
tired
285:17
tissue
93:7, 93:8
titer
278:12, 279:9, 302:1
titers
279:6, 279:8, 279:10, 296:3, 299:2, 300:12, 300:22, 302:7
title
19:6, 67:21, 68:6, 98:15, 126:6, 139:8, 141:8, 162:2, 162:17, 284:3
titled
11:12, 12:1, 139:5, 261:20, 262:1
today
7:7, 8:6, 12:11, 12:17, 12:20, 13:19, 14:5, 46:4, 51:11, 55:15, 59:2, 72:7, 115:7, 115:11, 116:6, 123:13, 125:10, 167:7, 168:16, 206:5, 206:6, 215:20, 240:11, 241:3, 242:12, 249:12, 249:16, 288:20, 290:15, 312:7
together
86:17, 173:4, 173:7, 214:16, 278:5
told
95:15, 207:14
ton
64:12
took
144:9, 225:22
top
67:15, 210:7, 216:21, 283:22, 286:18
topic
27:10, 35:8, 36:2, 38:5, 38:9, 58:1, 117:21, 130:7, 142:14, 207:18, 209:1, 220:1, 220:18
topics
61:5, 84:10, 210:13, 210:15
toronto
14:9, 14:11, 14:18, 14:20, 15:5, 15:12, 15:14, 15:15, 16:7, 16:9, 38:20, 53:8
total
68:10, 70:19, 71:22, 76:4
towards
45:3, 45:12, 45:18, 46:7, 74:9, 145:5, 145:21
trademark
1:1, 6:19, 8:10

train
17:9
traits
252:6
transcript
7:6
transcription
126:11
transcripts
42:2
transfection
250:5
transition
14:21
transitioning
14:17
translatable
100:20
translate
135:15
translated
150:20, 284:5,
286:1, 286:12
translates
41:21, 285:8
translation
245:12
transmission
18:8
transport
21:5, 24:13,
158:19, 159:19,
196:12, 226:17,
226:19, 227:13,
228:10, 231:8,
232:19, 232:20,
233:2
transporting
18:17
trial
1:2, 7:2,
23:11, 23:12,
259:20, 260:3,
260:5, 260:16,
261:6
trials
206:10, 259:11
tries
105:1
trigger
284:4, 287:4
triple
134:10
true
118:3, 198:10,
254:18, 270:14,
293:5, 314:9
truthfully
8:6, 199:19
try
21:18, 63:22,
110:16, 113:15,
114:5, 120:4,
128:13, 148:18,
150:4, 151:21,
204:11, 241:15,
256:19, 280:7,
292:5, 305:21
trying
58:3, 61:10,
62:20, 64:20,
78:16, 79:5,
80:13, 80:19,
82:16, 87:4,
91:4, 91:10,
95:19, 100:18,
101:6, 101:8,
102:2, 103:3,
104:17, 105:7,
106:12, 107:20,
110:10, 112:19,
113:21, 119:2,
119:9, 135:19,
153:6, 155:18,
163:12, 164:21,
169:12, 185:6,
198:15, 199:5,
201:11, 204:5,
206:17, 217:20,
220:22, 222:1,
222:7, 222:22,
228:18, 228:20,
229:9, 235:20,
241:20, 245:4,
245:9, 245:14,
246:14, 257:14,
265:17, 270:6,
277:1, 278:4,
279:21, 282:9,
290:19, 306:21,
306:22
tuesday
1:17, 314:17
tumor
18:13, 18:18,
250:3, 250:14
turn
16:10, 67:3,
67:11, 81:13,
81:17, 179:9,
210:2, 215:22,
236:2, 237:14,
244:2, 259:6,
263:18, 273:4,
283:18, 293:10
tv
36:22, 37:1
twenty-two
127:14
two
6:17, 8:9,
8:20, 9:5, 9:19,
10:1, 10:15,
11:4, 11:10,
11:17, 11:19,
14:1, 15:15,
17:8, 31:21,
61:12, 84:1,
84:10, 121:15,
148:16, 154:20,
154:22, 164:5,
178:14, 178:22,
184:1, 184:11,
184:19, 189:2,
199:7, 203:16,
204:6, 207:5,
207:9, 208:21,
209:6, 209:7,
209:14, 210:14,
212:12, 212:17,
213:3, 213:10,
219:14, 258:7,
278:2, 281:3,
285:13, 289:13,
289:14, 290:12,
290:19, 291:2,
291:6, 291:11,
291:12, 292:9,
292:19, 293:4
two-sentence
71:19
tx
1:7
type
20:4, 30:1,
31:8, 32:13,
33:19, 34:1,
35:20, 40:7,
40:16, 94:12,
121:11, 123:5,
127:19, 132:21,
174:11, 175:9,
247:22, 251:8,
265:16, 285:10,
285:20, 286:1,
286:4, 287:14,
287:18, 287:19,
288:15, 288:22,
289:9, 290:3,
290:9, 290:16,
290:22, 291:9,
291:17, 292:7,
292:13, 292:22
types
26:2, 28:3,
30:21, 51:7,
51:22, 52:19,
84:2, 93:3,
121:15, 121:21,
123:20, 125:20,
127:17, 134:14,
175:4, 194:12,
218:10, 239:2,
245:18, 258:7,
289:14, 291:2,
291:6, 292:19,
293:4, 309:21
typically
159:10, 258:13,
294:15
typo
94:20

U

unable
106:8, 113:2,

113:9, 115:19, 116:5, 117:8, 118:1, 119:14, 149:11, 151:10, 155:12, 158:3, 167:15, 235:14, 270:13, 291:3, 306:10, 307:12
uncertainties
303:7, 303:13
uncertainty
300:18, 301:21, 303:1
unclear
7:13, 184:4, 312:19
under
16:13, 19:6, 19:12, 32:8, 62:11, 98:19, 168:5, 168:6, 168:10, 213:2, 240:22, 248:11, 262:11, 305:12
undergrad
24:16
understanding
29:22, 41:4, 54:21, 54:22, 55:3, 63:6, 71:7, 82:6, 82:11, 87:8, 172:15, 187:15, 289:13
understood
7:18, 15:1, 45:7, 71:9, 128:3, 129:3, 129:12, 129:22, 130:4, 130:14, 130:22, 157:9, 157:14, 158:4, 169:21, 170:7
undertake
199:18
unformulated
262:16, 263:5, 263:10, 263:17
unique
154:10
united
1:1
units
30:15, 32:5
univalent
304:12, 306:2, 307:7
university
14:9, 14:11, 14:14, 14:17, 14:20, 15:4, 15:11, 15:14, 15:15, 16:6, 16:8, 24:17, 38:20
unless
12:8, 32:21, 66:14, 103:10, 104:19, 149:22, 155:7, 155:15, 155:17, 167:4, 167:12
until
14:10, 14:21, 55:2
updates
17:2, 17:3
use
21:21, 23:18, 24:5, 46:1, 46:10, 48:13, 51:20, 73:3, 78:7, 84:21, 85:3, 96:18, 99:5, 99:15, 104:8, 122:20, 124:1, 125:3, 125:12, 127:1, 138:1, 146:14, 146:19, 162:8, 162:14, 165:13, 165:17, 166:10, 166:14, 178:2, 178:4, 179:22, 180:7, 181:19, 185:11, 185:14, 185:18, 185:21, 186:5, 188:13, 188:17, 189:18, 191:8, 191:13, 194:4, 195:16, 196:5, 196:14, 197:3, 208:5, 210:6, 218:22, 219:21, 220:3, 220:16, 220:20, 224:17, 224:22, 227:19, 228:16, 229:6, 229:21, 230:13, 230:21, 234:5, 238:13, 238:20, 242:22, 243:22, 245:1, 254:4, 260:21, 261:1, 272:11, 309:17, 310:3, 311:17
useful
92:13, 100:21, 143:10, 192:5, 233:2, 233:14, 274:22
uses
67:20, 68:5, 124:15, 126:15, 141:3, 191:6, 191:11, 193:18, 195:11, 239:5, 239:18, 240:12, 241:5, 241:17, 242:13, 300:19
using
18:8, 52:14, 61:14, 68:8, 69:14, 70:1, 72:10, 74:3, 74:4, 75:16, 76:11, 76:17, 119:4, 126:15, 139:10, 139:19, 140:19, 143:2, 143:13, 143:16, 152:19, 157:20, 162:18, 179:4, 181:10, 186:9, 205:17, 206:14, 208:6, 218:16, 221:18, 230:4, 244:5, 244:20, 279:2, 290:6, 294:1, 296:12, 296:15
usual
142:3
usually
31:16, 91:19, 208:9, 214:2, 215:9, 259:4
utility
191:18, 275:8

V

vaccinated
278:22, 295:22, 296:2, 298:2, 298:13, 299:1
vaccination
131:19, 132:4, 133:13, 134:3, 296:4, 299:3, 300:13, 302:7
vaccinations
299:19, 301:17, 302:21
vaccine's
155:5
vaccines
19:3, 21:21, 23:7, 79:13, 81:22, 83:10, 85:11, 87:17, 98:8, 98:14, 98:21, 113:10, 113:16, 113:17, 115:12, 115:20, 118:1, 119:8, 128:3, 129:1, 129:4, 130:14, 131:1, 132:11, 134:16, 147:21, 152:1, 152:6, 152:10, 158:15,

159:4, 159:13, 160:3, 161:3, 161:12, 161:15, 166:19, 166:20, 167:8, 167:9, 195:16, 196:4, 202:20, 219:22, 220:2, 220:4, 220:17, 220:19, 220:21, 222:4, 222:20, 223:13, 223:20, 238:13, 238:20, 239:11, 245:3, 250:4, 250:13, 259:10, 261:21, 262:2, 297:16, 297:17, 298:4, 300:11, 301:1, 301:3
vague
151:3, 153:17, 161:1, 161:2, 166:21, 167:10, 168:15, 312:19
validity
217:8, 217:17
value
272:21, 279:11
variability
118:14
variable
299:20, 299:22, 312:4
variance
160:20
variations
307:16, 308:1
variety
27:17
various
118:15
vascular
250:8
vector
72:16, 162:18, 164:4
vectors
134:11, 219:13, 219:17
vehicle
165:9, 165:18, 233:7
vehicles
52:19, 218:1
verify
9:6, 11:16, 16:16
version
133:10
versus
188:7, 201:3, 300:1, 303:20
vessel
18:17
vessels
18:10
via
3:5
view
55:12, 55:17, 56:19, 247:19, 258:16
viral
41:22, 161:3, 161:10, 219:17, 279:1
virus
41:20, 112:17, 114:9, 114:16, 114:22, 161:10, 175:9
vitro
126:11, 135:14, 135:20, 136:3, 136:13, 137:21, 138:7, 138:10, 138:14, 144:3
vivo
67:16, 135:15, 135:20, 136:4, 136:17, 138:7, 138:15, 139:6, 139:9, 139:19, 139:22, 140:2, 143:2, 143:12, 143:16, 143:21, 144:2, 144:4, 219:19, 283:22, 286:20, 287:2, 287:8, 293:18, 294:1
volume
162:22

W

wait
263:3, 263:22, 266:7
want
11:19, 16:10, 19:5, 25:5, 29:21, 32:15, 56:3, 84:20, 96:10, 96:18, 96:22, 105:13, 106:19, 119:22, 121:3, 122:22, 127:8, 143:3, 153:20, 157:3, 162:16, 164:12, 169:9, 188:9, 198:20, 199:14, 201:8, 204:3, 222:16, 225:18, 227:4, 228:14, 232:15, 237:14, 241:8, 241:12, 249:20, 254:4, 265:11, 285:19, 295:16, 296:10, 304:15, 305:2, 308:14, 310:9, 312:8, 313:13
warren
1:16, 2:10, 5:3, 6:2, 6:12, 11:13, 314:5, 314:15
washington
3:7
waste
230:10
watch
37:2
watching
36:22
water
162:22, 204:22, 205:5, 205:13, 205:18, 205:19, 206:2
way
11:3, 25:5, 33:14, 40:20, 47:9, 47:16, 48:9, 49:9, 82:18, 83:17, 85:7, 91:19, 94:4, 105:18, 106:1, 111:17, 114:5, 119:3, 136:8, 138:2, 149:21, 156:16, 156:22, 161:13, 161:16, 169:13, 176:20, 177:9, 186:4, 187:21, 190:15, 192:8, 195:6, 197:9, 200:22, 201:6, 205:20, 214:8, 215:8, 220:9, 221:9, 223:3, 224:19, 227:22, 230:18, 230:20, 232:12, 240:16, 241:6, 258:8, 266:2, 268:2, 271:7, 280:3, 287:12, 305:19, 306:6, 307:11, 309:6, 314:23
ways
47:14, 49:19, 82:10, 185:4, 199:7, 217:4, 257:4, 268:4
we'll
140:13, 313:15
we're
7:7, 20:21, 22:11, 53:11,

68:3, 111:9, 120:14, 230:1, 238:1, 238:16
we've
21:6, 39:11, 52:9, 53:1, 55:13, 76:19, 256:14, 276:1, 276:8, 278:2
weight
72:10
welcome
81:9, 215:16, 282:16
wenli
3:15, 3:20
went
12:21, 13:8, 13:9, 29:18, 136:20, 144:1
whatever
22:22, 68:12, 72:2, 75:12, 76:6, 90:13, 90:14, 94:16, 94:22, 141:2, 210:21
whenever
62:20, 135:18, 166:9, 232:13, 257:15
whereas
189:11
whereof
314:26
whether
37:22, 53:5, 62:13, 104:2, 104:11, 106:18, 106:21, 109:10, 109:16, 111:2, 111:14, 111:22, 112:16, 113:3, 113:9, 114:20, 115:8, 115:12, 115:20, 116:6, 117:9, 117:18, 118:1, 118:18, 119:7, 119:14, 130:6, 130:7, 145:12, 147:21, 155:12, 158:4, 178:22, 188:10, 206:16, 207:4, 207:9, 209:7, 229:4, 229:10, 230:5, 231:10, 231:17, 232:9, 234:4, 234:16, 255:13, 255:21, 264:19, 270:14, 271:16, 273:1, 274:21, 276:12, 291:4, 296:19, 307:5
white
257:18
whole
35:8, 65:5, 95:4, 148:11, 148:21, 149:16, 150:8, 151:1
wide
154:7
williams
3:3
wilmerhale
1:18, 2:11, 3:13, 13:2, 14:4, 16:20, 214:19, 314:16
wilmerhale's
313:12
window
281:9
winners
233:9, 252:12
within
2:15, 18:13, 25:4, 25:13, 26:1, 26:20, 29:15, 30:10, 30:15, 41:12, 57:11, 62:9, 78:18, 83:18, 87:17, 94:12, 118:14, 130:4, 154:5, 168:2, 218:19, 239:1, 248:20, 249:9, 252:6, 262:14, 263:2, 263:15, 291:5, 299:21, 310:18, 311:5, 314:3
without
59:17, 113:8, 114:19, 119:13, 196:5, 198:12, 201:10, 201:22, 202:3, 202:8, 202:11, 203:12, 203:21, 204:14, 204:19, 205:4, 205:15, 205:22, 206:7, 256:5, 257:20, 270:13
witness
5:2, 9:3, 192:1, 198:8, 198:20, 270:4, 283:2, 312:9, 314:5, 314:10, 314:26
witness's
312:15, 312:17
word
50:17, 68:5, 70:8, 91:5, 98:15, 107:12, 172:21, 180:22, 186:18, 187:15, 196:22, 197:2, 197:15, 290:6, 300:19, 302:14
worded
305:18
words
67:20, 164:15, 168:2, 172:14, 172:22, 173:3, 181:15, 182:6, 182:7, 182:11, 182:13
work
15:13, 17:9, 21:12, 21:13, 24:5, 25:13, 25:22, 26:1, 28:13, 28:22, 29:6, 29:16, 30:17, 30:18, 31:17, 33:15, 34:12, 38:4, 39:4, 40:14, 45:21, 51:22, 52:3, 107:2, 117:15, 136:4, 151:7, 153:8, 158:15, 158:21, 159:17, 206:18, 229:11, 229:13, 241:22, 243:22, 244:6, 244:13, 259:13
worked
25:13, 26:3, 27:13, 28:17, 33:12, 38:14, 44:22, 53:5, 214:15, 304:7
working
28:18, 32:22, 33:7, 82:1, 82:8, 82:14, 82:20, 83:1, 83:5, 85:12, 85:16, 86:4, 86:19, 86:22, 87:2, 87:11, 87:18, 107:4, 162:5, 162:7, 162:13, 218:13, 218:16, 243:17, 304:4, 304:6
works
49:18, 51:7, 51:18, 104:2, 104:3, 104:11, 106:21, 136:3, 156:4, 159:2, 196:10, 232:22

worth
259:19, 261:5
worthwhile
260:15
wouldn't
200:19, 207:16, 207:19
wrap
313:6
write
64:21, 64:22, 65:17, 65:18, 81:2, 96:8, 96:9, 200:10, 214:5, 214:13, 221:19, 269:6, 269:14
writes
70:17, 85:6
writing
70:7, 90:22, 91:19
written
57:8, 57:14, 66:16, 72:9, 73:5, 77:22, 78:1, 78:17, 79:9, 79:11, 79:22, 80:5, 80:7, 80:14, 80:16, 87:17, 90:14, 90:18, 91:3, 91:5, 91:6, 99:18, 101:10, 139:12, 161:14, 173:11, 173:17, 181:13, 181:14, 182:20, 187:21, 221:22, 237:9
wrote
82:22, 83:10, 88:21, 89:15, 281:2

X

xun
3:4

Y

yang
131:15
yeah
11:1, 14:16, 15:6, 17:21, 26:11, 29:4, 36:19, 46:13, 52:22, 67:10, 76:21, 95:13, 112:5, 122:8, 123:16, 124:5, 124:17, 124:20, 125:7, 127:18, 132:21, 135:2, 137:13, 140:5, 141:9, 141:17, 144:15, 148:6, 152:4, 153:18, 157:18, 162:6, 181:4, 182:11, 212:8, 213:19, 222:6, 225:18, 229:9, 235:5, 236:10, 238:8, 246:21, 261:9, 265:15, 266:22, 273:19, 285:17, 287:5, 301:6, 304:6, 308:6, 309:7
years
21:6, 53:8, 128:2, 128:10, 128:17
yep
246:18
york
4:6
yourself
36:15, 37:11, 38:6, 71:4, 71:10, 213:3, 273:8, 287:20, 288:3
yup
17:1, 38:21, 127:21, 179:8, 243:6, 284:21

Z

zero
279:1
zeta
68:21, 72:19

.

.005
141:14
.01
201:3
.05
73:16, 139:16, 141:13, 147:3, 147:10
.1
280:16
.10
94:21
.5000
3:8
.6000
3:18, 4:7

0

01358
1:10
01359
1:11
02109
1:19, 3:17
0266640
53:20, 53:21
03
313:20, 314:18

1

1
68:10, 70:18, 71:22, 76:4
1.5
70:11
10
70:10, 94:21, 144:9, 147:15, 294:19
10,702,600
1:12, 8:18, 9:7, 9:10
10,933,127
1:13, 8:18, 9:15, 9:16
10,993,127
9:13
100
30:6, 310:13, 311:22
1000
69:11, 139:1
1001
5:7, 8:22, 9:1, 9:6, 9:12, 308:18
1002
69:12
1004
141:8
1005
141:10
1009
5:9, 53:14, 53:15, 53:19
101
52:4
1010
5:11, 282:21, 282:22
10166
4:6
103
311:22
104
311:22
105
311:22
109
308:19, 308:20, 308:21, 308:22, 309:3, 312:2
11
5:8
112
164:8

114
161:18, 161:20, 161:21
119
162:4, 162:5, 162:6, 162:10
12
67:6, 125:9, 144:5, 174:16, 283:18
120
126:10, 162:17
121
163:19
122
52:5, 164:8
127
10:10, 10:22, 11:18, 13:9, 125:7, 125:8, 217:8, 217:18
13
1:17, 2:6, 211:12, 283:20, 283:21, 286:17, 314:18
130
210:2, 210:3, 210:7, 212:11, 212:15, 215:5
1319
143:19, 144:5
1320
144:5
134
67:5, 67:6, 67:7, 67:9
135
67:3, 67:4
139
139:3, 139:4
14
211:12, 287:2
14605
263:18
15
144:9, 162:17, 162:19, 163:3, 163:19, 164:2, 164:9, 166:4
16
67:2, 67:18, 67:22, 69:1, 72:6, 74:8, 75:20, 76:3, 77:3, 77:10, 78:17, 78:20, 78:21, 79:1, 79:12, 80:9, 80:15, 81:4, 186:16, 314:29
17
67:2, 69:11, 69:16, 69:19, 69:22, 72:20, 73:2, 73:10, 74:8, 74:21, 74:22, 75:20, 76:7, 77:3, 77:11, 78:17, 78:20, 78:21, 79:2, 80:9, 80:15, 80:19, 81:4, 138:22, 139:2, 139:5, 139:9, 139:19, 140:15, 142:11, 146:13, 146:18, 294:11, 295:11
18
69:12, 69:17, 69:19, 69:22, 72:21, 73:3, 74:21, 75:1, 75:5, 76:12, 77:14, 78:17, 78:20, 78:22, 79:2, 79:12, 80:9, 80:15, 80:20, 81:3, 81:4, 140:18, 140:20, 141:3, 239:9
180
309:7
182
143:15, 309:6
19
110:2, 110:4, 110:8, 110:11, 110:14, 110:17, 110:20, 111:2, 111:15, 111:18, 111:22, 112:9, 113:3, 113:10, 113:16, 115:4, 115:9, 115:12, 141:6
199
41:17
1st
14:10, 15:1, 15:2, 314:27

2

20
53:8, 68:10, 70:18, 71:22, 76:4, 116:18, 119:10, 141:15, 147:22, 226:4
200
4:5
2000
34:22, 35:10, 36:6, 36:17, 130:12, 245:22
2002
37:21
20024
3:7
2005
253:7, 253:11
2010
34:16, 34:22, 35:10, 36:6, 36:17, 37:4
2012
34:16, 35:5, 37:10, 211:12
2013
53:20, 53:21
2015
131:1, 131:18, 133:12, 134:2, 134:16, 222:2, 238:11, 246:10, 246:20, 247:2, 250:1, 251:11, 251:19, 252:15, 253:11, 253:12, 254:22, 256:7, 256:21, 257:9, 282:10, 288:8, 304:3, 304:10, 305:22, 307:5
202
67:9, 67:10, 92:2, 124:18, 124:19, 125:7, 139:3, 179:10, 179:12
202.434
3:8
2021
5:10, 261:15, 261:16, 261:19, 263:7, 263:19
2023
1:10, 1:11, 1:17, 2:5
2024
15:2, 314:17, 314:27
2028
314:29
203
273:4, 273:6, 273:7, 273:8, 275:2, 275:3, 275:12, 275:16, 275:19, 276:3, 281:6, 281:17
204
276:9, 276:14, 276:15, 276:16, 276:17, 277:14
205
277:5, 277:14
21
141:20, 279:1
212.318
4:7

2198
5:8, 11:7, 11:11, 12:1, 12:3
22
127:12, 127:16, 142:5, 142:8, 142:11, 146:13, 146:16, 146:17, 146:19, 246:3
24
73:22, 75:13, 76:13, 80:22, 249:18
25
242:17, 279:11
26
153:19, 154:13, 160:12
261
5:10
27
68:13, 68:20
28
161:14
282
5:11
2a
275:7

3

3
313:20, 314:18
30
1:17, 2:5, 81:19, 94:21, 314:17
31
73:7, 73:12, 75:8, 139:13, 140:21, 141:11, 141:18, 142:2, 142:9, 147:8, 163:22, 294:18
340
98:4, 98:5, 98:6, 98:13, 99:1, 120:1, 120:3, 120:5, 120:7, 120:11, 120:15, 120:17, 121:5, 121:10
344
121:20
35
279:5
350
98:13, 120:1, 120:3, 121:5, 121:10, 121:13
37
164:1, 215:22, 216:4, 216:8
38.5
70:11
397
179:9, 179:14, 182:15, 182:21, 183:6, 183:11, 183:17, 185:18, 186:3, 187:1, 187:11, 188:10, 189:1, 189:9
3d
18:8, 18:11, 310:16, 311:3

4

40
294:20
406
236:2, 236:5
41
293:10, 293:12, 293:14
43
218:4, 295:13, 295:15, 297:7, 297:13
458
211:6, 211:8, 212:7, 212:13, 212:19, 213:4, 213:18
46
161:20, 162:2, 225:19, 227:7, 259:6, 259:9, 260:12
47
259:6, 259:9, 260:12
48
73:22, 162:9, 226:7, 294:20
49
226:17, 227:7

5

50
70:10, 226:7
500
126:13
51
218:21, 219:12
52
221:11
53
5:9, 219:20, 220:15, 221:12
547014
1:22
55
221:16, 224:12
56
47:2
57
237:16, 238:2, 238:3, 238:4, 283:20, 283:21, 286:17, 293:10, 293:15, 295:13, 295:15, 297:7
576
210:21

6

60
1:19, 2:11, 3:16, 314:16
600
10:10, 10:20, 10:22, 11:18, 12:5, 13:8, 53:10, 128:16, 129:3, 129:11, 129:21, 130:13, 161:19, 170:14, 170:16, 170:17, 171:3, 171:11, 171:16, 171:20, 172:4, 174:1, 174:13, 217:8, 217:18, 285:2, 308:17, 308:18, 309:2, 311:16
61
210:21
617.526
3:18
62
16:11
63
249:22
64
47:2
65
242:19, 242:20, 242:21
67
154:16, 154:17
680
3:6
689
213:17

7

7
1:17, 2:6, 314:18
714,458
211:12
72
75:13, 76:14, 80:22
720
210:11, 211:2
73
46:13, 161:14
79
179:10, 179:12

8

80
275:11, 275:13

81
81:17, 81:19,
81:21, 82:19,
83:1, 275:11,
275:13, 278:3
82
88:3, 89:11
83
81:13
85
281:5

9

9-kilobyte
262:13, 263:1,
263:14
90
164:5, 164:7
903
122:2, 122:8,
125:1, 125:3,
125:5
92
16:14, 16:17
923
126:9
928
127:4
94
52:8
96
73:22
96.4
163:22
97
19:5
993
9:14
995
67:13, 67:14,
67:15, 68:3,
68:5, 70:4,
70:15
996
213:17