Protocol 1277 Informed consent statement for Oral History Interviews

(This form can be sent in advance and signed or read into the tape at be beginning of the interview.)

The interview will be recorded, and I will use the audio file to make a transcript. The transcript will be shared with you, with an opportunity to correct it. The attached form indicates options for making the final edited transcript available.

My name is Emma Vail and I am a student at Duke University. I am in a course on the history of genomics that includes oral history. One goal is to produce a written transcript of interviews with important figures in genomics. Some of the interviews may be archived or made public through a website. The conditions for making the transcripts public (the audio tapes will not be public) are indicated in the accompanying form, and you can choose any of those options, or write in your own conditions.

I selected you as the person I would like to interview. The interview should last 30-45 minutes. Your participation in this interview is strictly voluntary, and you may withdraw at any time. You do not have to answer every question asked. The information that you choose to share publicly will be "on the record" and may be attributed to you, unless use is restricted the conditions you specify on the form.

This interview is being recorded and I may take notes during the interview. The interviews that are posted publicly will be archived as a history resource. If you prefer that the interview be used only for the course and not made public, please indicate this on the form.

One risk of this study is that you may disclose information that later could be requested for legal proceedings. Or you may say something that embarrasses you or offends someone else when they read it on a public website. The benefit of participating in this study is ensuring that your side of the story is properly portrayed in the history of genomics.

Signed: _____ Date: 11/19/12

Person interviewed: Craig Venter Student Interviewer Emma Vail
(Print clearly) (Print clearly)

Use of archived final transcript

Members of the Duke University community, students, faculty and staff at other institutions, or members of the general public may access the digital archives. Typical research uses of interview materials include scholarly or other publications, presentations, exhibits, class projects, or websites. However there may be other uses made as well, since the materials will be available to the general public. Investigative reporters and lawyers engaged in or contemplating litigation have, for example, used the Human Genome Archive.

Your permission to post the edited, written transcript of your interview, and any related documents, to a digital archive is completely voluntary. Unless you consent to their wider use, all materials from your interview will be available only to members of the research team affiliated with this project.

The form below provides you with different options for how, when, and with whom your interview materials will be shared.

(A) _____ I place **no restrictions** on my interview materials.

OR

(B) X My interview materials may be reviewed, used, and quoted by students and researchers affiliated with Duke University; *and in addition* (check all that apply):

___Researchers unaffiliated with the Center for Public Genomics may **read** the interview transcript and any related documents only after obtaining my permission.

X Researchers unaffiliated with the Center for Public Genomics may **quote** from the interview only after obtaining my permission.

___Researchers unaffiliated with the Center for Public Genomics **DO NOT HAVE** my permission to **read or quote** from the interview.

Posting interview materials to public digital archives: In spite of any restrictions listed above, I give permission for my interview materials to be made publicly available on the Internet by deposit in an institutionally affiliated archive:

___ 1 year from the date of this form

___ 5 years from the date of this form

X 10 years from the date of this form

___25 years from the date of this form

___After my death

___Other: _____ (please specify a date or condition)

Signature: _____ Date: 11/19/12

Transcript of Interview with J. Craig Venter by Emma Vail

October 23, 2012

EV: As I said before, I'm a student at Duke University under Professor Bob Cook-Deegan and I'm in a class that's studying the history of the Human Genome Project and the progression of genetics as it is today. We're doing an oral history and we're trying to conduct oral history interviews and this interview is being recorded. Now did you get the informed consent statement?

JCV: I received the e-mail with all that in it. I haven't had a chance to review it carefully. Is this is an undergraduate or a graduate class?

EV: This is an undergraduate class.

JCV: Okay and what happens with these interviews?

EV: Well, I'll go ahead and read you the informed consent and then you can agree or disagree to it. "This interview will be recorded and I will use the audio file to make a transcript. The transcript will be shared with you with an opportunity to correct it. The attached form indicates options for making the final edited transcript available," and that you got in the e-mail. "My name is Emma Vail and I am a student at Duke University. I am in a course on the history of genomics that includes oral history. One goal is to produce a written transcript of interviews with important figures in genomics. Some of the interviews may be archived or made public through a website. The conditions for making the transcript public, the audio tapes will not be public, are indicated in the accompanying form and you can choose any of those options or write in your own conditions. I selected you as the person I would like to interview. The interview should last about 30 to 45 minutes but if you need to cut me off that's completely fine, I understand. Your participation in this interview is strictly voluntary and you may withdraw at any time."

JCV: Okay.

EV: "You do not have to answer every question asked. The information that you choose to share publicly will be on the record and may be attributed to you unless use is restricted, the conditions you specify on the form. This interview is being recorded and I might take notes during the interview. The interviews that are posted publicly will be archived as a history resource. If you prefer that the interview be used only for the course and not made public, please indicate this on the form. One risk of this study is that you may disclose information later that could be requested for legal proceedings or you may say something that

embarrasses you or offends someone else when they read it on our public website. The benefit of participating in this study is ensuring that your side of the story is properly portrayed in the history of genomics." Dr. Venter do you consent to having this interview recorded?

JCV: Sure.

EV: I guess we'll just get on with the questions. I apologize for starting late. I was given the wrong number and had to figure out which one to call, but the bottom line is we're on the line now, so we'll get going.

JCV: Okay.

EV: First question: There was a long debate from 1985 until the Human Genome Project actually got officially started in 1990. With the increasingly partisan congress and current budget climate, do you think that the Human Genome Project would be funded by congress today?

JCV: That's really difficult to know but certainly I bet it would be given a lot more scrutiny today. Getting a 3 billion dollar budget past congress right now would be very tough, so I'd say less than 50/50 chance.

EV: All right. Next, in the early 1990s you were rejected for funding from the National Center for Human Genome Research and the NIH, so you turned to private nonprofit funding. You did the H. Flu Sequencing Project and Human Sequencing Project at TIGR, but you also terminated your arrangement with the Human Genome Sciences then directed the Celera Sequencing Project. At Celera it is clear from your book that there was serious tension, so you did the sequence-driven research in a government lab in a nonprofit and for-profit framework, but there were complications in all three frameworks. What are the strengths and weaknesses for these three support structures in your opinion?

JCV: I covered that quite a bit in my book but the short version would be in general government funding is really good for doing things that nobody else would do, that are important for society at large. I think the Human Genome Project starting in the government was a good thing and it spurred on a lot of developments in private industry and very quickly industry was able to adapt, but it was very clear, and whether it's an indictment of the government overall or just the people associated with the Human Genome Project, they were not able to adapt and basically sort of froze things in with not the most advanced technology and I think it was part of that the large bureaucracy that was set up around it that made people not adaptable in any way.

In fact, they started to believe all the hype that was being put out that the human sequencing, the human genome was just such an insurmountable task that it needed billions

of dollars and armies of people and there seemed to be very little interest in adapting even when new techniques and new approaches appeared. I don't think there would have been a Human Genome Project without it starting in the government and I think Jim Watson in particular deserves great credit for really pushing to get it started. Once it got started though it was sort of frozen in that bureaucracy and unable to change. The not-for-profit world was a great place to do the first genome in history.

As you know from my book, we even applied for NIH funding. The sequence one ended up being the first genome done in history other than a viral genome and it's only because we had some independent resources that when Francis Collins and the NIH turned down our grant, saying it's impossible to do, that we had other resources to do that. The challenge for most of science though is not everybody is lucky enough like we were to have some alternate forces to do the experiment. The scale of the human genome obviously started, it was 100 million dollar project for us to do. Without one super-wealthy donor or set of donors there was probably no way that was going to happen in the not-for-profit world.

Even when PerkinElmer offered to give me money to sequence the human genome, they would not let me do it in a not-for-profit organization, so basically it was forced to be done in a for-profit company and that's why Celera came into being. It's pretty unusual for something like the human genome to initially be sequenced in what was a public company and a for-profit company even though it was more science and I think it's because the people at then PerkinElmer that funded it were actually making sequencing instruments and they saw it more as a chance to sell instruments than anything with the genome itself. It was a weird combination of different events but it was also clear, it was left wide open for somebody to step up because of the slow pace of all the government projects and the unwillingness to try new technology.

EV: All right. You said that the government is good for doing things that nobody else could do, but you've made some remarkable progress in the field of genomics in the past decade or so with JCVI, so do you think that private funding in your case, have you had more success with private funding than public funding?

JCV: The short answer is obviously yes but the reason for that is because government funding, much like the same issue we just talked about with the Human Genome Project, is risk adverse. Even though there is new exciting science being proposed all the time, it rarely if ever gets funded by NIH. The only way that advances get made are twofold, either scientists learn how to gain the grant system where you basically are getting a grant for work you've already completed and therefore you know it works and it works with the non-risk system with the government and then they use the new grant that they just got

to try new science and some new ideas, but there's only a few labs that have that level of success with continuing grants where they can gain things that way.

Without that situation, you have to have some access to independent funds, whether commercial funding, donations or whatever to really try new experiments. I think that's why we've been successful in the not-for-profit world. In fact, the not-for-profit world benefitted totally from the for-profit world because of my donation of the Celera spot that I was given to my institute and that's been the endowment that funded things. In a way, sequence and the human genome and doing the risky experiment with Celera is what led to the resources for the last 12 years that my institute has used to come up with these new breakthrough approaches such as synthetic genomics.

EV: Right, next question. Jim Watson has said that you wish to "own the human genome the way Hitler wanted to own the world." However, so far as we can tell you own no patents on actual genes in the human genome. You clearly are a fan of entrepreneurial science and believe that patents are sometimes a good thing. At what point do patents become detrimental to furthering research and in what ways are they valuable and important?

JCV: Well, Jim Watson says lots of quirky things at times …

EV: (Laughs)

JCV: In his career and they have high entertainment value, but he made the patent issue be detrimental for research even though his arguments had nothing to do with patents. I think that's covered pretty extensively in my book. It was a means to attack what we were doing because he felt it threatened the budget that he was compiling with public money to sequence the human genome. So it was just a means of attacking things but there's a lot of people out there particularly in academia who the term patents create an immediate negative response.

Patents have little or no impact on research other than a lot of universities and a lot of private institutions they provide a means for monetizing breakthrough research and funding future research. If you just look at an example of the patents at Stanford and UC San Francisco for the first cloned insulin, I'm pretty sure that's generated hundreds of millions of dollars that those institutions have benefitted from for funding research. The only ones that patents really work against are if your competitor has a patent and you want to commercially develop something and you're not able to do so. I don't think they have anything to do with research. They have a lot to do with commercialization and a lot of the controversy that's been out there about patents like with the BRCA1 patents had nothing to do with research.

Basically a number of clinical labs wanted to make money and generate revenue by doing the BRCA1 gene test and they were not allowed to do that because of the company that had a patent on it and was enforcing it. It's totally usually a ruse when people are claiming it's impacting research versus just people's commercial goals.

EV: You referred to the BRCA1 case. Do you think that, you obviously do agree that genes can be patented, but in the judge's brief it stated that, "a patentable material or object is a non-naturally occurring manufacture or composition of matter, a product of human ingenuity, having a distinctive name, character and use." How do you think that DNA qualifies to be patentable when it is a part of nature and is naturally occurring?

JCV: Let's take the human insulin gene. The insulin gene was not patented as part of the human genome. It was patented as a man-made construct that the scientists at Stanford and UC San Francisco managed to clone out of the human genome and make a unique construct that actually produced human insulin. You cannot find that construct in nature. These things are a matter of record and a matter of law. It's not really subject to opinion unless you're a judge making legal opinions. It's a fact that DNA can be patented and life can be patented and has been ever since the Chakrabarty decision. It's a matter of law in the US and most of the rest of the world.

EV: Thanks for clarifying. Another question: One of the areas you work in is synthetic biology. One of the organisms you sequenced was the smallpox virus and you published that sequence in Gen, Inc. In your 2009 interview with Jared Bloud, the Duke student then working on a similar project to mine, you stated that government researchers lack the "get it done" attitude. You are also an advocate of privately funded research. Now with the NSABB, government is worried about dual-use research. Your own institute has written a policy report about oversight of such research. Do you think the bureaucracy of the government hinders research and would science be better off without any meddling of big government or how should the government oversee such research?

JCV: That's a complex mixed question with about 10 different somewhat related components I guess, but if we just take the last line which is the question part, I think all dual-use research and advances certainly need to be monitored by the government. I'm not sure the NSABB has been particularly effective in any regard doing that but I think the Obama Bioethics Commission did a fantastic job with their report in 2010 when we announced the first synthetic cell. President Obama asked the bioethics commission to take on with their number one charge.

I think when there's potential serious public danger from somebody making a lethal virus by copying something off the Internet such as smallpox and doing that in a secret lab or a home-brew-kitchen, those are something that the public should be highly concerned with and we've been advocates [inaudible 00:26:52] which reported on the Obama Bioethics Commission on that company that synthesized DNA and all of the nucleotides, should have an obligation to screen any requested sequences against pathological agents and also require that people ordering such constructs be members of bona fide research institutions.

My company Synthetic Genomics actually does do DNA synthesis. We would never provide something to somebody wanting it shipped to a home address or a business other than a bona fide research institution. What becomes a question for the legal and law enforcement communities as well as the scientific community is at what stage can communities self-police versus needing outside regulation. The scientific community itself has done pretty well for the last 30 or more years on recombinant DNA and there's been no accidents or problems with it because of some simple guidelines that were set up. The field of synthetic genomics and synthetic DNA is an orders of magnitude more complicated than just the early recombinant DNA field.

I think it needs to be watched closely and if it gets into the realm where groups are doing something that could cause significant public harm, I think we may have to, and it's not being just part of the scientific community and self-regulation, might be the time to consider bringing things into actual laws and law enforcement range. Those people are concerned with people that know nothing about science, nothing about these issues coming up with Draconian laws through lack of understanding of the science or what's really possible and therefore setting back research and just being one more step that sets the U.S. back in its competitiveness with the rest of the world. It's a complex issue and there's no simple answer.

Even having laws and regulations, it's like the issue with gun laws. Gun laws only prevent law-abiding citizens from having guns. They don't prevent people committing crimes from having guns. As I said, there's no simple answer to this situation. It needs constant monitoring.

EV: That's an interesting analogy, I hadn't thought of it that way, but I appreciate it. Do you think the regulation of the publication of this controversial research, should it be controlled more by the government or more by private companies and institutions such as your institute?

JCV: I think one of the things I've constantly stressed in science is every scientist has to have and every scientific institution has to have their own moral guidelines and issues. It's interesting some of the people that were upset about the publication of the modifications in the flu virus from the European group that

were advocating it should be censored and not published were on totally the opposite side of the issue when it came to publishing the smallpox genome, which is I think orders of magnitude more dangerous than a modification to a flu virus.

The Journal of Nature published the smallpox genome with the complete blessing of the U.S. government. I think the editor of Science magazine, Bruce Alberts, has come down on both sides of these issues. In fact, when we were publishing in 2003 the YX174 genome and then the first synthetic genome, we offered with some U.S. government agencies and with the Journal of Science to limit the information that was on our scientific paper if they thought it would help to not spread the use of this technology to groups that we didn't want to have it.

Bruce Alberts came down very strongly on that issue and that that would be science censorship and then switched positions on the modification of the flu virus. I think people are just confused on this issue and there's not much in the way of real scientific leadership that knows how to set these agendas. I think it's going to come through a purchase from the legal system. My understanding is that, appropriately so, the FBI is very concerned about home-brew research, people doing molecular biology in their kitchens without having the scientific background or the understanding or the ethics and things that come with getting a PhD and training in a major institution.

EV: Do you think that's a legitimate threat of people having chemistry laboratories in their kitchens and synthesizing genes for the smallpox virus or influenza? Is that realistic?

JCV: It's very realistic. You can buy a DNA synthesizer off of EBay. It gets down to people's motivations and why they would do that, but the technology is out there and the machines, the chemicals are not restricted.

EV: All right. Next question: You and Watson strike me as similar in personality. You're both very outspoken, driven individuals who are as proficient in the science world as you are in politics, yet you continually disagree on many issues including the patent issue. We know he congratulated you after your "What is Life" lecture in Dublin last year. How do you think Watson has influenced you to become the scientist you are today?

JCV: I'm not sure I'm flattered by saying we have the same personalities …

EV: Definitely not the same. (Laughter).

JCV: If we start there, I think Jim Watson is somebody who's made now 60 years ago one of the most important contributions in the early stages of molecular biology and I have immense respect for that accomplishment. I think his outspokenness

has been mostly a plus for the scientific community, but the reality is I'm not sure other than the topic of genetics of race and intelligence that we differ on issues so much. I don't think we differ at all on patents.

His institution while he was director, Cold Spring Harbor, has filed far more patents than all my organizations that I've been associated with put together. He's clearly at the institutional level a strong believer in research at Cold Spring Harbor being patented and reaping the financial rewards for doing so.

As I said, a lot of the public statements he has had made have been for the drama, for the attention versus any fundamental belief system. I wish we disagreed on more.

EV: (Laughs).

JCV: The only thing we truly disagreed on was how the Human Genome Project should proceed and how fast it should proceed. I think he was just more of a victim of a mindset that came out of the early days of molecular biology that was I think historically very similar to the mindset that he helped overcome with the discovery of the double helix because the scientific community was positive for the previous 50 or more years that proteins were the basis of the genetic code, not DNA. Narrow thinking, thinking that people, what they learn, what their prejudices are are things that set back science constantly.

They have throughout history. They did with realizing that DNA was the genetic material and people get locked into their thinking that the Human Genome Project was just such a gargantuan, insurmountable project that there couldn't be a simple way to do it. Now I see the lab can sequence a human genome in less than a day on a single machine. That's a lot of advancement in 10 years but we wouldn't have gotten there with the same kind of thinking that you could attribute to people being certain that proteins were the genetic material, not DNA. We constantly have to overcome people's biases and prejudices in science and it's a long, slow process for doing it. It's a frustrating process.

The positive thing behind it is then in theory only the correct ideas get through, but it's simply not the case. The people that carried forward the notion that protein was the genetic material for 50 years or more, just think how far advanced science would be if the early drosophila scientists did the experiment that Avery did in 1944 showing that DNA was in fact the genetic material. It would be a field that would be well over 100 years old instead of 60 years old.

EV: Okay.

BCD: So Craig I wanted to intervene. This is Bob Cook-Deegan and Emma is doing this next door, I just wanted to say hi and thank you so much for agreeing to do the interview.

JCV: Bob, nice to hear from you. She's asking good if not somewhat complicated questions. I didn't know if you had a hand in the questions or if she generated them herself?

BCD: We don't let them unleash their questions on you without at least doing a quick review, but we're trying to take a light hand. We'll have to make sure that you guys meet at some point.

JCV: That would be nice. I think she's doing a good job.

BCD: All right. Anyway, thanks again for doing it and I'll leave it to Emma again and go back to my office.

JCV: All right Bob, nice to hear from you.

EV: Again, if you have other issues to attend to feel free to cut me off. I have plenty of questions to ask and probably won't get through all of them. Can I continue?

JCV: Pick your best three questions and let's go with those.

EV: All right. I'll ask what I'm most interested in hearing from you. You are working on mostly synthetic genomics right now and you were recently featured in the New York Times for your ideas on synthetically engineered bugs that eat waste, produce biofuels and create medicine. What are your future plans with JCVI and will you focus more on medical research, genetic engineering or decoding and interpreting the human genome? What do you think are the most important questions that need to be answered?

JCV: The Venter Institute has a lot of independent scientists working in different spaces. We are working on virology and we're one of the major sequencing centers for the flu virus from different species from around the world and trying to develop new tools to predict future evolutionary changes in the flu. We have a team working with a group at Synthetic Genomics and Novartis and, in this case, partnered with the U.S. government to come up with a method for rapidly making the flu vaccine so it cannot take nine months like it did with H1N1.

We have a group headed by Karen Ellison that is exploring the microbiome and the very first study on the sequencing with the microbiome came out of my institute and another spinoff of the work we did on the human genome. We are also doing the same approach with the environment, doing shotgun sequencing of the ocean. A lot of independent research projects going on in a lot of different areas. One that I am pushing, synthetic genomics as well as at The Venter Institute is all about synthetic life and the relation between life and computers.

We've shown that DNA with the first synthetic cell is in fact not only necessary but sufficient and carries all the information needed for life, but we can go in and out of the

digital world. We can sequence a genome and digitize DNA and now we can start with a digital world, regenerate DNA and regenerate life and so many implications of that.

A new project we are just starting now where because we can digitize life and translate it, we can actually move life at the speed of light. One of the applications we're working on with this is potentially in a future pandemic we can eliminate pandemics by being able to send vaccines around the world at the speed of light so it would take less than a minute to send a vaccine digitally around the world and we are building devices that can then take that digital information and turn it back into biology or go into the digital biological converter or biological teleporter to make that change. We can make proteins phase at single cells that are self-replicating now.

Try to imagine a future where you can download biology from the Internet. You can download medicines. You can download vaccines. Maybe download a cell if you're on Mars …

EV: (Laughs)

JCV: That can process food in a new way. What's come out of our genomic work which I call it digitizing biology and now what's coming out of going the other way with synthetic DNA will totally change the future. The fuels and the food are part of what will change but I think this is the start of a major new revolution.

EV: Are you also developing the actual software for the computer to download like you said biology onto the Internet? Is that going to happen sooner rather than later or are you more working on the actual scientific biology side of it right now?

JCV: We have groups working on both. We're filling instruments to download the digital information and create new biology and we're working on software for designing that biology and being able to transmit it. Sometime in the next 12 months we hope to have the first major demonstrations of studying biology at speed of light.

EV: Wow. Are you also developing policy to go along with that because there might be a bit of a public outcry when they find out you can do advanced science on the Internet like there was when the smallpox virus was published, so are you conscious of the policy side of it as well?

JCV: We have a major policy group at The Venter Institute headed by Bob Bateman that also includes Jimmy Carter's granddaughter. We are constantly asking

policy questions stimulated by this, but yes these issues are going to be much bigger than one group asking those questions.

EV: Are you collaborating with the government in that?

JCV: We are working with a couple different government agencies on the demonstrations of this. I can't give you more details right now …

EV: (Laughs)

JCV: But I think the policy discussions will be a very key part of it, you're absolutely right.

EV: All right. On a different note, when your autobiography was released it was criticized as a means to "settle scores" (that's from the New York Times review) and to justify your actions. Do you think that criticism is fair?

JCV: I didn't really like that one review.

EV: Understandably.

JCV: I think if you look back at the history of all the press coverage, all the nonsense that was out there, I viewed it as a chance to give an accurate view of the events, an inside view truly from my side. As you've seen in the current election, facts have become very fungible in the U.S. I don't consider facts in science that they should be fungible. Science has to have a certain level of integrity. You get information, the information can be challenged and proven or disproven, but I think what happened particularly during the "human genome race" is particularly from certain quarters the facts not only became fungible, they just sort of went out the window and things really by major scientists moved into just straight political attacks.

I think that's, nobody's really looked at that at a policy level or anything else, maybe because that their politics are so strewn now with people making up their own facts. When the scientific community does that, people don't seem surprised or bothered. I think it was just, and obviously if you're giving a very different opinion versus what was out there by people, for example providing facts about whether it was me filing patents or the NIH doing it, those are important facts to have out there. I'm not sure which scores I actually settled with my book. (Laughter)

It's like did the debate last night really change anybody's mind? People that were in the camp that bought the mantras that I was sequencing the genome to own it and patent it, they used that as a rallying cry and a justification for what they were doing. To me that is a very sad part of science and I think it's at very least important to have the real facts out there of what the situation was. So I didn't view it as

settling scores as much as trying to get an accurate portrayal of the real events versus the politicized versions of them that were out there.

EV: Your reference to Eric Slander that was more of a joking remark or –

JCV: That was so, in fact that got quoted quite a bit, that was not my quotation if you actually go back to look at the book. Those were all coined by Sydney Brenner. He came up with the term Eric Finlander and Eric Slander. People quote the book and if it's written in the book they treat it as though those were my terms. They were quite comical.

EV: (Laughs)

JCV: I think Sydney Brenner is one of the most hilarious guys in science and one with the best sense of humor.

EV: Well it's definitely clever.

JCV: Pardon?

EV: It's definitely a clever reference.

JCV: Part of it is because many people in the scientific community by referencing Sydney Brenner's comments showed that some of these guys didn't have a great view of other people's integrity. Integrity is all you have in science. Once you lose your integrity you have nothing left.

EV: All right. I think I'm about to get kicked out of the conference room that I'm borrowing, but thank you so much for speaking with me and I wish I could talk more with you, but maybe some other time (laughs).

JCV: As Bob said, I look forward to meeting you in person and I've enjoyed the conversation with you.

EV: All right, have a good day.

JCV: All right, thanks.

EV: Bye.

JCV: Bye-bye.