The Embryo Question is a three-part series about the cluster of cells at the crossroads of science, ethics and the law. Read the introduction.

When Noor Siddiqui was growing up, her mother developed retinitis pigmentosa, a condition that leads to gradual vision loss. When Ms. Siddiqui's mother was in her 30s, she began going blind. Last summer, Ms. Siddiqui told a podcast host that in the years her family sought a diagnosis, "what stuck with me during that whole time was just this unfairness, right? I won this genetic lottery where I get to see my grandkids, right? And then for my mom, she lost it — right? — just because of a typo, a random letter change that, when she was born and was being formed, she ended up having and just totally changed the trajectory of her life," she said.

The "letter change" she referred to was probably a de novo, or spontaneous, mutation in her mother's genome. "It wasn't my grandparents', her parents', fault," Ms. Siddiqui continued. "She didn't inherit it from them. It just spontaneously, randomly, by just sheer horrible luck happened to her." This experience "burned a hole in my heart for a while," eventually leading her to found Orchid, a way of helping parents anticipate just such genetic misfortunes.

Orchid screens embryos' DNA for hundreds of conditions, such as retinitis pigmentosa, which can be traced to a single genetic variant. But the company also goes further, offering what is known as polygenic screening, which gives parents what is essentially a risk profile on each embryo's propensity for conditions such as heart disease, for which the genetic component is far more complex.

Today it is an expensive procedure offered to patients undergoing I.V.F., who are often but not always infertile couples seeking treatment. But Ms. Siddiqui — and others in Silicon Valley, where investors in and users of this technology abound — envision such comprehensive screening eventually replacing the old-fashioned way of having children altogether. “Sex is for fun, and embryo screening is for babies,” she said in a video she shared on X. “It’s going to become insane not to screen for these things.”

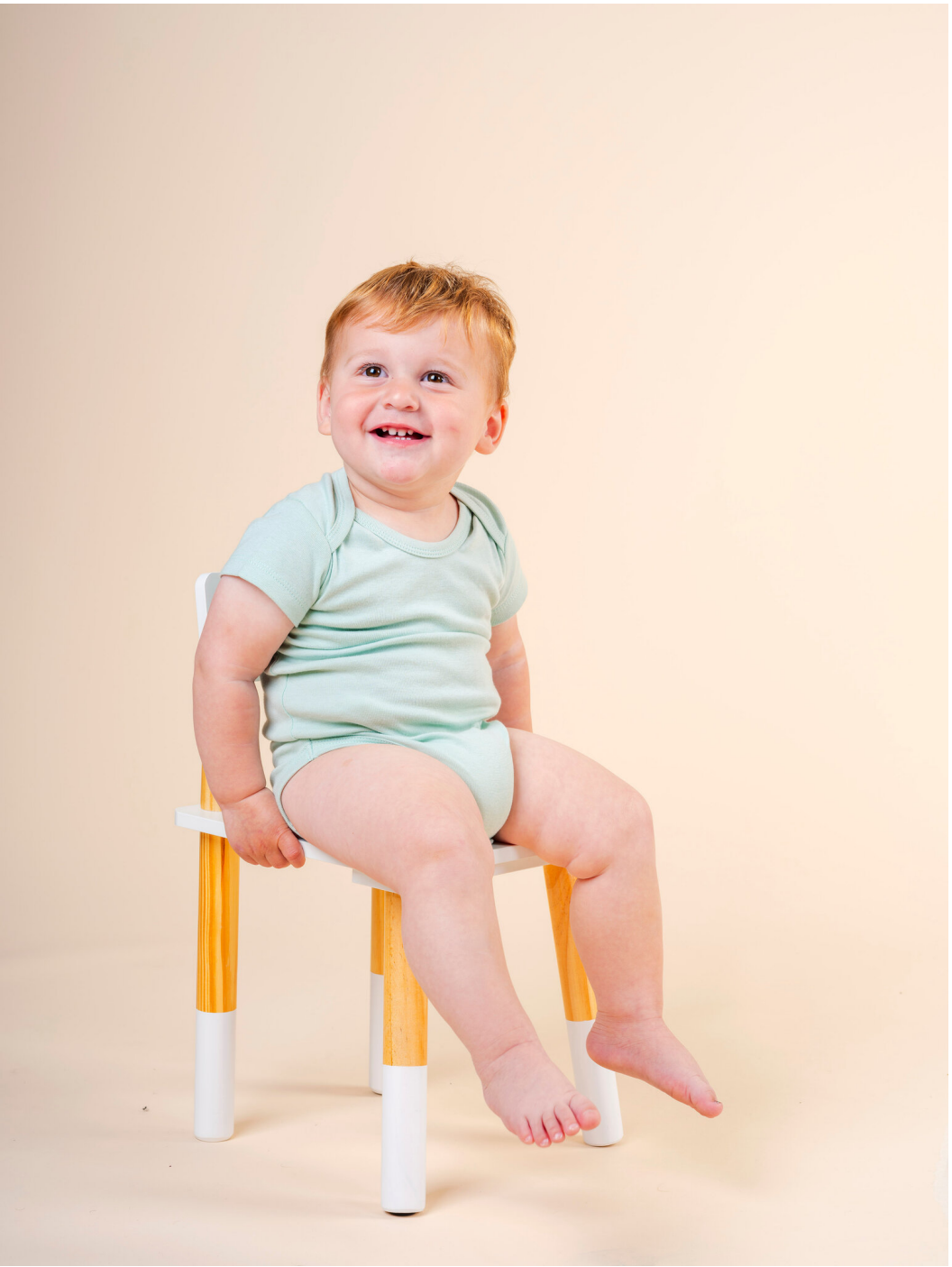
“These things” presumably refers to conditions like obesity and autism, both of which Orchid says it can screen for. What she and others who run screening companies tend to talk about even less is that such things could also include traits like intellectual ability and height.

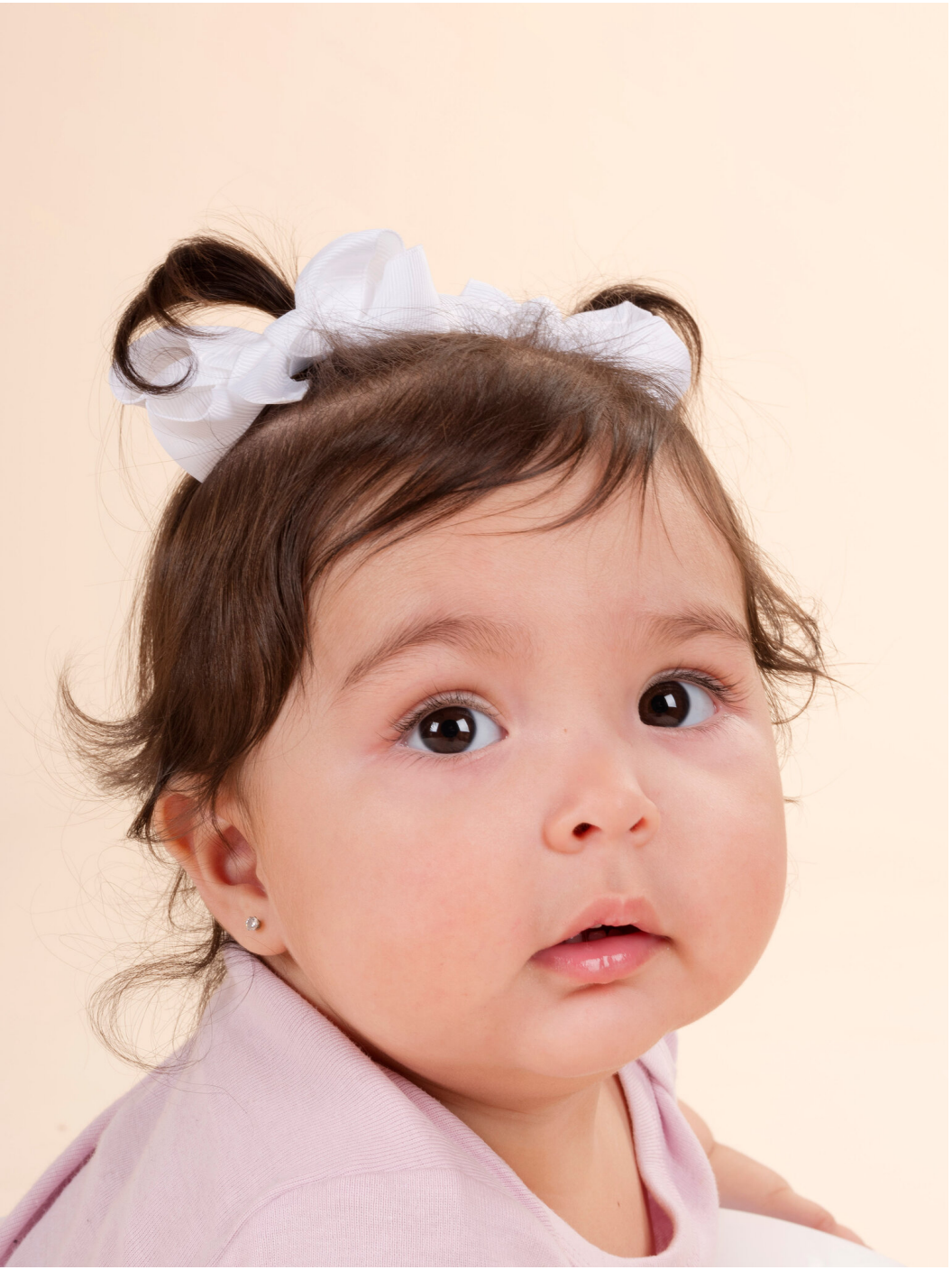
The regulatory regimes that govern the creation of life around the world vary widely. Portugal generally limits cryopreservation of embryos to three years; in Britain, it’s 55. Poland requires that unused embryos be donated to other couples, anonymously, after 20 years, even if the original patients continue to pay to keep them stored. Israel permits parents to request posthumous sperm retrieval after the death of a son. Single women in China are generally not allowed to freeze their eggs, and in South Korea they may not use I.V.F. In the United Arab Emirates, I.V.F. is only for married couples, and the use of donor sperm or eggs is against the law, as Sunni Muslim clerics have declared it a form of adultery since it introduces a third party into the marriage.

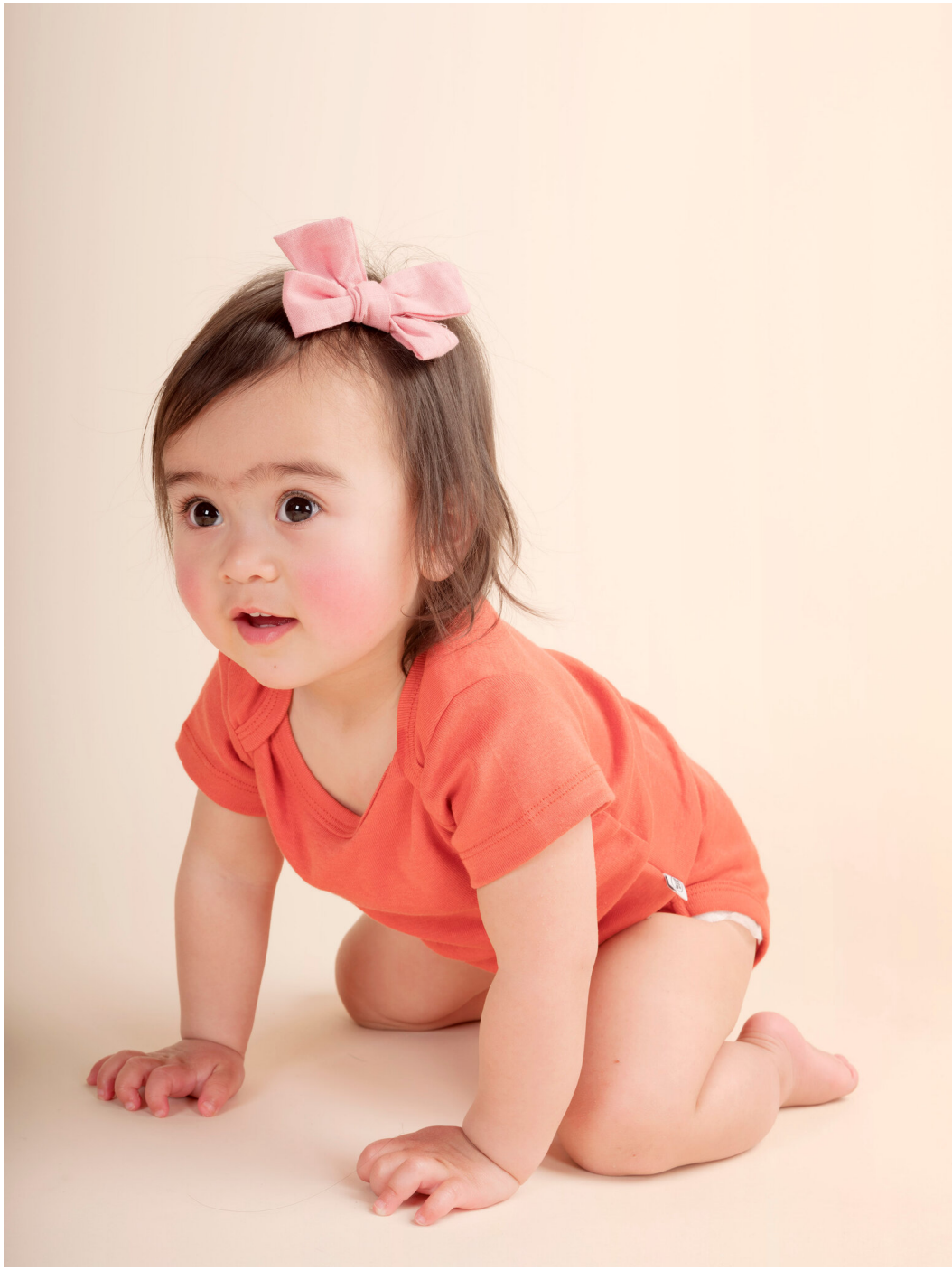
In the United States, despite more than $1 billion invested in fertility-focused start-ups in the past decade, there is remarkably little regulation or even basic public scrutiny of what practices are acceptable. Instead, venture capital and private equity firms have spurred the creation of technologies and innovations in the field, with no mechanism in place for oversight.

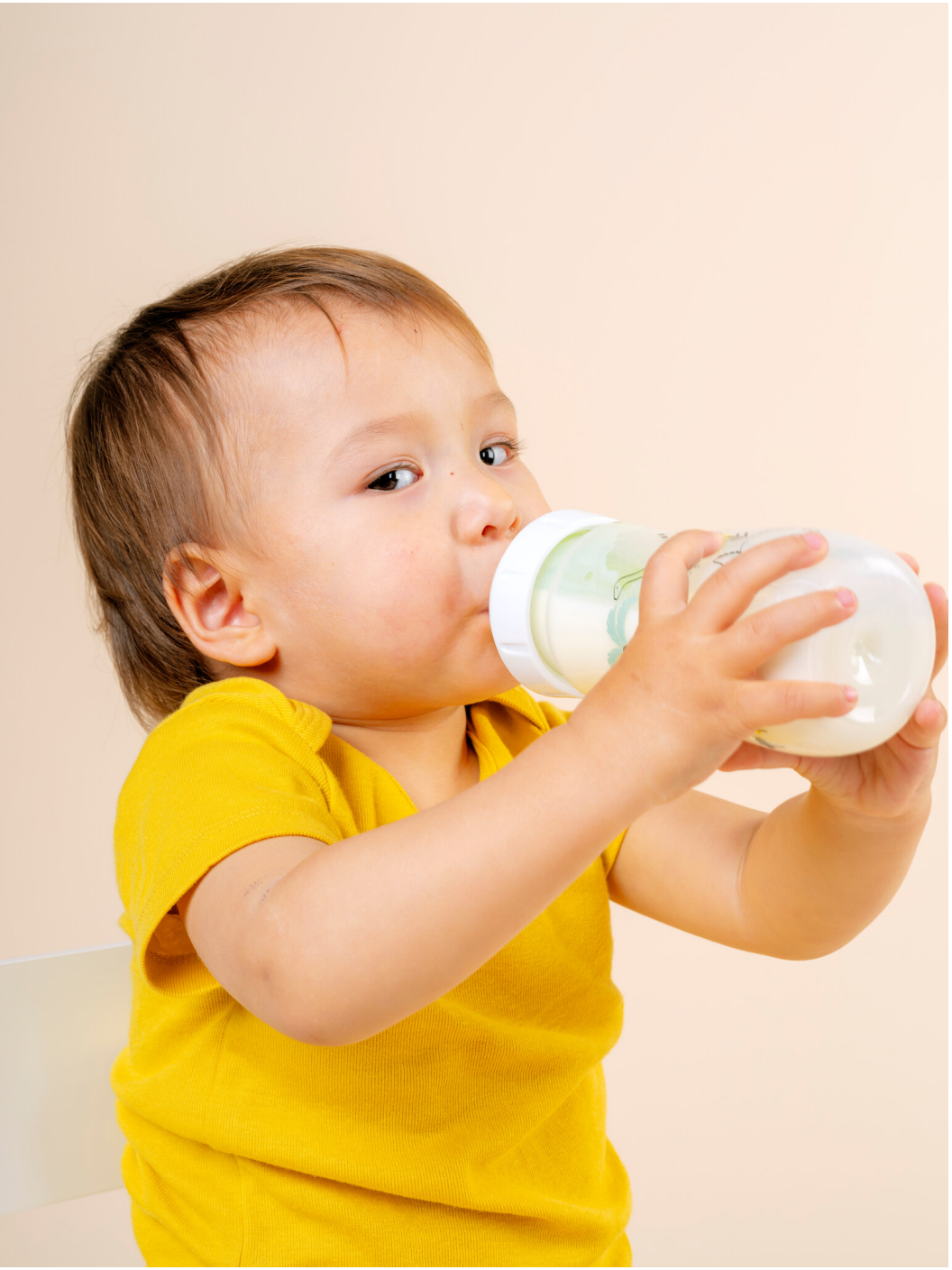
Today the United States is known for its wide range of available services, which include sex selection and even eye color choice, as well as polygenic embryo screening, and has become a destination for fertility patients from around the world.

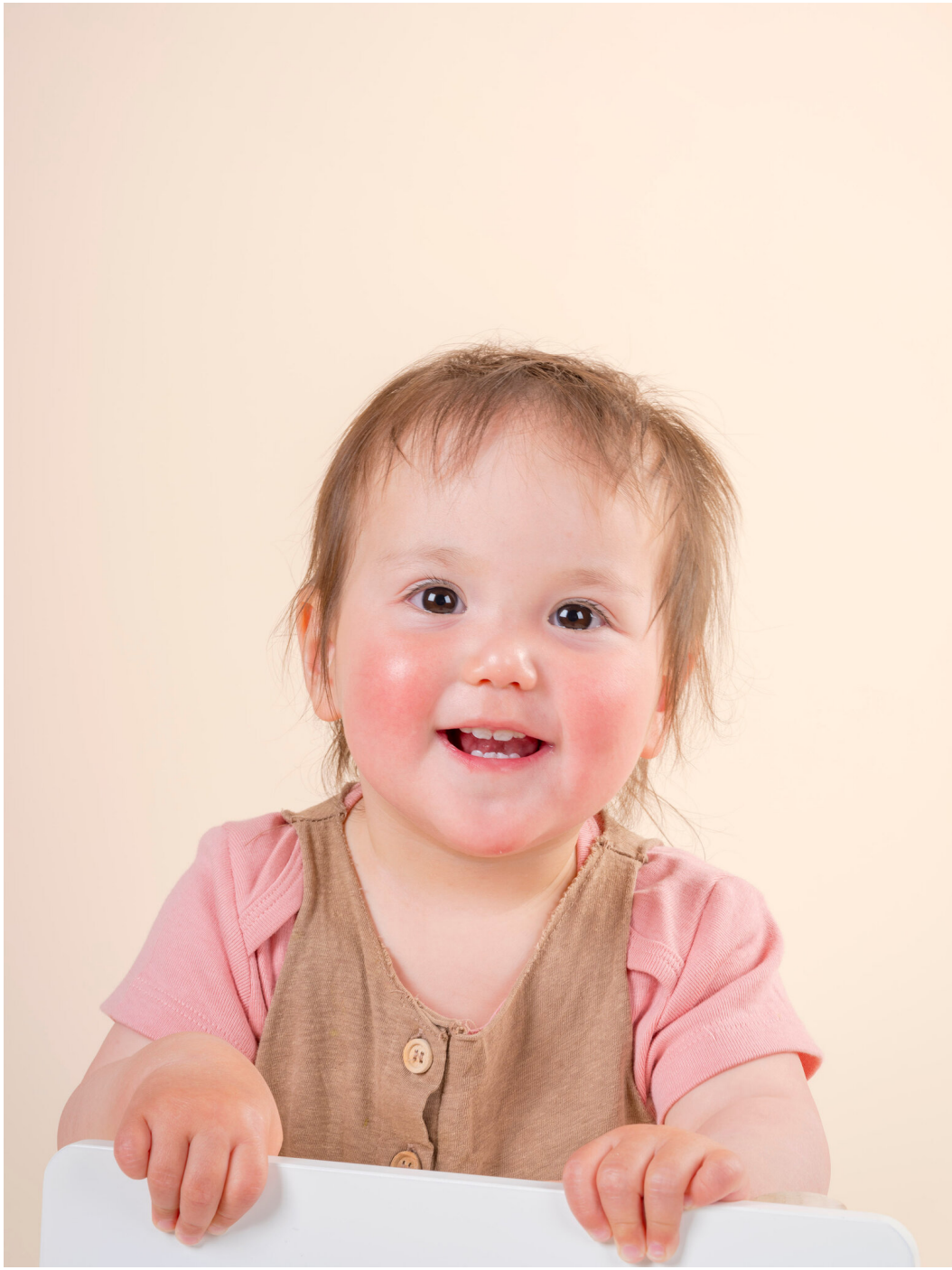
But the innovations that arise from this freewheeling environment can shape the way we think about embryos and even change how we treat them, sometimes before we've realized that such a shift is unfolding.











IN 1990 RESEARCHERS reported the first successful use of preimplantation genetic testing. The embryos belonged to couples in which the female partner was a carrier of one of two heritable conditions that typically affect only males — one a form of intellectual disability, the other a rare deadly condition called adrenoleukodystrophy. The embryologist Alan Handyside, in a major breakthrough, took single cells biopsied from embryos and identified their sex, which allowed the couples to choose female embryos for implantation and avoid passing on those conditions.

Over the next three decades, advances across various fronts have led to more sophisticated and targeted testing. Today some form of preimplantation genetic testing, or P.G.T., is used in over half of I.V.F. cycles in the United States, at a cost of $3,000 to $5,000 per batch of embryos. The most common options patients have are tests for extra or missing chromosomes, structural chromosomal rearrangements that can trigger pregnancy loss and disorders linked to a single gene, such as cystic fibrosis and muscular dystrophy.

More recently, with the advent of powerful statistical techniques that can analyze huge databases of genetic information, several American companies have started offering P.G.T.-P., which screens embryos for their polygenic risk scores. The technology has typically been used for adults, ostensibly to assess their probability

of developing specific conditions. For example, people whose test shows a high risk score for heart disease might change their diet or increase their physical activity.

The risk scores come from what are called genomewide association studies, which identify which of hundreds of thousands of genetic variants are statistically linked with a specific condition or trait. While tests for single-gene diseases can conclusively verify the presence or absence of a specific genetic mutation, these scores can assign only probabilities and do not account for environmental or other factors.

The usefulness of polygenic risk scoring in adults is still an open question; its application to embryos is even less straightforward. Because the results are probabilistic, having a slightly elevated risk of a condition does not necessarily translate into developing it. The risk calculus is further complicated by the vastly different environment for a child born today compared with the adults whose biological samples, the large-scale collection of which began in the mid-2000s, make up the data sets from which these risk scores are generated.

Todd Lencz, who researches genetic biomarkers for schizophrenia, gave me the example of a genetic variant that predisposes people carrying it to smoke more. Currently, polygenic risk scores take into account those genes' presence as a predictor of shorter life span or higher risk for cardiovascular disease. But people born

with that variant today will encounter an environment and a culture around smoking very different from those of someone who grew up in the 1970s with the same predisposition. Smoking-prone babies born now might “never even encounter a cigarette in their life,” he said.

There are many other questions about P.G.T.-P.’s accuracy and efficacy. Much of the analysis that has generated the risk scores comes from two large data sets, one American and one British. Because of the demographics that make up these data sets, the screening tools are most accurate for people of European descent. Other countries, particularly in East Asia, have assembled their own biobanks, and a multicountry project across Africa has resulted in the discovery of millions of variants in the human genome. But how these findings apply to people with parents of, say, multiple ethnic backgrounds remains “a wide open question right now,” Dr. Lencz said.

Advocates of the screening argue that it nevertheless provides valuable information that can help parents assess their embryos’ propensity to develop certain diseases: “Have healthy babies,” as the landing page of Orchid puts it. But polygenic embryo screening goes further than the dubious promise of health. Studies have identified sets of genes linked to everything from educational attainment and height to mental health conditions such as depression and schizophrenia. It’s one thing to screen for

conditions like Type 1 diabetes; it's quite another to go looking for the embryo deemed most likely to clear six feet and test into the Ivy League.

Japhy was the first Orchid-screened child to be born. His mother, Leah Culver, opted for Orchid's polygenic screening during the I.V.F. process, and she would do it again, she said: "It's worth having the data for scientific purposes. More data and more information is a good thing."

IN JULY the technology newsletter The Information reported on Silicon Valley's enthusiastic investment in and consumption of frontier fertility technology. It cited three sources who said that in private, Ms. Siddiqui has "claimed that her company is able to measure embryos' intelligence." (A company representative denied the claim to The Information.)

Genomic Prediction, a New Jersey-based testing lab that offers a range of screening services, including polygenic screening, initially offered consumers a score for gene variants associated with intellectual disability but rescinded it after it attracted controversy. (A company representative said it was removed from the panel of markers it can test for after the screening was found to "not be effective, given the data.") "The testing was meant to look at intellectual disability, not intellectual ability," Nathan Treff, Genomic Prediction's chief scientific officer and one of its founders, told me, disputing the idea that parents were looking for supersmart embryos. Intellectual disability, he stressed, is "a medical condition," and he did not rule out one day offering screening for it again.

This is technically true — but the line between screening for a disability and screening for IQ is not as clear as he makes it out to be. Someone with an IQ of around 70 is considered to meet the threshold for an intellectual disability. But for the cases in which that intellectual disability is not caused by a known genetic syndrome, the technology is not accurate enough to screen out an embryo that will grow up to have an IQ of 69 — intellectually disabled — versus one with an IQ of, say, 78.

Thus, the only way to screen for intellectual disability is through screening for IQ more broadly by combing through the many hundreds or thousands of DNA markers that contribute to intellectual ability — a less P.R.-friendly truth that some in the sector downplay to the public at large — even as others openly market it to potential clients. In October, The Guardian, which had reviewed undercover recordings obtained by the British-based nonprofit Hope Not Hate, reported that a U.S. company, Heliospect Genomics, claimed in a presentation to prospective clients that it could select the "smartest" out of 10 embryos, for an average gain of more than six IQ points.

The same dynamics apply to other conditions. While these companies say they're screening for idiopathic short stature or psychiatric conditions like depression, it is not at all clear that they have the ability to deliver on the precision promised. Does a high risk score for idiopathic short stature mean an embryo will grow up to meet the threshold for a medical condition? Or simply that

the person will be on the shorter side? Does a high score for depression mean that a given embryo might grow into a person with mild seasonal affective disorder or develop debilitating mental illness?

Some people who study genomics don't believe the technology, now or in the future, can deliver on its promises, in part because many diseases are caused by numerous risk factors beyond genetics. "The risk from things the test can't measure is much greater," said Anneke Lucassen, a clinician and a professor of genomic medicine at the University of Oxford. Using such incomplete information to make decisions about which embryo to implant is "about as likely as a coin toss to deliver the outcome desired."

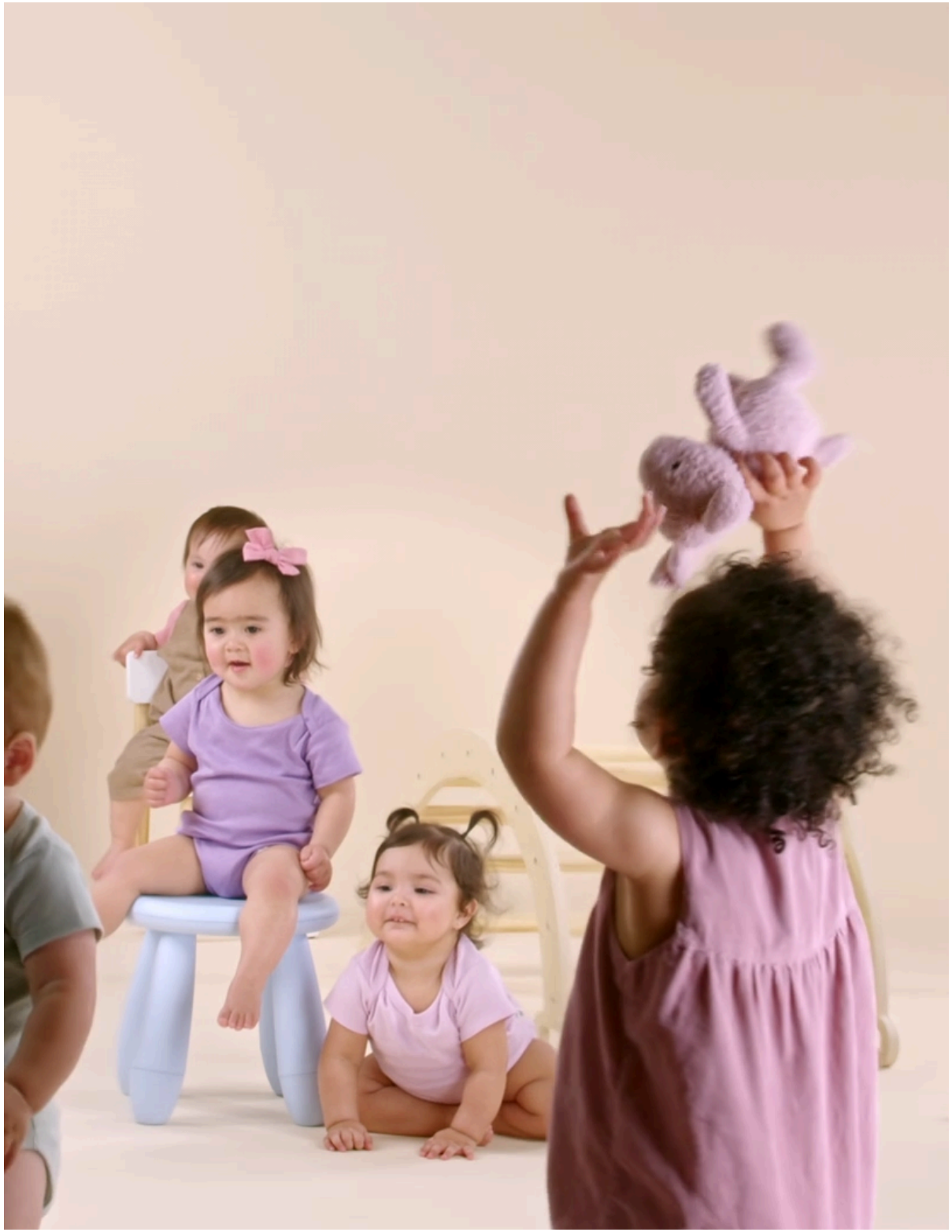
Polygenic embryo screening has not yet gained widespread acceptance, but one representative survey of Americans conducted in 2022 found that a majority said they had no moral objection to using P.G.T.-P. for medical and nonmedical traits and nearly 4 in 10 said they were "more likely than not" to use it if it would slightly increase their child's likelihood of getting into a top college.

Another recent study found that while potential patients were enthusiastic about the possibilities, medical providers were not persuaded. "We're not here to create what we think is or what the patient thinks is ideal. We're here to help them with a medical condition, which is infertility," one fertility doctor who was surveyed said. Other care providers surveyed raised concerns

about lawsuits. What if patients selected embryos that were supposed to be “tall, beautiful and smart and they’re short, squat, thick and a little dull?” one wondered.

In December 2023 the Psychiatric Genomics Consortium, an international group of researchers studying the biology of mental health, criticized Orchid for using its data; the consortium’s founder made the point that the group’s aim was to improve the lives of people with mental illness, not to prevent them from being born. (An Orchid spokesperson said the company did not use the consortium’s data but did not share its source.)

New technologies affect not only patient preferences but also social expectations around embryos and how we treat them. Vardit Ravitsky, a bioethicist and the president of the Hastings Center, which examines ethical issues related to health and technology, sees these new screening tools as a step change from previous iterations of genetic testing. “It’s a qualitatively new message of: We should have the best children that we can, across the spectrum,” she said. Once such a tool is available, “it immediately becomes a societal expectation to use it, and the rejection of it or the refusal of it becomes a morally significant choice,” she continued, pointing to the extensive literature showing that women who refuse prenatal testing are seen as irresponsible.



Simone Collins and Malcolm Collins, two natalists who became internet famous for sharing their vision of peopling the world with their descendants, live in a Pennsylvania idyll far from Silicon Valley. They are frequently photographed at home with their children, showcasing their family-centered lifestyle as they make their case in various outlets for having as many babies as possible.

Despite their geographic remove, they are nevertheless representative of the technology milieu's worldview, in which children are often spoken of as a means to something else — staving off population collapse, an optimization project, a data-driven experiment — rather than an end in themselves. The Collinses are far from the most prominent proponents of this view. Elon Musk, who has been warning about a baby bust for years, has reportedly used Orchid for at least one of his dozen or so children, and he and Ms. Siddiqui have gushed at each other on X.

The Collinses, who have worked in tech and private equity, have created more than 40 embryos over seven rounds of I.V.F. (They've used six to have their four kids, with one more on the way, and donated three.) While all of the embryos were tested for chromosomal abnormalities, polygenic screening was available only for the last two batches of embryos.

Their goal in using genetic screening, they told me, was to orchestrate their pregnancies so that those with the highest risk of serious disease were transferred last, buying those eventual

children a few additional years for a cure to arrive. “We looked primarily at diseases that currently do not have very good cures,” Ms. Collins explained. After that, she said, they looked at “mental-health-adjacent traits” such as depression, anxiety, brain fog and inability to deal with stress, as well as intelligence. “At worst, we’re randomly selecting embryos, which is what people do by default,” she said. “And at best, we’re reducing our kids’ odds of having cancer and schizophrenia or having cancer and schizophrenia at a time before a cure has come out.”

When we spoke, Ms. Collins highlighted her concern about serious diseases, including a possible hereditary risk of ovarian cancer, which was responsible for cutting her mother’s life short. But in other interviews, she and her husband have described those mental traits as their top priority. She added that anecdotally, the tests’ predictive power for behavioral traits — one of the metrics guiding their choice to implant the two embryos that are now their daughters — appears to be strong. The Collinses said they wanted daughters who were “low stress,” and lo and behold, Ms. Collins said, “ultimately both of our daughters are extremely chill and genial.” Although, “God knows, once they hit puberty,” she joked, “it’s going to go crazy.”

The Collinses submitted their embryos’ genetic data to multiple companies, including Heliospect, and received slightly different scores from each one. Because there is no standardization in the

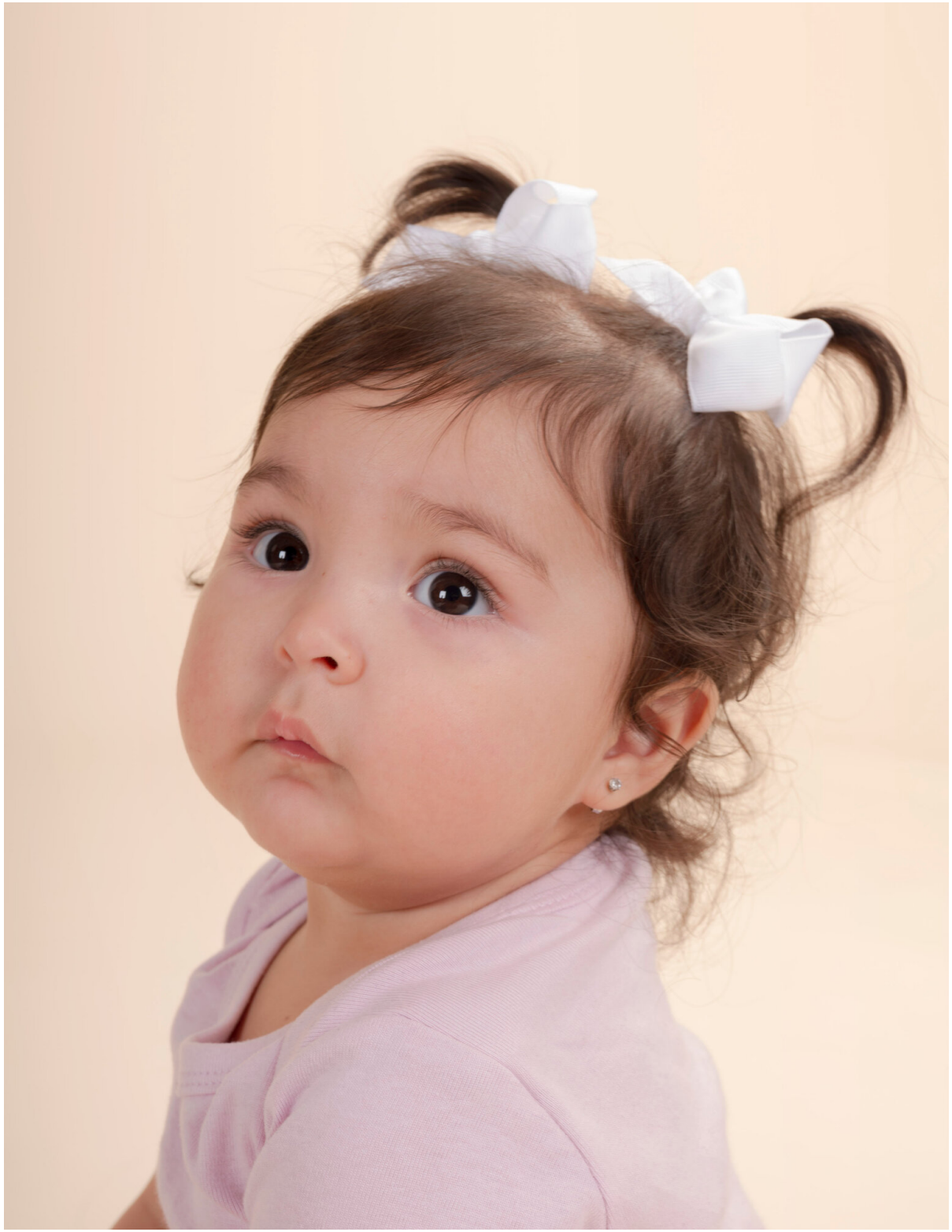
field, companies rate embryos differently, depending on the algorithms used and the underlying data sets on which they've been trained.

When the Collinses put all of the numbers in a giant spreadsheet and scrutinized them, they found that, despite the variable scores, the results were fairly consistent. They were fortunate to not have faced what some ethicists worry about — the possibility of having to choose between embryos that have, say, a high risk for a disease but also a high score for a desired trait or even among embryos with higher scores for different types of diseases. "We thought we might have to engage in serious trade-offs, but it turned out that, at least among our embryos, there was fairly high correlation between lower risk and higher scores on things we wanted, like intelligence," Ms. Collins said.

Not everyone is so lucky. According to a case study from Genomic Prediction, one couple who created five chromosomally normal embryos in their first round of I.V.F. decided not to transfer any of them after receiving their polygenic risk scores, as some showed elevated risks of breast cancer. The parents eventually created 33 embryos in their quest to have several children. Ms. Siddiqui has said she and her partner have created 16 embryos, for which she already has the profiles.

Several European countries have taken these quandaries off the table by simply banning the procedure. While Britain permits screening for an approved list of roughly 1,700 single-gene disorders, it does not permit polygenic embryo screening. In Germany, where the shadow of the country's Nazi past hangs over the entire fertility sector, embryo testing was allowed only in 2011 and was initially just for illnesses that affect children. In the past few years, ethics commissions in some German states have heard petitions from parents to screen for later-onset conditions, deciding them case by case.

In the United States, where such screening is not subject to any regulatory oversight, it is already in commercial use. Orchid has partnerships with at least 40 clinics nationwide. Dr. Treff said in January the company had provided risk scores for roughly 420 clients for more than 1,600 embryos. Genetic counseling is required for those who use the service. But patients and providers are presumably left to navigate the ethical questions for themselves.



Knowing she wanted a girl, Angelina Batchelder tested all eight of her embryos, selecting the healthiest female embryo to implant. “She’s literally my miracle baby,” says Ms. Batchelder. “I do thank science, but I thank God,” and she thanked her doctor. She added, “I’m just overwhelmed.”

IT IS NO ONE’S business what particular couples do with their embryos, but the capacity to genetically test embryos for a range of characteristics, find some of them wanting and then file them away in large-scale, easily traceable storage (some companies are already using radio frequency identification and blockchain technologies for this) is unlikely to remain purely a private matter for long.

When I spoke with the fertility investor David Sable in May, he speculated about what he described as “Ray Bradbury science fiction” scenarios — warehouses full of embryos, for instance, ranked by quality and categorized by traits. Such a course of events isn’t exactly likely, he cautioned; he thought that social and scientific norms would discourage it, even in the absence of explicit regulation. But just a few months later, it emerged that Heliospect’s chief executive, Michael Christensen, was envisioning just this scenario, enabled by the possibility of lab-grown human eggs. According to Hope Not Hate’s investigation, he envisions a future in which couples could produce embryos by the thousands, then select those with the best ratings for transfer.

A majority of I.V.F. patients are white, and even in states where the cost of I.V.F. is covered by private insurance, Black and Hispanic women are less likely to use the technology. That lends such visions as Mr. Christensen's an even more dystopian tilt.

By giving parents the illusion of so much control, these technologies could lead to viewing embryos as a consumer product while overemphasizing the role of genetics in life outcomes. Proponents of procreative beneficence, such as the bioethicist Julian Savulescu, argue that the parental duty to give a child as many advantages as possible makes a strong case for technologies such as polygenic embryo testing.

Other advocates such as the Collinses believe widespread adoption of the screening could be a boon for public health by lowering health care spending on heritable diseases and, more controversially, for social ills such as violent crime by raising a society's overall IQ. "Societies that have more intelligent people will have lower rates of crime, of rape, of violence, because intelligence correlates negatively with those societal blights," Ms. Collins told me. Such population-level engineering, when done by a parent as opposed to the state, has been called liberal eugenics by its advocates.

But as the authors of a 2022 paper pointed out, simply selecting for female embryos instead of male embryos would provide an even greater degree of risk reduction for diseases such as schizophrenia,

heart disease, stroke and diabetes. And given that women attend college at higher rates than men in 114 countries, choosing female embryos would probably raise a child's lifetime educational attainment, too. While we're at it, having fewer male children would also probably lead to less violent crime, one of the rationales the Collinses proposed for screening for IQ.

Is that really how we'd like to achieve these various societal goals? "We already have genetic determinism in our society, and we're just making it worse by using technologies that send the message that the best thing you can do for your children is at the genetic level," said Dr. Ravitsky. "It's not about their nutrition. It's not about their education. It's not about having a loving and stable family environment. It's just about their genes. So I think there's something dangerous about the societal message."

Even vocal critics of polygenic screening acknowledge why prospective parents would seek this knowledge, especially when the parents or someone they love has suffered from a serious health condition. "I don't want to sound like I'm against having healthy children. I'm all in favor of having healthy children," Dr. Ravitsky said. Defining and measuring health, though, are also matters of interpretation. Genomic Prediction's single embryo health score, for example, weights the different risks of each disease using the measure of quality-adjusted life years, a common public health metric used to estimate disease burdens on a population level. But what is a quality life?

Many of those working in the field of polygenic embryo scoring have personal experience with a disease that they understandably wish to see eliminated. Dr. Treff has Type 1 diabetes. In a podcast, he observed that had his company's technology been available to his parents, he probably wouldn't have been picked, despite the manageable nature of his condition in a developed country. (One irony is that the people choosing to use these tests are likely to be the ones with the best access to health care.) Ms. Collins was diagnosed with autism later in life; she and her husband are not screening for neuroatypicality in their children, but she acknowledged that many parents would.

Dr. Treff, Ms. Siddiqui and others in this field do not dwell, publicly at least, on the fact that you cannot eliminate some diseases without eliminating the people who carry them. When I asked Dr. Treff about that — whether his parents would likely have chosen a different embryo, one not disposed to having diabetes — he didn't seem troubled. "I'm here. It's too late for me," he said. "This is really about the future, and it's about working to eliminate these diseases from family trees."

His kids, he noted, could now create children without diabetes, an option that no one had until now. "My parents didn't. I didn't. But now my kids do, and so that's what I think we should be focused on," he said. I'd be surprised if Ms. Siddiqui, who did not respond to interview requests, would judge her mother's life as anything but a

gift to those who know her, even if she and her family had to endure standing by as her mother lost her sight. But with her technology, that specific life might never have come into being.

IF THIS FUTURE in which we engage in the mass ranking of embryos by dubious risk scores seems far-fetched, it's worth looking at how a technology that's been in place for only the past decade or so has already altered how we think about and relate to embryos: time-lapse microscopy.

Time-lapse microscopy entered wide commercial use in the early 2010s. The technology allows embryologists to observe embryos' development, captured at five- to 20-minute intervals on a computer screen, thanks to specialized incubators outfitted with cameras, instead of removing them from the incubator once a day to check their progress under a microscope. This lets the embryos divide and grow undisturbed, reducing the risk of any accidents or damage.

But in the years since, the technology has evolved, giving embryologists new metrics to contemplate as they weigh which embryos to implant: the time between cell divisions, say, or the degree of visible cell fragmentation. All of this data is now used to train algorithms to ostensibly select the best ones for implantation, so pattern recognition can supplement or eventually even supplant human judgment.

So far, though, there have been no conclusive studies that show algorithmic embryo selection produces better live birthrates — the clinical term for "actual baby" and, for most I.V.F. patients, the only

metric that truly matters — than human embryologists using traditional techniques. And algorithms bring with them immediate ethical questions. The selection of which embryo may be born "is quite a fundamental decision to leave up to a model," as the scholar Lucy van de Wiel put it to me.

But the ability to visualize embryos at frequent intervals using time-lapse microscopy has not just given us new insights into their development; it has also shaped our feelings about them.

Some clinics offer live updates of the developing embryos right to a patient's iPad or phone, but this can create confusion for patients and lead to back seat embryology, with patients second-guessing their clinicians' choices. It's more common for patients to receive a link or a USB stick with video footage of their chosen embryo on the day of the transfer, which is also their last day in the clinic. What follows is a two-week wait before they'll know whether the transfer was successful, during which they possess footage that, as the British-based sociologist Manuela Perrotta found in her research, they may not know how to interpret.

Some patients get resourceful. Magdalena Zernicka-Goetz, a prominent developmental biologist, regularly hears from patients who find her research online and, knowing that she spends her days looking at embryos, ask her to weigh in on their photos or videos. Others, after experiencing a failed transfer or miscarriage, stick the USB in a drawer and try not to think about it. Still others

feel a deep sense of connection to what they saw onscreen. “I felt like it was, it was a baby,” one 29-year-old patient, finally pregnant after eight years of trying, told Dr. Perrotta and a research co-author. “It sounds really weird, but it felt like I was looking at a potential baby there, and watching it move and do all the stuff, and I just looked, it looked — I know it wasn’t just cells for me.”

Of course it wasn’t just cells for her. But was it really moving and doing all the stuff? These videos typically consist of five days of photos that are compressed into a two-minute clip, animating the embryo’s division and growth, so rather than seeming almost static, as they do in real time, the embryos appear “lively,” as the anthropologist Manon Lefèvre put it.

Images of embryos, balls of cells, are now commonplace in I.V.F. social media communities, billed as baby’s first photo. They often appear as printouts placed alongside the gurgling months-old baby, a version of the “how it started, how it’s going” meme.

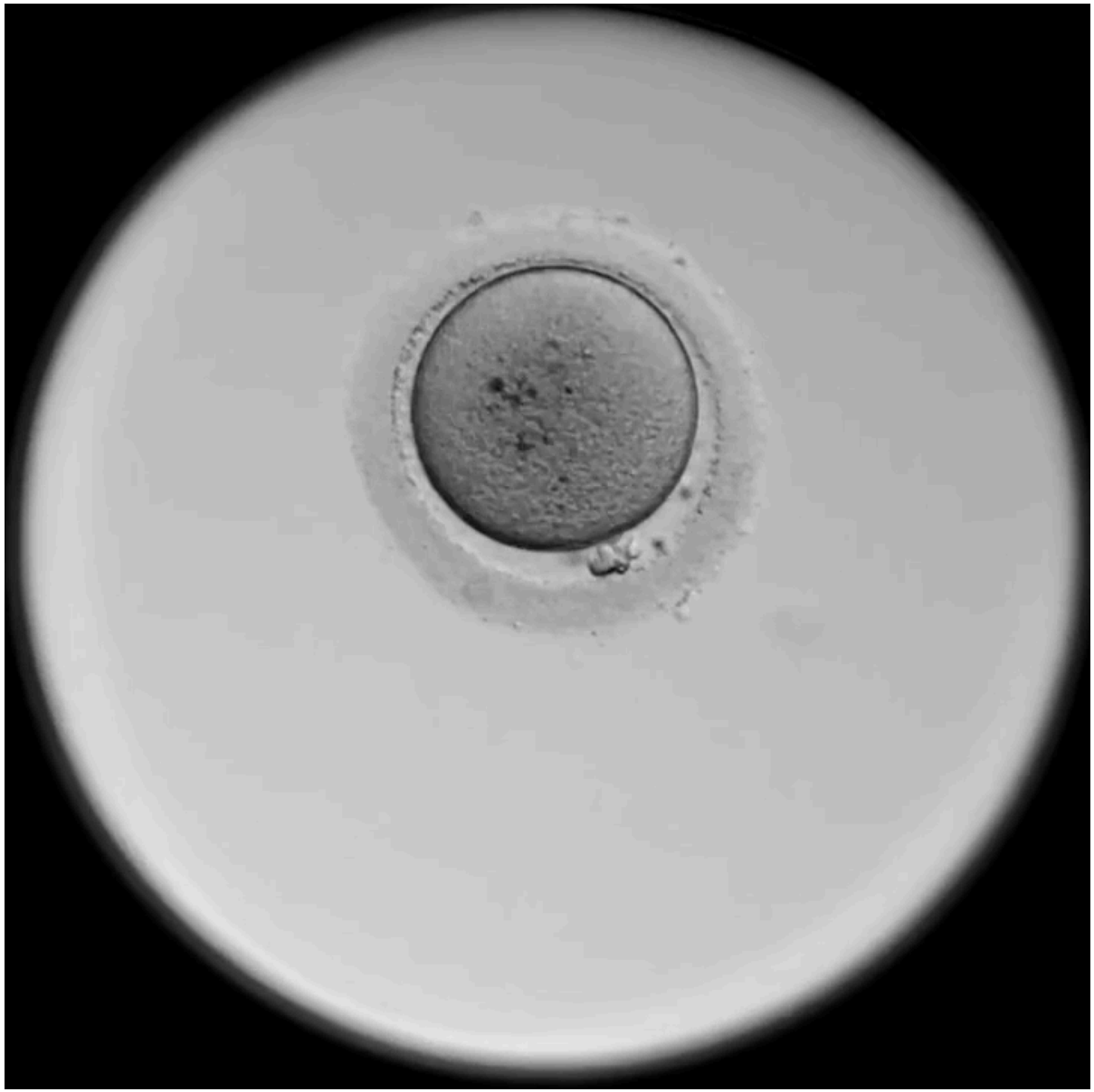
In her fieldwork at a prominent Northeastern fertility clinic, Dr. Lefèvre, who wrote her dissertation on how embryos carry different meanings throughout the I.V.F. process, observed clinicians using these visuals to anthropomorphize embryos, in order to encourage patients (“There’s the little guy! Look, it’s almost waving!”), sometimes to the point of silliness (“It looks just like you, sir!”)

As with early fetal images, this new visual access to embryos can take on a political cast. Lennart Nilsson, the Swedish photographer whose detailed portraits of fetuses and embryos were published in Life magazine as a photo essay titled “Drama of Life Before Birth,” was shocked to learn on a visit to London in the 1980s that these images of miscarried and aborted fetuses were being used as anti-abortion propaganda. (They were adopted by abortion opponents in the United States even earlier.) After seeing that, he barred the sale of his images to anti-abortion organizations.

Anthropomorphizing a couple of cells under a dish might seem a heavier lift, but as Sarah Franklin, a scholar of reproduction at Cambridge University, has pointed out, the widespread circulation of photos of petri dishes and microinjections of a sperm cell into a plump egg has created “a new visual grammar of coming into being.” I.V.F. and its related visual technologies made human embryos “the most famous of the newly mediagenic human cells,” as she put it, “increasingly public, visible, legible and even iconic.”

Learning about time-lapse microscopy made me wonder: Did a video like this exist of my embryos? I emailed the fertility clinic to ask. One Thursday morning, I sat down with my breakfast and opened up a link sent by the embryologist who was in the room the day of my embryo transfer. There it (she?) was, a gray circle wobbling and pulsing inside another circle, the egg’s zona pellucida, floating in a specially designed dish that could hold up to 16 embryos.

I didn't have footage of the other six that made it to Day 5, as the camera was zoomed in on just this one, the one that would become my daughter. I previously joked that my daughter was "the embryo that went the distance," but now it no longer seemed like a joke. There were little dots and squiggles underneath the large fertilized egg. What were those? There was no sound, and I turned up the volume, although I wasn't sure what I thought I should be hearing. A soundtrack? A voice-over from the embryologist explaining what I was seeing, like David Attenborough narrating a wildlife program?



A time-lapse video of the author's embryo. Geri Time-Lapse Camera/Clínica Fertility Madrid, via Anna Louie Sussman

I knew I was watching a sped-up video, but I consumed it at face value nonetheless. I watched the two pronuclei appear, then fade away. At 30 seconds in, the circle split into two blobs that jostled for

space. Then there were four cells, then eight. The cells got smaller each time they divided. By a minute or so in, the mass of cells began to resemble a rosette of wobbly orbs — and a lively one indeed.

On the one hand, it was hard to look at the image and not acknowledge that what I was looking at was, to use a timeworn expression, a clump of cells. They were cells. And they were arranged in a clump. At the same time, I knew the fate of this specific clump of cells: They had been observed over five days by our embryologist and stood out to her as our best chance for a child. They were selected, transferred and then, miraculously, implanted. They continued to develop and specialize over the course of nine months into organs, a spine, fingers, toes. Finally, they — all trillion-plus cells of her — emerged into the world.

At two minutes into the video, the clump, my daughter, seemed to enlarge slightly, and the hollowing out, lumenogenesis, began. A few little cells slipped out of the circle and danced around on the surface of the zona pellucida, hovering near the spot where they'd escaped, like an astronaut just outside the spacecraft. My mind was awash in clichés. I was in awe, transfixed, mesmerized.

Watching her develop onscreen was a novelty for me, because I already knew the outcome. But not all of it: My daughter isn't an Orchid baby. Her genetic risk factors remain a black box. I don't yet know what, if any, health conditions she will face or whether I

could have done something about it when she was an embryo. Now that she and I are acquainted, it seems insane — to borrow Ms. Siddiqui's term — to reduce her to a string of genetic code, given the delightful person that she is. But there will always be a part of me that wonders, guiltily, if I did her a disservice by not learning more.

Some argue that these technologies are simply options, ones we are free to use or not. But regardless of whether we use them, their mere existence will alter our relationship to embryos. By animating embryos and enabling a close-up encounter with them, time-lapse microscopy renders them more human than they already are; polygenic embryo screening reduces them to a set of probabilities. I am not convinced that not using such technologies leaves one untouched.

Right now, the availability of polygenic embryo screening is dictated by the market, its promise most vocally endorsed by the tech elite, who, as backers of the companies selling it, may have a vested interest in promoting it. The ability to act on the information it purports to provide — to hire a personal trainer, switch to an all-organic diet or consult health specialists who don't take insurance — is also reserved for those with means. One doesn't have to fully buy into its promises to worry about its implications, to wonder if this is a space in which market forces should perhaps not be given

free rein and to feel that, whether or not we avail ourselves of polygenic embryo screening, it and related innovations will eventually have implications for us all.

Look for the third and final chapter of this series when it publishes next week.

Anna Louie Sussman is a journalist who writes about gender, economics and reproduction. She is working on a book about family building in an age of uncertainty.
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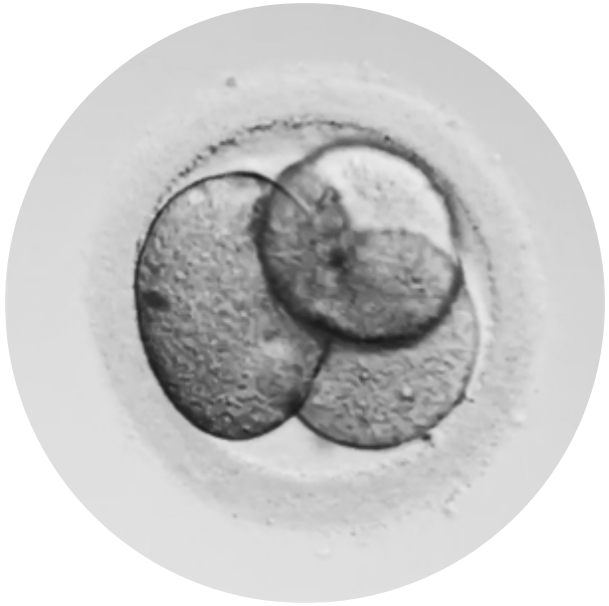
Additional reporting by Tenzin D. Tsagong.

The Embryo Question is a series about the cluster of cells at the crossroads of science, ethics and the law.



Part One
Should We Limit Embryo Research?