What happens when you die?

Not the comforting answer. Not the scary answer. The physics answer.

Richard Feynman had a way of looking at death that wasn't cold or cynical. It was strangely beautiful: you are not "made of stuff." You are a pattern in motion, built from atoms that have been traveling the universe for billions of years.

So what actually happens when life ends? Where do "you" go? And is there any sense in which something about you is… immortal?

In this video, we explore Feynman-style thinking about death through atoms, energy, and the deep recycling of nature.

You'll learn:

1. What happens to your atoms after you're gone
2. Why energy doesn't vanish, but changes form
3. The difference between matter, energy, and the information that made "you"
4. Why the universe is constantly reusing the same ancient atoms
5. The surprising kind of "immortality" physics can honestly support
6. This isn't meant to preach. It's meant to show how reality treats life: temporary, yes… but connected to everything.

(I will inject annotations in parenthetical words and notations to call your attention to the teachings of Shakyamuni and our school of Buddhism. It is a matter of profound respect, wonder, and appreciation for Buddhist teachings and insights of thousands of years of scholarship to define our enlightenment, found in the very same words in many cases, that are somehow contorted or misunderstood by modern readers.
I must also admit that my recent readings and annotations and videos on the MahaPariNirvana Sutra and my current conditions has had me thinking more about end-of-life and appropriate thoughts and preparations.

Sifu Sylvain,
Threefold Lotus Kwoon, Quantum Life Buddhism)

The Transcript:

from a video of the words and insights of Dr. Richard Feynman:

Here's a question that will sound a little morbid, but stay with me. When you die, where do you go? Now, I don't mean heaven or hell or any of that. I'm a physicist, and I'm asking you something much more interesting. Where does the stuff that is you actually go? Because here's what's strange. You've got about 7 billion billion billion atoms in your body right now. That's a seven followed by 27 zeros, seven octillion atoms. And when you die, not one of those atoms disappears. Not a single one. They're all still here. So, if nothing is lost, in what sense are you gone? That's what we're going to figure out today. By the end of this, you'll understand something profound about what you're made of, where it came from, where it's going, and why the very idea of you is stranger than you ever imagined. I think you'll never look at yourself or a blade of grass or a distant star or even a breath of air quite the same way again.

Let's start with something simple. let's start with a candle. You light a candle and it burns. The wax melts, the wick glows, and after a while, the candle is gone. Now, you might say the candle has been destroyed. But that's not quite right, is it? Where did the candle go? Well, some of it turned into light. Photons bounced around the room and eventually got absorbed by the walls, warming them slightly. Some of it turned into heat, which warmed the air and spread out through the room. And some of it, the carbon in the wax, combined with oxygen in the air to make carbon dioxide. That carbon dioxide is now floating around, maybe drifting out the window, maybe being breathed in by someone walking by outside. The point is, the candle didn't **vanish**. It ***transformed***. The atoms that made up the candle are all still somewhere. They've just rearranged themselves into different configurations, different molecules, different forms. This is one of the most fundamental laws in all of physics. Energy cannot be created or destroyed. It can only change from one form to another. We call this the first law of thermodynamics. And I want you to understand this isn't just a good approximation. This isn't just usually true. In every experiment ever conducted, in every observation ever made, this law has held. It is as close to an absolute truth as we have ever found in physics.

*(For reference I encourage you to see videos and writings on the "**Engine of Life**" in our YouTube channel...)*

Now, here's where it gets interesting. You, sitting there listening to me, you are not so different from that candle. You are in the most literal sense burning right now. As you sit there, your body is taking in oxygen, combining it with the food you ate, and releasing energy. But let me tell you exactly how much energy, because the numbers are extraordinary. At any given moment, your body contains about 250 grams of a molecule called ATP, Adenosine TriPhosphate.

That's the energy currency of life. Every cell in your body uses ATP to do work, to move, to build proteins, to think. And here's what's remarkable. That 250 gram of ATP represents only about four watts of power. The equivalent of a small LED light bulb, that's all the ATP you have at any moment. But wait, your body uses far more than four watts. At rest, you're burning about 80 to 100 watts. When you're exercising, maybe 500 watts or more. So, how does that work? The answer is that your cells are recycling ATP at a furious rate. Each ATP molecule gets used and regenerated about a thousand times per day. Your body produces, uses, and regenerates roughly your entire body weight in ATP every single day. 40 to 70 kg of

ATP made fresh every 24 hours. Let me put this another way. Over the course of a day, a healthy person produces about 1,200 watts of total energy. That's enough to power 1,200 household light bulbs simultaneously. If you could somehow harness it all at once, of course, you can't. The energy is released gradually, continuously as your cells burn through that recycled ATP. And where does this happen? In tiny structures inside your cells called mitochondria. You have about 10 million billion of them. 10 quadrillion mitochondria, each one a microscopic power plant. Each one burning fuel and churning out ATP. The mitochondria have their own DNA separate from the DNA in your cell's nucleus. This is because they used to be free-living bacteria. About two billion years ago, one of our single-celled ancestors engulfed a bacterium but didn't digest it. Instead, they formed a partnership. The bacterium provided energy and the host cell provided protection and nutrients. Over billions of years, that bacterium became the mitochondria. You are in a very real sense a colony of organisms.

Here's another way to think about the energy numbers. The average cell uses about 10 billion ATP molecules per day. You have roughly 37 trillion cells. Do the math and your body is cycling through something like 3 times 10^{25th} ATP molecules every day. That's 300 trillion trillion molecules being built, used, and rebuilt in a continuous chemical symphony that never stops from the moment you're born until the moment you die. And consider this, your brain, which is only about 2% of your body weight, uses about 20% of your energy. A single thought, a single memory being formed requires billions of ATP molecules. When you're thinking hard, solving a problem, your neurons are firing at tremendous rates. Each firing requiring billions of sodium ions to be pumped back across cell membranes. Each pump cycle requiring ATP. It's estimated that a single action potential, one electrical signal traveling down one neuron, requires about a billion sodium ions to be moved, which means about a billion ATP molecules to reset that one neuron for its next signal.

When that symphony stops, that's death. Not because the atoms go away, but because the process stops, the pattern stops being maintained.

(I refer to this "symphony", this "pattern" as the "Identification" process we are samsarically locked into. And, it is also the 9 consciousnesses. That includes the very 9th consciousness wherein the potential enlightenment or Buddha-ness manifests. In this view you could envision Buddha as a pattern for the experience of enlightenment in your mind.)

But I'm getting ahead of myself. Let me go back to basics. And just like the candle, you are constantly releasing atoms into the world. Every breath you exhale carries away carbon dioxide, about 200 milliliters of it. That's carbon that was part of your body a moment ago, now floating free. Every drop of sweat releases water and salts.

Every time you shed a skin cell, that's atoms leaving your body. You lose about 30,000 to 40,000 dead skin cells every minute. You are not a static thing. You are a process, a river of atoms flowing through a particular pattern we call you. Now suppose you wanted a physicist to speak at your funeral. I've actually thought about this. You'd want the physicist to talk to your grieving family about the

Conservation of energy. You'd want them to understand that your energy has not died.

(It has transformed. Again the Engine of Life, the Nidana, the chain of tendencies and conditions assembling all "symphonies", of form in Life.)

Here's what I'd want that physicist to say. No energy gets created in the universe and none is destroyed. All your energy, every vibration, every bit of heat, every wave of every particle that was your beloved, it all remains in this world. The photons that bounced off your face, the particles whose paths were interrupted by your smile, by the touch of your hair, hundreds of trillions of them, they've scattered off into the world like children running in all directions. They're still out there. They will always be out there. According to the law of conservation of energy, not a bit of you is gone. You're just less orderly. That's all. But wait, let's go deeper. Much deeper. Let's ask where those atoms came from in the first place. Pick up your hand and look at it.

Let me tell you exactly what you're made of. By mass, you are about 65% oxygen. Surprised? Most people are, but remember, you're mostly water, and water is H2O, and oxygen is the heavy part. One oxygen atom weighs 16 times as much as one hydrogen atom. So even though hydrogen atoms outnumber oxygen atoms 2 to1 in water, oxygen dominates by weight; after oxygen comes carbon about -- 18% of your mass, then hydrogen at about 10%. Then nitrogen at about 3%. Together these four elements oxygen, carbon, hydrogen and nitrogen make up about 96% of your body mass. just four elements out of the 92 naturally occurring ones. The remaining 4% includes calcium, about 2% mostly in your bones and teeth, phosphorus, about 1% critical for your DNA and ATP. Then smaller amounts of potassium, sulfur, sodium, chlorine, and magnesium. And finally, trace elements, iron, zinc, copper, iodine, and a few others in tiny amounts. but absolutely essential. The iron in your body, if you extracted at all, would make a nail about 3 inches long. That's it. But without that tiny bit of iron, you couldn't carry oxygen in your blood, and you'd die in minutes.

Now, let's count atoms instead of weighing them. By number of atoms, you're about 63% hydrogen, 24% oxygen, and 12% carbon. The vast majority of atoms in your body are hydrogen. The simplest atom, just one proton and one electron. Here's a striking way to think about it. There are more atoms in your body than there are stars in the observable universe. The observable universe contains roughly 200 billion galaxies, each with roughly 200 billion stars. That's about 4 times 10^{22nd} power stars. But you have 7 times 10 ^{27th} atoms. You contain about a 100,000 times more atoms than the universe has stars. Now I want you to consider the carbon atoms in your skin. There are about 700 billion billion of them in your body. 7 times 10^{26th} power.

Where did they come from? Well, you ate them. They were in your food. Maybe in a piece of bread or a carrot or a steak. And where did the bread get its carbon? From the wheat plant, which pulled carbon dioxide out of the air during photosynthesis. And where did that carbon dioxide come from? Other plants and animals that breathed it out or decomposed or burned. But trace it back far enough and you get to a remarkable place. The carbon in your hand was not always on Earth. Wasn't even made on Earth. It was forged in the heart of a dying star. Let me explain this carefully because it's one of the most beautiful things we've discovered about the universe. In the beginning, just after the Big Bang about 14 billion years ago, the universe had only the simplest atoms. Let me be precise about this because the details matter and they're fascinating. At the very beginning, in the first fraction of a second, there weren't even atoms.

The universe was a soup of quarks and gluons, so hot and dense that nothing we would recognize as matter could exist.

The temperature was over a trillion degrees. As the universe expanded and cooled, quarks combined into protons and neutrons. This happened when the universe was about one microsecond old. Think about that. One millionth of a second after the big bang, the building blocks of all matter came into existence. But even then, it was too hot for protons and neutrons to stick together. They would combine and immediately be blasted apart by the intense radiation. It was like trying to build a house of cards in a hurricane. In the first 3 minutes after the Big Bang, the universe was a roaring soup of particles at unimaginable temperatures, about 10 billion degrees. At 1 second old, it was still too hot for even simple atomic nuclei to survive. Protons and neutrons were forming and breaking apart constantly. Here's a key fact: At 1 second old, there were about seven protons for every neutron. Why? Because neutrons are slightly heavier than protons. And in the hot conditions of the early universe, the reactions that converted neutrons to protons happened slightly faster than the reverse. This ratio would turn out to be crucial for the chemistry of the entire universe. But as the universe expanded, it cooled.

*(I will note here that several new discoveries in Astrophysics have called into serious question previously held beliefs on the "age" of this universe as well as the postulated "Big Bang" of classical physics and Astronomy. I have often held the work of Roger Penrose and his "**CCC**" or Conformal Cyclical Cosmology as a brilliant light into this research. My own interpretation is that what is "labeled" or identified as the Big Bang should be relabeled the **Big Inversion** from the previous instantiation of this universe into its reanimation. All this is to say that the insights of this paper still hold.)*

And when it cooled enough, about three minutes after the big bang, something remarkable happened, protons and neutrons began sticking together. First they made deuterium, heavy hydrogen, one proton and one neutron. Then helium 3, two protons and one neutron. Then helium 4, two protons and two neutrons. And a tiny tiny bit of lithium 7. The timing was everything. By about 3 minutes, the temperature had dropped to about a billion degrees, cool enough for nuclei to form, but still hot enough for fusion to happen. This window lasted only about 17 minutes. By 20 minutes after the Big Bang, the universe had cooled too much. The density dropped. The particles were too far apart to collide often enough. And so, the cosmic nuclear reactor shut down. What was the result? a universe that was about 75% hydrogen by mass, about 25% helium, about 0.01% deuterium, and about 110 billionth lithium. And nothing else. No carbon, no oxygen, no nitrogen, no iron, no calcium, none of the heavy stuff that makes up rocks and trees and people. Here's the key point. There was a bottleneck. There's no stable nucleus with five nucleons or eight nucleons. Helium 4 is very stable, but if you add one more proton or neutron, the resulting nucleus falls apart almost instantly. And two helium 4 nuclei combined would make beryllium 8, which falls apart in about 10us 16 seconds.

(For a beautiful insight on this "sticking together" process in the Buddhist teachings, please find the elegant interpretation of the 12 linked causal chain or Niddana from the book "The Doctrine of Awakening: The Attainment of Self-Mastery According to the Earliest Buddhist Texts", by Julius Evola, ISBN-13: 978-0892815531. "Evola... had a clarity of mind and a gift for explaining tremendously difficult concepts in nonacademic language. His account of the niddana-chain (the twelve stages of conditioned genesis) is a masterpiece. It equips the reader for a whole new understanding, not only of Buddhism, but of the human state in general." — Gnosis Magazine)

There was no way in those first 20 minutes of cosmic history to build anything heavier than lithium. So where did all the heavy elements come from? They had to wait for stars. The first stars formed about 200 million years after the Big Bang when gravity pulled together the primordial hydrogen and helium into dense clouds that collapsed and ignited. These first stars were monsters 30 to 300 times the mass of our sun, burning hot and bright and fast. A star, you see, is a giant nuclear reactor. In its core, under tremendous pressure and temperature, about 15 million degrees in a star like our sun, hydrogen atoms fuse together to form helium. Four hydrogen nuclei smash together and become one helium nucleus, releasing energy in the process. That's what makes the sun shine. That's the power source that has kept our star burning for 5 billion years. But in more massive stars, the story goes further. When the hydrogen runs out in the core, the core contracts and heats up even more. If it gets hot enough, about 100 million degrees, something remarkable happens. Helium atoms start fusing into carbon. This is called the triple alpha process. And it's a delicate thing. Two helium nuclei fuse to form beryllium 8, which is wildly unstable. It falls apart in about 10^7 seconds. That's a decimal point followed by 16 zeros and then a one almost instantly. But if in that tiny window a third helium nucleus comes along and collides with the beryllium 8, you get carbon 12 stable carbon. The carbon that makes up the backbone of every organic molecule in your body. Here's something remarkable about this process. The reaction rate depends on temperature to the 40th power. The 40th power. That means if you double the temperature, the reaction rate increases by about a trillion trillion trillion times. This is why the triple alpha process only happens at very high temperatures above 100 million degrees and why it's so sensitive to conditions. It's like a finely tuned mechanism. The physicist Fred Hoyle actually predicted that this reaction must exist based purely on the observation that carbon exists in the universe. He said in effect, if carbon exists, there must be some way to make it. There must be a resonance, an energy level in the carbon nucleus at exactly the right energy to make this reaction possible. And when experimenters looked, they found exactly the resonance he predicted at 7.65 million electron volts above the ground state. This is sometimes cited as evidence for the Anthropic principle, the idea that the universe must have the properties that allow for the existence of observers like us. If this resonance didn't exist, if the energy levels were even slightly different, carbon wouldn't form efficiently in stars, and we wouldn't be here to wonder about it. Nature had to be precisely tuned for carbon to exist. And here we are made of it.

Now, the story doesn't stop at carbon. In massive stars, much more massive than our sun, the fusion continues. Carbon fuses with helium to form oxygen. Oxygen fuses to form neon. Neon to magnesium, magnesium to silicon, silicon to iron. But iron is the end of the line for normal fusion. Here's why. When you fuse lighter elements together, you release energy. The products weigh slightly less than the ingredients. And that missing mass becomes energy according to Einstein's famous equation. But iron is at the bottom of the binding energy curve. Fusing iron doesn't release energy. It absorbs it. It's like trying to roll a ball up a hill instead of down. So when a massive star builds up an iron core, something dramatic happens. The core can no longer generate energy to hold itself up against gravity. In less than a second, an iron core the size of the Earth and with the mass of the sun collapses into a ball of neutrons just a few kilometers across. This gravitational collapse releases an enormous amount of energy, more than 100 times what our sun will radiate over its entire 10 billion-year lifetime. The outer layers of the star are blown off in a catastrophic explosion. This is a supernova, one of the most violent events in the universe. For a few weeks, a single exploding star can outshine an entire galaxy of a hundred billion stars. And in that explosion, in those brief catastrophic seconds, something magical happens. The conditions become so extreme, so hot, so dense with neutrons that elements heavier than iron can form. This is called the R process. R for rapid. Neutron capture happens so fast, millions of captures per second, that the nuclei can build up faster than radioactive decay can tear them down. Think about what's happening. You have a nuclear fire raging at temperatures exceeding a billion degrees. Neutrons are flying everywhere. An iron nucleus absorbs a neutron, then another, then another. In seconds, it's captured dozens of neutrons and become wildly unstable. But before it can decay, it captures more. The nuclei are racing up the periodic table, becoming gold, platinum, uranium. In 2017, astronomers detected gravitational waves from two neutron stars colliding, and they pointed their telescopes at the source. They saw the glow of newly formed heavy elements, including gold, being forged in real time. We watched the universe make gold. The kilo-nova, as it's called, produced about 10 Earth masses of gold in seconds. 10 Earth masses. That's where much of the gold in your wedding ring came from. Neutron star collisions. So, some of your heavy elements came from supernovas and some came from colliding neutron stars. Either way, we're talking about the most extreme events in the cosmos. And then all of this material, everything the star spent millions of years building in its core, everything the supernova or neutron star collision created in seconds, it gets flung out into space at 10,000 km/s. It mixes with interstellar gas clouds and eventually those clouds collapse under their own gravity to form new stars, new planets, new everything.

Our sun is a third generation star. The dust cloud that formed the solar system was already enriched with heavy elements from earlier supernovas. The earth condensed from that dust about 4 and a half billion years ago. And you, every atom of carbon and oxygen and nitrogen and calcium and iron in your body, you are made of star stuff. This isn't poetry. It's fact. The iron in your blood, the same iron that carries oxygen from your lungs to your tissues, was forged in a star that exploded before the sun was born. The calcium in your bones, came from the dying breath of a red giant. The phosphorus in your DNA, the element that forms the backbone of the molecule that carries your genetic code, was created in a supernova.

Speaking of DNA, let me tell you how much information is stored in your body. A single human cell contains about three billion base pairs of DNA. If you stretched out all the DNA in one cell, it would be about 2 meters long. Now you have roughly 37 trillion cells. And most of them have a complete copy of your genome. If you stretched out all the DNA in your body, end to end, it would reach from Earth to the sun and back about 600 times. That's over a 100red billion km of DNA. And that DNA is constantly being copied, checked, repaired, and read. Every second, your cells are reading millions of genetic instructions, building proteins, maintaining the patterns that make you you. I like to put it this way. I am a universe of atoms. And I am also just an atom in the universe. Now, let me tell you something that might surprise you.

(And now we have a beautiful description of "Impermanence" mirroring the early teachings of ShakyamuniBuddha.)

Those atoms in your body, most of them weren't there a year ago. Studies using radioactive tracers have shown that about 98% of the atoms in your body are replaced every year. This was first discovered in the 1,950 seconds at Oakidge National Laboratory, where scientists used radioactive isotopes to track atoms moving through the body. The water in your body turns over in about 2 weeks. Half the water molecules in you right now weren't there 16 days ago. Think about that. You drink, you sweat, you urinate, you breathe out water vapor. The water flows through you like a river. The sodium and potassium in your cells, they cycle in and out constantly through ion channels, millions of times per second in each cell. The calcium and phosphorus in your bones, even your bones, the hardest tissues in your body, they get replaced every year or so as the tiny crystals in your skeleton dissolve and reform. Your bones are not static structures. They're constantly being demolished and rebuilt by specialized cells called osteoclass and osteoblasts. Different tissues replace themselves at different rates. And the numbers are fascinating. The cells lining your stomach last only about 5 days. They're constantly being destroyed by stomach acid and constantly being replaced. That means your stomach lining is completely new every week. Your taste buds last about 10 days. Your red blood cells live about 4 months before they're broken down in your spleen and recycled. Your white blood cells, the soldiers of your immune system, live anywhere from a few hours to several years depending on the type. Your skin cells last two to three weeks. Your liver regenerates itself every year or two. Some cells though are with you for life. Most of the neurons in your brain, the cells that hold your memories and make you who you are, were born when you were very young and will be with you until you die. Some neurons in your cerebral cortex are as old as you are. The cells of your eye lens formed before you were born will never be replaced. And certain cells in your heart muscle, the Cardiomyocytes, are remarkably long lived. They turn over very slowly, only about 1% per year. So here's a strange thought. The atoms that made up your body when you were 10 years old are almost entirely gone, scattered to the winds, literally. Some of them are in other people now. Some are in trees. Some are in the ocean. Some have been breathed in by a stranger on the other side of the world. The atoms that were you at age 10 are not the atoms that are you today. And yet you feel continuous. You remember being 10. You feel like the same person. So what is it that persists if not the atoms themselves? It's the pattern, the organization, the information. Think of it like a whirlpool in a river. The water flowing through the whirlpool is constantly changing. New water comes in, old water flows out. But the whirlpool itself, the pattern, the shape that persists, the whirlpool is not a thing made of specific water molecules. It's a dynamic pattern that water molecules temporarily participate in. You are like that. A pattern that persists while the material flows through. Or think of a flame.

The flame of a candle is not made of any particular molecules. The molecules are constantly changing. Fuel coming in, combustion products going out. But the flame persists as a pattern, a self- sustaining process as long as conditions allow. You are in some sense a very complicated flame.

Now, wait. Someone might say, "If our atoms are constantly being replaced and we're still the same person, then what actually changes when we die?" Uh, that's a good question. Let me try to answer it carefully. When you're alive, you're what physicists call an open system. You're constantly exchanging matter and energy with your environment. Food comes in, waste goes out, heat radiates away, new atoms replace old ones. But there's a pattern that maintains itself. Your cells keep working together in a coordinated way. Your heart keeps beating. Your brain keeps firing. The pattern sustains itself by consuming energy and maintaining organization against the natural tendency toward disorder. This tendency toward disorder is called entropy and it's described by the second law of thermodynamics. The second law says that in any isolated system, entropy tends to increase. Things tend to become more disordered, more mixed up, more uniform. Heat flows from hot to cold, never the reverse. A drop of ink spreads through a glass of water. It never spontaneously concentrates. A glass can fall off a table and shatter. The pieces never spontaneously reassemble and jump back up. Why? Because there are vastly more disordered arrangements than ordered ones. Think of a deck of cards. There's only one way to arrange it in perfect order, ace through king, in each suit. But there are about 8 times 10^{67th} ways to arrange it. If you shuffle the deck randomly, what are the odds you'll get perfect order? Essentially zero. Not because physics forbids it, but because the disordered arrangements overwhelmingly outnumber the ordered one. The same is true of atoms. The atoms in your body could in principle spontaneously rearrange themselves into random gas. Physics doesn't forbid it, but the probability is so astronomically low that it will never happen in the lifetime of the universe. Life fights against this tendency toward disorder.

Every living thing is a temporary pocket of low entropy, a temporary island of order in a universe that trends toward disorder. But it takes work. It takes energy to maintain that order. You have to keep eating, keep breathing, keep burning fuel to stay organized. The physicist Irwin Schrodinger in his famous book, *What is Life*? pointed out that living things feed on negative entropy. They take in ordered energy rich molecules like glucose and they excrete disordered waste like carbon dioxide and water. The price of maintaining your low entropy body is increasing the entropy of your surroundings even more. Life doesn't violate the second law. It just shifts entropy from here to there, from inside to outside. While overall entropy still increases. When you die, that fight ends. The pattern stops sustaining itself. The coordination breaks down.

Your cells stop working together and the second law takes over. What happens next is remarkably fast. Without oxygen, your cells begin to die within minutes. The enzymes that were busy building things start breaking things down instead. Bacteria that live peacefully in your gut, held in check by your immune system, begin to multiply and spread. Within hours, they're consuming you from the inside. Decomposition releases carbon dioxide back into the atmosphere. It releases nitrogen compounds into the soil. It releases water. Over weeks and months, the complex organic molecules that made up your body are broken down into simpler and simpler compounds. The atoms that were organized into you disperse. Some of your atoms become part of the soil. Some get taken up by plant roots. Some are eaten by insects and bacteria. Some evaporate as gases and drift away on the wind. Your carbon atoms might end up in a blade of grass. That grass might be eaten by a cow. That cow might be eaten by someone in a restaurant across the world. Your atoms, the ones that were briefly part of you, become briefly part of other living things. This is the carbon cycle. About 90% of all the carbon dioxide returned to the atmosphere each year comes from decomposition, from the breakdown of dead organisms. Without decomposition, carbon would get locked up in dead bodies, and the whole cycle would grind to a halt. Decomposition is not just the end of life. It's what makes new life possible. Here's a remarkable thing to consider. The carbon atoms in your body have been around for billions of years. Some of them were probably once part of a dinosaur. Think about that. A 100 million years ago, a dinosaur breathed in, ate plants, incorporated carbon into its bones and muscles, then it died, decomposed, and that carbon went back into the cycle. Plants pulled it from the air. Animals ate the plants. Microbes broke down the dead. And so on for a 100 million years, atoms cycling through countless living things until some of that carbon ended up in the food you ate last week. And now it's part of you.

Here's another way to think about it. Consider a glass of water. The water molecules in that glass have been around for billions of years, cycling through the hydraological cycle. Some of those molecules evaporated from a prehistoric ocean, fell as rain on a Jurassic forest, were drunk by a dinosaur, excreted, evaporated again, fell again, flowed through rivers and underground aquifers for millions of years, and ended up in your glass. You're drinking the same water made of the same oxygen and hydrogen atoms that dinosaurs drank. And it goes the other way, too. Some of the atoms in you right now will millions of years from now be part of creatures that don't exist yet. You are connected materially, atomically to the deep past and the deep future.

But here's something even more immediate. Every breath you take connects you to everyone who has ever lived. Let me show you a calculation that physics students sometimes do called Caesar's last breath. When Julius Caesar was assassinated in 44 BC, he exhaled a final breath. That breath contained about 25 sextilian molecules. That's a 25 followed by 21 zeros. Now, that seems like a lot, but the

Earth's atmosphere contains about 10 to the 44th molecules. So Caesar's last breath was just a tiny fraction of the whole atmosphere. But here's the thing. Over the past 2,000 years, those molecules have mixed throughout the entire atmosphere. They've spread around the globe. Nitrogen, which makes up most of the air, is remarkably stable. A nitrogen molecule, two atoms bound together by a triple bond, can persist for millions, maybe billions of years. It doesn't react with much. So those molecules from Caesar's last breath are still out there spread uniformly through the atmosphere. And when you do the math, when you compare the tiny fraction that was Caesar's breath to the enormous number of molecules in your breath, the numbers almost exactly cancel out. The result, on average, every breath you take contains about one molecule from Caesar's dying gasp. Not metaphorically, mathematically, statistically. And it's not just Caesar. Every breath you take contains molecules breathed by Cleopatra, by Genghis Khan, by Leonardo da Vinci, by your great great grandmother. The air we breathe connects us to everyone who has ever exhaled. Let me pause here and check that I've been clear because this is important and I want to make sure a bright 12-year-old could follow along. Here's what we've established. Everything is made of atoms. The universe started with only hydrogen, helium, and a trace of lithium. All made in the first 3 minutes after the big bang. Everything else, every carbon and oxygen and iron atom was made later inside stars. Stars fuse light elements into heavy ones. Supernovas and neutron star collisions create the heaviest elements. These atoms get scattered into space, form new solar systems, and eventually become part of planets and people. The atoms in your body came from stars that exploded billions of years ago. While you're alive, your atoms are constantly being replaced about 98% every year. But the pattern that is you, does not persist when you die. The pattern stops being maintained and your atoms scatter back into the world to become part of other things. Your energy doesn't disappear either. It just spreads out and becomes less organized. And every breath you take connects you materially to every person who has ever lived. Got it? Good.

Now, let's tackle a common misconception. Some people hear this and say, "Well, if my atoms go on existing after I die, then in some sense, I'm immortal." But this isn't quite right. And it's important to understand why. The atoms that make up you have no memory of being you. A carbon atom that was in your brain doesn't carry around some essence of your thoughts. It's just a carbon atom. Six protons, six neutrons, six electrons behaving exactly like every other carbon one two atom *(carbon 12)* in the universe.

What made it part of you was its position, its relationship to all the other atoms. The pattern it was participating in. Once that pattern dissolves, the atom is just an atom again. So the immortality of your atoms is not the same as your immortality. Your atoms will persist, but you, the pattern, the organization, the information, the particular arrangement that thinks and feels and remembers, that's what ends at death. Is this sad? I don't know. I find it fascinating and in a way beautiful. Let me give you a thought experiment. Suppose I told you that in 5 years, every atom in your body will have been replaced. Would you feel like you're going to die in 5 years? Of course not. You feel like you're going to keep living just with different atoms carrying on the pattern. The specific atoms don't matter. What matters is the continuity of the pattern. When the pattern stops being maintained, that's death. But the atoms themselves are indifferent to the whole thing. Now, here's something truly remarkable. How long do atoms themselves last? A carbon atom in your body is made of protons, neutrons, and electrons. The electrons can be knocked off and replaced. That happens all the time in chemistry. The neutrons, if they're outside a nucleus, decay in about 15 minutes into a proton, an electron, and an anti-neutrino. But inside a nucleus, bound together with protons by the strong nuclear force, neutrons are stable. And protons, protons appear to be extraordinarily stable. Scientists have been looking for proton decay for over 40 years. They've built enormous detectors, tens of thousands of tons of ultra pure water in deep underground mines, isolated from cosmic rays, watching patiently for a single proton to disintegrate. And they've never seen it happen, not once.

The current experiments tell us that the average proton must live longer than $10^{34\text{th}}$ years. That's a 1 followed by 34 zeros. For comparison, the universe is only about 10 to the 10th years old, 14 billion years. The lower limit on proton lifetime is a 100 trillion trillion times longer than the current age of the universe. Now, some theories in physics predict that protons might eventually decay. Grand unified theories suggest that protons could have a half-life of maybe 10 the 36 years or even longer. But even if that's true, it's so rare we've never observed it. What does this mean? It means the atoms that make up your body are for all practical purposes immortal. They've already existed for billions of years. They will continue to exist for billions more, maybe trillions, maybe forever. They were here before the Earth formed. They'll be here long after the sun burns out and becomes a white dwarf. They are far more permanent than any building, any mountain, any star. And you, for one brief moment in cosmic time, got to borrow some of them. You got to organize them into something that could think about where they came from. Something that could look up at the stars and realize that the atoms in its eyes were once inside those very stars. Now, let me tell you about the far future because it's relevant to understanding what happens to energy and matter in the long run. Remember how I said entropy always increases? The second law of thermodynamics says the universe is heading toward a state of maximum disorder. What does that mean when taken to its logical conclusion? Physicists call it the heat death of the universe doesn't mean things get hot. Quite the opposite. It means things get cold and uniform and still. But before we get to that ultimate fate, let's talk about what happens closer to home. In about 5 billion years, the sun will exhaust the hydrogen in its core. Without hydrogen fusion to hold it up against gravity, the core will contract and heat up. This will cause the outer layers of the sun to expand enormously. The sun will become a red giant, swelling to perhaps 200 times its current size. Its surface will reach out past the orbit of Mercury, past Venus, and possibly engulf the Earth. Even if Earth survives, it will be sterilized. The oceans will boil away. The atmosphere will be stripped off. Everything alive will be gone long before the sun itself dies. Eventually, the sun will shed its outer layers in a beautiful planetary nebula, and its core will collapse into a white dwarf, a dense ball of carbon and oxygen about the size of the Earth, but with the mass of the sun. This white dwarf will slowly cool over billions of years, eventually becoming a cold, dark cinder. But that's just our sun. What about the universe as a whole?

Here's the timeline as best we understand it. In about a 100 billion years, the expansion of the universe will have carried all the distant galaxies beyond our cosmic horizon. The sky will go dark except for the stars in our own local group. Eventually, the Milky Way and Andromeda will merge into one giant galaxy, and that's all we'll have. In about a trillion years, the last new stars will form. The gas clouds needed to make new stars will be exhausted. The lights will start going out. In a 100red trillion years, the last red dwarf stars, tiny and mistily, burning their hydrogen slowly, will finally exhaust their fuel and fade to black. The universe will be dark. But it gets worse. The stellar remnants, the white dwarfs and neutron stars, they'll still be around for a while. But over time scales of 10 to the 37th years, if protons do eventually decay, even these will slowly evaporate. Atom by atom, the matter in the universe will dissolve. And the black holes, they evaporate too. Stephen Hawking showed that black holes slowly radiate energy and shrink. A black hole with the mass of the sun would take about 10 to the 67th years to evaporate. A super massive black hole at the center of a galaxy would last maybe 10 to the 100th years. But eventually even they're gone. What's left? Just photons, neutrinos, and maybe some electrons and positrons spread incredibly thin across an incomprehensibly vast cold empty space. No temperature differences. No energy gradients, no possibility of doing work, maximum entropy, heat death. The universe will be just a few degrees above absolute zero. Actually, not even that. As the universe continues to expand, the temperature will asymptotically approach zero, but never quite reach it. *(Remember the "CCC", cyclical conformal cosmos…?)*

In this state, nothing interesting can happen. No stars, no chemistry, no life, no change. Just a vast, cold, dark, expanding, nothing forever. This is what the second law of thermodynamics predicts as the ultimate fate of the universe. Everything you love, everything humanity has ever built, every star and galaxy and planet will eventually be dispersed into a uniform, featureless void. Is this depressing? Maybe. But here's another way to think about it. Right now, the universe is young. It's only 14 billion years old. The era of stars, the era in which complex structures can exist, in which life can flourish. This era will last for roughly 10 to the 14th years. That's a 100red trillion years. We're at the very beginning. If the history of the universe were a thousand page book and the Stelliferous era, the era of stars, were the whole book, we would be on the first word of the first sentence of the first page. Stars have been shining for about 14 billion years, and they'll keep shining for another 100 trillion. We've seen 0.01% of the age of stars. And the universe didn't have to be this way. The laws of physics could have been different. There could have been no stable matter, no stars, no planets, no life. But instead, we got a universe that makes carbon in stellar furnaces that spreads it through space in spectacular explosions that allows it to clump together into planets where chemistry can become biology and biology can become consciousness. We are unimaginably lucky to exist at all.
And we are unimaginably lucky to exist now in this brief window of cosmic history when the universe is interesting. This brings me to the big picture. Why does any of this matter? What does it change about how we see the world? I think it changes a lot when I look at a leaf. I don't just see a leaf. I see carbon atoms that were pulled from the air that came from decomposed plants and animals that were exhaled by creatures living and dead for millions of years that ultimately trace back to ancient supernovas. Every leaf is a temporary assembly of atoms that have been on epic

journeys through space and time. When I breathe, I'm taking in atoms that have been through countless other lungs, human and animal, over millions of years. Right now, as you read this, you are breathing in atoms that were once part of dinosaurs, ancient forests, Roman emperors, medieval peasants, and every other breathing creature that has ever lived. We are all connected not in some vague spiritual sense, but materially, atomically, demonstrably.

And when I think about death, I don't see it as an ending in the sense of annihilation. ***Nothing is annihilated***.

(This was often misunderstood in the early years of Buddhist monks and sects. Annihilation and indeed transformation was based on identification and the idea of a "real" or permanent self, along with ideas on emptiness. Only in the Mahayana are these misunderstandings confronted head-on in the sutras on the perfection of wisdom or mind and authors like Nagarjuna. The following paragraph will remind the reader of the "Self" as a realization of one to one co-generative energies in the cosmic Engine of Life, without identification or form.)

Everything is transformed. The pattern that is me will dissolve. Yes, the organization will disperse. The low entropy island that I represent will melt back into the high entropy ocean of the universe. But the atoms will go on to be part of new patterns. Some of them will end up in other people. Some will end up in trees or birds or fish. Some will be breathed in by children not yet born. Some will eventually find their way back into new stars where they'll participate in fusion reactions and maybe be scattered again by new supernovas to become part of new planets and new life forms in the distant future. There's a kind of comfort in that, I think. Not the comfort of personal survival, because that's not what this is, but the comfort of being part of something vast and ongoing, of knowing that you're made of the same stuff as everything else, and that stuff will keep existing and keep rearranging itself into new wonders long after you're gone. The universe is not wasting material. Nothing is thrown away. Every atom that has ever been part of a living thing will be part of living things again. I once stood at the seashore and started to think about this. The waves, mountains of molecules, each one stupidly minding its own business, trillions of them apart, yet forming white surf in unison, ages and ages before any eyes could see. Year after year, thunderously pounding the shore as now. For whom? For what? On a dead planet with no life to entertain. And then life appeared. Deep in the sea, molecules began to copy themselves. They made others like themselves. And a new dance started, growing in size and complexity. Living things, masses of atoms, DNA, protein, dancing a pattern ever more intricate, out of the cradle onto the dry land. Here it is standing. Atoms with consciousness, matter with curiosity. That's what you are. You are matter that has organized itself to the point where it can wonder about itself.

You are the universe asking questions about its own nature. (***Tathagata***!)

You are atoms contemplating atoms. And when you die, the universe doesn't lose any atoms. It just loses one particular way of asking questions. But here's the remarkable thing. The questions you asked, the thoughts you thought, they had effects. They changed other patterns. They rippled outward. Every conversation you've ever had changed someone else' brain slightly. Every book you've read, every idea you've shared, every moment of kindness or cruelty left traces in the world. Information propagates. Ideas outlast the brains that conceive them. The patterns you created in other minds, the ways you influence the world, those can persist far longer than any particular arrangement of carbon and oxygen. Perhaps the most durable part of you isn't your atoms at all. It's the patterns you created in the minds of others. I want to leave you with one last thought. We've talked about how atoms cycle through living things. How energy transforms but never disappears.

How you're connected to stars and dinosaurs and everyone who has ever breathed. But there's something even stranger that modern physics hints at, though we don't fully understand it yet. The atoms in your body, they're not really separate things at all. At the deepest level, quantum field theory tells us that particles are excitations of underlying fields. Let me explain what that means. Think of a field as something that has a value at every point in space. Like temperature in a room or the height of waves on a pond.

Now, quantum mechanics says these fields can't sit still. They fluctuate. They vibrate. And when they vibrate in certain ways, we see what we call particles. The electron in your eye and the electron in a distant star are fundamentally the same kind of ripple in the same underlying electron field. There's one electron field that fills the entire universe. And what we call individual electrons are just places where that field is vibrating in a particular way. As the physicist David Tong puts it, every particle in your body, indeed, every particle in the universe is a tiny ripple of the underlying field molded into a particle by the machinery of quantum mechanics. This is why every electron in the universe has exactly the same mass, exactly the same charge, exactly the same properties. They're not separate objects that happen to be identical. They're excitations of the same field. Like two ripples on the same pond, aren't two different ponds. They're two disturbances in the same water. Similarly, for quarks, for photons, for all the fundamental particles, they're all ripples and fields that permeate all of space and time. So the separateness we see, the boundary between you and me and the air and the ground, that's a kind of useful approximation created by the particular way matter is arranged. At the deepest level, it's all one thing. Even empty space isn't really empty. The quantum fields are always there, always fluctuating. If you could somehow remove all particles from a box, you wouldn't have nothing. You'd have the vacuum, which in quantum field theory is a seething bubbling sea of virtual particles constantly appearing and disappearing. Field fluctuations that briefly create particle antiparticle pairs before they annihilate each other. This isn't just theory. We can measure the effects of these vacuum fluctuations. The Casemir effect, for example, is a measurable force between two metal plates placed very close together. The vacuum fluctuations between the plates are restricted, while outside the plates they're not. And this imbalance creates a tiny but measurable force pushing the plates together. We've measured this force. The vacuum is real and it's busy. The lamb shift discovered in 1947 showed that the energy levels of hydrogen atoms are slightly different from what we'd expect without vacuum fluctuations. The electron in a hydrogen atom is constantly being jostled by virtual particles appearing and disappearing around it. And this shifts its energy levels by a tiny amount. This shift was one of the great triumphs of quantum electrodynamics matching experiment to 11 decimal places. So, even nothing isn't nothing. Even the emptiest parts of intergalactic space, billions of light years from the nearest galaxy, are still full of quantum fields, still full of fluctuations, still full of virtual particles coming into existence and vanishing again. Nothingness itself is complicated in physics. I don't know exactly what to make of all that. I don't think anyone does yet. But I find it suggestive. It hints that the unity we feel when we realize we're made of star stuff, that unity might go even deeper than atoms. It might go all the way down to the fundamental fabric of reality. So when you ask what happens when you die, here's the answer physics gives us. Your atoms scatter and become part of other things. Your energy disperses and becomes less organized.

The pattern that was you dissolves, but nothing is lost. Nothing is destroyed. It's all still here. It's all still part of the same vast ancient ongoing cosmic process that has been running for 14 billion years and will continue for billions or trillions more. You were never really separate from it anyway. The fields you're made of extend to infinity. The atoms you're made of have journeyed through stars. The energy you embody has transformed countless times and will transform countless more. You are a temporary eddy in a river of matter and energy that has been flowing since the beginning of time. I find this view of things deeply satisfying. It connects me to everything. It makes me feel like a participant in something much larger than myself. The universe isn't just something I look at. I am part of it. I am it looking at itself. Consider the hydrogen atoms in the water you drank this morning have been around since the first 3 minutes after the Big Bang. They are among the oldest things in existence. And now 14 billion years later, some of those primordial atoms are arranged in such a way that they can contemplate their own origin. They can wonder about the big bang that created them. They can calculate the conditions in which they formed. They can understand the fusion reactions that will eventually transform them into heavier elements. That's extraordinary. That's what you are. Ancient matter organized by evolution and chemistry into a pattern that can understand itself. And yes, the pattern that is me will end someday. But the atoms will go on, the energy will go on, the effects I had on the world will go on. And that's enough. It has to be enough because it's what's true.

Now, I'd love to hear from you, knowing that every breath you take probably contains at least one molecule from Caesar's dying gasp, from Cleopatra's whisper, from a dinosaur's roar a 100 million years ago. Whose atoms do you think you're carrying?

Whose breath are you sharing?