

**What it means we evolved:
Dialogue between Darwin and Galileo**
Play with two characters, in three acts.

CHARACTERS

DARWIN: British, upper class, dignified, stiff, unimaginative, not inward-looking. Age early 70's (He died at 73). While he addresses the audience he could wear the black hat he wears in a well-known photograph.

GALILEO: Italian, eccentric, animated, egotistical, devious, sarcastic. Age 60's. His pauses to think can give the audience time to absorb prior ideas and wonder what he's going to come up with next. His "thinking" pauses can be signified by having him stroke his beard.

SETTING

Heaven, except at the beginning and end when Darwin addresses the audience directly.

STAGING

No props needed. The two characters stand on stage and walk about.
Intermissions can be inserted between acts, or the action can run without interruption.
Without intermissions the play runs about 1 hour 20 minutes.

TIME

The present

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ACT 1

*Darwin tells Galileo the meaning he gave evolution.
Galileo becomes jealous of the fame Darwin won through his theory.*

Introduction—2012—their two revolutions

(DARWIN stands front and center, addressing the audience.)

DARWIN: Hello. I'm Charles Darwin. Of course, I'm... dead. So, usually I'm up... there.

But, I used to be down here, remember? I was caught up in a remarkable revolution, involving one of the greatest discoveries of all time, that all living creatures, including us, had evolved. From up, there, the revolution seemed to be going on just fine. However, the other day some bold new thinking came my way, and I was persuaded you should be told about it. So I thought it best I come back down.

I was up, there, minding my own business as usual, when I had a visitor. It was in conversation with this visitor that the bold new thinking came up. First, though, I had to tell my visitor about the revolution I was involved in, and the role I played in it. You may already know all about that, but I think it's worth reminding you. So I'm going to tell you how the conversation went, from start to finish, just the way it happened.

(DARWIN takes a step back, and peers down and forward as if looking down at Earth from Heaven.)

GALILEO wanders in, pondering how to approach DARWIN.

DARWIN looks at him, hesitates, looks back down again. Pauses, then looks at GALILEO again.

DARWIN: I say, hello. Don't see many of you guys here at the edge.
(Turns back to look down, nodding.)

GALILEO: No, well, if I hadn't drawn the short straw I wouldn't be here. I like to be over there, *(points up stage)* with the bocci, the wine, good company, music, know what I mean?

*(DARWIN continues to peer down. Pause.
DARWIN looks at GALILEO.)*

DARWIN: I suppose I should introduce myself. I'm—

GALILEO: I know who you are. You're Charles Darwin. You're the guy who never stops looking down, there. That's why my companions sent me over, to find out what you find so interesting. Why you care so much about what's going on down there?

DARWIN: And you're...

GALILEO: I'm Galileo Galilei.

DARWIN: Galileo, oh, goodness, you're one of my heroes. I—

GALILEO: Yeah, well, I don't like to talk about it too much. I cared a bit at first, kept looking down, like we all do, to see what happens after we die, then I lost interest and decided to just have a good time, like everyone else. (Turns to shout to his companions offstage.) Except—now, when I've been sent over to find out what keeps him looking down, there.

(*To DARWIN.*) What year is it now, down there?

DARWIN: It's--2012 (*Give present year*). Your revolution, in physics, that's about four centuries ago. The revolution I was involved with, in evolution, came two centuries after that, around two centuries ago.

New origin story. Definition of evolution. Vestiges

GALILEO: "Evolution!" I stopped paying attention about three centuries ago. What's this "evolution"?

DARWIN: It's a new origin story. After you died, we went on discovering new continents. Everywhere we went, all over the Earth, we found new species of living creatures we'd ever seen before. The great question of the day became, where had all these species come from? We realized that, by digging down into the ground, we could trace today's living creatures back to the bones of their distant ancestors.

GALILEO: A new origin story! People have been coming across old bones and speculating about their origins for thousands of years. But, to dig down specifically to find old bones, I suppose that is "original." So what, besides some old bones, did your digging turn up?

DARWIN: We made two very important discoveries! First, species weren't eternal, they'd come into existence and after a million years or so most of them would go extinct. And second, each species of living creature started out right where the species most like it already lived. They seemed to grow out of one another, forming strings of species that fanned out like the twigs of a tree. Trace those twigs back, and you could imagine finding all living creatures having sprouted off from a single trunk.

So species were not created specially, each one, by God. Instead they seemed to spawn each other. To distinguish that from "creation" we called it "evolution."

GALILEO: Now that is revolutionary indeed! How did you manage to get out word of something so "heretical"?

DARWIN: Oh, it wasn't hard. The British public first learned about it from a book titled, *Vestiges of the Natural History of Creation*. "Vestiges" we called it. Everyone was reading the book, talking about it, trying to figure out what to make of it.

GALILEO: No inquisition? No excommunication? No trials? No house arrest?

DARWIN: Well, it did cause a tremendous hullabaloo. The author published anonymously, went to his grave without telling anyone, that's how controversial it was. But within a few years evolution was being shouted from the housetops from one end of the country to the other.

GALILEO: So, an entirely new origin story is discovered and published, no one is punished, and everybody just laps it up. My friend, compared to us, you had it easy. In just a few years, your revolution is over!

DARWIN: Yes. Except for figuring out what it all meant.

GALILEO: What it meant! No special creation! I'm sure the Church fathers had an interest in what that meant.

DARWIN: Well, that may have been a concern for this *Vestiges* fellow, because he made out that evolution was God's work. All living creatures develop from embryos, he said. All embryos develop through the same sequence of stages, some creatures, like fish for example, going through just the first few, others, such as mammals, going through them all. So the specifications for all those creatures were already there in the original embryo, from the beginning, he said, each kind of creature ready to emerge as the right conditions came along.

And where had that original embryo come from? From God, he said. God created it, and then let it evolve, and that's how he created living creatures.

GALILEO: (*Aside.*) So revolutionary a discovery—an entirely new origin story--and this *Vestiges* fellow gives the credit to God, shielding the process from prying eyes.

Darwin as scientist. Natural selection. Wallace. Fame?

(*To Darwin.*) I hope someone had the courage to come up with something a little more—scientific!

DARWIN: Well, that would be me! I was one of England's first converts to, an entirely new way of thinking about science, called "Positivism." It was a scheme for practicing science on a purely material basis, all experiment and measurement, nothing supernatural permitted at all. To be a scientist meant seeing the entire world as purely physical.

I was spellbound. That became my passion. That's what drove me, about half a dozen years before *Vestiges* got published, to come up with a purely physical mechanism for evolution, with no appeal to gods or spirits at all.

GALILEO: (*Aside.*) Bravo! Reason has a new champion! (*To Darwin.*) I salute you! So, tell me about the mechanism you came up with.

DARWIN: I got the idea from one of the most advanced technologies of my time: how breeders improved their livestock. They let only creatures with desirable variations breed, so those variations became more common in future generations.

Nature, I realized, already did something like that. Most creatures die young, only a few go on to reproduce. Now, what variations was nature selecting for, I asked myself? Which variations will make creatures more likely to survive to reproduce and pass on those variations? I realized it would be those variations that made creatures better adapted to their environment. After a long enough time, the species would have accumulated enough of those variations to amount to a new species, much better adapted to the environment than the old one. The result? Evolution—with no need for God at all. I called my mechanism natural selection.

GALILEO: Is that it? Once you point it out, it seems, obvious. No one else had come up with this idea before?

DARWIN: No, it would be only a very slight tendency. You'd be able to see the effects of it only over thousands of generations. In a single generation its effect would be negligible, there'd be nothing to see. I think that's why no one else had come up with it.

GALILEO: Well, anyway, you had your theory! So why wasn't it you who published the book introducing the British public to evolution?

DARWIN: I was still only a naturalist at that point, not a scientist. I hesitated to give my name to something as controversial as taking God completely out of creation. I asked some friends what they thought, they advised me not to publish it. So I put it away. Then, a few years later, when *Vestiges* got published, I was very relieved I'd let someone else take the heat, I can tell you.

GALILEO: (*Aside.*) So, our champion of reason lacks the courage of his convictions! (*To Darwin*) But something did eventually make you publish... Ah, of course, someone else came up with the same idea.

DARWIN: Well, yes. About 15 years after *Vestiges* got published, this young fellow Alfred Wallace comes up with the same theory and submits it for publication. (*Aside.*) Shook me up, I can tell you. (*To Galileo.*) So we published together.

GALILEO: Ah, someone with real courage! And, so very generous, to share the credit!

DARWIN: Oh yes, Wallace was a real sport about it. But I was older and, after spending eight years studying winkles, I was better known than he was, so it was my book that drew the most attention. I called it "On the Origin of Species by Means of Natural Selection."

It was really about just natural selection, but because I presented evolution without any mention of god at all, the fuss over Vestiges spread to my book! People began talking about “Darwin’s” theory of evolution, as if I’d invented the whole thing in the first place. No, I’d just come up with a purely physical origin for living creatures, natural selection.

GALILEO: Come up with a purely physical origin for living creatures! Weren’t you simply taking credit for an idea that we had already come up with, that all plants and animals are simply machines. With all your digging, all your livestock breeding, your “selection,” weren’t you simply trading on an idea we’d established centuries before?

Hah! So, how was your presentation of our bold surmise received?

DARWIN: It was accepted as entirely original! By this time, the new way of doing science had pretty-much taken over, so a purely physical account of the origin of living creatures was welcomed, at least by scientists.

GALILEO: Of course they welcomed it, the reverence people had for God for having created all living creatures, that glory would now go to them, practitioners of your new science. And to add to their own glory I’m sure they hailed you as the greatest scientist of your age.

DARWIN: Well, no, what little acclaim I got was very short-lived. In fact, after I died, it looked as if my theory might be abandoned.

The problem wasn’t selection, it was variation. Natural selection works by eliminating all variation leaving only those characteristics that best adapt a species to its environment. Unless it’s supplied with new variations, natural selection just comes to a halt, and evolution would stop. I’d assumed that somehow in nature new variations just appeared. But no one could figure out where they’d come from. If there was no source of variation in nature, people said, natural selection couldn’t be what drove evolution, and they began looking elsewhere.

GALILEO: So much for your pretty theory taken from pig breeding! So much for “evolution”!

DARWIN: Oh, evolution wasn’t being abandoned. Evolutionary ideas were continuing to spread, out beyond science into the humanities. According to Vestiges, already laid down in the embryo could be specifications for creatures even more spiritually advanced than us, intended by God, from the beginning, to come after us and carry his plan to the next level. Speculations about what sort of creatures those might be led to new sorts of spiritualism. It seemed to be only my strictly scientific sort of evolution that was in question.

GALILEO: Spiritualism! Even that served people better than your “science.” Hah!

The Modern Synthesis

DARWIN: Well, actually, about half a century after I died, scientists did discover a new and purely physical source of variation. They revived my theory of natural selection, combined it with this new source of variation in what they called the Modern Synthesis. And to make this new mechanism really scientific they translated it into math.

GALILEO: (*Aside*) What kind of scientist leaves it to others to translate his ideas into mathematics! Oh, well! (*To Darwin*) What was this purely physical source of variation that rescued your sorry mechanism from oblivion?

DARWIN: If you're going to be so dismissive I've a good mind not to tell you. But that wouldn't be right.

This new source of variation had to do with molecules--long strings of atoms to you--in the nucleus of each cell on our bodies, called "genes." They're the blueprints that distinguish one kind of creature from another. Turns out, it's these genes--and not Vestiges' God-- that tell the embryo how to develop, all the way from a single cell to the full-grown adult.

GALILEO: (*Aside*) Long strings of atoms, blueprints for life, in every cell of our bodies, now that's a discovery to be famous for! Not like this "livestock breeding" program! Ah, well! (*To Darwin.*) *Go on.*

DARWIN: Of course, long complex molecules like that are subject to decay, and that was the new source of variation, the random damage genes accumulate as they decay. Every once in a while, just by chance, the result will actually be an improvement. That's where natural selection comes in. Natural selection will keep selecting in favor of each of those improvements until there's enough of them to provide some entirely new benefit, like an elephant's trunk, or... legs turning into flippers.

GALILEO (*Expresses silent fury.*)

DARWIN: So, once again, my theory was helping account for evolution on a purely physical basis. I was thrilled to see it persuading more and more scientists to embrace the new materialist philosophy. And then to see it spreading out from the scientific community to society at large.

(*to Galileo*) Seeing my theory contribute to the march of the new science, that's what keeps me looking down, there! (*Strikes triumphant pose, turns to face the audience.*)

GALILEO: (*Having a tantrum.*) He grubs around in the dirt, uncovers fragments of bone that, under his fingers, without him having any talent for real science, turn into ingots of gold, and now everyone celebrates his name. Shouldn't every great scientist live in such a time, when science has become the object of public veneration! With my genius for logic and mathematics, what glory could I not earn for myself, down there, now!

Is there no way I could have my genius represented down there, to dazzle those gullible multitudes?

Where could I find someone, anyone, to represent me?

(Thinks.)

(Light dawns, he turns, looks at Darwin) Maybe this naturalist, this winkle collector!

(Paces, thinking.)

Given such a messenger, what message should I craft? Something to advance his revolution, something to amaze and shock his audience. It can only be a new mechanism of evolution.

Of this evolution I know nothing. I will need a fully-staffed library. Maybe I can use him for that too!

(Dances, laughs.) What fun I can have with him!

(Paces thinking.)

DARWIN: *(Announcement of intermission. To audience)* Galileo seems to be having some kind of fit. While we wait for him to recover I'm going to take a little break, rest my voice. I'll be back in just a few moments to tell you what happened next.

ACT 2

Galileo pumps Darwin for information about evolution

GALILEO: (*Dances, laughs.*) Maybe I can use him as my library, too! What fun I can have with him!

How can I get him to hand over the key to the library? I'll engage him where he feels he is in control, the master--this new science of his. Then I'll draw him into a contest where mastery and control actually lie with me—logic.

First, I must make some amends and soften him up.

Materialism denies mind—Wallace and spiritualism

(*To Darwin.*) Mr. Darwin, I beg you, do pardon me if I have seemed insufficiently appreciative of your life's work, and how much you have contributed to the advance of the new science and the success of your revolution. How I wish I had the insight into the human condition that you, through your accomplishments, have won for yourself.

DARWIN: Oh, very gracious of you!

GALILEO: Here's something I would love to know. With God entirely out of the business of creation, with all of nature having a purely physical origin, where do we humans come from?

DARWIN: Only too happy to oblige. The truth is, we evolved too. From a line of monkeys, that sort of thing. In only a few million years. We're just one more evolved species.

GALILEO: But, what about our mental powers? Our capacities of mind? Consciousness? Free will?

DARWIN: Oh, that's all completely changed since your day. In our new material philosophy there are no mental powers. We're purely physical, like everything else in the universe. All our thinking happens in the brain, as chemistry. Consciousness is simply that chemistry being aware of itself, somehow. But it can't do anything, all our decisions are made for us in the brain; your sense of having free will, that's just an illusion. We're no different from other animals, we just have bigger brains.

GALILEO: So, this new way of practicing science, this material philosophy you speak of, it denies us mind?

DARWIN: Yes. What you call "mind," that's not physical, so it's supernatural. We'd never have achieved so much if we hadn't banished mind from our new science. That's what's led to such astonishing progress.

GALILEO: And to an origin story that need offer no account of how mind might evolve. What a triumph for the new science! About this synthesis, there can be no doubt of its truth?

DARWIN: Oh, no, it's all been proved beyond any shadow of a doubt. It's all purely scientific.

GALILEO: Amazing! Your science, how far it has advanced beyond my understanding. Yet how I would love to speculate about our origins, as you do.

Would you indulge the fancy of a once-famous scientist? Suppose I came up with a couple of questions about this synthesis, that you couldn't answer, would you do me the honor of joining me as I scout around for an alternative?

DARWIN: So you could go on believing in dualism, mind and matter existing independently! No one at all believes in that any more, it just can't be made to work. Remember Wallace, my co-discoverer of natural selection? He said the capabilities we associate with civilization, such as art and science, developed too quickly for natural selection to account for them. So he went off looking for an alternative. Smart fellow! But look where he ended up—spiritualism! Made a laughing stock of himself, poor fellow. *(Pause.)* OK. I've always been a huge admirer of yours, I can't deny you a hearing. So, go ahead. Ask your questions. *(Pause.)* And yes, if I can't answer them, I promise I'll join you in looking for alternatives. I don't think you'll succeed. But try your best.

GALILEO: Thank you. *(Aside, gleefully.)* He's handed me the key. Now let's turn it in the lock!

Criticisms of the Modern Synthesis

Let's start with your new source of variation. You damage, at random, the blueprint for a very very complex machine—a living creature. Every once in a while, by chance, the variation you end up with will be favorable. But much more often, variations resulting from damage to such a blueprint, at random, will be harmful. Won't there be very many more harmful, than favorable, variations?

DARWIN: Oh yes, but natural selection takes care of them. They don't count.

GALILEO: But according to you, natural selection can make a detectable difference only over thousands of generations. In one generation, you said, its effect is negligible. Maybe for every beneficial variation it favors, it can eliminate one variation that's harmful. But that will still leave many more harmful than favorable variations, and as these accumulate, generation after generation, as more harm accumulates than benefit, why will the result will not be extinction, rather than evolution?

DARWIN: That's all been accounted for in the math, I don't understand it. But everyone says it works.

GALILEO: Oh! But you didn't need math to come up with natural selection, in the first place. You understood it well enough to publish a book about it. Now, that natural selection, that you came up with, do you believe it could identify, and eliminate, every single harmful variation, in every generation, while leaving only the variations that are favorable, that you need for evolution to occur? Do you think it can do that?

DARWIN: (*Aside*) I never did take the trouble to understand the math they translated it into. Of course, no one else did either. Once it's a matter of statistics, you just take their word for it. (*To Galileo.*) Well, I suppose I have to admit I can't give you an answer on that one. I don't know the math. What's the other question?

GALILEO: All that was needed to make an elephant's trunk, you said, was enough damaged but favorable genes. I think you may have left something out. Think what you are asking of the living creature! It must take those damaged genes, each being selected for some small benefit it alone provides, and re-engineer them so together they become exquisite machinery capable of creating something as intricate as an elephant's trunk, not merely in the adult but in every stage of growth leading up to it.

What an amazing capability for re-engineering its own genes the creature clearly has. With such a capability, why should it have to wait until all those genes have been damaged, at random? If they needed to be damaged first it certainly has the engineering capability to damage them itself, just the ones it wants, whenever it wants. So, my second question is, given that a living creature is so capable an engineer of its own genes, why do you have to have some other mechanism damage to its genes, at random, in the first place?

DARWIN: (*Pause.*) I've always felt there was something missing in that part of the theory, but I couldn't put my finger on it, to figure out the answer.

(*Pause.*) I'll just have to think something like that up, now.

(*Pause.*) Oh, I can't do this on the spur of the moment.

(*To Galileo*) OK, you win. I still believe in the Modern Synthesis, I just haven't kept up properly. But I did promise if I couldn't answer your questions, myself, I'd join you in a search for an alternative. So--I will.

GALILEO: How gracious you are, thank you!

(*Aside.*) The library is mine. Let's enter and begin the construction of a new mechanism of evolution. It shouldn't be hard...

DARWIN: Not hard! What do you mean?

GALILEO: Not hard for me, I mean, because I know nothing, I start from scratch. No preconceptions. I'll simply ask you to tell me anything natural selection and your modern synthesis cannot account for. Then, from what you tell me, we'll figure out something to

put in its place. OK?

Are you ready?

DARWIN: I suppose so. I did promise.

GALILEO: Good! Very well! Let's begin.

1. How smart a process, to create first life. 2 to 40th

Tell me something natural selection cannot account for.

DARWIN: What do you mean? It can account for everything, that's what makes it so powerful.

GALILEO: No, no, there must be something it can't account for. Think!

DARWIN: Well, obviously, natural selection can't account for how life began. Until the first living creatures began reproducing through successive, there'd be nothing generations for natural selection to work on. Problem is, though, we know nothing about how the first creatures evolved. So we have to look elsewhere where we do have some information.

GALILEO: Oh, do we indeed! (*Aside.*) We have to look elsewhere than where the obvious solution is. Let's not do that. (*To Darwin.*) Let's look exactly there.

(*Thinks.*)

Tell me, how long did it take for the first living creatures to evolve?

DARWIN: Seems to have happened really fast, in something like 100 million years.

GALILEO: And how much of all of evolution is this 100 million years?

DARWIN: Evolution's been going on for about four billion years altogether, so 100 million years is about a fortieth, I suppose, yes.

GALILEO: And how difficult must it have been for those first living creatures to evolve, do you think?

DARWIN: Oh colossally difficult. Just starting from chemicals, you know, to make living creatures able to sustain, grow, and reproduce themselves, awesomely difficult.

GALILEO: (*Thinks.*)

If you wanted to measure the capability of all of evolution, with this step, the creation of the first living creatures, being one unit, how many units like that, do you think, would there be in all of evolution?

DARWIN: What a silly question! There's no saying. There's no way to think about it.

GALILEO: Oh, no, you're wrong. We can think about anything. We can just come up with an estimate. All of evolution, one hundred times the capability of that first step? A thousand times?

DARWIN: Well, I suppose we could guess one thousand times. But what difference could it make!

GALILEO: A thousand! Then there's no problem. Look, you start with just chemicals, and in one hundred million years you have something that isn't just chemicals any more. It has form, structure, processes going on inside, systems to make it all work. Something--a process, or a handful of processes--must have become more capable, smarter, than the simple chemistry it started as. Now, if these processes can get smart enough to create the first living creatures in just one hundred million years, what could they not do in forty times as long!

Suppose those chemical processes got just twice as smart in the course of creating the first life, and continued to get twice as smart every one hundred million years. By now the processes would be 2 to the 40th times as smart as when they started. Do you know how much smarter that would be?

DARWIN: Let's see, two times two, times two...

GALILEO: Don't bother to work it out, it's a lot more than a thousand, more than a billion. (*Aside.*) It's more than a trillion! (*To Darwin.*) So, to account for evolution, you need know nothing more than whatever it was that could get smart enough to create the first living creature, in 100 million years, and then follow it as it continues to get smarter at that same rate, overcoming ever-greater challenges, developing ever-greater capabilities. And you know such a process, able to get smarter, does exist, else life could not have got off the ground, and you and I would not be here today.

DARWIN: Well, that's no help. If we can't find out how the first living creatures evolved, that means we'll never learn how evolution works.

GALILEO: Don't be so easily discouraged. We've all the rest of evolution to look at for clues to what that original process was. (*Aside.*) Already we know something about it, we know it isn't natural selection. (*To Darwin.*) So tell me, what happened next that your modern synthesis cannot account for.

2. *Tiny steps. Eucaryotic cell. An agent coming of age*

DARWIN: Well, they say it can proceed only in tiny steps. But about halfway along, a couple of billion years ago, a new kind of cell pops up out of nowhere. It wasn't like the simple bacterial cell that was common then, it was the kind of cell we're made of, highly complex, with a nucleus. It was as if everyone's plodding along and suddenly a whole city leaps up and soars off into space. There'd never been any jump like that before and there hasn't been one that big since. That was no tiny step!

GALILEO: So whatever it is that's driving evolution, two billion years ago it comes of age, becomes aware of its powers, and celebrates with a show of fireworks.

3. *Dozens of new kinds of animals—Tinkerer?*

Now it's come to maturity, what's does it do next?

DARWIN: Next! Well, if you take time since then, about three quarters of the way along, dozens of different kinds of complicated creatures suddenly pop up, all within just ten or twenty million years. A flash, really. All the major divisions of animals, like insects, snails, creatures like us with backbones, nothing like each other. And there haven't been any more such radically new kinds created since.

GALILEO: You know, this sounds like one of us, a tinkerer. "I've got an idea." Hey presto! Two dozen new kinds of living creatures. And that's it. Now he turns to something else.

Tell me something else about these new creatures your synthesis can't account for?

4. *Intermediates—Tinkerer is resourceful.*

DARWIN: Well, there's a problem of lack of intermediates. Between quite similar species, you can find lots of intermediates, and quite a few between creatures at the next few levels up, such as families. But between more different kinds of creatures, you get fewer and fewer intermediates. Between one moth and another, lots of varieties, lots of species. But between fish and amphibia, reptiles and birds, almost none. If the same process of tiny steps was at work everywhere you'd expect just the opposite, lots more intermediate species between the bigger jumps.

GALILEO: So when our tinkerer applies himself he can create entirely new kinds of creatures, in one go. (*Aside.*) Very resourceful, is our tinkerer. Now, who is he? No, where is he?

(*To Darwin.*) Where is our tinkerer?

Genome. As tinkerer. Role in first life. Number of genes, strung how—a mystery.

DARWIN: What you call your tinkerer, there's only two places he can be: in living creatures themselves; or in their environments, as I proposed. Or... some kind of god, like in Vestiges.

GALILEO: (*Shakes his head. Thinks.*)

What about the genes you mentioned, these blueprints for life? Tell me more about them.

DARWIN: They come all joined together end to end to make even longer molecules, the chromosomes. And we think of them as all making up what we call "the genome." That's all the genes a creature has. You only get to see that when a cell divides, all the chromosomes come together, they stay together for a while, then they divide and separate and two new cells form around them. That's how creatures grow and reproduce.

GALILEO: And this genome, how long has it been around?

DARWIN: Well, there's always new ones, every time a cell divides. On the other hand, I suppose you could say it's been around since life first began, since it keeps on duplicating itself and, as creatures evolve, it just keeps growing.

GALILEO: As creatures evolve, it just keeps growing! Could this be our tinkerer? Let's check him out. Let's go back to the origin of the first living creatures and see what kind of a role he plays there.

Those first living creatures, how many genes must their genomes have consisted of?

DARWIN: Oh, I don't know exactly, but it must be hundreds. To be able to survive, and digest things, grow, and reproduce--hundreds!

GALILEO: (*Thinks.*) Now imagine, what would it take for those genes to be assembled out of a soup of chemicals, and to be strung together?

DARWIN: I've no idea, and nor does anyone else, I've already told you that.

Genome as intelligent designer. As it thinks it creates species

GALILEO: (*Thinks.*) But it must be possible to speculate about how it developed the first glimmers of its intelligence.

DARWIN: Oh my God! That would amount to "intelligent design"! You can't bring that in. You'd never get anywhere down there if you could be accused of believing in "intelligent design."

GALILEO: (*Aside.*) How sweet it is, for me, to know so little that I have no fear of this "intelligent design." (*To Darwin.*) Yes, I am proposing an intelligent designer. Let's get to know it a little better.

(Thinks.) Tell me, Mr. Darwin, what would happen when such a creature--thinks?

DARWIN: I want to make it perfectly clear, I don't approve of this line of inquiry--making any connection between evolution and intelligence or thinking. It's entirely against my principles.

GALILEO: But you promised me...

DARWIN: Oh, yes. So I did. Alright, I'll go along.

I assume as this creature thinks it will make changes in a brain of some kind, like we do. When we remember something, like someone's name, we lay down memories as chemical changes in brain cells.

GALILEO: And the genome is made up of genes. And what do genes do?

DARWIN: I've already told you, they're the specifications for how living creatures develop, they're what define species. Wait a moment--if what you're suggesting were true, just by thinking, the genome could make changes to the genes it consists of, and create new species.

(Pause.)

Oh, what am I thinking! The genome doesn't have a brain.

GALILEO: You silly man, it is a brain. It holds information. It tells the cell what to do. Here, I propose to you, in the genome thinking new species into existence, is a new mechanism of evolution.

DARWIN: Well, it may be new! But what does it tell us we didn't know before? What questions does it answer?

GALILEO: Well, it tells us "who"—the genome--and "where"—in the nucleus of the cell, and "how"—by thinking new species into existence. Now, "what" and "why"? Let's answer those questions. What! *(Thinks.)* What it is we have to account for?

Evolution is creative. Gives us thinking. Thinking is evolving

What's most obvious about evolution?

DARWIN: Most obvious? Nothing about it was obvious at first. Now it all seems obvious.

GALILEO: No, what's most obvious! Quick, quick! Shout out something about evolution, anything! Quick, quick.

DARWIN: Elephants. Elephants. Once, there were no elephants, now there are elephants. Evolution created elephants. There's nothing like that in the physical world. And that goes for all living creatures. So, I suppose, evolution is creative, like us, that's what's most obvious.

GALILEO: Ah. Creative. Like us!

(Thinks.)

Maybe you got things the wrong way round. Maybe, it isn't creative, like us. Maybe, we're creative because it's creative. It must have become creative, first. Then--it could make us creative. Isn't that the way round it's got to be? It was being creative long before we came along. And it made us, didn't it?

DARWIN: I suppose you could say that.

GALILEO: So, it became creative first, then it built creativity into us.

Maybe that's how we got consciousness and free will too. Maybe the genome got consciousness and free will first and—then—figured out how to build them into us.

Maybe we think, because the genome can think. First the genome got to think, then it built thinking into us. We think because it thinks....

DARWIN: Hold on. Hold on! That's just logic. I don't trust logic without some study of nature to back it up.

GALILEO: You take care of the study of nature, let old Galileo here handle the logic. So, first, the genome comes up with thinking--somehow. Maybe evolving involves thinking. Then it builds thinking into us.

Maybe thinking, in us, is something evolving, maybe it's our thoughts evolving. Maybe that's what happens when we think—one thought evolves into another thought—somehow.

Maybe, all kinds of mental processes, not just thinking, but consciousness, free will, being creative, are thoughts evolving into other thoughts. Thinking and evolving--maybe they're the same thing.

Mr. Darwin--Thinking equals evolving. What does that sound like to you?

DARWIN: Sounds like math to me. I don't do math and physics.

Combine 2 traditions, mind and evolution

GALILEO: What I'm talking about is not math. It's not physics. It's everything else. What else is there besides physics? There are only two things, neither of which we understand very well, despite our respective revolutions. One, what it means that living creatures evolve. And two, our own conscious experience. Now, I have just combined

these two things into one. Both of them are driven by processes of evolution going on inside some kind of mind.

DARWIN: You're talking about mind as if it was real. You can't just make up stuff up like that! My God, people would think I was crazy if I went back and talked like that.

GALILEO: Yes, but you are talking to me, Galileo Galilei, and this is how I think. It was good enough for my revolution, maybe it can help you with yours.

*We're vehicles for genome. Civilization leads to machines and instruments.
Pre-adaptation. Us pre-adapted for what?*

Now, where was I? Oh, yes—What! What is it we want to account for? What is most obvious, about us? We're merely one more creature the genome dreamed up. (*Aside.*) But it put a lot of thought into us. Gave us upright posture, freed our hands for toolmaking, gave us capacity for speech, huge increase in our brains, all at the same time, all in a few million years.

Now, "why"? "Why" did it do that?
(*To Darwin.*)

Where is this genome? Isn't there one in every cell in our bodies? So we're its conveyances, we're how it gets around. But just for that it built a lot of new features, like language, into us? Not only that, it also gave us some of its own mental powers, consciousness, free will, creativity. No. Why did it make us such exceptional creatures....

DARWIN: But why mental, why not...

GALILEO: Shut up, I'm thinking! Your young friend Wallace pointed out that into us it also built the abilities we'd need to create civilization. (*Aside.*) With civilization you get: metals... machines. And: glass... instruments. Machines and instruments. Hmm.

(*To Darwin.*) Tell me, Mr. Darwin, is there any indication of this genome of ours exploring?

DARWIN: Well, there are reports of "pre-adaptation," of creatures appearing to come pre-adapted for new environments.

GALILEO: Ah, of course! (*Aside.*) When the genome gets wind of a new environment, it thinks up a new creature able to explore it, in one go, no intermediates needed. Now, us, it equips us to create machines, instruments, and it gives us powers like its own, to make decisions, and act for it. Why? What for?

(*Looks around at sky, smiles. To Darwin.*) Look, those people down there, Mr. Darwin, what were they all pre-adapted for, Eh? Something for you to mull over, while you stand there looking down.

GALILEO: *GALILEO: (Aside.)* The library--time to close the doors. Now, let's turn to preparing our courier for his mission, disseminating our new theory among his people.

What remains to be done? *(Thinks)*

(Darwin looks down.)

(Announcement of intermission. DARWIN, to audience) I stood looking down for quite a while, trying to figure out what Galileo was talking about. Us, pre-adapted? You're probably as puzzled as I am. To give you a little time to think about it, I'm going to take another small break. When I come back I'll tell you how our conversation ended.

ACT 3

Galileo readies Darwin to present his theory of evolution to Earthlings

GALILEO: (Aside.) What remains to be done? My ideas I must repackage so they are simple enough for him and his people to understand. And I must ready him for, and overcome any resistance he may have to, taking the trip back down to Earth.

To do that, I must impress upon him the importance of his new mission?

(Heads back to rejoin Darwin.)

***Role of new concepts in Galileo's revolution. Gravity an "as if" theory.
6 new ideas needed to understand evolution. Start with three.***

Mr. Darwin, your generosity in sharing with me your understanding of the natural world has convinced me that your revolution is a much more formidable challenge that ours in physics. Evolution is entirely new, and reaches to the foundations of everything.

How far has your revolution advanced, I asked myself, in relation to where we started. But once Newton came up with his grand theory of gravity I stopped paying attention. But after Newton came up with his grand concept of gravity I stopped following the progress of my revolution. Do, I beg you, tell me what happened to his theory after that?

DARWIN: Oh, it was very successful. Took two more centuries for someone else to come up with the right theory--relativity, something about space being curved. No one understands it, the math, you know. So most of the time people make do with the theory of gravity and carry on as if it's still true.

GALILEO: So, after all the time we spent, on our revolution, it took another two centuries for a full understanding to be arrived at.

To come up with gravity we had to create three entirely new concepts. I can well imagine coming up with this—relativity--took at least another three. That would be six entirely new concepts altogether.

It could take at least as many to fully understand evolution.

DARWIN: Six entirely new concepts! But that could take centuries!

GALILEO: Well, yes, it could. Just being able to make a discovery does not necessarily mean you already have the concepts you need to understand it. The ancient Greeks knew about electricity, but they never did get to understand it.

Coming up with six entirely new concepts could hold up your revolution for centuries. But suppose you and I, between us, came up with just three new ideas. Maybe we could

turn them into an “as if” theory, like gravity--nature is “as if” our new theory of evolution is true. And suppose we communicated it to those people down there, they could use it as a “make do” theory, drawing on it to come up with new questions making it easier for them to arrive at the other new concepts required.

Don't you think you should go down and tell your people, down there, about the new ideas we've come up with? The further success of your revolution could depend on it.

DARWIN: Down there? You mean, go down there? Go down and visit people? What for?

GALILEO: You'd tell them about the three new ideas we came up with.

DARWIN: Three new ideas we came up with? What do you mean? We were just chatting.

GALILEO: Please give me some credit! We came up with three new ideas. Listen carefully. I'm going to tell you about them one more time.

***Idea 1. Intelligent genome = mechanism of evolution.
Genome not a god. Materialism vs mind. Risk of fatalism.***

Idea number one—a new mechanism of evolution--the genome being intelligent. As it thinks, it will make changes to the genes it's made of, just as we, when we think, make changes to our brains, remember? Through those changes to its genes it can, in effect, think into existence new species of living creatures.

DARWIN: Oh, yes, I remember. That was all very nice, in theory. But are you actually saying, the genome is intelligent? Doesn't that make it like God? Doesn't that put us back where I came in, two centuries ago?

GALILEO: The genome's nothing like a god. It exists only on the Earth, so it is not infinite. It can have existed for no longer than the Earth itself, so it is not eternal. It did not create the universe. And it is not all-knowing, most of its creatures go extinct. And it cares maybe not all for you and me individually. So no, I do not find it anything like a god. To me, it is more like one of us, dependent on a mind that's creative, but fallible. Can you make do with so humble an agent of evolution?

DARWIN: I suppose so. But why bring in mind? Isn't that sort of—supernatural? And it's not necessary. In practice you can't tell a world where people have minds from one where they don't, where they're driven by brain chemistry. They'll behave just the same, you can't tell the difference.

GALILEO: Ah, how well you've learned your lessons from this new science of yours! I think I must help you unlearn them.

I'll give you a choice. You are about to give a presentation on your materialist philosophy. You must choose between two audiences. One consists of people without mind, who will have no conscious awareness of anything you say, who'll give responses generated directly from their brain chemistry. The people in the other audience do have minds. They will follow what you say in consciousness, they'll consciously weigh what you say against what they think, and of their own free will work out what questions to ask you. The two audiences look identical. Which will you choose?

DARWIN: Hmmm! That does make a difference, doesn't it! I would like to think people were consciously experiencing what I was saying, and coming up with feedback of their own free will.

But consciousness is so intangible. Chemistry in the brain, what someone does, that kind of thing is fixed and easy to understand. But conscious experience, it's so mysterious.

GALILEO: How strange! To me it's just the opposite. Look, you must have had an experience like this: reading a letter from someone makes you feel curious about something, then you think, I want to find out more to satisfy my feeling of curiosity, so you decide to satisfy your desire by referring to a book next to you. All those impressions you can trace, following one after another, in consciousness, each drawing directly on conscious feelings in mind, not at all on chemistry or behavior. To me, that seems simple to understand. But once you've come to a decision and instructed your brain what to do, your brain chemistry takes over, and you see your hands reach over to pick up the book and open it. You just give the instruction, and it does it. But how it does it you've no idea. The conscious part, though, you have control over, you can always change what happens next.

DARWIN: Can you? Can you really?

GALILEO: Of course you can. You can just decide what to think about. What to look at—can't you? Even just deciding to believe in mind or not to believe, can change what happens. Believe in mind--that you have conscious control over it--and you are likely to train it, to build up powers within it that will enrich your old age. But deny mind, assume that everything's decided for you by brain chemistry, that nothing you think can make any difference, and why would it occur to you to train it? So, no training, no powers, no mellow old age. You've made a difference, just by deciding whether or not to believe in mind.

Has it occurred to you, your theory of natural selection could affect people in ways they, and you, might deeply regret? Instead of your theory spreading a new wisdom, it could spread, instead, fatalism. The materialist philosophy, by itself, can never be more than a footnote to a particular scientific method. But in the form of your theory, that we evolved through a purely physical mechanism, it could spread fatalism to everyone, everywhere, leading to a new global dark age.

DARWIN: Oh, my goodness, what a terrifying possibility! You know, I think you're right, I haven't given enough thought to all this stuff about mind, I think someone should warn them, those people down there, about this risk of fatalism.

Not me, of course! Where were we?

GALILEO: We've just reviewed idea number one—the genome has mind. It is creative and conscious, has free will. And an intelligence capable of thinking into existence whatever creature it wants. Into us, for example, it chose to build consciousness, creativity, and free will. That's where we get them from.

***Idea 2. Thinking = evolution. Two ways to study evolution.
Better natural philosophy. Species as thoughts. Mind as an "as-if" theory.***

Now, Idea number two—thinking equals evolution.

DARWIN: Oh, I didn't understand any of that.

GALILEO: Well, pay attention, I'm going to tell you again. Just through accidents of history, we've ended up with two different traditions for talking about the same thing. One is the much older tradition we use for talking about mind, about conscious experience, what we feel, what we're aware of, how we reach decisions. The other is a new tradition we're still making up for talking about evolution. What I did was combine these two traditions, mind and evolution, into one. Once I did that, it was obvious it must be true.

DARWIN: Oh, I didn't think it was obvious.

GALILEO: Well it was obvious to me! What made it so obvious was, it gives us a much better way to think about things. Simpler, everything neatly accounted for. Here's what it says: it says there are only two kinds of things. On the one hand, there is matter, and the physical processes that act on matter. On the other hand there is mind, and evolutionary processes operating in mind--either something being thought about, or living creatures evolving. And in this universe, that is all there can be. That is all you need to account for everything. Anything you can imagine--war, art, science, life, even conscious experiences themselves--they can involve only: physical processes happening in matter; and evolution happening in mind. There can be nothing else. Nothing supernatural.

DARWIN: I don't know, it seems much too neat to me, too logical.

GALILEO: Well, here's something that may change your mind. Once you combine thinking with evolving you have two ways of studying it—not only can you explore it from the outside through the study of nature, as you do now, but you can also explore it from the inside through your own conscious experience. Both ways, you'll be looking at the same process operating in mind. But with two ways of studying that process, instead of only one, your revolution is sure to go much faster.

DARWIN: That's all very well. But evolution doesn't exist out there, in some kind of disembodied mind. It's just a name we came up with to help us talk about where living creatures came from. Living creatures--they're out there in the field, wandering about! They're just flesh and blood bodies. They eat, they evolve. There's no mind involved.

GALILEO: So, tell me, where do species come from? They're real enough for you to have written a book entitled "On the Origin of Species." Where, except in mind, can they exist?

DARWIN: I don't know. I know them when I see them, that's all.

GALILEO: Look at it this way! Think of mind as an "as if" theory, like gravity. The way we experience things, the creativity of nature, it's "as if" minds existed separate from matter, "as if" all evolution took place in such a mind. Just an "as if" theory for now, OK?

As I said before, for a complete understanding of evolution we're probably still three essential new concepts short. One of those will have to explain how evolution can maintain some kind of mind in which species exist as thoughts.

For want of such a concept, that is as much as I can make of idea number two—thinking equals evolving.

Idea 3. Pre-adaptation = Meaning in life.

Idea number three—Pre-adaptation. Where does our meaning in life come from? It comes from whatever we have been pre-adapted for—whatever we've been pre-adapted for, we are bound to embrace as our own meaning in life.

And where does pre-adaptation come from? Whatever the genome wants us to do, it will pre-adapt us for. By figuring out what we've been pre-adapted for, we learn what the genome wants us to do, and so something else about our own meaning in life, whether we've yet become aware of it or not.

DARWIN: My goodness, you can pull a fast one with that. You could just say anything. Give me an example.

GALILEO: (*Thinks.*)

We will one day no doubt visit the moon and the other planets. Such exploration is highly meaningful to us. But by carrying the genome to worlds where it has never been, we're also providing the genome with something it surely wants. Because travel among the planets is meaningful to the genome, the genome pre-adapted us for it, so it has become meaningful to us.

How can we know we've been pre-adapted for space flight? Remember your friend Wallace saying how we evolved made us capable of starting civilization, and I pointed out how civilization resulted in us creating machines and instruments. Without them space flight would be impossible. Through equipping us for civilization, the genome pre-adapted us for space travel. That's what's made such exploration part of our meaning.

Now take each step in how we evolved, see what that pre-adapted us for, and what meaning in our lives that implies. Little by little, we'll patch together a more complete vision of the meaning of life.

*Instead of science, nature study + the humanities.
Rebuild human nature from the ground up. New quest.*

DARWIN: I suppose that does have some kind of weird logic to it. But it seems terribly complicated. Aren't you setting evolution up to become just another highly technical science, another branch of physics?

GALILEO: Why would I bother? If physics alone could tell us how living creatures evolved, and all about conscious thought, we'd already understand them. But we don't. To understand them we obviously need a new source of wisdom. Could there be any source of wisdom to compare with knowing how we were made? No. If we evolved then the wisdom we need we'll find in the amazing machinery that drove our evolution. If we have consciousness, that will tell us how consciousness can be created. If we have free will, it must tell us how free will works.

DARWIN: Well, if not physics, what do we need?

GALILEO: Evolution is a tale told over four billion years, full of event and accidents, adventures and tragedies. Better for that would be your nature study. History. Storytelling. The humanities. Maybe through some future combination of nature study and the humanities we'll discover other powers in evolution just as wonderful as consciousness and free will, that we can add to the powers we already have! (*Aside.*) What a grand adventure that would be, bringing down into our own nature more of evolution's awesome creative powers. (*To Darwin.*) What more profound quest could you ask for? Physics! Hah! This is much grander than physics.

Together we could rebuild human nature from the ground up, on a firmer foundation, to greater heights. Mankind will never be the same!

DARWIN: Goodness, there is grandeur in that view of life--nature study and the humanities leading to a new understanding of evolution, with the potential to make human nature better than ever! That's what I've really wanted, all along. And, down there, they've no idea! They should be told. Someone must tell them. I'm sure they'll be very grateful to whoever it is.

Dislodge natural selection to release full potential of evolution for meaning in life.

GALILEO: It must be you. They know you. They trust you. Your theory is acting like the cap on a bottle holding in all the potential for meaning of us having evolved. Only you have the authority to remove that cap and give everyone access to all that meaning.

DARWIN: Oh, my goodness. What a responsibility! Yes, I see it has to be me.

GALILEO: Look I must go. And so must you. You have a new mission to fulfill, a new passion to communicate. Start by pointing out what wonderful talents we already come with, vision and hearing through which we can appreciate the finest art, the greatest symphonies. Ask them, why do we have senses vastly more capable than you'd need merely to be adapted to the environment? To answer that question, introduce our new ideas. Express your passion. Bare your deepest feelings, pour out your heart--

DARWIN: Oh, hold on, I am British you know. Not too good at that feeling stuff.

GALILEO: Be bold, dramatic. You are about to set in motion a new Renaissance. Promise your people that through learning how we evolved they will develop, today, and mankind will inherit, for ever more, wonderful new mental powers. Tell them, they will earn for themselves eternal glory! All future ages will look back to them and marvel at their audacity!

DARWIN: Oh, wait a moment! Don't get too carried away.

GALILEO: Well, can you tell them just what happened here, how we arrived at this grand vision, together? You talking to me, Galileo Galilei. Can you do that?

DARWIN: Well, I think so. I think I can do that.

GALILEO: Then farewell, my friend. Take your time. It is a very important mission you are embarking on. I wish you every success. Don't forget, remember me, Galileo Galilei, to your friends down there. Ciao.

(Turns, walks offstage, laughing.)

DARWIN: *(Addresses audience)* So I told him I'd tell you all about our conversation. And that's what I've tried to do, here, today. Thank you.

SHAUN JOHNSTON, author.

Johnston was born in London in 1939. He studied biochemistry at University College London. Since 1992, under the imprint “Evolved Self Publishing,” he has been writing and publishing creative works on the subject of evolution. These include two novels and a self improvement manual. They are available at Amazon. For more information about his publishing program visit www.evolvedself.com.

Johnston also publishes the website “Take On Darwin” at www.takeondarwin.com where he maintains resources people in the humanities can use to explore alternative approaches to evolution.

Student groups may perform this play at no cost beyond informing Johnston of their intention of doing so. Johnston offers to perform this play, in Darwin costume, playing both parts, for student groups in and around NYC and the mid Hudson Valley where he lives.