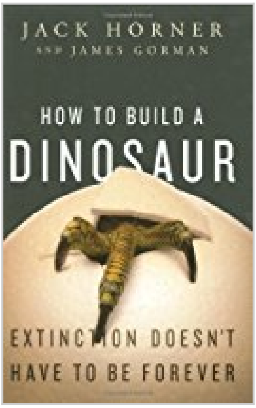

How to Build a Dinosaur: Extinction Doesn't Have to Be Forever

By Jack Horner, James Gorman

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In movies, in novels, in comic strips, and on television, we've all seen dinosaurs-or at least somebody's educated guess of what they would look like. But what if it were possible to build, or grow, a real dinosaur without finding ancient DNA? Jack Horner, the scientist who advised Steven Spielberg on the blockbuster film Jurassic Park and a pioneer in bringing paleontology into the twenty-first century, teams up with the editor of the New York Times's Science Times section to reveal exactly what's in store. In the 1980s, Horner began using CAT scans to look inside fossilized dinosaur eggs, and he and his colleagues have been delving deeper ever since. At North Carolina State University, Mary Schweitzer has extracted fossil molecules-proteins that survived 68 million years-from a Tyrannosaurus rex fossil excavated by Horner. These proteins show that T. rex and the modern chicken are kissing cousins. At McGill University, Hans Larsson is manipulating a chicken embryo to awaken the dinosaur within-starting by getting it to grow a tail and eventually prompting it to grow the forelimbs of a dinosaur. All of this is happening without changing a single gene. This incredible research is leading to discoveries and applications so profound they're scary in the power they confer on humanity. How to Build a Dinosaur is a tour of the hot rocky deserts and air-conditioned laboratories at the forefront of this scientific revolution.

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Editorial Review

Review
"The authors cover highly technical scientific fields in a manner accessible to lay audiences, who will be captivated by Audie Award nominee Patrick Lawlor's Mr. Wizard-like zeal." ---Library Journal Audio Review

About the Author
James Gorman is deputy science editor of the New York Times and editor of its Science Times section.

Jack Horner is a regents professor of paleontology at Montana State University and the author or coauthor of several books on dinosaurs.

Patrick Lawlor has recorded over three hundred audiobooks in just about every genre. He has been an Audie Award finalist multiple times and has garnered several AudioFile Earphones Awards, a Publishers Weekly Listen-Up Award, and many Library Journal and Kirkus starred audio reviews.

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For Darwin

INTRODUCTION

Nothing is too wonderful to be true if it be consistent with the laws of nature, and in such things as these, experiment is the best test of such consistency.

—Michael Faraday

Let's suppose you wanted to pick a moment in the history of life and play it over again, backward and forward, like a football play on a highlights DVD, so you could see exactly how it happened. Rewind. Stop. Play. Rewind frame by frame. Stop. Play frame by frame.

Stephen Jay Gould, one of the best-known evolutionary biologists of his time, wrote in *Wonderful Life*, his book on the weird and wonderful fossils of a rock formation known as the Burgess Shale, that you can't go home again, evolutionarily, unless you want to risk not being here when you come back. What he was saying was that evolution is a chance business, contingent on many influences and events. You can't rewind it and run it over and hope to get the same result. The second time through *Homo sapiens* might not appear. Primates might not appear.

That's evolution on a grand scale, major trends in the history of life that involved mass extinctions and numerous species jockeying for evolutionary position. We can't rewind that tape without a planet to toy with. But I'm thinking about a time machine with a somewhat closer focus, an evolutionary microscope that could target, say, the first appearance of feathers on dinosaurs, or the evolution of dinosaurs into birds.

This time machine/microscope could zero in on one body part. For birds we might start small, with a much maligned body part—the tail. We don't think about tails much, not at the high levels of modern evolutionary biology, but they are more intriguing than you might imagine. They appear and disappear in evolution. They appear and disappear in the growth of a tadpole. Most primates have tails. Humans and great apes are exceptions.

The dinosaurs had tails, some quite remarkable. Birds, the descendants of dinosaurs, now almost universally described by scientists as avian dinosaurs, do not have tails. They have tail feathers but not an extended muscular tail complete with vertebrae and nerves. Some of the first birds had long tails, and some later birds had short tails. But there is no modern bird with a tail.

How did that change occur? Is there a way to re-create that evolutionary change and see how it happened, right down to the molecules involved in directing, or stopping, tail growth?

I think the answer is yes. I think we can rewind the tape of bird evolution to the point before feathers or a tail emerged, or teeth disappeared. Then we can watch it run forward, and then rewind again, and try to play it without the evolutionary change, reverting to the original process. I'm not suggesting we can do this on a grand scale, but we can pick a species, study its growth as an embryo, learn how it develops, and learn how to change that development.

Then we can experiment with individual embryos, intervening in development in different ways—with no change, with one change, or several changes. This would be a bit like redoing Game 6 of the 1986 World Series between the New York Mets and the Boston Red Sox, when a ground ball ran between first baseman Bill Buckner's legs and changed the tide of the series.

We would be doing more than just fiddling with the tape; we would be redoing the play, with Bill Buckner and all the players. And the idea would be to determine the precise cause of the Mets' joy and Red Sox' sadness. Was it Buckner's failing legs, the speed of the ball, the topography of the field? What caused him to miss the ball? And when we think we know the cause, we test our hypothesis. We give him younger legs or smooth out the field and then we see if in this altered set of circumstances, he snags the grounder.

That's impossible to do in baseball. We don't have a way to go back in time. We can do it with computer models, of course, in both baseball and biology. But with current technology and our current understanding of development and evolution, we could also do it with a living organism. This ability is largely the result of a new and thriving field of research that has joined together the study of how an embryo develops with the study of how evolution occurs. The idea, in simple terms, is that because the shape or form of an animal emerges as it grows from a fertilized egg to hatching or birth, any evolutionary change in that shape must be reflected in a change in the way the embryo grows.

For example, in a long-tailed ancient bird embryo the tail would have started to develop and continued to develop until the chick hatched with a full tail. The embryos of descendant species, which hatched with no tails, would have to develop in a different way. We can observe the embryos of modern birds as they develop, and if we can pinpoint the moment at which the tail stops growing, we can figure out exactly what events occurred at the molecular level to stop tail growth. We can say—that's where the change occurred in evolution. And it is an idea we can test. We can try intervening at that moment in the embryo's growth to change the growth and development signals back to what we believe they were before the tail disappeared in evolution. If we are right, then the long tail should grow. If we can do this with a tail, we ought to be able to do it with teeth, feathers, wings, and feet.

The most studied and most available bird for both laboratory and culinary experiments is the chicken. Why couldn’t we take a chicken embryo and biochemically nudge it this way and that, until what hatched was not a chicken but a small dinosaur, with teeth, forearms with claws, and a tail? No reason at all.

We haven’t done it yet. But we are taking the first small steps. This book is about those steps, the path ahead, what we could learn, and why we should do this experiment.

Hatching a dinosaur from a chicken’s egg may sound like something that belongs in a movie. It seems very remote from my specialty, vertebrate paleontology, in particular the study of dinosaurs. Paleontologists, after all, are the slightly eccentric folks who dig up old bones in sun-drenched badlands and like to talk too much about skulls and femurs. Well, that may be true, as far as it goes. But that’s only part of the story. At heart, every paleontologist is as much Frank Buck as Stephen Jay Gould.

Frank Buck was a real person who became a hero of movies and books before and after World War II. He went into the jungles and remote places of the world and brought back not fossils, but exotic living animals. He was—and this appealed to many a small boy—not a hunter who killed his prey, but a collector of live animals. And his motto, once as well known as any of today’s catchphrases, was: Bring ’em back alive.

Well, paleontologists may deal with the long dead. But at the heart of all the digging and preparation of skeletons and museum displays is the attempt to reconstruct the past, to re-create moments in the history of life. What we would really love to do, if we could, is bring ’em back alive.

Users Review

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Manuel Jett:

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