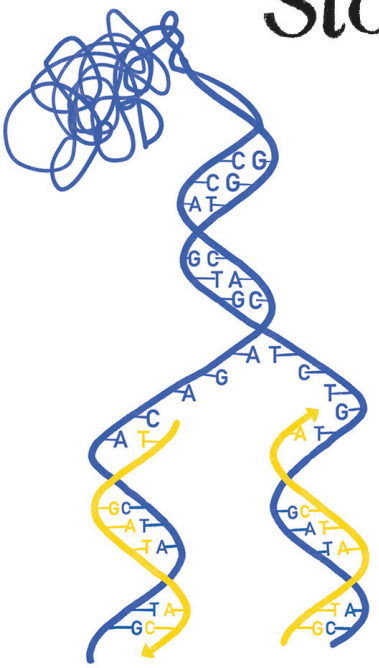
Biology

The Whole Story



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For Rowan

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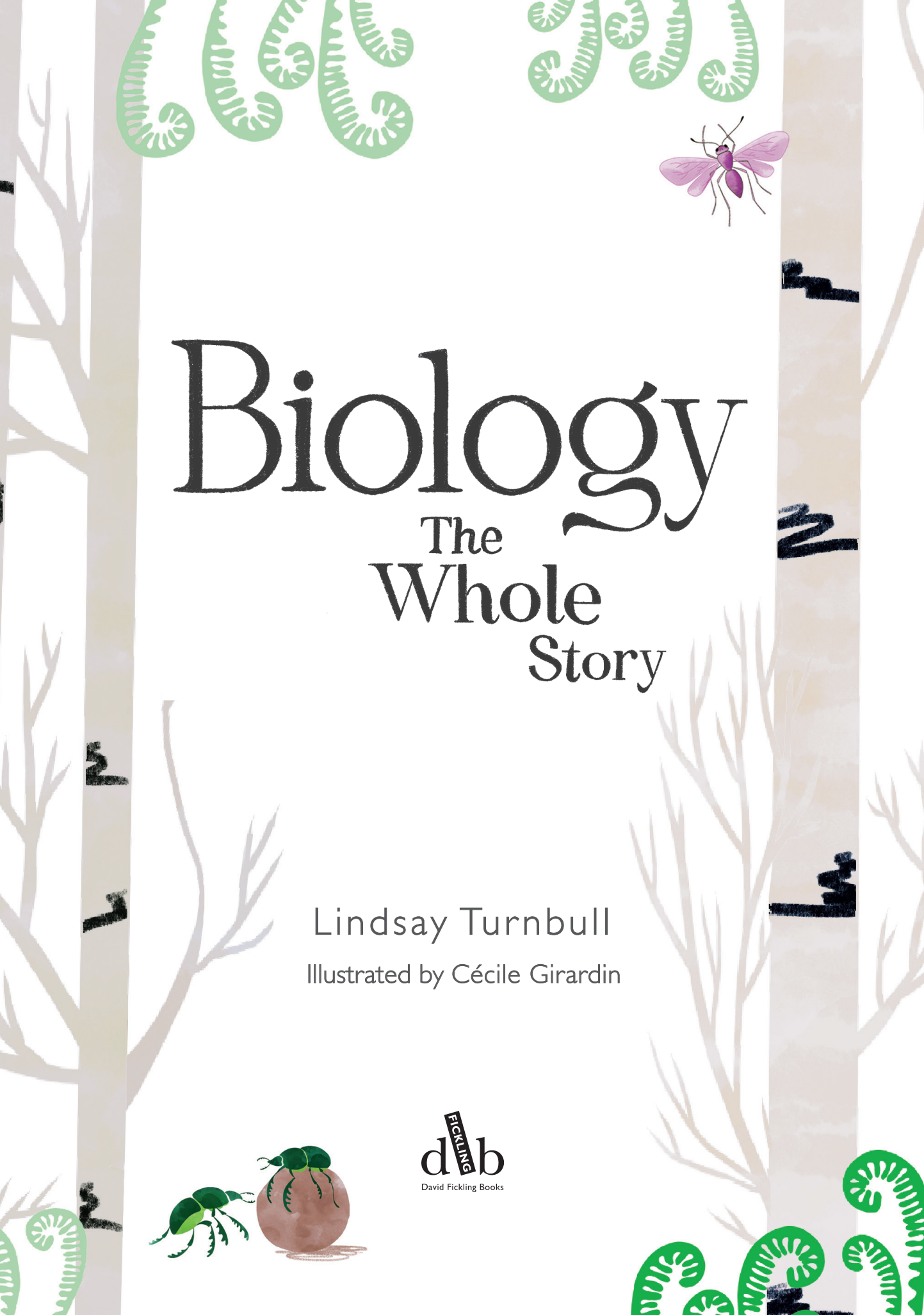

Biology
The Whole Story

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Why this book?

INTRODUCTION

Physics is often described as the science of the twentieth century, but biology has staked a bold claim to be the science of the twenty-first. Every day we are bombarded with new and important biological findings, from new vaccines for deadly viruses to strange new species lurking in hitherto unexplored places. Of course, the physicists haven't yet thrown in the towel. They continue to vie for public attention by enticing us with exciting new projects, and most recently they have turned their attentions to our neighbouring planet, Mars.

NASA's *Perseverance* rover is a robotic vehicle that landed on Mars in 2021 to trundle around its surface, collecting samples and setting them aside for future human visitors to inspect. The mission is a spectacular feat of human ingenuity and the scientists at NASA are rightly proud of their achievements. But the stated goal of the mission is unmistakeably biological – to look for signs of ancient past life on Mars's dusty surface – because today, its thin atmosphere and lack of liquid water mean that the red planet is undoubtedly a dead planet.

Personally, I'm happy to give Mars a miss. It's not that Mars isn't beautiful in its austere way, nor that it doesn't have some attractions, like the largest volcano in our solar system. But Mars, like so many of us humans, is utterly eclipsed by its gorgeous, stunning sibling. Why would you want to go to Mars when you can live on its shining sister – Earth?

Earth is unmistakeably a living planet. Suspended in the blackness of space, oceans of deep-blue water hold glowing green continents in their liquid embrace. The Earth's atmosphere is thick – and rich in oxygen gas – quite unlike the atmosphere of every other dull and lifeless rock that's scattered around our solar system. And it teems with unimaginable wonders.

Earth is currently home to at least eight million species of animals and plants – the products of four-and-a-half-billion years of evolution – and all earthlings have free access to at least part of this bounty. We can gasp at the aerobatics of a passing swift, or shudder at the scuttling arthropods that rush out from underneath the nearest rock. Even a drop of pond water contains a twirling, whirling frenzy of micro-organisms, which any microscope can reveal.

We ourselves are just one example of evolution's creative frenzy. Humans

have undoubtedly been highly successful, spreading around the globe and reaching every continent. But we don't live quietly alongside other species – instead, we have transformed the planet, removing entire ecosystems and replacing them with others that more closely serve our needs. Indeed, so profound is our impact, that many now believe our planet may not support us for much longer.

Today, many children worry deeply about the planet-scale mess that they stand to inherit. If they are to tackle the challenges ahead, then a good grasp of biology is essential; but this is a daunting prospect. Biology is an enormous subject that grows every day, and the problems that biologists are expected to solve keep mounting: we need better antibiotics; we must prevent the emergence of the next pandemic; and all the time, species are disappearing, as the diversity of life on Earth comes under pressure from a growing human population that demands more every day.

I certainly sympathize with those children. I teach students at the University of Oxford, and they too worry about their future. They often feel overwhelmed by the immensity of biology, and it's my job to try to make it manageable. Studying the school curriculum and looking at other sources of readily available information led me to conclude that there are two intertwined problems with teaching and learning biology today. The first problem is that biology does, indeed, continue to grow at an alarming rate. Biologists begin with an idea and then further investigations add more knowledge and the original idea might start to fracture into several sub-ideas, each with their own supporting evidence. In the end, this continued growth makes it difficult to teach any biological topic, as it's extremely hard to know what is essential and what is simply nice to know.

The second problem is the tendency to serve up biology in rather large indigestible chunks. Even the best textbooks continue to lay biology out in a rather dull way and don't attempt to turn it into an enjoyable read. It's the student's job to simply learn the information, and there isn't any real context or story to help the reader along.

This is strange because the history of life on our planet is the most incredible story. It begins with a molten rock being bombarded by meteorites and it ends with what you see around you today: a teeming world of species that interact with each other

and their surroundings. Between that distant hot rock and the present day, millions of living things have sprung into being, and although most have since vanished, we can learn something new from each and every one of them.

The story of life on Earth provides the perfect backdrop for the important biological concepts that we all need to know, and I have used that story to structure this book. You'll be glad to know that I don't give equal space to each period of the Earth's history – indeed this would be a recipe for a very dull book – as for very long periods we honestly don't really know what was happening. It also doesn't follow a slavish chronology – my goal is to tell the story in the way that makes it easiest to understand, so animals get two chapters before plants get to muscle in and tell their story.

Despite my best efforts, many episodes in the story of life are still somewhat controversial. There are also many things that we simply don't know. I believe that the best way to deal with this issue is to be honest, in the hope that this might inspire some readers to fill these gaps by becoming biologists themselves. So, I hope that you will find these gaps reassuring – there's still plenty for budding biologists to find out!

Finally, when writing about science, a decision has to be made about the scientists themselves, and mostly I decided to leave them out. I accept that science is done by real people and obviously they deserve appropriate credit, but mentioning them all means introducing yet more names to a subject that is already full to bursting with new terminology. To deal with this particular problem, there is a glossary at the back of this book and any technical word written in italics, like ***cell nucleus***, can be found there, together with a brief definition. The book also contains illustrations. These have been developed in conjunction with my fantastic colleague, Cécile Girardin, and are simpler than those found in most text books. They are not a replacement for a text-book diagram and we have allowed ourselves a certain artistic licence when we think it helps to make a tricky concept clearer (a ribosome is not really a stout man in braces!).

In writing this book, I relied on the expertise of many incredible colleagues at the University of Oxford, who shared their knowledge with the relish and

eagerness that typifies most biologists. Of course, I must take the blame for any errors. As I have already explained, new discoveries are made every day, but I still believe that many of the core concepts in this book have stood the test of time and are unlikely to change dramatically. So, if each biological topic can be thought of as a delicious dish, then future biologists might tinker slightly with the ingredients, but I doubt that they will entirely change the recipe.

So, now, let's begin with the fundamental unit of all life on Earth – the cell. These tiny entities form the building blocks of larger creatures, but most of the cells on Earth live alone – quietly passing on their information to the next generation and turning long-evolved plans for world domination into action. Cells might be small but don't let their size fool you. These tiny titans are the ultimate life form and if cell biology were a delicious dish, then it would be the equivalent of the best cake you've ever eaten.