

To the Student

We designed this book to help you attain a confident, competent, and coherent understanding of basic chemistry, in particular of the chemistry associated with organisms and their origins. That said, this is not a chemistry for biologists or non-scientists book but rather an approach to the difficult and often counterintuitive ideas at the heart of chemistry, for an intelligent and engaged student who, often quite reasonably, finds these ideas unbelievable, arbitrary, or incoherent. Our goal is to assist you in developing an understanding of the foundations of chemistry, so that you can apply these ideas to a range of new situations. We are aware that many of you are not excited by the prospect of learning chemistry and we share your concerns—many of the ideas presented are difficult and often counterintuitive and past experiences with chemistry not have been optimal. At the same time, it is possible to approach chemistry from a more reasoned and rational direction, recognizing difficult ideas, why we are forced to accept them, and how we can apply them.

Why is basic chemistry often perceived as boring? One reason maybe the way it is all too commonly presented: a laundry list of facts to remember and exercises to perform, often with little effort made to connect abstract and frankly weird concepts to your lifetime of day-to-day and quite real experiences. For example, it is certainly not obvious that matter is made of a small set of essentially indestructible objects—atoms—connected to one another in various ways; or how such combinations of atoms—molecules—can lead to complex processes like life and dreams. Where did this strange idea come from? How is it that we come to appreciate and accept the reality of things as abstract as atoms and molecules, or that a tree is composed primarily of gas, carbon dioxide, and water molecules, rearranged? Is it even possible for the average person to really accept, understand and learn to work with, such bizarre abstractions? We think we are reasonably average people not withstanding our excessive amounts of formal education and our obsessive efforts to understand what may seem to be insignificant, weird, and occasionally trivial problems. We think that while scientific understanding is not easy, it can be made more engaging by recognizing explicitly which ideas are odd and what types of observations and logic led or forced scientists to accept them.

Throughout our journey we will consider what makes sense from our day-to-day experiences, how that differs from the current models of chemical systems, and what types of observations resolve the apparent contradictions between the two. We encourage you to take your own ideas seriously and consider when they do and do not make scientific sense. This is not an easy task, but it is the only way to understand scientific ideas, rather than simply memorizing words and formulae.

Why think about chemistry from a biological perspective? The answer is simple really. Biological systems, whether cells, organisms, or ecosystems, are the most complicated examples of chemical systems. They rely on chemical reactions and the chemical properties of atoms and molecules to produce truly amazing behaviors. They are the end products of evolutionary processes that have been going on for more than 3.5 billion years; processes based on random variations that are captured and turned into information through natural selection. Molecular analyses strongly support the rather amazing conclusion—namely that all organisms currently living on earth are related and descended from a common ancestor through unbroken lineages.

The underlying unity of life, and its chemical basis, is only one of many amazing, bizarre, and counterintuitive ideas we will encounter. To help you grapple with these ideas we will use various interactive materials that will help you test and strengthen your understanding. Where you feel lost, try to articulate what, exactly, you find confusing and why. You can start a Socratic dialog with yourself, and then bring it to your instructor and fellow students. That is the best way to learn, or so claims Socrates.

A note on footnotes: The authors have an inordinate fondness for footnotes. We do not expect you, the student, to read them or the follow the links within them, but they enable us to indulge our interests in various topics. Please be careful to avoid getting lost in them—that may well be a mistake.