



biological parts and pieces. Many of the operating parts in a cell function for the metabolism, scaffolding, or reproduction of the cell. Many cells may function only in supportive or nutritive roles. Our goal is to avoid a phonebook of detail in favor of teasing out the underlying principles. The details are essential for understanding how the parts of the brain work; however, simply understanding what the parts are, even in detail, is not equivalent to understanding how the parts and their interactions *embody* and *process* information. This latter problem involves understanding what things *do*, instead of simply what they *are* (FIGURE 1.5).

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Which Parts Matter?

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In modern computers, great care has been taken to separate information content from its physical embodiment. In the brain, the clean hardware/software distinction is misleading. The division of hardware and software in the brain is unclear, if the distinction exists at all. For a complete view of cognitive neuroscience, we will explore topics from the level of single molecules to systems of neurons.

To understand the levels problem, consider the screen on your cell phone. Suppose that no one knew how a cell phone worked, but you were interested in finding out how the components of the screen gave rise to the funny YouTube videos that you watch on it. So you study the personalities of the

FIGURE 1.5 (a) The 20 amino acids that make up every protein in your body and (b) a leaf of Sanskrit manuscript. Knowing only the pieces is insufficient—as insufficient for understanding how biology functions by dint of protein machines as it is for reading a manuscript in an unknown language. The mission of this book is to provide a principles-based approach to understanding what things do.

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characters, why they are sometimes funny and sometimes not, your reaction to their facial expressions, humorous situations, and so on. Through careful study, you may generate a theory of comedy and rules for why it has such powerful effects on humans and not on monkeys or cats. But even at the end of that theoretical work, you are still stuck with a question: exactly what is the relationship between the function of a transistor and the comedy that is displayed on the screen?

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You might turn to studying the tiny transistors and the way they are fashioned out of semiconductor materials. This would result in a description of how electrical currents and voltages relate to the detailed structure of the transistor; however, even your complete description of the transistor would give you no insight into why a video was funny.

In the same way, descriptions of cognitive events (such as the perception of a social dilemma in a drama) may require scientific descriptions that are remote from the operation of the underlying biological parts. On the other hand, the two levels, although distant in description, are inseparable: the breaking of a single transistor can kill the display of the