manages to cover. To get through it all, he mostly sticks to the point, which renders some parts a bit disjointed. Also, his rapid progress generally leaves no room to give the unknowing reader a sense of the years of study that led to the eventual identification and characterization of the basic cellular processes. In a few cases, most notably the development of cell theory, the author does elaborate on the historical context. Whereas the concept of the cell makes perfect sense to us with the benefit of hindsight, the original construction of the concept required the development of new technologies and lots of unconventional thinking.

The last chapter, subtitled "the mystery of the first cell," is actually about the very beginning. It tempts with the promise of explaining all, but Wolpert waits a few pages before going into some of the current theories for the origin of life, which are at present fairly unsatisfying. Cells are keeping some of their secrets, and understanding the origin of the cell remains a notable challenge. So, in the end there is no end. *How We Live and Why We Die* comes full circle from the cell's beginning to the beginning of the cell. But Wolpert manages to pack a great deal of cell biology into the book's couple hundred pages.

–Helen Pickersgill

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MATHEMATICS

Correspondence in Flux

Brie Finegold

The Calculus of Friendship
What a Teacher and a Student Learned About Life While Corresponding About Math

by Steven Strogatz

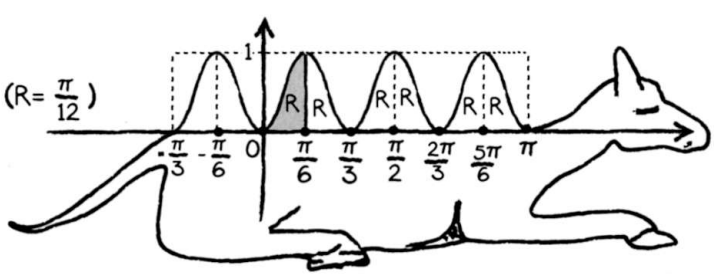
Princeton University Press, Princeton, NJ, 2009. 180 pp. $19.95. ISBN 9780691134932.

Thinking about "the calculus of friendship" is not as cold an exercise as it might first seem. We depend on a continuity in our friendships, ignoring lapses in communication and momentary mean streaks. Mathematics is no different: As Steven Strogatz notes, "Experience teaches us that change can be sudden, discontinuous, and wrenching. Calculus draws its power by refusing to see that."

The spring of his freshman year in college, Strogatz (now an applied mathematician at Cornell University) began to exchange letters with his high school calculus teacher, Don Joffray. At some point, their amiable correspondence about math problems led to a true friendship. In *The Calculus of Friendship*, Strogatz weaves their letters into reflections on the philosophical similarities between calculus and human relationships and portrays a friendship firmly founded on a love of dreaming up and solving calculus problems. Student and teacher switched roles as their correspondence ebbed and flowed over the course of 30 years. Their excitement in sharing mathematical jewels and tidbits leaves us as anxious to read the next letter as its recipient must have been.

Strogatz recalls how his teacher's storytelling abilities quickly instilled listeners with a sense of respect for those who solve mathematical puzzles. While teaching, Joffray did not strive to impress the class with his own quickness. Rather "in a hushed tone, he'd tell us about the time that Jamie Williams wrote down a formula for the nth term of the Fibonacci sequence." The Fibonacci sequence (0, 1, 1, 2, 3, 5, 8, 13, 21, …) is a sequence of integers in which every term after the initial pair is the sum of the previous two terms. Of course, now we are goaded into wondering how to figure out a formula for the sequence's nth term that depends only on n. And readers who ruminate over the problem to no avail will find the answer later in the book.

Becoming invested in answering mathematical questions is a major benefit of reading the book. Have you ever been dissatisfied with the standard proof that the square root of two is irrational? (The square root of two is the length of the hypotenuse of a triangle whose legs are of length one. And a number is irrational if it is not the ratio of two integers.) Writing from his college dorm, Strogatz describes to his former teacher a geometric proof of this fact. It is easy to follow yet avoids the tone (too frequently found in textbooks) of "okay, dummy, so this is step one." The respect and admiration the two men held for each other and for the inner workings of mathematics are palpable in their writing. And although some solutions are explicitly worked through, the problems presented in the book are tantalizing on their own. They would be well worth some scribbles on a napkin during lunch.



The camel's humps for $k = 3$.

CREDIT: DON JOFFRAY/FROM *THE CALCULUS OF FRIENDSHIP*

One can also feel the personality and humor of these pen pals emerging through their symbol-sprinkled sentences. In a letter concerning Fourier series, Joffray gives the name "camel hump theorem" to the fact that no matter what natural number k one picks, $\int_{-\pi}^{\pi} \sin^2 kx\, dx = \pi$. He writes, "Geometrically I saw this as a squeezing of a camel's humps as k escalates through the natural numbers." Joff, as Strogatz begins to call him, ends the next paragraph with "Humph!" A sketch of a camel with humps (for the case $k = 3$) follows.

Key ideas that are used by scientists of all types float to the surface again and again via specific problems. We learn of young Strogatz's frustration when he devises a problem whose solution cannot be expressed in terms of the familiar elementary functions. We share in his use of computer approximations and dimensional analysis as tools for gaining intuition about a problem. We notice that there is merit to finding multiple proofs to one theorem.

Most important, we share in the joy of doing mathematics, not just the results. Were it true that phrases like "And that's the beauty of this!" appeared in technical papers as often as they do in *The Calculus of Friendship*, more people might be drawn to reading modern research papers.

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