

# **Elizabeth Blackburn and the Story of Telomeres**

Deciphering the Ends of DNA

Catherine Brady

The MIT Press  
Cambridge, Massachusetts  
London, England

© 2007 Catherine Brady

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.

For information about special quantity discounts, please send e-mail to <special\_sales@mitpress.mit.edu>.

This book was set in Sabon and Meta by SNP Best-set Typesetter Ltd., Hong Kong.

Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Brady, Catherine, 1955–

Elizabeth Blackburn and the story of telomeres : deciphering the ends of DNA / Catherine Brady.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-262-02622-2 (hardcover : alk. paper)

1. Blackburn, Elizabeth H. 2. Biochemists—United States—Biography.  
3. Telomere—History. I. Title.

QP511.8.B53B73 2007

572.092—dc22

[B]

2007000080

10 9 8 7 6 5 4 3 2 1

# 1

## A Certain Sense of Self

Like many other seventeen-year-old girls in 1965, Elizabeth Blackburn listened to the records of the Beatles and Peter, Paul, and Mary and wore the miniskirts that were just coming into fashion, but she felt so shy in the presence of boys that she could not look them in the eye. Rigorously schooled by her mother in polite manners that sidestepped confrontation, Elizabeth was a model student who seemed readily guided by her teachers. But her delight in books exceeded the bounds of obedient studiousness—in particular, she was thrilled by her recent discovery of a biology text complete with detailed illustrations of amino acids, strung together in long chains and then folded up into complex three-dimensional shapes to form enzymes and other proteins. For Liz, these elegant structures had a teasing beauty, promising tantalizing clues to the processes of life and yet also enfolding that mystery. Even the names of the amino acids—phenylalanine, leucine—struck her as poetic. Though she confessed her fascination to no one, she traced drawings of amino acids on large, thin sheets of white paper and then tacked them up on her bedroom wall.

From the start she carefully protected the passion that would shape her life as a scientist, her fierce determination often masked by a polite, acquiescent demeanor. The nice girl who remained silent when confronted

or thwarted purchased the freedom of a secret, willful, essential self. Blackburn's first clear memory dates to when she was about three years old. Playing in the yard behind her family's house, she had found a bull ant and was handling it gently, talking to it as it crisscrossed her palm and the back of her hand. When her mother came on the scene, she brushed the insect from Liz's hand and vehemently warned her never to touch these insects, whose bite could result in a painful welt. Surprised by her mother's concern, Liz obeyed. But she remained stubbornly and silently certain that the ant could not hurt her.

Elizabeth Helen Blackburn was born in Hobart, Tasmania, on November 26, 1948, to Marcia Constance (née Jack) and Harold Stewart Blackburn, two general practitioners. Blackburn noted that family lore claims her father's family is descended from Alfred the Great, a ninth-century English ruler. Legend has it that during wartime, when Alfred took refuge in a swineherd's hut, the swineherd's wife asked him to watch over cakes she had placed in the oven, but preoccupied by affairs of state, he forgot his task. In relating her family's history, Blackburn ruefully admitted that "he was famous for burning the cakes, a trait for which I probably inherited the gene."<sup>1</sup> More certain evidence suggests that she inherited from both sides of her family a strong inclination for science. Her father's family had originally come from the north of England in 1882; her great-grandfather, the Reverend Thomas Blackburn, an Anglican minister, moved from Hawaii to Australia to pursue a passionate avocation. Like many Victorians, he was inspired by the publication in 1859 of Charles Darwin's *Origin of the Species*, which had spurred widespread interest in collecting and studying specimens of insects and fossils. Having completed and cataloged an extensive insect collection in Hawaii, Blackburn continued to collect *Coleoptera* beetles in Australia until he had amassed a total of three thousand specimens. In the later years of his life, he corresponded with the British Museum, anxious to sell this collection and certain it could provide his family with a substantial inheritance. Although the family still possesses his letters, there is no record of whether the museum obtained and preserved the collection. Elizabeth's father, Harold Blackburn, born in 1919 and raised in Adelaide, shared his grandfather's scientific bent and earned a medical degree from the University of Adelaide.

Elizabeth's maternal great-grandfather, Robert Logan Jack, was trained as a geologist in Edinburgh. With his geologist son, Robert Lockhart Jack, he traveled through China, surveying for minerals, until they were forced to flee the Boxer Rebellion in 1904, escaping through Yunnan Province. Robert Logan Jack later wrote books about his travels in China and northern Australia, where he continued working as a geologist. Robert Lockhart Jack married Fanny Marr, and they had two children, Bill and Marcia, born in Adelaide in 1918. The family soon moved to Melbourne, where Marcia spent most of her childhood. Like her future husband, she grew up in a middle-class family and attended private school, earning her medical degree from the University of Melbourne during World War II.

Marcia and Harold met during the war, when he served as a captain in the Australian Army, and they married after the war ended. Reticent about their personal lives, neither of them ever told their children the details of their courtship. While they raised a family, Marcia practiced medicine intermittently, working part-time in a large family practice. The first of their seven children, Katherine, was born in 1946 in Adelaide. After the family moved to Snug, Tasmania, three more children were born—Elizabeth (known as Liz) in 1948, Barbara in 1949, and John in 1950. In 1954, when the family spent a year in London, Andrew was born, followed by Margaret in 1957 and Caroline in 1960.

Until Liz was four years old, the family lived in Snug, a small bush town south of Hobart, a coastal city of some 130,000 to 150,000 in southeastern Tasmania, where her father had found work as a government medical officer. Snug was situated on the sheltered North West Bay, with a main street that ran from the highway to the sea. The town's few gridded streets, lined with bungalows, simply ended at farmland or wilderness. Out of necessity, the children were taught to be fearful of snakes, especially the venomous tiger snakes, but other warnings did not deter Liz from squatting on the beach to pick up jellyfish that had washed up on the sand, though some were poisonous. Fascinated by small living creatures, she loved to hold them and even sang to them.

Living nearby in Snug was Liz's godmother, a dental nurse named Cluny Portnell, who went by the name of Bill. A childless single woman, Bill lived near the beach with her sister, and Liz was sent to stay with

Bill in her small house whenever her mother was particularly busy. Despite the pleasure of spending time with Bill and her cats, Liz felt homesick on these visits. After the family moved away, Bill sent Liz a book for every birthday—well-written books by contemporary authors that had been chosen with great care and deliberation, far more advanced than the books Liz was already reading, and a clear and welcome signal of Bill's strong expectation that her goddaughter should excel. Blackburn retained strong ties with Bill into adulthood.

The family moved when Harold Blackburn decided to join a medical practice in a town that offered more educational opportunities for the children. From the time Liz was four until she turned sixteen, the family lived in Launceston, a town of about seventy thousand people in northeastern Tasmania, a move up from the sleepy hinterland of Snug. Situated at the convergence of the North Esk and South Esk rivers, Launceston was set among steep hills, with a mountain range in the distance, dominated by Mount Barrow.

In Launceston the family first lived in a typical one-story Australian suburban bungalow, with a peaked, gabled roof and a veranda that wrapped around two sides of the house. Her mother often took Liz to afternoon tea at the home of their two elderly neighbors, where even at a young age she was expected to sit quietly and politely on their nice chairs. With five children filling up her own crowded house, frequently spilling out to the front lawn to play fantasy games with the children of the neighborhood, Liz delighted in the tidiness of her neighbors' home.

Liz's father was a busy physician, but that did not fully account for his absence from family life. Every morning, her mother sat down to a full breakfast with the children, but her father would appear only briefly before leaving for his office. In addition to his long hours of work, he led a social life separate from that of his wife and children, often spending weekends fishing with his mates. Drinking was the worrisome common factor in these different friendships as well as a strong motive for Harold's frequent absences. Liz recalled "a few occasions of happiness with my father, few and far between, so I clung to them. When I was about kindergarten age, we had a fire going in the front living room, and I was sitting on his lap eating an apple, and I said, what shall I do

with the core, and he said, throw it into the fire, and I threw it into the fire.” Liz often resented her father’s absence, but even more she longed for his love: “Once I remember seeing my father, who had just got home, picking up my little brother, who was about two, and tossing him playfully in the air. My father was silhouetted against the light coming in from the front door at the end of the long hallway that ran down the center of the house, and I remember wishing that he would pick me up and throw me in the air too. But I didn’t ask him.”

Every night Liz’s mother made a point of coming to each of the children’s bedrooms to kiss them good night. Marcia provided her children with art, elocution, and piano lessons and was determined to send them to expensive private schools. Although she rigorously instilled politeness in her children, Marcia conveyed tolerance—even fondness—for her second daughter’s strong-willed nature and often told amused stories about Liz’s stubbornness. Once, when Liz discovered a doll that had been put away at the top of a cupboard, slated to be a present for her or her sister at a later date, she persisted in begging for the doll, yelling at her mother and badgering her until she capitulated.

Liz felt closest to her sister Katherine, who was two years older, and for a time was jealous of her next youngest sister, Barbara, who had been quite sick as an infant and thus commanded much of her mother’s time. Liz revered Katherine, and she was one of the few people whose disapproval Liz would tolerate when corrected for not doing her share of the family chores. When Liz was about six, her parents made a nine-month sojourn to London, where her father did postgraduate work. Marcia and Harold left the younger children behind in Tasmania, but Liz and Katherine accompanied their parents to England and stayed briefly with relatives in the English countryside, an experience that drew them even closer.

With the exception of this trip, Liz was educated at Broadland House, a public school for girls. Like most of the nonstate schools, Broadland House Church of England Girls Grammar School operated under the auspices of a church. The school encompassed grades from kindergarten through secondary school. Separate schooling for girls and boys reflected the distinctly divergent expectations for their future roles. During the rough equivalent of middle school, the curriculum at Broadland House

split into two tracks, one emphasizing secretarial training, including typing and shorthand, and the other stressing general academics. Although the school did not offer courses in classical languages or culture, it strove to impart a well-rounded grounding in the humanities, strongly focused on British literature and history. Modern history was taught under the heading of social sciences, reflecting the somewhat narrow, colonial range of the school's curriculum and a relative innocence about the world for which it was educating its girls.

At five, Liz was capable of noting, almost with objectivity, how polite she was outwardly, even when she sometimes felt deeply angry. Well-mannered behavior often belied her strong will. On her first day of kindergarten, the children were permitted to draw with pastels, and she drew a big locomotive entirely in black pastel. The teacher, Mrs. Mundy, suggested she shouldn't use so much black, and Liz felt outraged to be told how to draw *her* locomotive. Timidity and training kept her from protesting, but "although I didn't say anything, I didn't like getting what I took to be reproof for what I thought I was doing perfectly well."

Her sister Katherine's memories also suggest Liz had a stubbornly certain sense of self, subtly dissonant with her shy, meek demeanor. Angry at a "mean" first-grade teacher, Liz did not rebel openly but enlisted Katherine to exact a surreptitious justice, mistreating the textbooks this teacher had given her and dangling them out the window on a string. In third grade, Liz got in trouble with a teacher for "smudging her ink" and adamantly insisted she had not done it. "She was so upset to be falsely accused that our mother had to pay a visit to the teacher," Katherine reported.<sup>2</sup> That Marcia would do so says a great deal about her acceptance of and support for her daughter, which helped to preserve Liz's sense of self.

When Liz was in fourth grade, the family moved to another house in Launceston. Built in the early nineteenth century, Elphin House had steeply pitched roofs and a large garden full of wonders: a goldfish pond with a central birdbath of stone, a walk-in aviary for budgerigars and canaries, a henhouse, a vegetable plot, and a row of fruit trees. Liz would sit on the window seat of her brother's bedroom, eating small fresh apples from their own trees and reading Jane Austen novels. In this roomy, magical house, she had ample opportunity to indulge her

passionate love for animals. She befriended neighbor's pets as well as her own, and the family owned dogs, a number of cats—including Mugwumpian, whom Liz adored—and some budgerigars that her little brother Andrew once let out of their cage. Liz also kept guinea pigs as her own pets for a number of years. She lavished care on them, raiding the vegetable plot in the back garden for leafy greens to feed them despite the risk of being caught and scolded by her father. When her guinea pigs had babies, she showed them off to school friends, holding the tiny, hairless creatures in her hand, and was mystified by her friends' squeamishness and disgust. By the time she turned twelve, her father decided that she was spending time on her pets that she should have spent on chores and took her guinea pigs away.

When the family lived in Elphin House, they employed a nanny-cum-housekeeper, Flora Douglas, called Duggie by everyone in the family. Constant and reliable, if somewhat severe, Duggie was sought out by a vaguely lonely Liz, who was sometimes treated to a visit to Duggie's large room to look at her books and play with her things. It was not an unhappy childhood, and yet often Liz yearned for a happiness she never quite felt.

Marcia enrolled Liz in piano lessons after she turned seven, and she was not too busy to make the long drive to northwest Tasmania so Liz could participate in a piano competition. Eventually, Liz also learned to play the violin, and her mother enrolled her in Saturday morning art lessons, which she loved, and proudly took her daughter to see her own artwork in an exhibition of prizewinners from a local children's competition. Liz's older sister Katherine recognized Liz's talent for drawing and music, yet she never felt jealous, because "our mother emphasized that she loved everyone equally."<sup>3</sup> If Marcia seemed to view Liz as exceptionally gifted, she conveyed to all her children the strong sense that the family was "somehow a cut above the common herd"—an attitude all the more striking in Australian society, where the concept of "mateship" meant that a man was admired particularly when he did not act superior to anyone else. According to Katherine, Marcia intended to instill in her children that they were "*intellectually* a cut above."<sup>4</sup> Marcia expected each of her children to pursue a profession and taught them to believe that reason and reasonable expectations should govern their

values and actions, never insisting on a single right way but subtly implying it. For Marcia, intellect and gentility, not money and social position, were markers of class, and she taught her children to distance themselves from anything that smacked of vulgarity. When Liz once asked her about the family's income, Marcia responded euphemistically (they were "comfortably off"), and she shunned any display of wealth.

Later, when Liz was in her teens, her mother arranged for her to take Saturday morning elocution classes from Alison Beattie, the daughter of close family friends. Alison's father, who had emigrated from Scotland, was a gentle, approachable man, openly affectionate with his family, unlike Liz's father. All the Blackburn children were welcomed into the Beatties' family circle. On school days, when girls commonly went home at lunch, Liz sometimes went to their house instead of her own. Mr. Beattie joined the family for a cozy lunch by the fire, often reading books aloud to the children in his strong Scottish accent.

With her older sister Katherine, Alison had studied at the Royal Academy of Dramatic Art in London. On Saturday mornings Liz and a school friend received lessons from Alison in the family's back room, with the gas fire roaring, studying elocution, enunciation, and pronunciation (in a British accent), with Alison drawing on her stage training to teach the girls how to exploit breath and posture in their speech, entertaining them by letting them practice saying lines from Gilbert and Sullivan as clearly and rapidly as they could. These lessons provide evidence that Liz's mother, once again, had anticipated what would be important for her shy daughter.

Liz liked school and, in particular, the relative social freedom of a girls' school, in which intense friendships and rivalries were formed. In early middle school, she became enemies with another girl and recalled them roundly insulting each other in the cloakroom. From the beginning, she excelled academically and felt driven to succeed. She would get up early on the day of a test and walk around the garden or the living room, repeating to herself over and over the terms and concepts that would appear on the test.

In a school that took girls' sports seriously, Liz played on the high school's lowest-ranked tennis team, which meant she joined relatively uncompetitive games with teammates who didn't care if she wasn't a

particularly good athlete. She felt physically and emotionally free: “We would change into our sports clothes, which included voluminous black bloomers, a blue blouse, and a short black inverted pleated tunic, worn with a tasseled girdle, the color of the particular school house we belonged to, tied round the waist. We wore warm cotton wind-cheaters in the winter, and I loved the feel of a new one when its lining was still all fluffy. I remember walking to the sports fields on quite cool days in windy weather and loving the whole feeling of being free in our bodies and in enjoyable company.” The girls had only limited opportunities to mix socially with boys, primarily at dances held jointly with Broadland House’s “brother” school, Launceston Church Grammar School. Liz went to the dances and even had crushes on a few boys, but always from a distance: “I did not think of myself as very pretty. I was quite shy in general about this sort of thing and not venturesome in pursuing any relationships until I went to college.”

Broadland House provided a rich education, and at home Liz indulged her taste for gorgeously illustrated books about science, including one by Jacob Bronowski. Liz was fascinated by these books, particularly by the beautifully colored illustrations that made science alluring. She avidly read an adoring biography of Marie Curie, written by her daughter, Eve Curie. Reading about the life of a woman scientist opened a window of possibility for which Liz hungered: “The yearning for things helped push me into science. I was naturally curious and I loved animals, and I was educated quite well. I believed then and still do that I loved science because it also became a world in which I could escape, in the way that for some people religion is an escape into a world where things are fair and you know where you stand. I remember being able to articulate clearly in my mind at quite a young age—not that I ever discussed it with anyone—that through science I could escape into a world where things were secure and fair.”

Liz sustained this interest despite the fact that so many of her secondary-school science classes drew on dry textbooks, offering systematic zoology and botany classifications. Not until ninth or tenth grade did she have an opportunity to do laboratory science in chemistry and biology. Because Broadland House did not yet have a laboratory in Liz’s earlier high school years, students attended chemistry lab classes at a

neighboring school, Methodist Ladies College, a few blocks away. The girls would take the short walk blissfully free and temporarily unsupervised, and Liz became the ringleader of a group of girls who decided one day to see if they could mix chemicals together to make an explosion. The more abstract and private curiosity she felt about science suddenly became cool and rebellious, and choosing to take this risk granted her a sense of power. After Broadland House acquired its own chemistry lab, Liz continued to indulge a taste for doing slightly dangerous things. From a mixture of iodine and ammonia, she and her friends created “touch powder,” which produced small but startling explosions—applied to the inner rim of a desk, it would produce a bang when the lid of the desk was closed. The girls put some touch powder on the steps of one of the school buildings in the hope that the headmistress would activate a loud bang by walking on it. They liked the headmistress perfectly well, but they liked producing a reaction even more and were gleeful when she set off an explosion.

That her teachers identified her as an exemplary student not only granted Liz leeway for these escapades but also nurtured her ambition to excel. “I enjoyed writing quite learned essays,” Blackburn recalled. “I would use our extensive library at home and our *Encyclopaedia Britannica*, wonderful big books that I adored, treasure troves of information, and I would write on a card table covered with books open for reference as I wrote.” When a high school English teacher singled out one student’s essay for praise before the whole class, announcing that the piece was “typical of the exceptional person,” Liz at first did not realize the teacher was talking about her, though her classmates had already guessed and were looking at her: “I felt gratified but also slightly embarrassed and worried that my schoolmates might resent my success.” In a photograph taken for a school publication, Liz is shown sitting before a chemical balance, dressed in her school uniform and weighing out a chemical reagent with an expression of great care. Her passion for science was fostered by a personable young chemistry teacher: “Closer to us in age than most of our teachers, she was a contrast to the fuddy-duddies and seemed to enjoy us, calling us ‘a motley crew.’ She made chemistry fun, and I came to see science as an interesting and serious thing to do.”

Before Liz finished secondary school, her parents separated. The tension in the marriage, aggravated by her father's drinking, had become increasingly apparent to the children, who were not shocked when their mother broke the news one day at lunch. Soon after this announcement, Marcia and the seven children moved to Melbourne to live in the home she had inherited from her late parents. Until the upstairs tenants left, the family crowded into the one-bedroom downstairs flat, a painful change from Elphin House, which for Liz had held an aura of magic. Marcia supported her children on her own until the divorce proceedings were complete and she resumed a more regular medical practice, but the resourcefulness and energy her children had always relied on began to fail her. Struggling to sustain her family by herself, she suffered from bouts of depression severe enough to require hospitalization. Because of her mother's illness, Katherine, who had been studying in Adelaide, arranged to continue her premedical studies at the university in Melbourne. Liz became withdrawn: "I rarely had friends over to the house. I did not want anyone outside the family to be part of this complex life, for which they might judge or, worse, pity me. I did not know anyone who had a comparable experience."

The family could no longer afford private school tuition, so the children attended the coed University High School. During this last year of high school, when her mother struggled with depression, Liz's teenage world was "self-circumscribed" by her choice to immerse herself in schoolwork: "School and studies were an escape from the anxiety and uncertainty that were always in the background, owing to my mother's illness." Liz concentrated so fiercely on academics that her sister Katherine felt she couldn't "really raise issues in the family with her." When Katherine chided Liz for her failure to take on a larger share of the housework, "Liz got furiously angry," and though she was instantly remorseful, she didn't give in. Katherine noted, "I was much keener to please than Liz was. She wasn't scared off by what other people thought about her."<sup>5</sup>

At this crucial time in her life, Blackburn received warm encouragement from teachers, but she did not discuss with her friends her interest in biochemistry, an intellectual fascination grounded in her aesthetic attraction to those illustrations of amino acids and in "a feeling that

because biochemistry was about molecules and the workings of cells, it offered a doorway into the mystery of how life worked. I felt you had to go to that level of detail to understand life.” She was grateful to Mr. Stuttard, a math teacher who encouraged her interest in science. Once, when he wrote a difficult algebraic problem on the board and asked if any of the students could solve it, Liz volunteered and solved the problem elegantly. He asked her how she’d done it, and she answered, to her surprise, that she didn’t know: “I had intuited the process but could not articulate how I had gotten from A to B. At that moment, I was aware that I was able to intuit things in a certain way. I didn’t consciously set about problem solving but responded to the problem with a creative processing I couldn’t fully access logically.” When Mr. Stuttard asked her what subject she would pursue in college, she promptly answered, “Biochemistry.” He spoke about her to a biochemistry professor at Melbourne University, where she would be accepted for the following year.

Complete concentration enabled Liz to do exceptionally well in the end-of-year final statewide matriculation exams; in three of the subjects, she earned the highest scores in the state of Victoria, an achievement known as “winning the exhibitions.” At the time the results were posted, a local reporter arrived at the house to interview Liz and take her picture for the paper. Her mother waited for Liz to arrive home from her summer job at a bakery and sent the reporter out to announce the news, watching from the front window, giddy with excitement. Liz took the news calmly but worried about whether to pose for the photograph with her recently acquired guitar, “all the better to try to look normal and conventional and not too much of a nerd.” Her sister Katherine recalled that the actual photo featured dressmaking, not a guitar, but confirmed the impression that the photographer emphasized her sister’s feminine hobbies, as if her intellectual achievement had to be “normalized.”

Without talking to anyone about her choice, Liz decided to major in biochemistry in college. At an orientation meeting, as Liz discussed with a college adviser whether she should take a difficult course, she mentioned quite diffidently that she had won the exhibition in the subject. Again, she did not seek advice on which courses to take; she had become used to making decisions on her own, especially since the onset of her mother’s illness, and did not worry about whether science was a femi-

nine pursuit. She owed this beneficial insularity at least in part to her mother, who never assumed any such limitation on professional aspirations, but it was also her mother, perhaps out of a desire to protect her single-minded daughter, who once challenged Liz's ambition by remarking, "You know, there are other things besides going to university." That her mother would contemplate, even hypothetically, any alternative made Liz fiercely indignant. But she never openly declared her certainty to her mother or anyone else. Early in her first year at college, while she and some friends visited acquaintances in Hobart, their host, a schoolteacher, asked about their academic interests. When Liz answered that she was studying biochemistry, the man said, "What's a nice girl like you doing in science?" Liz made a polite, noncommittal reply.

