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Bringing Culture into Human Biology and Biology Back into Anthropology

Alan H. Goodman

ABSTRACT In the recent past, human biology in anthropology was typically theorized as separate from—even in tension with—culture. In contrast, by further theorizing the social, political, and ecological processes through which what I call "cultural–biologicals" dialectically come into being, I foreground the restlessness and site specificity of human biology. In this article, I highlight research of three junior colleagues to propose two general processes connecting culture to biology: (1) through culturally specific readings of biological variables that, in turn, have biological consequences, and (2) through systems of global and local stratification that "get under the skin." Anthropology is well positioned to follow the diverse pathways through which forms of stratification such as racism, sexism, and class inequalities seep into our biological beings, influencing states of nutrition, stress, and health, as well as ecology and culture. I show that biology does not stand still. By highlighting some of the restlessness of biological processes, I hope to move anthropology to reconsider a more complex, site-specific, and dialectical approach to human biology. Rethinking biology—especially human biology—in these ways may profoundly change how anthropologists, biologists, and citizens understand biology and thereby care for human bodies. [*biology, anthropology, political economy, theory, biocultural*]

RESUMEN En el pasado reciente, la biología humana en antropología fue típicamente teorizada como separada—aún en tensión—con la cultura. En contraste, propongo que antropólogos reincorporen una biología humana más específica en términos de lugar y dinámica dentro de la antropología y, además, teoricen los procesos sociales, políticos y ecológicos a través de los cuales surgió dialécticamente lo que yo llamo "cultural-biológico". En este artículo destaco la investigación de tres colegas de menor antigüedad para proponer dos procesos generales conectando cultura a biología: (1) a través de lecturas culturalmente específicas de variables biológicas que, a la vez, tienen consecuencias biológicas, y (2) a través de sistemas de estratificación global y local que "producen exasperación". La antropología esta bien posicionada para seguir los diversos caminos a través de los cuales formas de estratificación como racismo, sexismo y desigualdades de clase se filtran en nuestros seres biológicos, influenciando estados de nutrición, estrés y salud, así como ecología y cultura. Demuestro que la biología no se estanca. A través de enfatizar algunos de los siempre cambiantes procesos biológicos, espero mover la antropología a reconsiderar una aproximación más compleja, especifica del lugar, y dialéctica a la biología humana. Repensar la biología—específicamente la biología humana—en estas maneras puede profundamente cambiar cómo los antropólogos, los biólogos, y los ciudadanos entienden biología, y de este modo prestan atención a los cuerpos humanos. [*biología, antropología, economía política, teoría, biocultural*]

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> One of the historian's most tenacious mental habits is the strict separation of biology as an immutable sphere of life from society and culture as spheres that are variable and change over time. In this dichotomy between nature and history, the body is assigned to the category of nature and biology. [Duden 1991:vii]

INTRODUCTION: TOWARD A MORE CULTURAL HUMAN BIOLOGY

In her 2007 article, "In DNA Era, New Worries about Prejudice," Amy Harmon discussed the meaning of genetics on the front page of a Sunday *New York Times*. The article was the 11th in a Pulitzer Prize–winning series, "The DNA Age." The decision to publish a series of articles exploring "the DNA age" in the world's premier newspaper is striking. *New York Times* readers were either already—or about to become—mightily concerned with genetics. The science of genetics makes news, and news informs our understanding of genetics. Even more to the point of this article, the series popularized a particular cultural framing of genomics in which biology is reducible to DNA.

As a biological anthropologist, I am committed to a political economy of human biology of real people in real places (Wolf 1982). I especially desire to better understand the biology in cultural concepts such as "ancestry" and the culture in biological processes such as the etiology of diarrhea, which might have simple proximate causes such as poor sanitation but complex webs of causation that led to such poor conditions. These webs extend from culture and ecology, or life on the ground, to global flows of ideas, people, and material objects.

These chains or webs of etiology are central to ideas about biological complexity.[1] A fuller appreciation of how the local gets into bodies and becomes biological clarifies the multiple realities of disease etiologies. Additionally, interdisciplinary research that may arise from studying etiology from the proximate to the source may also pinpoint efficient interventions.

The advances in genomic sciences discussed in Harmon's *New York Times* article are indeed compelling. Nonetheless, both my understanding of biological complexity and my anthropological training make me wary of the common and uncritical acceptance of genetic causality. Abby Lippman (1991), among many others, highlights and problematizes how genetics stands in for all of biology, a form of what she calls "geneticization."[2]

As I hope to show, biology, and especially human biology, is much more flexible and fascinating than DNA sequences. Human biology is constantly in motion, reacting to contexts that are time and site specific. Human biology is every bit as created by culture as it is a result of DNA sequences. In a sense, human biology sits between, and in dialectical communication with, genetics and culture.

Anthropologists are best positioned to take a leading role in theorizing a cultural human biology. I rebrand this new human biology as "cultural–biological" to emphasize the cultural that is always in human biology. It is easier to see biology as stable and always law like and much more challenging, indeed, to work with, make sense of, and act upon a complex and unstable human biology. However, the advantages are great in theorizing human biology in these contingent ways. Acknowledging the fluidity of human biology across place, time, and individual lives will almost certainly improve biomedical research and reduce human suffering.

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Harmon's article (2007) highlights the promises of new genomic data and technologies while also noting scientific and ethical cautions. With extensive, inexpensive, and easily collectable information on DNA sequences, concerns arise that individuals and groups may be exposed to a renewed wave of genetic discrimination. Such discrimination may perhaps lead to difficulties in obtaining health coverage for individuals with an allele shown to be associated with an increased disease risk. Moreover, correlations may show up in a database between certain alleles and, for example, low measured intelligence or criminal behaviors. Will such correlative findings skew public policies toward genetic solutions, as has been attempted frequently before?[3] Would such data skew research further toward genetic theories and solutions to diseases? How can one be sure that easily calculated correlations are both causal and universally applicable before jumping to solutions?[4] Fearing they might be feeding into a new wave of genetic determinism, anthropologists might responsibly shy away from genetics. However, in doing so, they risk throwing out the beautiful baby of biology with the bathwater of geneticization.

Henry Louis (Skip) Gates, director of Harvard's W. E. B. DuBois Institute for African and African American Research, is one of the experts interviewed by Harmon. Gates is an eloquent, popular, and prolific writer. An avid disciplinary border crosser, Gates creates collaborative projects, including many PBS series such as "African American Lives," that highlight genetics to shed light on ancestries. Harmon quotes Gates: "We are living through an era of the ascendance of biology . . . walking a fine line between using biology and allowing it to be abused" (Harmon 2007).

Gates is unerringly right about an undefined "we" of science—powerful publics who walk a fine line that too often borders on the abuse of genetic theory.[5] Scientists and science pundits have too often used genetic differences to explain behavior and culture, explicating alleged differences in intelligence while naturalizing existing social inequalities (Blakey 1991; Fausto-Sterling 1992).[6] There is something in the "DNA era" that compels us to conjure DNA as both "nature" and "blueprint" (Hubbard and Wald 1993; Nelkins and Lindee 2004). When discussing the ascendance of biology, perhaps Gates was more precisely pointing to the ascendance of genetics or even geneticization, the idea that genes are hyperdeterminative.[7]

However, significant countertrends are also emerging. In biology, scientists are reframing organisms as dialectical and dynamic products of multiple genetic systems and complex environments (Boyce et al. 2012; Mitchell 2009; Rose 2003). These more developmental perspectives are highlighted in the fast-paced field of epigenetics, wherein the study of development and evolution have reunited in the explication of epigenetic (beyond the genome) mechanisms by which experience influences future generations via processes that semipermanently turn gene sequences off or on (Boyce et al. 2012). Highlighting the complexity that is endemic to biology, Sandra Mitchell (2009) calls for integrative pluralism, studying biology at different levels.

Of course, readers of this journal are likely aware that many cultural anthropologists and other social scientists have recognized that states of human illnesses are neither natural nor genetically predetermined. Instead, many appreciate that such processes are the complex results of genetics, local conditions, meanings, and political-economic processes (see, e.g., Lock and Kaufert 2001; Montoya 2011; Morgan 2009; Rapp 1999). Just as we cannot reduce genetics to geneticization, we cannot reduce biology to genetics. Building upon recent momentum within and outside anthropology, in this article I explore the potential for a more critical and self-reflective approach to understanding human biology.

The AAA's public education project "Race: Are We So Different?" challenges diverse publics to question the meanings of race and the consequences of racism (http://www.understandingrace.org). In this spirit, I pose a simple question: What is biology? Similar to "race," I think we will find that the concept of "biology"—especially human biology—is profoundly cultural. Humans did not invent human biology in the same way that particular groups of Europeans invented, reified, and made to seem scientific the idea of race. Yet, the division between biology, the humanities, and social sciences has reinforced an understanding of bodies as unchanging natural entities. As highlighted in this article's opening epigraph, the historian Barbara Duden (1991) writes eloquently of the problematic dichotomy in which biology is posited as unchanging nature whereas history is dynamic.

Indeed, medical anthropologists have led the way and, like Duden, have theorized cultural bodies. An excellent starting point is the lead article of the first issue of *Medical Anthropology Quarterly* by Nancy Scheper-Hughes and Margaret Lock (1987). Countering the ceding of the body to biology, they present three bodies: the individual, the social, and the political. I hope that biologically oriented anthropologists will work with theorists such as Scheper-Hughes and Lock to more fully recapture the cultural biology in the body (Goodman 2006). The research of Mary Orgel and colleagues (2005) on the extreme anthropometric measurement of the doll "Barbie" is a playful example of insights from biocultural collaborations in which Barbie's body is a cultural–biological.

Biological substances are everywhere, moving through ecosystems, nature–cultures, and everyday lives. Human biology is in laboratories and hospitals, and also in boardrooms and on playgrounds. We are cultural–biological bodies that emerge and change in complex and fascinating ways. The central question I pose in this article concerns how we think about and act upon human biology.

I propose three starting points by which anthropologists can take the lead in reconsidering how we think about human biology.

(1) *Cultural–biologicals*, such as blood pressure, height for age, distribution chart, and enamel-lead levels (all of which are discussed later), are dialectically interwoven from genes, the organism, and the environment (Lewontin 2000). More critical still, human biology emerges from the complex dance of genes and nature–cultures (Goodman 2006).

(2) *Human biologies* are local and site specific in how we attach meanings to them and bring them into being (Lock and Kaufert 2001). What is true about biology in one time and place is often different elsewhere. Cultural–biologicals are far less universal and deterministic than are physical mechanisms such as gravity (Mitchell 2009).[8] This is particularly true for human biologies because they are also born out of rapidly interacting flows of ideas and materialities. Like artisanal foods, human biology has its own "terroir," the complex interplay among local soil, microbes, and climate that emerges within particular nature–cultures (Heller 2013).

(3) *Global political-economic processes* are critical to understanding how conditions on the ground get under the skin (Goodman and Leatherman 1998a). To paraphrase Wolf (1982), an anthropology that extends from global political-economic to local culture and ecology to biochemical processes can help us to better understand the biological conditions of real people in real places.

To illustrate the possible future of biology in anthropology, I highlight three projects by relatively junior colleagues: Joseph Jones (University of Massachusetts, Amherst and William and Mary), Clarence Gravlee (University of Florida), and Naomi Azar (Hampshire College and Long Island University).[9] These three scholars focus on diverse yet complementary examples about how phenotypes are read and the ways in which political-economic processes imprint themselves on the body. I highlight these projects as creative exemplars to help us to imagine how anthropology might contribute to better understanding disease processes and many other mysteries of human biology.

An important disclaimer: I have worked directly with two of the three researchers. Although these projects illustrate particular points, there are many other projects from which I could have drawn. This embarrassment of riches did not exist a decade ago. These works are part of a promising and exciting trend.

We anthropologists are also not alone. The movement to understand biology as part of culture is central to the maturing fields of social epidemiology, devoted to understanding the social, economic, and political origins of illness and disease (see, e.g., Krieger 2001, 2005; Marmot and Wilkinson 2006). Leading theorists and practitioners of social epidemiology have called for studies of the political-economic and social origins of disease. A growing field of medicine focuses on the impact of social and economic inequalities on health—what is euphemistically referred to as "health-disparities research."

In addition, epigenetics mechanisms—such as histone modification and DNA methylation by which environmental conditions regulate the actions of genes (Riddihough and Zahn 2010)—illustrate clear biological mechanisms whereby conditions to which prior generations were exposed have lasting consequences, influencing descendants generation later (see also work by anthropologists such as Kuzawa and Sweet 2008; McDade 2012; Rutherford 2009).

Finally, even if lived experience does not modify gene expression, everyday life experiences may have multigenerational consequences (Henry and Ulijaszek 1996). Thus, it is important to know what is happening now and also during early life and during the lives of prior generations. Case in point: the toxic metal lead, as Jones (2013) illustrates, can get into a mother's bones when she is calcifying bone in her early life. The lead is subsequently released into her bloodstream as part of bone turnover during pregnancy and lactation. Ultimately, her fetus and newborn are exposed to toxic lead that was previously sequestered in its mother's bones.

These multigenerational mechanisms unsettle the notion that DNA comes first and the environment works off of a predetermined genetic blueprint. Epigenetics shows that genes and environments are dialectically interwoven. The same is true for biology and culture.

Tracking back to Frederick Douglass and Franz Boas, anthropology has a long history of efforts to link social and economic conditions to biological outcomes. Douglass (1950) considered the similar economic conditions of African slaves and the Irish. Way ahead of his time, he writes about the dialectics of biology and living conditions. Boas (1912) studied the anthropometry of immigrant families to better understand the influence of living conditions and the permanence of racial types. Boas's work is a precursor to the so-called Barker hypothesis that links early life events to adult disease and longevity (Henry and Ulijaszek 1996).

Whereas we are now aware of many strong associations between ecological and social conditions and biological outcomes, we have little sense of the causal webs that lead to and underlie these associations. The following are three projects that point toward and try to better understand how the cultural gets into human biology.

LEAD CONCENTRATIONS, CULTURALLY MODIFIED TEETH, AGENCY, AND NORTHERN SLAVERY

Consider two biologicals: culturally modified teeth (CMT) and elemental lead trapped in the tooth enamel of enslaved Africans. How might these biologicals come together to shed light on the buried pasts of enslaved Africans? Culturally modified teeth constitute a visible writing on the body (see Figure 1). Enamel-lead concentrations are less visible but no less reflective of human actions.

FIGURE 1. *Example of the front teeth of an individual (NYABG burial 281) with hourglass-type CMT. In life, the teeth have been shaved from the sides. (Image courtesy of Howard University, National Park Service, and Goodman et al. 2009).*

Jones's (2013) dissertation focuses on measuring and interpreting lead in tooth enamel as a tool to better understand, as he puns, "oral histories" of enslaved 18th-century Africans from the New York African Burial Ground (NYABG). The NYABG was rediscovered during a federal construction project in 1991. Over 400 individuals from roughly the 18th century were exhumed from lower Manhattan at this time and reinterred in a moving celebration in 2003.[10]

Jones's and the descendant community's interest in ancestry and human agency motivated his meticulous research on lead. Whereas Jones's dissertation also considers the source and public health implications of this toxic metal, his central question revolves around Jerome Handler's (1994) ethnohistorical observations about geographic origins and CMT. Handler extensively collected and analyzed auction and runaway documents pertaining to enslaved Africans focused on the southern states and the Caribbean. He found that descriptions of CMT were exclusive to individuals who grew up in Africa and were then enslaved, and not in cases of those born into slavery in the Americas. Handler hypothesized that individuals with CMT must have grown up in Africa and later in life were enslaved and shipped to the Americas. Handler further suggests that CMT are a sign of independence and cultural agency because the practice seems to have stopped during enslavement.

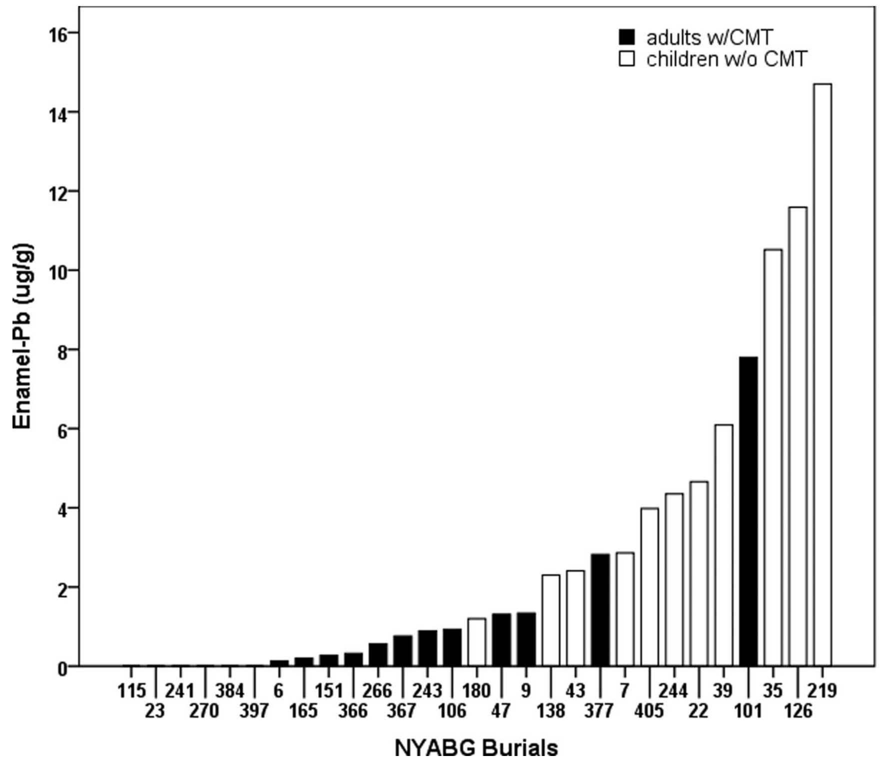

FIGURE 2. *Variation in lead (Pb) concentration of individuals from the NYABG. The x axis depicts lead concentration in enamel, each bar representing the specific lead concentrations of an individual, from lowest to highest. Open bars are children without CMT who were likely to have been born in the Americas. Black bars are adults, presumably African born, with modified teeth.*

Because of global differences in the chemistry of different landscapes and waters and the permanence of the chemicals' "signatures" once they get into developing tooth enamel, enamel chemistry provides an indelible record of the geographic location of an individual during calcification in life's developmental stages (Ericson 1985). Jones used these distinctive features to independently test whether any individuals with CMT had a chemical signature suggesting anything other than an early life in Africa, as Handler's observations suggest. Jones took advantage of the capabilities of laser ablation-inductively coupled plasma-mass spectrophotometry (LA-ICP-MS), a method that volatilizes a trace amount of enamel and can link the location of a sample within a tooth to a specific age at development.[11]

Jones finds an incredible range of variation in average lead concentration in teeth, from below detection limits to some of the higher values ever recorded for enamel (see Figure 2). As expected, lead is generally low in individuals with modified teeth (black bars), who we assume are African born, and high in nonmodified, young individuals—those we assume were born enslaved (open bars). However, Jones found two clear exceptions, burials 101 and 377, with both high lead concentrations and CMT. One explanation is that these two individuals were exposed to high lead levels during infancy in Africa. However, other chemical analyses do not support this interpretation. Jones thinks the most likely explanation is that these two individuals were born in North America (where they were exposed to lead) and had their teeth modified while enslaved.

He suggests that Handler's hypothesis generally applies to the enslaved individuals buried at the NYABG, but perhaps not always. I find this result interesting because a chemical analysis of a biological tissue sheds light on a cultural practice and specifically implies that enslaved New York Africans may have maintained some cultural agency despite enslavement.

What I find most fascinating about this research is the potential for detailed biochemical research to provide insights into previously silent individual biographies—of movements, struggles, and resistance. Here, biochemistry enriches our knowledge of slavery in the North via a story about cultural inscriptions on the body. This research leads to economic and lifestyle questions about the sources of the lead and other questions about the impact of lead in the bodies of enslaved Africans.

THE MEANING OF SKIN COLOR AND HOW IT CONNECTS TO BLOOD PRESSURE

In a publication stemming from his dissertation research, Clarence Gravlee evaluates how the cultural consensus (emic) category of "color"—socially perceived race—influences blood pressure (Gravlee et al. 2005). Among diasporic Africans in the Americas, darker skin color is nearly always associated with increased blood pressure (Tyroler and James 1978).

The older default mechanism purported to explain how darker skin color leads to high blood pressure assumes that diasporic Africans are genetically predisposed to high blood pressure (Boyle 1970). Because blood pressures are generally low in Africa, it could be that African slaves who were transported to the Americas (the Middle Passage) were somehow genetically selected by forces at work during the Middle Passage.[12] Dark skin is a proxy for a higher degree of African ancestry/genetics.

Gravlee and coworkers (2005) contrast the genetic model with the cultural meaning of skin color. They propose that dark skin color also signifies decreasing social status and increasing exposure to racism (see also Dressler 1991; Tyroler and James 1978). Thus, a correlation between skin color and blood pressure might be due to the social signification of skin color rather than genetics. Gravlee and coworkers point out that in the first default explanation, pigmentation, or skin color measured by spectrophotometry, may be associated with the second instance of "color," the social category, but they are not the same. Thus, an association of skin color with high blood pressure may be attributed to the wrong mechanism. Gravlee and coworkers thoughtfully derived a test to separately evaluate the two mechanisms.

At their field research in Guayama, Puerto Rico, Gravlee and coworkers (2005) measured skin pigmentation by standard reflectance spectrophotometry. They also completed an ethnography-based classification of individuals into color–race categories. Here, they followed Marvin Harris's (1970) ethnographic work on racial classification in Brazil and extended it by using systematic methods developed by cognitive anthropologists, including cultural-consensus theory (Romney et al. 1986). Based on a series of interviews, Gravlee and coworkers developed a consensus color classification based on interviews with Guayamans. A series of drawings of typical faces of males and females with different color classifications is presented in Figure 3.

Gravlee and coworkers (2005) found that ascribed color, rather than skin pigmentation, is associated with blood pressure (Figure 4). They also controlled for all of the usual covariates such as age, use of hypertensive drugs, and even skin pigmentation. They grouped individuals into three levels of socioeconomic status (SES)—low, medium, and high—and two color categories: *Negros* or blacks (indicated by a solid line) and those defined as lighter, either *blanco* (white) or *trigueño* (an intermediate category), indicated by a dashed line.

The interaction between SES and ascribed color is particularly fascinating. As SES increases, those who are classified as Negro have higher mean blood pressures, whereas blood pressure decreases as SES increases for the lighter color group of blancos and trigueños (see Figure 4).

Gravlee and coworkers (2005) explain that these findings are consistent with ethnographic studies of class–race

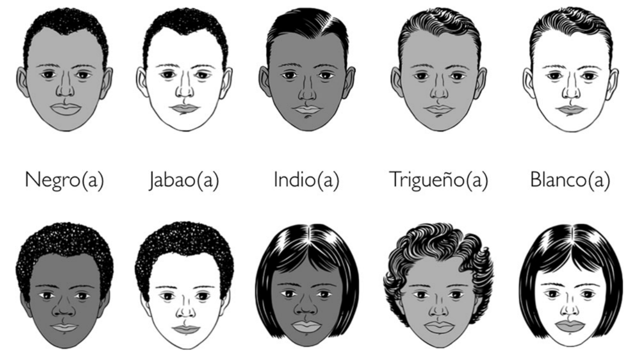

FIGURE 3. *Examples of color classification. (Image courtesy of Clarence Gravlee)*

in Puerto Rico. Color–race is relatively insignificant in low-SES contexts, and racism is most pernicious in the middle and upper classes. Respondents who are classified as Negro at high SES are living in a light-skinned world. As a result, they may experience institutional and interpersonal racism that leads to systemic stress and increased blood pressure.[13]

In summary, race is not biological in the sense that it is the same as human genetic variation. However, race is a powerful cultural category that has biological consequences (Goodman et al. 2012; Gravlee 2009). Race is biological because it is a culturally meaningful phenotype.

REACHING FOR GREATER HEIGHTS

Randy Newman's song "Short People" hit a popular chord and number two on the billboard charts in 1977. An Internet search yields many references and recordings of his song, including a video of Newman playing his song with over four million hits.[14] As someone whose childhood height hovered close to two standard deviations below the U.S. average, what was to become the Food and Drug Administration's cutoff for being a candidate for recombinant human growth hormone (hGH) therapy to increase stature, I admit to confusion as to the song's message. Did Newman really dislike short people ("short people got no reason to live," "don't want no short people"), was the song actually a clever parable about prejudice ("short people are just like you and I"), or was it just a catchy, ironic ditty? Was Newman just as confused as I was?

Regardless, the song helped focus attention on heightism, a widely held prejudice against short people. Height, like race, is also something that biological anthropologists have long and intensely studied. Height (or stature) once signified social status (the rich are taller than the poor). And, like race and skin color, height is a signifier. In the biological anthropologist's toolkit, height is now used more to indicate access to adequate nutrition and sanitary environmental conditions rather than one's nobility (Bogin 1999).

We know a lot about height; quite likely it is the best-studied anthropometric measurement. Height increases with age in a nonlinear fashion. Human males are generally taller than females, a prominent aspect of sexual dimorphism.

Heights vary among individuals within groups, and mean adult group heights vary over time as well as around the globe (Eveleth and Tanner 1991).

British physician James Tanner (1986) proposed that an excellent sign of an egalitarian society would be one in which height does not vary by social class. After completing a large-scale review of worldwide variation, Tanner, dean of height studies, observed that mean adult heights invariably increase with improved economic conditions and decrease as economic conditions decline (Tanner 1986). This association, he states, is consistent for all historical periods and in dozens of countries across the globe (Tanner 1986; see also Eveleth and Tanner 1991). To say it even more grandly, everywhere Tanner looked—and he looked at data from a remarkably large and varied number of places and times—economic conditions were indelibly written into and onto the body. Greater height, for Tanner, was a sign of economic conditions that provided adequate food and other resources and of decreases in the stresses of life that inhibit growth.[15]

Height variation among groups is now a well-accepted indicator of early life conditions (Bogin 1999; Steckel 1995). Going back at least to Boas, and now with Eveleth and Tanner's (1991) data, biological anthropologists, economic historians, and health professionals have been even more active in using group heights to rapidly assess general living conditions (Komlos 1995).[16] Group height comes as near as we can determine to a universal indicator of early life circumstances.

Note that these differences are at the group rather than individual level. Within-group individual height variation is likely to be reduced when economic variation is reduced. Especially when food is generally available, individual variation in height is primarily due to parental height and genetics (Bogin 1999).

Naomi Azar (2001) studied the marketing of hGH as an example of the medicalization and manufacturing of a disease—that of shortness (Conrad 2007). For her senior thesis, she interviewed and hung out with clinicians, psychologists, support group members, and anyone who was being treated, had declined treatment, or had been a candidate for hGH due to their shortness.

Whereas recombinant hGH products such as Humatrope (Eli Lilly and Company) have been used to "treat" short stature since their development, a sea change occurred on July 25, 2003, when the Food and Drug Administration approved the use of recombinant hGH for children with idiopathic (unknown cause) short stature (Cohen and Cosgrove 2009). Administration involves daily injections of hGH, typically for a few years and sometimes for as long as a decade.[17]

Azar (2001) suggests that hGH injection transforms short stature, a signifier of individual genetics or group-resource access, into a medically treatable disease. Giving daily injections of hGH to short children has the hoped-for potential consequence of moving kids up a couple of inches on the height distribution curve.

Increased height relative to peers has consequences. Psychologists report that greater height boosts self-esteem (Bullinger et al. 2009). Timothy Judge and Daniel Cable (2004) estimate that an inch of adult height is correlated with a $789 per year increase in annual salary. Do the math. A couple of inches over a working life could make a big difference, unless, of course, height is only correlated and not causal.

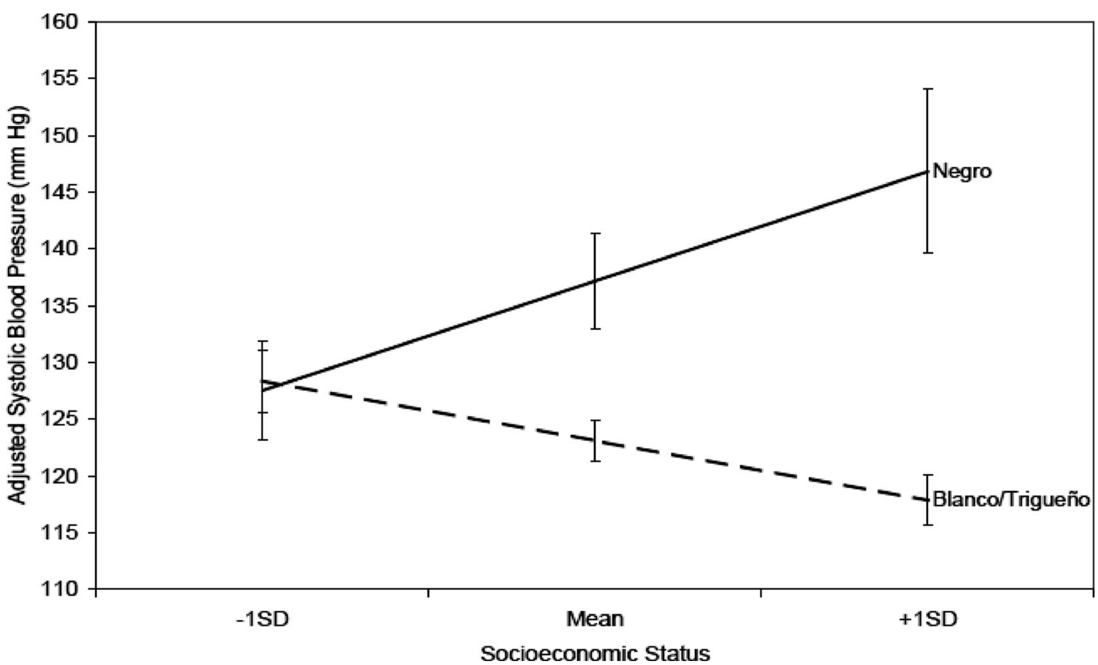

FIGURE 4. *Systolic blood pressure by color classification and socioeconomic status. (Image modified from Gravlee et al. 2005, used with permission from Clarence Gravlee)*

On the other hand, the medicalization of height augments the notion that being short is bad. Assuming the height–benefit relationship is causal, what changes? If a child grows taller than she or he (mostly he) would have without hGH injections, it is hoped that self-esteem, happiness, and future income and social status would also increase. However, because the valuation of height is relative to other individuals, now other individuals are relatively shorter and are likely to face greater discrimination. If so, there is no net group change in perceived worth (Azar 2001; Kimbrell 1997). The solution is an individual and, frankly, an antisocial one. All that has changed is the relative place of some lucky individuals who can either convince their insurance companies to cover the cost of hGH injections or afford to pay for the injections out of pocket.[18] The economic winners are physicians, drug companies, and their investors. The silent losers are the rest of us: those who pay insurance premiums. The biggest losers are those who are overtaken by individuals who get hGH and move down the height distribution curve.

Finally, hGH administration to growing children has not been around long enough or studied well enough to understand all of the potential long-term consequences. As is evidenced from the now more widely known "abuses" of hGH to enhance athletic performance. Growth hormone is a powerful anabolic steroid that is involved in a wide spectrum of metabolic processes.

Nonetheless, I would bet that pharmaceutical companies are pleased to see that they have started a potential tallness race. The market of children who are below two standard deviations of average height, the shortest two to three percent of 8- to 16-year-old children—about 400 thousand children in the United States alone—is huge, especially at the price of hGH therapy, about $20,000 per year in 2002, and one that will stabilize as long as we continue to have parents who desire taller children.

At this moment, parents are forced to gamble on the future heights of their children not by giving them better nutrition and less stress but by paying for daily injections of hGH, estimated to yield an average of no more than two more inches and a cost per inch estimated at $52,634 (Lee et al. 2006). The increase in psychological benefit and later earnings might be worth it to the individuals. And it is their and their guardians' decision.

What is mind blowing about this moment is that family wealth, decision making, and biotechnology are changing the relationship between height and its meanings and causes. At an individual level, the relationship between height, social status, and potential earnings might be driven by an altogether new process: wealthier families are able to provide their children with hGH.

TOWARD A MORE SITE-SPECIFIC CULTURAL BIOLOGY

In the long era before multivariate modeling and high-speed computation, it was far more difficult to keep track of more than a handful of interacting variables. Typical experiments tried to isolate one or two variables in a controlled fashion. A reproducible experiment typically focused on easily measured causes and effects.[19] Pathogen A causes disease B. Genotype X, with some environmental influence, leads to phenotype Y. Scientifically important: yes. Sufficient: no.

Even with today's greater computational horsepower, linking upstream political-economic changes to complex local conditions and then to biological consequences is a difficult endeavor. Statistical power and effect sizes are often small, and even more troubling is the near certainty that the results might be time, location, and context specific. A set of relationships that is statistically robust turns out repeatedly to be less robust upon replication at another time or in another place.

That said, technological advances have given us immense improvements in the identification of allelic sequences, and we are beginning to isolate and quantify compounds and chemicals in foods and environments. Now that 55 or so "essential" nutrients have been identified, phytochemicals, phenols, probiotics, and other currently considered "nonessential" food compounds are emerging as worthy of study. Rather than advocating that these newly identified compounds will prove to be important in any way, I mention them merely to suggest how little we know about what is in the apples we eat—and that we know even less about the interactions among essential nutrients and other compounds. The well-known food writer Michael Pollan (2008), for example, calls nutritionism the continued inattention to interactions in favor of the old cause–effect model: one nutrient leads to one deficiency disease.

The toxic consequences of lead have been widely known for nearly a century (Hernberg 2000; Schell et al. 2005); however, in the last quarter-century, instrumentation such as LA-ICP-MS used by Jones (2013; see also Goodman et al. 1998a) has allowed analytical chemists to efficiently quantify lead concentrations in biological solids such as teeth, bones, and fingernails. Jones's work on enamel provides a moving picture of changes to bodies' lead concentration during critical periods of early life. Similar advances are being made in measuring physiological stress and understanding the mechanism by which stressor and stress lead to breakdowns and illness (Blakey 2004; McEwen 2012). On many fronts, scientists are getting better at measuring the proximate variables that make us healthy or sick.

The harder part is understanding causal connections and the interactive consequence of key variables. Even in controlled experiments and a less turbulent natural world it would be hard, and it is even more difficult when consequences depend rather unpredictably on what else is going on. For example, lead is more likely to get absorbed into tooth enamel and bone when calcium is deficient. So, an evaluation of calcium nutrition leads to a better prediction of lead toxicity. Interestingly, both diet and the source of lead are related to local conditions and ultimately to historical and regional political-economic processes. This simple interaction of calcium and lead is just the tip of the iceberg of interactivity.

A main goal of scientific research is to study replicability: for purposes of this article, I mean by use of this term that a study should produce the same statistical results upon exactly repeating it with different samples or at different times. Recently, scientists and popular news outlets have begun to take seriously the larger-than-anticipated discrepancies in biomedical research findings (Naik 2011; Zimmer 2012). For example, Gautam Naik (2011) reports that nearly the majority of the studies of the drug company Bayer could not be replicated. Reasons given for the inability to achieve replicability typically include small sample-size effect, initial biases toward positive results, sometimes changing sample genetics and demographics, and less often changes in context.

I suggest all of the above and an additional reason: because biology does not sit still. What is true about biology once might not be true all the time. Biology is not like physics, in that laws are seldom universal (Mitchell 2009). This insight is not a new one for human biologists. Decades ago, Gabriel Lasker (1969) wrote eloquently about human plasticity, or how humans are constantly adapting and changing themselves and their environments.

Human biology is also infused with meaning. The examples above all show how biologicals are culturally interpreted and then have further biological consequences. Height is so meaningful that parents and pediatricians will subject children to hGH injections in the hope of achieving an extra inch or two. CMT of enslaved Africans suggest birthplace and, when combined with lead levels, agency and independence. Color in Puerto Rico signifies social status. Race–color becomes biological because social incongruities are stressful and raise blood pressures. These projects show the importance of considering the diverse ways in which specific biologicals are cultural.

Indeed, the most tangible sign of change may be the increased number of advertised faculty positions with the term *biocultural* (or *bio-cultural*) in the title and description. Just a decade ago such positions were virtually nonexistent, whereas today they are quite common.[20] For example, in a randomly timed search of the AAA jobs database (on October 3, 2012), I found three positions that used the term *biocultural*. A small department was looking for an archaeologist or biological anthropologist "able to integrate biocultural perspectives in teaching and research," and two large departments were advertising for a biological anthropologist interested in "the dynamic interactions between biology and culture" and a sociocultural anthropologist "who applies a biocultural approach and engages a political economic framework in the study of human health and well-being."

Nice, but one final exhortation: whereas all of the renewed interest in a more cultural biology is exciting, it does not go far enough. One key shortfall is theoretical. Nearly two decades ago, a colleague asked me: "What is the theory of/in bio-cultural anthropology?" The question crystallized for me that we barely agree upon a set of principles about how culture and biology interrelate. As previously noted, culture and biology are most often conceived of as distinct domains. The questions asked are about the impact of one on the other. Lines drawn between separate boxes or a Venn diagram suggest that culture and biology are linked or even overlap. Taking my lead from mentors George Armelagos and especially Brooke Thomas (1998), as heuristic devices, stress models and biocultural diagrams appeal to me (Goodman et al. 1988). But these diagrams do not capture the fact that human biology would not exist without culture.

What we most need is to better theorize human biology. Evolutionary geneticist Richard Lewontin (2000) has further elaborated on how biology is the unfolding of genes and environments by the organism. The organism makes its own niche and directs its own development. Neurobiologist Steven Rose (2003) has developed the concept of lifelines, a further elaboration of the complexity of multiple genetic systems and environments.[21] They provide starting points from outside anthropology.

Human biologicals obey all of the principles of interactivity, emergence, stochasticity, and site specificity that these dialectical biologists sally forth. Additionally, as Jonathan Marks (2002) forcefully reminds us, human biologies are imbued with deep meanings. We are vigilant readers of bodies: height, marks on teeth, skin tone, nose shapes, hair texture, body–mass ratios, skin wrinkles, tattoos, and much more. I advocate for a more theoretically grounded place of culture in human biological research because theory has stakes for real people in real places.

The most basic point of this article is a very old one: biology is always more than the sum of genetic sequences. In addition, most biologicals are not easily predicted from DNA sequences. Moreover, the biologicals with which we come into contact—such as the microorganisms on our skin, the spores and molds we breathe in, the plants and animals we consume, the nitrogen-fixing bacteria in soils, and the plants giving off oxygen—are all in motion: interwoven and dialectical results of multiple genetic systems and multiple environmental conditions, all orchestrated by organisms and ecosystems. All biological organisms have histories, are their histories, and are all simultaneously developing and evolving nature–cultures.

Our attention is attuned to Twitter-like sound bites. But human biology is hard to reduce to clichés and tweets. If we continue to think simplistically and mechanistically rather than interactively and dialectically, we will miss so much of the beautiful dance of biology.

WHAT IF BIOLOGY TOOK AN ANTHROPOLOGICAL TURN?

Rather than call this research *biocultural*, a term that has many different meanings and connotations, I suggest it might be better to label it "cultural–biological research" in order to emphasize how culture influences and is intertwined with biology.

In what Thomas (1998) calls the "biologies of inequality," biological anthropologists are participating in the search for the upstream political-economic and social origins of biological distress and disease. They join seamlessly with a new generation of cultural anthropologists such as Michael Montoya (2011) and Duana Fullwiley (2011), who are cultural–biological in their research on clinics and laboratory life. This new generation is collectively exploring webs of practice, politics, and diverse meanings of cultural–biologicals such as foods and immune systems. All the while, bioarchaeology is thriving across the subfields of anthropology, and the "critical anthropology of race and racism" has emerged as a collaborative integration of expertise among anthropologists engaged in many subfields (Goodman et al. 2012).

The examples outlined above have hopefully shown that culture is always in human biology. To no less degree than there is no biology without DNA, human biology does not exist without culture. As well, biologies are read through a sociocultural lens, with dialectical consequences for biology. The ideology of race is a lens through which we read phenotypes in ways that have biological consequences (Gravlee 2009). Biology is always interwoven with meaning and materiality.

So, what are the next steps toward a more anthropological biology? First, we already know quite a lot about the biological consequences of the material aspects of our lives. A good place to start is with pollutants and foods. Proximately, we owe it to ourselves to know better what is in our food, soils, and air (Heller 2013; Pollan 2008). If we can develop technologies to inexpensively sequence whole genomes, we ought to be able to identify and study the consequences of food compounds and potentially toxic substances.

Second, the new cultural biology ought to strive to better understand the upstream political-economic processes by which pollutants and nutrients get into foods, and then into our stores, restaurants, bowls, mouths, and bodies. Where, how, and why did they originate upstream (Goodman and Leatherman 1998a)? How can we trace a sugary drink from boardrooms to laboratories, packing plants, *tiendas* (small stores), and, finally, blood and bones (Foster 2008; Leatherman and Goodman 2005)?

Third, we need to better theorize and understand how ideologies and discourses have biological effects. How, for example, do values of Western goods such as Coca-Cola influence the economies and health of Mayans (Leatherman and Goodman 2005)? How does the value attached to darker skin tones become internalized and a chronic stressor (Krieger et al. 2009)? How do ideologies of self-worth arise, become reified, and then have physiological effects? Once poverty, inequality, and racism get under the skin, how do they become dialectically biocultural?

Can biological analyses make it back onto the center stage of anthropology? Integration across cultural and biological anthropologies may well be a foundational myth of our discipline (Segal and Yanagisako 2005). Even if this is true, I think it is a useful myth. However, I wish for something much more profound than the "integration lite" of the past. Finally, despite recent uses of the biocultural terminology in position advertisements, my informal analysis is that awards from graduate school slots to NSF grants and tenure are largely subfield specific and that this is a serious detriment to deep integration. There are formidable barriers to changing this particular status quo.

Although U.S. anthropologists have tried hard to respect work across biological and cultural anthropology, I agree with Daniel Segal and Sylvia Yanagisako (2005) that we have come up short in boundary crossing. But the solution is not to give up. Too much is at stake in ignoring biology or ceding it to other interests. We need not meet the challenge with lip-service integration but with new theory and deeply integrated projects.

Although the challenges are many, optimism prevails. There is broad and increased recognition that biologicals–bodies are sites of struggle and contestation. With about 17 percent of the U.S. GDP going toward health care, a focus on food and health provides great opportunities to link to funding sources and to other fields such as the health-inequalities movement in public health. Finally, we broadly aspire to a more engaged and public anthropology. It is time to update Boas to a new biology of social injustices. Challenge is exciting.

I propose that we build, on the one end, from critical and cultural analyses of the body in medical anthropology and cultural studies such as Rapp (1999) and Scheper-Hughes and Lock (1987). At the same time, we need to develop a series of studies in anthropological political economy that link upstream global processes to local culture and ecology and then to biological well-being (Goodman and Leatherman 1998b). Scientists and physicians from diverse backgrounds are also coming together in interdisciplinary groups to unveil and unravel the complex webs by which social conditions regulate gene actions, nervous system wiring, and many other core aspects of biology. A recent *Proceedings of the National Academy of Sciences* special issue on the biology of social adversity wonderfully highlights a diversity of potential mechanisms (Boyce et al. 2012).

This *PNAS* special issue suggests that when political-economic anthropologists reach to consider the biological consequences of the processes they are studying, they will find fascinating research and eager partners. Conversely, I hope scientists such as the contributors to the *PNAS* issue will reach beyond their rodent models and proximate causes of biological suffering. If they stretch toward efforts of colleagues in the social sciences to better understand the root causes of distress, we may be able to break the processes linking political-economic conditions, social adversities, and suffering.

What would a new anthropology look like? I picture a time in which we take seriously discourses both about biology and the body, and better understand how power and knowledge filter how we see biologies. In such an age, genetics would hopefully be a tool of analysis, with less geneticization. Perhaps a decade from now, there will be a series in the *New York Times* focused on the Anthropology Age.

Alan H. Goodman *School of Natural Sciences, Hampshire College, Amherst, MA, 01002 agoodman@hampshire.edu http://sites.hampshire.edu/agoodman*

NOTES

Acknowledgments. My American Anthropological Association's presidential address gave me the opportunity to attempt a rather grand analysis of a favorite topic: the current state of biological research in anthropology. I am fortunate to have had decades of support from many friends and colleagues. I would like to acknowledge all of them, but the network is far too large. I apologize for any oversights. That said, at the center of the network is Chaia Heller (Mount Holyoke College), anthropologist, poet, artist, and revolutionary. Others near the network's center have endured decades of my complaining, scheming, and theorizing, of which this article is an outpouring. Lynn Morgan (Mount Holyoke College) and James Trostle (Trinity) helped shape the oral and written versions. Among my greatest mentors, colleagues, and co-conspirators are George Armelagos (Emory), Michael Blakey (William and Mary), Thomas Leatherman, Alan Swedlund and Brooke Thomas (UMass, Amherst), Ricardo Santos (FIOCRUZ, Brazil), Michael Montoya (UC, Irvine), Rayna Rapp (New York University), Susan Lindee (UPenn), Richard Lewontin (Harvard), and Jonathan Marks (UNC, Charlotte). I am also deeply grateful to the individuals whose work I highlighted. As an undergraduate student at Hampshire College, Naomi Azar showed fearlessness in asking tough questions and completed a stellar honors thesis. Clarence (Lance) Gravlee exemplifies a new generation of anthropologists who apply relevant evidence to important questions and also resist classification as either cultural or biological anthropologist. Joseph Jones has been an inspiring student; my respect for his dignity and intellect is boundless. I have also been blessed with a fabulous AAA staff and executive board. Finally, this article has benefited from the pushes and editing of *AA* editors-in-chief Tom Boellstorff and Michael Chibnik, associate editor Rachel Caspari, and managing editor Mayumi Shimose. All shortcomings and errors are my own.

1. By "webs of etiology," I refer to the notion that the immediate or proximate causes of a malady, such as intestinal bacteria or poor sanitation, may come about through a complex chain or web of events. Likewise, host resistance, including nutritional status, is a proximate cause that itself is due to many factors that link local conditions to larger political-economic processes or upstream events (Goodman and Leatherman 1998b; Krieger 2001).
2. Lippman (1991) coined the term *geneticization* to refer to the diverse ways in which genetic information might be used to naturalistically explain differences leading to stigma and form of oppression.
3. *The Bell Curve* (Herrnstein and Murray 1994) promoted the view that "never dies" that intelligence is genetically different by race and class. The theoretical core of *The Bell Curve* is the deeply flawed myth that those residing in the United States live in a meritocracy—that is to say, all of us have equal starting points and opportunities, and therefore where we end up is due to individual merit.

   These are worrisome issues, but they are only indirectly the focus of this article. That said, it is worth adding that individuals are now routinely sequencing their complete genomes. One well-publicized example is the linguist Steven Pinker, who wrote about his experience in an article titled "My Genome, My Self" that was the cover story of *New York Times Magazine* (January 7, 2009). Today, genetic testing is becoming less expensive and more commonplace. For example, the company 23andMe trumpets themselves as "the best place to take a personalized journey through your DNA" (http://www.23andme.com).
4. We are actually in the midst of a wider realization that replicability of study results is often low (Naik 2011). I suspect that this lack of replicability may be especially true for genetic studies. Moreover, outright retractions are on a sharp rise (Zimmer 2012).
5. In fact, I teach a course called "The Use and Abuse of Biology." The title of the course came directly from the book *The Use and Abuse of Biology* by Marshall Sahlins (1976), who was writing in response to the emergence of sociobiology and its application to human behavior (Wilson 1975).
6. Documenting and understanding how naturalistic ideologies emerge and are reified are important cautions. The idea of geneticization as separate from genetics is important too (Lippman 1991).
7. Gates, of course, is not at all unique in inflating genetics to biology. In popular culture, genes are metaphorically referred to as blueprints and the Holy Grail (Nelkins and Lindee 2004). Students of mine have little difficulty finding ubiquitous advertisements where the iconic and often highly stylized DNA molecule is used. They also easily find referents to "biology" that should more precisely be references to genetics. This mistake was made just recently (February 17, 2013) in another *New York Times Magazine* cover story (Eakin 2013).
8. The history of the biological sciences, although complex, suggests a desire to emulate physics, including the discovery of universal laws that could be expressed in the form of equations (Mitchell 2009). The bordering social sciences, most notably psychology and anthropology, also tried to follow this trend. An interesting thought experiment might be to consider what biology might have been like had it tried to emulate or at least been in greater dialogue with a field such as history.
9. This next section focuses on projects by three individuals: an undergraduate honors thesis, the dissertation work of a graduate student, and the dissertation research of a tenured professor. They were chosen among a plethora of better-known or up-and-coming individuals. As an undergraduate student of Michael Blakey (Howard University), Joseph Jones became hooked on an anthropology that could help bring to light and objectively tell the stories of enslaved Africans. After receiving his B.A., Jones

continued with anthropology, pursuing his Ph.D. with me in biocultural anthropology and bioarchaeology at University of Massachusetts, Amherst. Jones also worked on the AAA's public education program on race (http://www.understandingrace.org) and is a coauthor of the companion book (Goodman et al. 2009).

Much of Clarence Gravlee's research revolves around the biological consequences of racism. His dissertation research was on perceptions of race and hypertension in Puerto Rico. Gravlee received his Ph.D. from the University of Florida, Gainesville, and is now an associate professor at this same institution. Gravlee continually takes on interesting projects about how concepts such as cultural consonance play out in the lives of individuals and have biological consequences. His work is important to understanding the biology of real people in real places.

Naomi Azar was an undergraduate at Hampshire College and is now a fifth-year doctoral student in clinical psychology at Long Island University, Brooklyn. In addition, she has worked for the Ford Foundation on community activism in Kenya and is actively involved in the storytelling scene in New York, including for "This American Life."

10. The project itself is remarkable for its interdisciplinary involvement of African diasporic scholars, junior colleagues, and the descendant community (Blakey 1989; Blakey and Rankin-Hill 2009; see http://www.gsa.gov/portal/content/249941).
11. A trace amount of enamel that is vaporized by the laser is carried into the spectrophotometer with inert argon gas. At this point, one can read out a wide range of elemental concentrations that correspond to specific places on the enamel and, in turn, determine elemental concentrations/exposures at specific times during the enamel's development during an individual's early life. Because one can sample sequentially developing areas of enamel, Jones and others are able to provide a sort of moving picture of changes in elemental concentrations across the early part of a human lifespan.
12. There is great controversy about salt sensitivity as an explanation for high blood pressure of diasporic Africans. Jackson (1991, 2005) has argued persuasively for selection for salt sensitivity, whereas Armelagos (2005) has argued that such selection was not nearly powerful enough to account for the changes in hypertension between diasporic Africans and Africans.
13. After the original presentation, Gravlee et al. (2009) expanded these results using genetic measures of African ancestry (in place of pigmentation) versus social ascription of color.
14. See http://www.youtube.com/watch?v=1NvgLkuEtkA, accessed January 28, 2013.
15. There are also some historical remnants of the idea that nobility were taller than peasants not because of better access to food and the like but, rather, because tallness equated to nobility. This association might linger in the sustained desire for tallness.
16. Interestingly, residents of the United States have grown very little in the last century, compared to many countries such as Denmark and the Netherlands. In addition, the decline from the top in height is paralleled by increases in infant and adult mortality. All of these measures are very tangible biological measures of social conditions. The news for us in the United States is not good overall, and of course it is even worse if you are poor and of color (Komlos and Lauderdale 2007).
17. A wide variety of pharmaceutical companies produce recombinant hGH. See, for example, the Human Growth Foundation website (http://www.hgfound.org/res_rGHmanufacturers.html, accessed February 12, 2013).
18. An interesting discussion of medical-insurance payment issues may be found on the Human Growth Foundation website (http://www.hgfound.org/res_medicalinsurance_claims_appeals.html, accessed February 12, 2013).
19. Laboratory experimentation, as opposed to "natural experiments" with humans, has a couple of key, obvious advantages. One is that the number of conditions that are varied is limited as much as possible. The other is that the use of animals with shorter lifespans allows for the purported cause and effect to be easily tracked.
20. This fact has been checked by Richard Thomas, who oversees position announcements for *Anthropology News*. Most of the positions seem to be for biological anthropologists, but sometimes the subfield is unclear.
21. Rose and Lewontin have also worked with a variety of scientists and social scientists since the 1960s to better understand the political-economic and social contexts of science (e.g., see Rose and Rose 1969).

REFERENCES CITED

Armelagos, George J.
2005 The Slavery Hypertension Hypothesis—Natural Selection and Scientific Investigation: A Commentary. Transforming Anthropology 13(2):119–124.

Azar, Naomi
2001 Disease, Treatment and the Market Place: Growth Hormone Therapy and the Manufacturing of a Disease. B.A. thesis, School of Natural Sciences, Hampshire College.

Blakey, Michael
1989 The New York African Burial Ground Project: An Examination of Enslaved Lives, a Construction of Ancestral Ties. Transforming Anthropology 7(1):53–58.
1991 Man and Nature, White and Other. *In* Decolonizing Anthropology. Faye Harrison, ed. Pp. 15–23. Washington, DC: Association of Black Anthropologists and American Anthropological Association.
2004 Physiological Stress as an Indicator of Disorder in Industrial Societies. *In* Diagnosing America: Anthropology and Public Engagement. Shepard Forman, ed. Pp. 149–192. Ann Arbor: University of Michigan Press.

Blakey, Michael, and Leslie Rankin-Hill, eds.
2009 The Skeletal Biology of the New York African Burial Ground, part 1. Washington, DC: Howard University Press.

Boas, Franz
1912 Changes in the Bodily Form of Descendants of Immigrants. American Anthropologist (N.S.) 14(3):530–562.

Bogin, Barry
1999 Patterns of Human Growth. 2nd edition. Cambridge, UK: Cambridge University Press.

Boyce, W. Thomas, Marla B. Sokolowski, and Gene E. Robinson
2012 Toward a New Biology of Social Adversity. Proceedings of the National Academy of Sciences 109(suppl. 2):17143–17148.
Boyle, Edwin
1970 Biological Pattern in Hypertension by Race, Sex, Body Weight, and Skin Color. Journal of the American Medical Association 213(10):1637–1643.
Bullinger, Monika, Maria Kołtowska-Häggström, David Sandberg, John Chaplin, Hartmut Wollmann, Meinolf Noeker, and Anna Levke Brütt
2009 Health-Related Quality of Life of Children and Adolescents with Growth Hormone Deficiency or Indiopathic Short Stature, part 2: Available Results and Future Directions. Hormone Research 72(2):74–81.
Cohen, Susan, and Christine Cosgrove
2009 Normal at Any Cost. New York: Penguin.
Conrad, Peter
2007 The Medicalization of Society: On the Transformation of Human Coinditions into Treatable Disorders. Baltimore: Johns Hopkins University Press.
Douglass, Frederick
1950[1854] The Claims of the Negro Ethnologically Considered. *In* The Life and Writings of Frederick Douglass. P. S. Foner, ed. Pp. 289–309. New York: International.
Dressler, William W.
1991 Social Class, Skin Color, and Arterial Blood Pressure in Two Societies. Ethnicity and Disease 1(1):60–77.
Duden, Barbara
1991 The Woman beneath the Skin: A Doctor's Patients in 18th-Century Germany. Cambridge, MA: Harvard University Press.
Eakin, Emily
2013 The Indiana Jones of Anthropology. New York Times Magazine, February 17. http://www.nytimes.com/2013/02/17/magazine/napoleon-chagnon-americas-most-controversial-anthropologist.html?smid=pl-share, accessed April 20, 2013.
Ericson, Jonathan E.
1985 Strontium Isotope Characterization in the Study of Prehistoric Human Ecology. Journal of Human Evolution 14(5):503–514.
Eveleth, Phyllis B., and James M. Tanner
1991 Worldwide Variation in Human Growth. 2nd edition. Cambridge: Cambridge University Press.
Fausto-Sterling, Anne
1992 Myths of Gender: Biological Theories about Women and Men. New York: Basic.
Foster, Robert J.
2008 Coca-Globalization: Following Soft Drinks from New York to New Guinea. New York: Palgrave MacMillan.
Fullwiley, Duana
2011 The Enculturated Gene: Sickle Cell Health Politics and Biological Difference in West Africa. Princeton: Princeton University Press.
Goodman, Alan
2006 Seeing Culture in Biology. *In* The Nature of Difference: Science, Society, and Human Biology. George T. H. Ellison and Alan H. Goodman, eds. Pp. 225–241. New York: Taylor and Francis.
Goodman, Alan H., and Thomas Leatherman
1998a Traversing the Chasm between Biology and Culture: An Introduction. *In* Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology. Alan H. Goodman and Thomas Leatherman, eds. Pp. 3–41. Ann Arbor: University of Michigan Press.
Goodman, Alan H., and Thomas Leatherman, eds.
1998b Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology. Ann Arbor: University of Michigan Press.
Goodman, Alan, R. Brooke Thomas, George Armelagos, and Alan Swedlund.
1988 Biocultural Perspectives on Stress in Prehistoric, Historical, and Contemporary Population Research. Yearbook of Physical Anthropology 31(suppl. 9):169–202.
Goodman, Alan H., Joseph L. Jones, John B. Reid, Mark Mack, Michael Blakey, Dulasiri D. Amarasiriwardena, Portia Buton, and Drew Coleman
2009 Isotopic and Elemental Chemistry of Teeth: Implications for Places of Birth, Forced Migration Patterns, Nutritional Status and Pollution. *In* The Skeletal Biology of the New York African Burial Ground, part I. Michael L. Blakey and Leslie M. Rankin-Hill, eds. Pp. 95–118. Washington, DC: Howard University Press.
Goodman, Alan, Yolanda Moses, and Joseph Jones
2012 Race: Are We So Different? Boston: Wiley-Blackwell.
Gravlee, Clarence C.
2009 How Race Becomes Biology: Embodiment of Social Inequality. American Journal of Physical Anthropology 139(1):47–57.
Gravlee, Clarence C., William W. Dressler, and H. Russell Bernard
2005 Skin Color, Social Classification, and Blood Pressure in Southeastern Puerto Rico. American Journal of Public Health 95(12):2191–2197.
Gravlee, Clarence C., Amy L. Non, and Connie J. Mulligan
2009 Genetic Ancestry, Social Classification, and Racial Inequalities in Blood Pressure in Southeastern Puerto Rico. PLoS One 4(9):e6821.
Handler, Jerome
1994 Determining African Birth from Skeletal Remains: A Note on Tooth Mutilation. Historical Archaeology 28(3):113–119.
Harmon, Amy
2007 In DNA Era, New Worries about Prejudice. New York Times, November 11. http://www.nytimes.com/2007/11/11/us/11dna.html, accessed April 17, 2013.
Harris, Marvin
1970 Referential Ambiguity in the Calculus of Brazilian Racial Identity. Southwest Journal of Anthropology 26(1):1–14.

Heller, Chaia
2013 Food, Farms, and Solidarity: French Farmers Challenge Industrial Agriculture and Genetically Modified Crops. Durham: Duke University Press.
Henry, C. K. Jeya, and Stanley J. Ulijaszek, eds.
1996 Long-Term Consequences of Early Environments: Growth, Development and the Lifespan Developmental Perspective. Cambridge: Cambridge University Press
Hernberg, Sven
2000 Lead Poisoning in a Historical Perspective. American Journal of Industrial Medicine 38(3):244–254.
Herrnstein, Richard J., and Charles Murray
1994 The Bell Curve: Intelligence and Class Structure in American Life. New York: New Press.
Hubbard, Ruth, and Elijah Wald
1993 Exploding the Gene Myth: How Genetic Information Is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers. Boston: Beacon.
Jackson, Fatimah L. C.
1991 An Evolutionary Perspective on Salt, Hypertension, and Human Genetic Variability. Hypertension 17(1):129–132.
2005 A Response to George Armelagos' Commentary. Transforming Anthropology 13(2):125–135.
Jones, Joseph
2013 The Political Ecology of Early Childhood Lead in Enslaved Africans from the New York African Burial Ground. Ph.D. dissertation, Department of Anthropology, University of Massachusetts, Amherst.
Judge, Timothy A., and Daniel M. Cable
2004 The Effect of Physical Height on Workplace Success and Income: Preliminary Test of a Theoretical Model. Journal of Applied Psychology 89(3):428–441.
Kimbrell, Andrew
1997 The Human Body Shop: The Cloning, Engineering and Marketing of Life. Washington, DC: Regnery.
Komlos, John
1995 The Biological Standard of Living in Europe and America, 1700–1900: Studies in Anthropometric History. London: Ashgate.
Komlos, John H., and Benjamin E. Lauderdale
2007 Underperformance in Affluence: The Remarkable Relative Decline in U.S. Heights in the Second Half of the 20th Century. Social Science Quarterly 88(2):283–305.
Krieger, Nancy
2001 Theories for Social Epidemiology in the 21st Century: An Ecosocial Perspective. International Journal of Epidemiology 30(4):668–677.
2005 Embodiment: A Conceptual Glossary for Epidemiology. Journal of Epidemiology and Community Health 59(5):350–355.
Krieger, Nancy, Dana Carney, Katie Lancaster, Pamela D. Waterman, Anna Kosheleva, and Mahzarin Banaji
2009 Combining Explicit and Implicit Measures of Racial Discrimination in Health Research. American Journal of Public Health 10(8):1485–1492.
Kuzawa, Christopher W., and Elizabeth Sweet
2008 Epigenetics and the Embodiment of Race: Developmental Origins of U.S. Racial Disparities in Cardiovascular Health. American Journal of Human Biology 21(1):2–15.
Lasker, Gabriel
1969 Human Biological Adaptability. Science 166(3912):1480–1486.
Leatherman, Thomas, and Alan Goodman
2005 Coca-Colonization of Diets in the Yucatan. Social Science and Medicine 61(4):833–846.
Lee, Joyce M., Matthew M. Davis, Sarah J. Clark, Timothy P. Hofer, and Alex R. Kemper
2006 Estimated Cost-Effectiveness of Growth Hormone Therapy for Idiopathic Short Stature. Archives of Pediatrics and Adolescent Medicine 160(3):263–269.
Lewontin, Richard
2000 The Triple Helix: Gene, Organism, and Environment. Cambridge: Harvard University Press.
Lippman, Abby
1991 Prenatal Genetic Testing and Screening: Constructing Needs and Reinforcing Inequalities. American Journal of Law and Medicine 17(1–2):15–50.
Lock, Margaret, and Patricia Kaufert
2001 Menopause, Local Biologies and Cultures of Aging. American Journal of Human Biology 13(4):494–504.
Marks, Jonathan
2002 What It Means to Be 98% Chimpanzee: Apes, People, and Their Genes. Berkeley: University of California Press.
Marmot, Michael, and Richard G. Wilkinson, eds.
2006 Social Determinants of Health. 2nd edition. New York: Oxford University Press.
McDade, Thomas W.
2012 Early Environments and the Ecology of Inflammation. Proceedings of the National Academy of Sciences 109(suppl. 2): 17281–17288.
McEwen, Bruce S.
2012 Brain on Stress: How the Social Environment Gets under the Skin. Proceedings of the National Academy of Sciences 109 (suppl. 2):17180–17185.
Mitchell, Sandra D.
2009 Unsimple Truths: Science, Complexity and Policy. Chicago: University of Chicago Press.
Montoya, Michael J.
2011 Making the Mexican Diabetic: Race, Science, and the Genetics of Inequality. Berkeley: University of California Press.
Morgan, Lynn M.
2009 Icons of Life: A Cultural History of Human Embryos. Berkeley: University of California Press.
Naik, Gautam
2011 Scientists' Elusive Goal: Reproducing Study Results. Wall Street Journal, December 2. http://online.wsj.com/article/SB10001424052970203764804577059841672541590.html, accessed April 20, 2013.
Nelkins, Dorothy, and M. Susan Lindee
2004 The DNA Mystique: The Gene as a Cultural Icon. Ann Arbor: University of Michigan Press.

Orgel, Mary, Jacqueline Urla, and Alan Swedlund
2005 Surveying a Cultural "Waistland": Some Biological Poetics and Politics of the Female Body. *In* Complexities: Beyond Nature and Nurture. Susan McKinnon and Sydel Silverman, eds. Pp. 132–156. Chicago: University of Chicago Press.

Pinker, Steven
2009 My Genome, My Self. New York Times Magazine, January 7. http://www.nytimes.com/2009/01/11/magazine/11Genome-t.html, accessed April 20, 2013.

Pollan, Michael
2008 In Defense of Food: An Eater's Manifesto. New York: Penguin.

Rapp, Rayna
1999 Testing Women, Testing the Fetus: The Social Impact of Amniocentesis in America. The Anthropology of Everyday Life series. New York: Routledge.

Riddihough, Guy, and Laura M. Zahn
2010 What Is Epigenetics? Science 330(6004):611.

Romney, A. Kimball, Susan C. Weller, and William H. Batchelder
1986 Culture as Consensus: A Theory of Culture and Informant Accuracy. American Anthropologist (N.S.) 88(2): 313–338.

Rose, Hilary, and Steven Rose
1969 Science and Society. New York: MacMillan.

Rose, Steven
2003 Lifelines: Life beyond the Gene. New York: Oxford University Press.

Rutherford, Julienne N.
2009 Fetal Signaling through Placental Structure and Endocrine Function: Illustrations and Implications from a Non-Human Primate Model. American Journal of Human Biology 21(6):745–753.

Sahlins, Marshall
1976 The Use and Abuse of Biology: An Anthropological Critique of Sociobiology. Ann Arbor: University of Michigan Press.

Schell, Lawrence M., Julia Ravenscroft, Maxine Cole, Agnes Jacobs, Joan Newman, and Akwesasne Task Force on the Environment
2005 Health Disparities and Toxicant Exposure of Akwesasne Mohawk Young Adults: A Partnership Approach to Research. Environmental Health Perspectives 113(12):1826–1832.

Scheper-Hughes, Nancy, and Margaret M. Lock
1987 The Mindful Body: A Prolegomenon to Future Work in Medical Anthropology. Medical Anthropology Quarterly 1(1):6–41.

Segal, Daniel A., and Sylvia J. Yanagisako, eds.
2005 Introduction. *In* Unwrapping the Sacred Bundle: Reflections on the Disciplining of Anthropology. Pp. 1–23. Durham, NC: Duke University Press.

Steckel, Richard H.
1995 Stature and the Standard of Living. Journal of Economic History 33(4):1903– 1940.

Tanner, James M.
1986 Growth as a Mirror of the Condition of a Society: Secular Trends and Class Distinctions. *In* Human Growth: A Multidisciplinary Review. A. Demirjian, ed. Pp. 3–34. London: Taylor and Francis.

Thomas, R. Brooke
1998 The Evolution of Human Adaptability Paradigms: Toward a Biology of Poverty. *In* Building a New Biocultural Synthesis: Political-Economic Perspectives on Human Biology. Linking Levels of Analysis Series. Alan H. Goodman and Thomas L. Leatherman, eds. Pp. 43–73. Ann Arbor: University of Michigan Press.

Tyroler, H. A., and Sherman A. James
1978 Blood Pressure and Skin Color. American Journal of Public Health 68(12):1170–1172.

Wilson, Edward O.
1975 Sociobiology: The New Synthesis. Cambridge, MA: Harvard University Press.

Wolf, Eric
1982 Europe and the People without History. Berkeley: University of California Press.

Zimmer, Carl
2012 A Sharp Rise in Retractions Prompts Calls for Reform. New York Times, April 16. http://www.nytimes.com/2012/04/17/science/rise-in-scientific-journal-retractions-prompts-calls-for-reform.html?smid=pl-share, accessed April 20, 2013.