We are so frequently concerned with how we get sick that we often neglect to ask why we get sick. Not simply why we get sick compared to our colleagues or younger selves, but why we get sick at all. Although this might be posed as a deeply philosophical question about the human condition, it can also be considered empirically. An anthropologist might point to the norms and politics of socio-cultural institutions; a geneticist may look to family trees and hereditary mutations that persist between generations; a physician might cite the pathophysiology of disease and curious cases from clinical experience. This chapter is about the evolutionary biologist, who tells a different story: we get sick because we are evolved beings, riddled with evolutionary trade-offs and maladapted to modern lifestyles. In the light of evolution, so the story goes, sickness and health need to be reinterpreted.

Evolutionary medicine attempts to answer why we get sick by exploring the ultimate, evolutionary causes of health and disease. This exploration aims to “transform the way patients and doctors see disease” (Nesse and Williams 1994: 245) and “bring the full power of evolutionary biology to bear on problems of human health” (Nesse and Stearns 2008: 43). With the help of evolutionary thinking, bodily vulnerabilities are envisioned as evolutionary trade-offs or the result of a mismatch between ancestral lifestyles and the modern world. A recent review surveys the diversity of medically relevant issues that would be reconceptualized by evolutionary thinking: “bottle-feeding, caesarian sections, infection, cleanliness, fever, exercise, diet, mate choice, contraception, semen sampling, and body odor suppression” (Gallup et al. 2014: 69). Breadth is heralded as a strength of the field.

Evolution also helps organize human physiology and anatomy into a coherent but historically contingent model of the body. Just as anatomy and chemistry are core subjects in the medical classroom, evolutionary biology would serve as a foundational subject that unified the seemingly disconnected volumes of medical knowledge. Learning tools focused on evolutionary medicine have been developed for high school, undergraduate, and medical students in the last 10 years (Antolin et al. 2012, Hidaka et al. 2015).

Before evolutionary medicine began to ask why we get sick, evolutionary theory helped us to understand the evolution of pathogens and the genetic dynamics of contemporary human populations. These applications have saved countless lives and remain essential to public health and clinical practice. Only in the last 25 years have evolutionary biologists begun to theorize about human ancestral biology and what it might mean for health today. This chapter explores such theories, their assumptions, and their potential role in clinical practice.
A Brief History of Evolution and Medicine

Throughout the 20th century, the relationship between evolution and medicine had a troubled history. Most striking was the rise of eugenics, before and during World War II, which led to a post-war distancing of evolutionary theory from medicine. Even today, proponents of evolutionary medicine must clarify that their recommendations do not advocate genetic purification or racial typologies, the outcomes of oversimplified views on genetic determinism (e.g., Gluckman et al. 2009, Nesse et al. 2010). Evolutionary biologist George C. Williams and psychiatrist Randolph Nesse’s foundational book, Why We Get Sick: The New Science of Darwinian Medicine (1994), clearly stated that evolutionary medicine is neither eugenic nor aligned with turn-of-the-century ideologies about Social Darwinism that “helped to justify withholding medical care from the poor” (11). Modern evolutionary medicine, like clinical medicine, aims to help those that suffer rather than the species as a whole.

Contemporary evolutionary medicine became possible because of 20th-century developments in evolutionary theory, genetics, and their intersection. Quantitative advances in our knowledge of human population genetics, host-pathogen interactions, and the phylogenetics of bacteria and viruses drew attention to the importance of natural selection in medical contexts (Zampieri 2009). When the Flexner Report of 1910 highlighted the importance of biomedicine in medical training and revamped medical professionalism, evolutionary thinking was in a lull and so neglected (Nesse and Stearns 2008, Duffy 2011). Fisher had yet to quantify population genetics, modern evolutionary theory had yet to be built, and E. O. Wilson’s controversial Sociobiology (1975) had yet to incite discussion about the application of evolution and genetic selectionism to human populations.

In the last 25 years, there has been growing interest in evolutionary explanations for health and disease. In 1991, Williams and Nesse urged physicians to embrace evolution as a foundation of medical knowledge in “The Dawn of Darwinian Medicine.” Embracing evolution meant modifying medical school curricula, re-evaluating clinical practice, and creating interdisciplinary institutes to advance evolutionarily informed medical research. If only physicians and researchers “were as attuned to Darwin as they have been to Pasteur” (1991: 2), they claimed, would medical knowledge progress at an unprecedented pace. Despite their optimism, the dawn started slowly.

The vast majority of evolutionary medicine’s theoretical and educational contributions have occurred in the last decade. There are a growing number of university courses, two dedicated journals (Evolution, Medicine, and Public Health; and the Journal of Evolutionary Medicine), collaborative research centers (e.g., the Triangle Center for Evolutionary Medicine [TriCEM] and the Arizona State University Center for Evolution and Medicine), and a curriculum supplement for U.S. high school science classes produced by the National Institutes of Health (Pennisi 2009, 2011). A recent survey of U.S. medical school deans indicated that evolution is more integrated into the curricula of some schools than it was a decade ago, and medical faculty are more likely to be trained in evolutionary biology; however, nearly half of those that responded to the survey worried that controversy might erupt should evolution be taught at their schools (Hidaka et al. 2015). This is unsurprising given the controversial place of evolution in the U.S. classroom (Glaze and Goldston 2015). Physicians have also been cautious to adopt evolutionary explanations because their role in clinical diagnostics, prognostics, and treatments remains unclear.

Evolutionary Explanations in Medicine

Before exploring evolutionary medicine critically, I need to outline the kinds of explanations it claims to offer. I mentioned above that evolutionary medicine explores the ultimate causes of health and disease. Ultimate, here, does not mean final or decisive, but refers to evolutionary
causes as opposed to proximal causes. The Harvard evolutionary biologist Ernst Mayr clearly distinguished between ultimate and proximate causes in his “Cause and Effect in Biology” (1961), arguing that both kinds of causes (and their associated explanations) were necessary to fully understand biological phenomena. He contrasted the functional biologist with the evolutionary biologist: the functional biologist asks how the mechanisms within organisms operate, whereas the evolutionary biologist asks why organismal traits were adaptive. The former asks proximate questions, the latter ultimate. These two question types establish typical disciplinary boundaries and an “explanatory asymmetry” that distinguishes “not between past and present causes, but between different types of causes or processes” (Scholl and Pigliucci 2015: 655). The ultimate cause of fever, for instance, might be that it helped our ancestors to ward off pathogens (e.g., by boosting our immune responses) and so fosters a selective advantage; this evolutionary explanation need not appeal to the proximate physiological causes of fever, such as its cellular mechanisms or hormonal regulations. The merits of the proximate-ultimate distinction continue to be debated by philosophers of biology (e.g., Ariew 2003, Amundson 2005, Laland et al. 2013, Scholl and Pigliucci 2015); nevertheless, it remains essential to evolutionary thinking in medicine.

Not long after Mayr’s article, Tinbergen (1963) went on to distinguish four questions that, when answered, offer a complete explanation for an organismal trait. Tinbergen did not map these onto Mayr’s proximate-ultimate distinction, but subsequent work mapped the parallel lines of inquiry, for better or worse (Laland et al. 2013). Integrating the frameworks might look like the following:

**Proximate questions (the “how” questions)**

1. How does the trait’s causal mechanism work?
2. How does the trait develop in the organism?

**Evolutionary questions (the “why” questions)**

3. Why is the trait adaptive (in its selective environment)?
4. Why did the trait evolve as it did?

Evolutionary medicine aims to bring the latter two “why” questions into medical reasoning. Why do we sneeze? Why do infants reflexively hold their breath underwater? Why do certain populations have Tay-Sachs disease? The hope is that posing these questions (and searching for their answers) will lead to lines of inquiry that more firmly ground medicine in biological evolution. With a firmer grasp of ultimate and proximate explanations, we can begin to tease apart the themes often found in evolutionary medicine and how these questions address them. The “why” questions in evolutionary medicine tackle four broad themes, as I have noted elsewhere (Cournoyea 2013):

**the macro-domain (long-term human evolution)**

1. the origin and adaptive function of physiological processes (like breastfeeding or yawning)
2. the adaptive use of supposed dysfunctions mismatched to modern lifestyles (like fever or autism)

**the micro-domain (short-term microorganism or human evolution)**

3. the evolutionary mechanisms that shape modern host-pathogen interactions (like HIV/AIDS)
4. the genetic dynamics of human populations (like heterozygote advantage with sickle-cell anemia).
Although both domains use evolutionary reasoning, each domain is unique in its subject matter, methodology, epistemic standards, and implications. Tinbergen’s “why” questions can be applied to both domains, but answers in the macro-domain remain speculative—theorizing about the adaptive significance of ancient bodily traits. The micro-domain is not as epistemologically or methodologically problematic, since experimental evolution and genotyping, for example, can be conducted and tested on contemporary organisms. When the evolutionary medicine literature lumps these domains together (without noting their unique styles of reasoning, evidence, and implications), it becomes possible to conflate success in the micro-domain for success in both domains. Unfortunately, this has been common practice.

A similar distinction has been made by Pierre-Olivier Méthot (2011) between forward-looking evolutionary medicine and backward-looking Darwinian medicine—these seem to align with the micro- and macro-domains, respectively. While the terms “evolutionary” and “Darwinian” are often used interchangeably in the literature, Méthot draws a methodological distinction between these research traditions and the role they play in research and clinical medicine. Forward-looking evolutionary medicine “tries to predict the effects of ongoing evolutionary processes on human health and disease in contemporary environments (e.g., hospitals)” while backward-looking Darwinian medicine “typically applies evolutionary principles from the vantage point of the evolutionary past of humans (here, the Pleistocene epoch) in order to assess present states of health and disease among populations” (76). Only Darwinian medicine is epistemologically and methodologically cohesive; evolutionary medicine is a disciplinary umbrella under which diverse research agendas share their use of evolutionary thinking. This distinction is apt but may lead to some confusion. Both evolutionary and Darwinian research traditions employ backward-looking ultimate explanations and forward-looking predictive models, at times—the central difference is one of time-scale. For example, the evolutionary processes and outcomes of antibiotic resistance, a topic typically explored in evolutionary medicine, may require backward-looking evolutionary thinking to trace the genetic ancestors of bacterial populations; a researcher may need to look “back” through ancestral lineages to understand the mutational process that has led to resistant strains. Méthot is aware of this potential confusion and qualifies that these explanatory styles are not used absolutely.

These nuances about naming may seem trivial, but they remain important to critical debates about what evolutionary medicine is and how it should be used. Although the micro-domain may be epistemologically and methodologically challenging, these challenges are acknowledged and debated by microbiologists, geneticists, and even physicians. The macro-domain remains problematic, and its relevance to medical research and practice remains unclear. For the remainder of the chapter, I use the term evolutionary medicine to refer exclusively to the macro-domain, which has been the focus of recent critiques. Having looked at these preliminaries, let me begin to sketch my two central criticisms of evolutionary medicine.

**Adaptationism and Ancestral Ideals of Health**

Adaptationism is an approach to evolutionary thinking that privileges natural selection over non-selective evolutionary forces, such as developmental constraints (which constrain variability) or drift (change in populations due to random sampling). To the adaptationist, fever evolved because it gave organisms a selective advantage: the ability to survive pathogens and have more offspring with the capacity for fever themselves. This style of reasoning offers a powerful approach for understanding why organisms are so well adapted to their environments. In general, evolutionary medicine is committed to the following adaptationist stances: (1) adaptations give us insight into why our bodies are so vulnerable to disease (the vulnerability stance);
(2) adaptations elucidate the mismatches between our ancestral biology and modern lifestyles (the diseases of civilization stance); and (3) adaptationism is important because it unifies disparate pieces of medical knowledge about the evolved body (the unificationist stance).

The adaptationism in these stances is not singular. Godfrey-Smith (2001) has outlined three kinds of adaptationism: explanatory, methodological, and empirical. Explanatory adaptationism claims that the uncanny fit between organism and environment should be the central puzzle in biology, and this puzzle is most effectively solved by appeal to natural selection. Methodological adaptationism is a pragmatic approach to conceptualizing organismal design that recommends adaptationist thinking as an organizing concept. Williams and Nesse (1991, 1994) are committed to methodological adaptation, although they do not always hold explanatory adaptationism (Méthot 2015). When hypothesizing the function of fever, we test evolutionary hypotheses (methodologically) by carefully considering all adaptive and non-adaptive possibilities. This does not imply that all traits are best explained by adaptationism; the strongest hypothesis for some traits may be that they have resulted from non-selective forces (Nesse 2011).

Empirical adaptationism asserts that natural selection is the most influential and important force in biological change. Evolutionary medicine’s strongest advocates appear to be committed to empirical adaptationism, specifically a pan-selectionist view of biological change where non-adaptive forces have little influence (Valles 2012). This is not to say that they advocate a view of the body in which all traits are adaptive, but that these traits were likely adaptive (or the trade-offs of other adaptations) in the environment in which we evolved. Many theorize that the human body’s adaptations took place during the Pleistocene epoch (approximately 2 million years ago until about 12,000 years ago), during what John Bowlby (1969) has called the environment of evolutionary adaptedness. Since nearly every aspect of our lives has been altered since that time—from diet to housing to social structures—evolutionary medicine argues that our bodies are not fit for modern environments. Yet the environment of evolutionary adaptedness has been challenged both for its oversimplification of our ancestral environment and because we can do little more than speculate about its conditions or impact on ancestral populations (Buller 2005). There is some debate and discussion of these critiques, but the vast majority of evolutionary medicine’s proponents appear committed to empirical adaptationism. Empirical adaptationism is taken for granted in two textbooks (Trevathan et al. 2008, Gluckman et al. 2009), though Gluckman et al. at least note that adaptive arguments are hypothetical. Although empirical adaptationism is assumed in Nesse and William’s early work, Nesse (2011) does warn students about accepting adaptive hypotheses without careful and thorough consideration. But even with careful consideration, empirical adaptationism remains speculative. These concerns were the thrust of Gould and Lewontin’s (1979) profound critique of the adaptationist program, and most biologists have heeded their call to consider alternative explanations.

There may also be a more nuanced critique of empirical adaptationism, articulated both by Canguilhem’s contextualism (Sholl 2014) and Walsh’s situated adaptationism (Walsh 2012). These views emphasize the dynamic interplay between organisms and their environments, putting the organism back into naturalist accounts of health, such that “health and disease are not to be found in the separate parts or matter comprising organisms, but in their total organization” (Sholl 2014: 142). This view of health undermines the importance of the environment of evolutionary adaptedness because “organisms are not only shaped by their past, but construct their present, healthy behavior is that which allows organisms to offset potentially problematic ‘mismatches’ or evolved constraints” (161). These “ecological” accounts are also echoed by approaches to health in disability studies and health promotion, which attempt to situate health in the dynamic organism-environment relationship.
Without a contextual account of health, we run the risk of idealizing the lives of our Stone Age ancestors. Our modern environment is likely responsible for many “diseases of civilization,” but these diseases are not simply the result of an environmental mismatch. We cannot simply naturalize health. Since, as Nesse (2011) asserts, evolutionary medicine is only one approach to medicine among many, it must adhere to the ethical and personal idiosyncrasies of a patient’s socio-cultural context and wider normative beliefs about health and illness (Lewis 2008). If suffering is the root of illness, then a patient might be healthy despite adaptive dysfunctionality or unhealthy while the body is functionally aligned with its evolutionary history. It is too simple to say that “medicine is based on biology and biology is based on evolution” (Nesse 2008: 416). Evolutionary medicine might even commit the naturalistic fallacy of suggesting that the natural should be normal, especially when naturalizing health/disease using speculative hypotheses about our evolutionary past. We should be wary of claims that certain biological “facts” are natural; naturalness is never a good enough reason to suggest that something should be normal. These concerns about adaptationism underscore my central concern: are ultimate explanations ever relevant to clinical practice? I am not optimistic, and I turn to this issue now.

The Clinical Irrelevance of Evolutionary Medicine

Clinical medicine aims to alleviate suffering through pragmatic, patient-centered, interventionist treatments. This aim is as old as medicine, enshrined in the Hippocratic Oath. Medical research that has no applicability to clinical practice may be interesting but irrelevant, details better suited to a basic science. This is not to say that research must always have direct applications to the clinic—developments in the basic sciences may eventually lead to advances in practice, even if we do not know when or in what capacity. The clinical applicability of evolutionary explanations has been a perennial concern, with Nesse and Williams (1994) admitting that “medicine is a practical enterprise, and it hasn’t been immediately obvious how evolutionary explanations might help us prevent or treat disease” (241). In the last five years, critiques from the philosophy of medicine have challenged the epistemic and pragmatic usefulness of such ultimate explanations to clinical medicine, with varied degrees of optimism (Ruse 2012, Valles 2012, Cournoyee 2013, Méthot 2015).

At the heart of these concerns is whether ultimate explanations can offer clinical guidelines independent of proximate explanations. Even though a complete explanation of a biological trait would include both proximate and ultimate explanations, these two explanations are epistemically independent (Griffiths 2009). Ultimate explanations are essential to the biological sciences, but they are merely heuristic in medicine. Proximate explanations should take precedence because they offer the possibility of intervention. This point is reinforced by the confidence we can have in proximate explanations that we cannot have in ultimate explanations. The need for practical certainty in medicine may even ethically preclude the speculative claims of adaptationist, ultimate explanations. Ruse (2012) briefly notes this point, citing Schaffner’s (1993) thorough discussion of how functional teleological language is merely heuristic and eventually superseded by mechanistic explanations.

Ultimate explanations do not always point us in the right direction. Knowing the evolutionary history and adaptive value of fever, for example, does not necessarily lead us to understand its proximate causes. Indeed, Nesse and Stearns (2008) acknowledge that despite clinically relevant recommendations,
on theory alone are notoriously suspect. Treatment should, whenever possible, be based on controlled studies of treatment outcomes. However, lack of evolutionary understanding among physicians fosters misunderstanding about issues as important as aging, diet, and when it is wise to use medications to block defensive responses. While there is a trend for doctors to just carry out protocols, we want doctors to have a deep knowledge base so their decisions are informed by understanding the body and disease. Better decisions come from doctors who understand the ecology of immune responses, the evolutionary reasons for polygenic diseases, the phylogeny of cancer cells, and the origins of antibiotics.

(41–42)

Yet these “controlled studies” explore the proximate causes of treatment options, and the “better decisions” come from the micro-domain: immune ecologies, intergenerational genetic diseases, the adaptability of cancer cells, and the development of antibiotic resistance. So what is the place of macro-domain evolutionary medicine in clinical practice? It remains unclear. Whether macro-domain evolutionary theory can influence interventionist medicine remains an open (and controversial) question—one that might need to be answered one speculative hypothesis at a time (Nesse 2011).

Consider Nunn et al.’s (2015) review of the Inaugural Meeting of the International Society for Evolution, Medicine and Public Health (ISEMPH) held in March 2015. They review some of the notable speakers who discussed putative evolutionary mismatches: shoes weaken our feet and predispose us to injury; unnecessary caesarian deliveries may lead to obesity and immune disorders; in-vitro fertilization may harm newborns “by bypassing the evolutionary norm of postcopulatory cryptic female choice such as choosing among particular sperm” (127). These are speculative hypotheses about the impacts of modern environments that seem to offer the potential for direct clinical applications, but before any of these hypotheses lead to clinical recommendations, we need proximate explanations to validate such ultimate theories.

It may be that an evolutionary perspective offers us a more complete “feeling for the organism” (Nesse 2008, Nesse et al. 2010), unifying physiology’s “hodgepodge of unconnected facts” (Nesse 2008: 427). This unificationist stance is largely educational, with the potential to encourage certain lines of inquiry and foster a “deep knowledge” of the human body (as Nesse and Stearns note above). Yet evolutionary medicine is not the only field vying for curricular time in medical schools, and it remains unclear that ultimate explanations would have a positive impact on clinical decision-making. A deep knowledge of evolution may help us in answering “What does it mean to be a human organism?” (Gluckman and Bergstrom 2011), but clinical medicine has little use for such speculations, as we see with the example of fever.

An Example: The Adaptive Value of Fever

Body temperature is dynamically maintained in a complex homeostasis. This is critical for physiological reactions, which are dependent on temperature, and varies from bodily core to periphery and during the time of day; these variations are also crucial in regulating tissue functions and maintaining circadian rhythms. Temperature is dynamically held at a set-point, and when actual core temperature differs from this point, a negative feedback loop (via the anterior hypothalamus) induces heat dissipation mechanisms such as sweating (Cannon 2013).

Fever occurs when body temperature rises above an individual’s healthy (or normal) range (usually 35.6°C–38.2°C when taken orally), a process triggered by a wide variety of infectious and non-infectious agents. These agents are either endogenous (e.g., cytokines or prostaglandins) or exogenous (e.g., bacterial proteins) and stimulate the hypothalamus to increase the
homeostatic set-point. Fevers differ from other, non-pathological elevations in temperature (i.e., hyperthermia, caused by exercise, heatstroke, drug reactions, etc.), because of this change in set-point (Cannon 2013).

The metabolic and behavioral changes that induce fever are costly—febrile animals have significant increases in both metabolism and oxygen consumption (Manthous et al. 1995). Fevers may even lead to collateral tissue damage or morbidities caused by metabolic demands that exceed the capabilities of its host (Hasday et al. 2000). Fevers can be fatal, especially in young children, and both environmental adjustments and medications are used to treat them. Paracetamol (acetaminophen) is the most commonly administered analgesic and antipyretic (i.e., fever preventative) to relieve the discomfort of fever and reduce temperatures; it acts by antagonizing prostaglandins, but it may ease discomfort because it helps with pain, rather than reducing one’s fever (Best and Schwartz 2014). Intensive care units (ICUs) commonly prescribe paracetamol for its analgesic and antipyretic effects (Jefferies et al. 2012, Suzuki et al. 2015).

The adaptive value of fever has been studied for more than 40 years. Fever in response to infection occurs in a wide variety of endothermic and ectothermic animals, including mammals, birds, ectothermic vertebrates, arthropods, and even annelids (Hasday et al. 2000). When infected with bacterial pathogens, both desert iguanas and goldfish move to warmer locations; mortality increases when these species are kept at afebrile temperatures (Covert and Reynolds 1977, Kluger 1978). In a fascinating example of convergent evolution, honeybees also generate hive-wide fever in response to a fungal, heat-sensitive pathogen (Starks et al. 2000). The widespread incidence of fever strongly suggests that it is an ancient, adaptive response to infection that may have evolved over 600 million years ago; this persistence is remarkable given fever’s metabolic cost and potential harms (Hasday et al. 2000).

The importance of fever for the human defense system is more obscure, with evidence tending to indicate that antipyretic treatments are sometimes harmful. Clinical recommendations remain highly specific to the circumstances of a patient’s condition. A multicenter prospective observational study conducted by Lee et al. (2012) found that the administration of non-steroidal anti-inflammatory drugs (NSAIDs) or acetaminophen to septic patients increased mortality. They hypothesize four potential explanations for the increase: (1) lowered body temperatures might prevent anti-viral and anti-bacterial effects of fever; (2) NSAIDs and acetaminophen may sometimes be toxic; (3) patients that failed to develop a fever had worse outcomes, or (4) some combination of these factors. This supports the conclusion that fever may be “naturally protective” (9), but only with cases of infection. Schulman et al. (2005) similarly found that aggressive antipyretic treatment was correlated with higher mortality in a randomized, prospective study of 82 patients. Animal models infected with influenza are also at increased risk of mortality with antipyretic treatment (Eyers et al. 2010).

In contrast to these results, several recent studies have concluded that antipyretic treatment is clinically neutral or beneficial. A meta-analysis of three randomized control trials showed that antipyretic treatment was not associated with better or worse outcomes in critically ill patients (Neto et al. 2014). The recently completed HEAT trial (a long-anticipated multicenter, randomized, placebo-control trial in Australia and New Zealand) concluded that ICU patients, who were suspected to have infections, did not spend less time in the ICU when treated with acetaminophen and exhibited no difference in “28-day mortality, 90-day mortality, or survival time to day 90” (Young et al. 2015: 2223). In the largest multicenter retrospective, observational study of paracetamol use in the ICU, results from four Australian ICUs (and 15,000 patients) found that antipyretic paracetamol therapy actually lowered mortalities, contrary to the hypothesis; however, survival varied with the severity of illness, suggesting the need for further research (Suzuki et al. 2015).
Despite the evidence that some fevers have adaptive significance, even the most thorough reviews conclude that clinical guidelines are tough to formulate broadly, since “the complex interactions among immunological and homeostatic mechanisms in critically ill patients precludes an accurate prediction of the ultimate effect of fever in such patients” (Hasday et al. 2000: 1900). Despite the potentially detrimental effects of antipyretics and “a greater understanding of evolved defence mechanisms” like fever, researchers who advocate adaptive explanations conclude that “[c]urrent [evolutionary] research is insufficient to warrant changing clinical practice but indicates the urgent need for further studies” (Best and Schwartz 2014: 92).

Although evolutionary medicine has emphasized the naturalness and adaptive efficacy of fever, it offers little more than encouragement for further research. We are still gathering evidence about the best uses of antipyretics, and the burden should not fall on evolutionary medicine to provide a rationale for clinical guidelines.

Fever does seem to be an excellent candidate for adaptive thinking: unifying our knowledge of infection and bodily defenses, and explaining why antipyretics may sometimes be harmful. Williams and Nesse (1991) mention this in their pioneering article, noting that when fever is pharmaceutically blocked, it “may” be easier to resist infection—a conclusion that, for them, “clearly illustrates use of the adaptationist program to make medically important and heuristically useful predictions” (6–7). Explanatory and methodological adaptationism also seem well suited to an exploration of fever, especially considering its prevalence throughout the animal kingdom.

There is one final concern. Evidence used to evaluate whether fever is functionally adaptive is the same as that used to evaluate whether fever should be treated. Inferences from homology and a comparative analysis of other bodily vulnerabilities give us some insight into the adaptiveness of febrile responses, but the details of these inferences are discovered in clinical trials and physiological research like those outlined above. We have good reason to believe that fever is adaptive, but whether fever is adaptive only during certain bacterial infections, or below a certain temperature threshold, or in certain patient populations is to be established by clinical research. And this very research allows physicians to construct the standards of clinical practice. Ultimate explanations, then, may be simply redundant.

Proximate explanations gleaned from controlled studies remain essential to guiding physicians in treating fevers. Antipyretic treatment must be evaluated in light of the infection’s progression, the fever’s intensity, and the patient’s capacity to withstand increased metabolic demands. The adaptive value of fever does not suggest that it should always be left to take its course or that patient outcomes (or comfort) would not be better aided with medications. Allowing most fevers to run their course may very well be the ideal clinical recommendation, but this needs to be based on clinical trials rather than evidence from evolution.

The Evolutionary Biologist’s Tale

Where does this leave the evolutionary biologist’s story in medicine? On optimistic but dubious terrain, I’m afraid. As Anne Gammelgaard (2000) argues, the natural goals of evolutionary theory and medicine are distinct and potentially incompatible. The goals of clinical medicine are specific to the suffering and life history of each patient as they aim to live a healthy life; however, macro-domain evolutionary explanations offer little more than speculative hypotheses about our ancestral past. Such hypotheses may lead us to problematically naturalize evolved functions and “exemplify the naturalistic fallacy since the healthy functioning of the individual cannot be derived from the evolutionary history of that individual” (115). These challenges must be balanced against the need for medical students and physicians to appreciate the complex history of our biologies. Ultimately, evolutionary medicine must itself adapt, taking such trade-offs and philosophical vulnerabilities seriously.

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References


**Further Reading**

Gluckman, P. D., A. Beedle, and M. Hanson (2009) *Principles of evolutionary medicine*, Oxford: Oxford University Press. (the most recent textbook on evolutionary medicine)