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To Love Your Neighbor: A Christian Perspective on the Study of Microbiology and Immunology

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17 September 2008

I have been blessed with enough of a sense of adventure to have experienced the awe-inspiring beauty of a rain forest at night, the top of Half Dome at Yosemite National Park, the sheer cliffs and rushing waters of the Narrows at Zion National Park, Plateau Point—which seems suspended in the Grand Canyon, and the top of a 14,000-foot peak in the Rocky Mountains of Colorado. These are the types of places about which one of the characters in Robert Pirsig's Zen and the Art of Motorcycle Maintenance observes, "This is the hardest stuff in the world to photograph. You need a three-hundred-and-sixty-degree lens, or something."¹ Just as the aesthetic experience of nature requires active participation within it and cannot be captured in the boundaries of a photograph, in order to truly understand the context of any academic discipline one must look up periodically from the reading, writing, bench, or field and take in this kind of global view. While I cannot lay claim to actual or intellectual lenses with perfect, 360-degree power, what follows is my attempt to evaluate the traditional borders and restrictions of the fields of Microbiology and Immunology through the globally relevant lens of Scripture, and to present an integrated portrait of how one might move Christianly within these fields; this practice of focusing Scripture's lens on one's discipline should be a defining characteristic of any Christian scholar.

On Being a Christian and a Biologist

It was in studying the created world that I first truly encountered the Creator; it was not long thereafter that I began to sense the importance of focusing Scripture's lens on my academic studies. In March of 1993 I was enrolled in a Tropical Biology course at Albion College in Michigan, and after traveling by three planes, a bus, and a boat we had arrived by moonlight near the mouth of the Sittee River in Belize. I expected our Spring Break field experience to be unique, interesting, and perhaps challenging, but for me it was also life-changing. In this place so removed from what I would call "civilization," the living abundance, the stunning diversity of plant and animal life, the magnitude of the canopy-forming trees, the sheer fullness of the understory, and the sense of natural balance spoke to me in a way no person or written text ever had. In this place, it was impossible for me to deny the existence of a Creator, and that this Creator cared very deeply for His creation. And, perhaps for the first time in my life, I was prepared to acknowledge that I also belonged to this creation cared for so intimately by God. A few months later, some fellow student-scientists introduced me to Jesus Christ, and although I had been a regular church attender prior to college, I hadn't been ready to meet Him until this time. Even though hindsight demonstrates how the Lord was priming me for these events, I still think of that trip to the Belizean rain forest as the beginning of my new life in Christ.

¹ Pirsig, R. 1974. Zen and the Art of Motorcycle Maintenance: an Inquiry into Values. New York: HarperCollins.

At this point in my life, I was a very dedicated student—indeed, I had already participated in an off-campus summer research program as a primer to pursue a doctorate in Biology—and as I read Scripture I was excited to see the wealth of references to the created world², as well as that God commanded followers to love Him with their minds³. Initially this meant to me that I could be a Christian and a Biologist, but over the last 15 years I have come to see that I am to be a Christian Biologist and seek out the many ways that my scientific mind can inform my study of Scripture, as well as the ways that my faith can inform my scientific practice. During that time, it has become one of my chief aims to lead an integrated life before Christ, in which faith and science work together to facilitate a growing comprehension of God’s truth. Thus, as a scientist, I have set out on what I hope will be a lifetime of study devoted to the principal non-verbal “text” which God has provided: the creation⁴.

Given the technological prowess of modern science, which allows intense scientific scrutiny of the created world at even the atomic level, it is essentially impossible to study the creation in its entirety. Thus, one must set out upon the path of a subdiscipline. As a Christian, one must then ask whether there is any particular subdiscipline within the Biological Sciences that is favored by God. From Genesis we learn that we are all to participate by tending, or caring for, God’s creation⁵; University of Wisconsin professor and vocal creation steward Calvin DeWitt notes that, “when Adam, Eve, and we, *keep* the creation, we make sure that the creatures under our care and keeping are maintained with all their proper connections—connections with members of the same species, with the many other species with which they interact, with the soil, air and water upon which they depend.⁶” While the text from Genesis and DeWitt’s exhortations would direct us primarily toward practical environmental stewardship (and rightly so), I would contend that one of the best ways to begin to care for creation is to understand it, both macro- and microscopically. In understanding God’s creation, we can then strive to maintain the vital connections to which we are called by Scripture and environmental stewards alike.

Although the Tropical Biology course that I took clearly had an immense impact on my spiritual development (and might be seen as the ideal lead-in for a career devoted to environmental science and creation care), the courses that most satisfied my intellectual curiosity were those in which the subjects of study were largely invisible to the naked eye: Genetics, Microbiology, Immunology, Cell Signaling. In my experience, the cell is a world unto itself, but a world that must interact very intimately with its surroundings. Indeed, noted physician and essayist Lewis Thomas once noted that, “Viewed from the distance of the moon, the astonishing thing about the earth, catching the breath, is that it is alive⁷.” Beyond this, Thomas further observes, “I have

²What I found (and continue to find) most compelling as a growing Christian and Biologist were the parables, metaphors, and similes that reference the created world. For a few examples, see Psalm 1; Matthew 13:1-23 and 31-35; Mark 8:14-21; Luke 12:22-34; John 15:1-8; Galatians 5:22.

³ Deuteronomy 6:4-9; Matthew 22:34-40..

⁴ This idea that God has given us two “books” to study (Scripture, and the creation) is a widely used concept, even by those who are not scientists by training (see, for example, Richard Foster’s chapter on *Study* in *Celebration of Discipline*, 1988, New York: HarperCollins Publishers). This idea is rooted in Scripture, which indicates that the creation can provide instruction about the nature of the Creator and thus is valuable to study (e.g., Psalm 19:1-4; Habakkuk 2:14; Romans 1:20).

⁵ Genesis 2:15

⁶ DeWitt CB. 1994. Preparing the way for action. PSCF 46:80-89.

⁷ Thomas L. 1974. *The lives of a cell: notes of a biology watcher*. New York: Penguin Books.

been trying to think of the earth as a kind of organism, but it is no go. I cannot think of it this way. It is too big, too complex, with too many working parts lacking visible connections...I wondered about this. If not like an organism, what is it like, what is it *most* like? Then...it came to me: it is *most* like a single cell⁸.” In a way, the biosphere *is* like a single cell—with a boundary (the earth’s atmosphere analogous to the cell’s membrane), and component parts that must work harmoniously to ensure the health of the entire system. Thus, I often catch my breath in wonder when peering through a microscope at the internal world of a cell in much the same way as an astronaut who views the earth from outer space; I am able to pursue the study of microscopic entities, and in studying the relationships within and among cells I know am contributing to creation care by increasing our understanding of the “proper connections” of which DeWitt speaks.

Within the microscopic world, Microbiology and Immunology are two biological subdisciplines that often intertwine. They sit at the foundation of many basic principles of health and disease, and therefore are significant in the care of God’s human creation. I find it fascinating that each of us is a bit like a walking ecosystem, with different populations of microorganisms colonizing nearly all of our bodily surfaces; I find it amazing that we almost always live peacefully in community with our microbial tenants; I find it frustrating when rogue microbes disrupt that community and force me to take to my bed. For the generally healthy individual, these rogue microbes cross the spectrum from annoying to life-threatening⁹, and short-lived to chronic¹⁰. While there are some who would study these entities in order to weaponize them as potential bioterror agents¹¹, this type of study is consistent neither with the tending of creation, nor with the Scriptural command to love our neighbors¹². Therefore, as a Christ-follower working as a scientist at the intersection of Microbiology and Immunology, perhaps my primary goal should be to elucidate mechanisms of pathogenesis, such that someday the tending of God’s creation might improve.

Biblical Perspectives on Infectious Disease

Now that our focus has been narrowed to the fields of Microbiology and Immunology, the next question we must deal with is whether there may be certain microbes, diseases or mechanisms that are more “worthy” of study from a Christian perspective. Historically, Christians have had a rather antagonistic relationship with microorganisms, health and disease; I would argue that this perspective is grounded more in fear and judgmental attitudes than it is in truth as revealed by Scripture and science, especially given advances in the study of microbiology over the last 150 years¹³. Perhaps the crux of this dilemma is that the scientist approaches infectious disease in

⁸ Ibid.

⁹ The spectrum here runs from the common cold to some of the most frightening calamities ever to surface in humanity, such as smallpox, the plague, or Ebola.

¹⁰ Many short-lived illnesses, such as viral gastroenteritis (commonly known as “stomach flu”) can be fairly violent and/or debilitating; chronic infectious diseases such as hepatitis, HIV/AIDS and the various infections associated with Herpes viruses are often quite mild in their early stages.

¹¹ The infectious agents most commonly discussed as potential agents of bioterrorism include anthrax, smallpox, and plague (Ostfeld ML. 2004. Bioterrorism as a foreign policy issue. SAIS Review 24:131-146).

¹² Genesis 2:15; Matthew 22:34-40; Mark 12:28-34; Luke 10:25-37.

¹³ The period lasting from approximately 1850-1920 is now known as the “golden age of Microbiology,” due to the rapid intellectual and technological growth and achievements during this time. Scientists during this period (among

terms of the germ (bacteria, virus, parasite, fungus), the physiology of the human host, and the environment in which the disease is spread, whereas some Christians interpret certain diseases as moral rather than biological entities. The idea that morality and disease are connected is not unfounded based on the Hebrew Law: Leviticus includes instructions for the controlled and temporary exile of the leprous¹⁴. These legal measures were maintained when leprosy ravaged medieval Europe, but were accompanied by funeral ceremonies that were performed for lepers (still very much alive) to signify their “death” to family, church and community, and initiate them into a homeless and solitary existence as an outcast and a beggar¹⁵. While the removal of the leprous from community life probably did slow the spread of this painful and disfiguring disease, the accompanying ceremonies and rituals made this much more than simple quarantine. Some of the underlying sentiments (including fear of contamination—either physical or spiritual) that contributed to the exile of lepers persist into the 21st century¹⁶.

Although there may be a moral component involved in the etiology of certain infectious diseases—especially those transmitted by intimate contact—one would be remiss to ignore both the scientific advances of recent centuries as well as the compassion displayed by Christ to all those who demonstrate faith in Him. In contrast to the attitudes that have prevailed in Christian communities for centuries, even a cursory glance at Jesus’ ministry reveals a strikingly different attitude and approach. Rather than driving lepers and sinners away, Jesus touched, dined with, and healed them. Healing was an important part of Jesus’ ministry: in addition to the record we have of specific individuals healed by Jesus¹⁷, there is also an indication that His teaching was often accompanied by times of “mass” healing as He interacted with large crowds of people¹⁸. This is seen especially in the synoptic Gospels, wherein the great number of healings recorded in part serve to demonstrate Jesus’ authority over all things and establish His “credibility” as Messiah before he set out on his final journey to Jerusalem for the crucifixion¹⁹.

In addition to the practical aspects of Jesus’ ministry, He also made it clear that after we first love God, we should love also our neighbors²⁰. Furthermore, Jesus’ teaching clarifies that our neighbors are not always people that we will find easy to love. As noted above, we see Jesus

them Louis Pasteur) unveiled the germ theory of disease, developed pasteurization, discovered penicillin, and improved aseptic surgical techniques (summarized in Wiley J, Sherwood L, Woolverton C. 2007.

Prescott/Harley/Klein’s Microbiology, 7th edition. McGraw-Hill.)

¹⁴ Leviticus 13:1-3, 45-46; 14:1-7.

¹⁵ Described in Allen PL. 2000. The wages of sin: sex and disease, past and present. Chicago: The University of Chicago Press.

¹⁶ Metaphors surrounding health and disease (including cancer, tuberculosis and HIV/AIDS) were explored by Susan Sontag (1989) in AIDS and its metaphors (New York: Picador).

¹⁷ Some of the numerous examples can be found in Matthew 15:21-28; Mark 7:24-37 and 10:46; Luke 7:1-17; John 11:38-44.

¹⁸ There also are numerous references to mass healings—which can be surprisingly easy to overlook, but nonetheless emphasize the importance of healing in Jesus’ ministry. Some examples can be found in Matthew 12:15, Mark 6:53-56, and Luke 5:15.

¹⁹ There is a distinctive turning point in the gospels of Matthew (16:21), Mark (10:33), and Luke (9:51) where Jesus intentionally sets out for Jerusalem and the crucifixion; one characteristic of the Scriptures is that there are fewer references to healings after this turning point, and increased frequency of teaching about His Kingdom.

²⁰ The command to love our neighbors comes both directly and indirectly from Jesus. See Matthew 19:16-24 and 22:34-40; Mark 12:28-34; Luke 10:25-37; John 13:14-17, 34.

dining with “tax collectors and sinners²¹,” interacting with and healing people with contagious and disfiguring diseases such as leprosy²², caring for foreigners²³, and instructing his followers to love even their enemies²⁴. Indeed, Jesus notes that, “It is not the healthy who need a doctor, but the sick²⁵”; one of our callings as believers is to see everyone as a neighbor, as a co-resident of Christ’s Kingdom, as someone worthy of Christ’s redemption.

While there are many quotidian implications of the command to love our neighbors, the question at hand herein is this: what does it mean to love one’s neighbors as a person who studies Microbiology and Immunology? The answer to this question is complex, and certainly not penned in black-and-white. The answer, however, does comprise two central concepts. First and foremost, it means that academic study of microorganisms and the immune system should be directed at topics that benefit, rather than those that intend to harm, God’s creation. This directive satisfies Scriptural directives to tend the creation and to love our neighbors, but does cast a very wide net. Indeed, I have been able to assemble only a very short list of research topics which originate with the intent to harm the creation. The first of these, and the only avenue of research that I would unequivocally designate as “forbidden” based on Biblical principles, would be the engineering of microorganisms for use as agents of bioterrorism²⁶. The second would be the generation and study of human embryonic stem cells, a research area that (at least for me) lies firmly in the grey, as one could argue that this technology may someday save lives, even while it ends potential lives.

Second, we must think about who we serve with the information gathered from our basic research and experimentation. Practically speaking, our science should serve our neighbors. Regardless of whether we think about this from a strictly scientific perspective or a strictly Scriptural perspective, we should always be prepared to look on any other human as a worthy neighbor. From the scientific perspective, thinking of our global neighbors is critically important at the intersection of Microbiology and Immunology, as the borders between nations are notably permeable to most infectious microbes²⁷. From the Scriptural perspective, we can also take a cue from Jesus’ words exhorting us to direct our caring and attention to the sick²⁸. Furthermore, Jesus spent much of his time in ministry among the marginalized people of His day. Based on this Scriptural principle alone, science which could ultimately benefit the marginalized peoples

²¹ There are many references to Jesus’ interaction with the “sinful” in Scripture. See, e.g., Matthew 9:10-11, 11:18; Mark 2:15-17; Luke 5:29-32.

²² Although the Law would (at least temporarily) exile those with leprosy, Jesus not only spoke to but physically touched these outcasts (see Matthew 8:1-4; Mark 1:40-45).

²³ See, for example, the parable of the Good Samaritan (10:25-37), Jesus’ interaction with the Samaritan woman at the well (John 4), the healing of the Centurion’s servant (Matthew 8:5-13).

²⁴ While the exhortation to love our enemies might be implicit from Jesus’ treatment of the leprous, foreigners, and other “sinners,” He also makes it explicit (e.g., during the Sermon on the Mount, Matthew 5:43-48).

²⁵ Matthew 9:12; Mark 2:15-17.

²⁶ This would include infectious agents such as anthrax, plague and smallpox.

²⁷ As an example, consider May 2007 brouhaha surrounding a drug-resistant tuberculosis-infected airline passenger, who ultimately was quarantined after passing through several European and North American cities (<http://www.npr.org/templates/story/story.php?storyId=10538667>; accessed 17 August 2008). While there have been no reports of further cases of tuberculosis tied to his international travels, this incident underscores the relative ease with which even serious infectious agents can be carried—often unknowingly—across national boundaries and even entire continents.

²⁸ Matthew 9:12; Mark 2:15-17.

of today would be a relevant Christianly way to approach these disciplines. To this I would add but one caveat: collectively, scientists must take care that diseases which, today, are primarily seen in the privileged are not neglected. Not only are the privileged among our neighbors, but diseases of the wealthy, which include many cancers and diseases of the cardiovascular system, are also diseases of old age. Thus, should substantial progress be made toward the reduction of global poverty, a corresponding increase in life expectancy would be expected; an increase in longevity should then result in an increased prevalence of these diseases of old age in places that they are not currently observed²⁹.

This all begs the question: could these principles be put into practice by a working scientist in the 21st century United States? The basic paradigm under which the fields of Microbiology and Immunology (and, really, all sciences) operate would encourage the study of any topic an investigator finds to be of interest, provided the technology appropriate to addressing the proposed hypotheses was available. In other words, to follow the ethic described above is theoretically possible (and even theoretically encouraged). On the surface, science seems very much like a playground for those curious about the natural world. However, in practice this ethic can be stymied by social/cultural norms and the politics of funding agencies, which tend to restrict the nature of science that *can* be done by controlling access to funds. These restrictions, which can be based in perceptions of collective morality, often prevent the completion of science that would reflect the Biblical command to love *all* of our neighbors, and not just the “pretty” ones. Indeed, there are two groups of neighbors who often suffer when science and culture collide: the undesirables, and the invisibles.

The Undesirable Neighbor

For our purposes, we will consider undesirable neighbors to belong to people groups that many at best would call, “other,” and at worst would label as amoral, sinful, or similarly unworthy. In the United States, the most significant recent illustration of the consequences of a failure to show love to undesirable neighbors occurred at the onset of the HIV/AIDS epidemic in 1981. As we shall see, this failure of neighborly love was not systemic in the United States at the time, but rather was a unique and practiced ignorance specific to HIV/AIDS.

While HIV/AIDS was becoming established in the United States, a series of Tylenol poisonings in the Chicago area which took place in 1982 demonstrated the possibilities of neighbor-care. In this instance, seven individuals (including a 12-year-old girl) were the victims of cyanide poisonings perpetrated by a still-unknown individual³⁰. Although there were very few, geographically isolated, deaths that occurred while I was in the 4th grade, I still remember the national media attention given to this story. According to AIDS activist and author Larry Kramer, the *New York Times* published 54 stories about the Tylenol poisonings during a 3-month period in 1982³¹. At the time, the nation’s investigative power immediately jumped to the aid of its citizen-neighbors, solving the mystery in less than 10 days and initiating a federal review of

²⁹ Kindt TJ, Goldsby RA, Osborne BA. 2007. Kuby Immunology, 6th edition. New York: W.H. Freeman and Company.

³⁰ Beck M, Monroe S, Prout LR, Hager M, LaBreque R. 1982 (Oct. 11). The Tylenol scare. Newsweek p. 32.

³¹ Kramer L. 1985. The normal heart. New York: Penguin Books. These figures were used as part of a minimalist backdrop for the not-so-loosely autobiographical play.

drug safety and packaging controls³². In this case, the randomness of the murders, the “innocence” of the victims, and the relative ubiquity of over-the-counter pain relievers such as Tylenol made it easy for everyone to imagine him- or herself as the next target. Thus, we can empathize with our neighbors in the face of random tragedy, or when we understand that such a horrible event could just as easily have struck in or near our own homes.

The ability to demonstrate neighbor-care at the level of research and epidemiology was also demonstrated several years prior to the Tylenol poisonings. In 1976, nearly 200 individuals, many of them military veterans or their family members, became ill with an unusual pneumonia after participating in an American Legion conference celebrating the United States bicentennial; just over 10% of those afflicted ultimately died. Indeed, when the bacterium that caused this unusual and sometimes fatal pneumonia was isolated several months later, it was even named in response to these events: *Legionella pneumophila*, which causes what is now commonly known as legionnaires’ disease³³. As with the Tylenol poisonings, this incidence of infectious disease is representative of a geographically isolated epidemiologic event. Once again, the nation’s full investigative power sought and determined the cause of the infections and deaths within several months. Here, however, the victims of the infection were not random (although they definitely were perceived as “innocent”). Instead, many of the victims were veterans of the United States military, people perceived as patriots, “good Americans,” even heroes. In the public’s and government’s view, it would be shameful *not* to serve them, or *not* to investigate the cause of the mysterious pneumonia. Thus, we can empathize with neighbors that we can easily deem “worthy,” even if we can’t imagine ourselves in their place.

At the same time as these two relatively isolated epidemiologic events, the disease which we now know as Acquired Immune Deficiency Syndrome (AIDS) and its instigating virus, the Human Immunodeficiency Virus type 1 (HIV-1), made its first appearance in the medical literature on 5 June 1981³⁴. However, in spite of the fact that (i) people were dying of this new syndrome, and (ii) the cases were neither few nor geographically restricted, AIDS entered *sotto voce* and neighbors were neglected. There are a number of reasonable explanations for the modest initial interest in the study of AIDS. Among these are: (i) many of the cases seen prior to the *MMWR* report of 5 June 1981 were seen by different physicians, and none of those physicians had any reason to believe their single patient was more than a “fluke;” (ii) lack of a geographic epicenter made it even more difficult for physicians and epidemiologists to recognize that these cases were not just clinical anomalies; (iii) the nature of AIDS is such that the clinical presentation varies from patient to patient, and thus recognizing an outbreak or epidemic required a greater number of cases. Even so, by the end of 1981, 339 cases of AIDS had been identified in the United States and the mortality rate was greater than 30%³⁵; it is worth noting that HIV/AIDS arrived with both a greater caseload and a higher mortality rate than was seen with the 1976 outbreak of legionnaires’ disease.

³² Beck M, Monroe S, Prout LR, Hager M, LaBreque R. 1982 (Oct. 11). The Tylenol scare. *Newsweek* p. 32.

³³ Schmeck HM. Legionnaires’ disease: 5 years later the mystery is all but gone [Internet; published in the *New York Times* 19 January 1982; accessed 7 August 2008]. Available from <http://query.nytimes.com/gst/fullpage.html?res=9400E1D81138F93AA25752C0A964948260&sec=technology&spo>

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³⁴ *Pneumocystis pneumonia*—Los Angeles. 1981. *Morbidity and mortality weekly report* 30:250-252.

³⁵ Information from the Centers for Disease Control (CDC), and accessed 09/01/08 from <http://www.avert.org/usastaty.htm>

In spite of these inauspicious beginnings, during that first year of HIV/AIDS it was clear to many physicians that a new epidemic was at hand—and yet there was no public alarm, and no substantial mobilization of research funding and personnel for nearly two years. And, in contrast to the nearly 5 dozen articles published about the Tylenol scare during the last 3 months of 1982 by the *New York Times*, the same paper published only seven stories about the growing AIDS epidemic between July of 1981 and February of 1983, a span of 19 months³⁶. By the time the seventh article appeared on 6 February 1983, there were nearly 1000 diagnosed cases of AIDS in the United States—more than five times the number of people who contracted *Legionella pneumophila* at the 1976 American Legion convention in Philadelphia. Even at the time, many in the medical and research communities were wondering at the meager nature of this response.

So, why was there such a difference in the local and national responses to the Tylenol poisonings, the outbreak of legionnaires' disease, and this new epidemic? In this instance, elected officials were quite representative of their largely Christian constituencies—although with strikingly unfortunate consequences. Historically, Christians have struggled with what meaning to ascribe to infectious diseases—especially those that are sexually transmitted. Most commonly, the incidence of sexually transmitted disease has been attributed to God's judgment of the sinful. This attitude was true of lovesickness during the Middle Ages, of the European syphilis epidemic during the early modern period, and most recently of HIV/AIDS³⁷. The notion that sexually transmitted diseases such as HIV/AIDS are contaminating, or suggest a state of unworthiness, has also been noted by non-Christian writers such as Susan Sontag, whose personal struggle with cancer caused her to evaluate the common metaphors which can interfere with the study and treatment of diseases. Near the end of the first decade of AIDS in the United States, she wrote, "In recent years some of the onus of cancer has been lifted by the emergence of a disease [AIDS] whose charge of stigmatization, whose capacity to create spoiled identity, is far greater. It seems that societies need to have one illness which becomes identified with evil, and attaches blame to its 'victims...'³⁸". It also didn't help that three of the four major risk groups for HIV infection at that time (homosexuals, injecting drug users, and Haitian immigrants) were all considered to be undesirable neighbors by the vocal cultural majority; only hemophiliacs were considered "innocent" among the primary risk groups³⁹. While these metaphors of moral and physical contamination are less prevalent in the United States today than they were several decades ago, to equate HIV/AIDS with both physical and spiritual death remains common in Africa⁴⁰.

A study that aimed to quantify this culture of blame appeared in the *New England Journal of Medicine*⁴¹. The results of these studies indicated that nearly 1 in 5 Americans favored exiling those with AIDS, and treating them much like the lepers of centuries past. While a later study

³⁶ Kramer L. 1985. *The Normal Heart*.

³⁷ Allen PL. 2000. *The wages of sin*.

³⁸ Sontag S. 1989.

³⁹ Shilts R. 1987. *And the band played on: politics, people and the AIDS epidemic*. New York: St. Martin's Press; Stine GJ. 2008. *AIDS Update 2007*. New York: McGraw-Hill.

⁴⁰ Nzioka C. 2000. The social meanings of death from HIV/AIDS: an African interpretive view. *Culture, Health & Sexuality* 2(1):1-14.

⁴¹ Blendon RJ, Donelan K. 1988. Discrimination against people with AIDS: the public's perspective. *N. Eng. J. Med.* 319(15):1022-1026.

indicated that a robust 94% of Americans felt that AIDS sufferers deserved compassion, that number shrank to 70% for those who acquired AIDS by “immoral” means, such as homosexual contact or injecting drugs⁴². Unfortunately, these attitudes were parlayed into a lack of both research funding and public education during the first 6 years of the HIV/AIDS epidemic in the United States. There was even a gag order on C. Everett Koop, the United States Surgeon General at the time, who was forced to look the fool when his superiors disallowed any discussion of HIV/AIDS from his office for the first 5 ½ years of the epidemic. Ultimately, Dr. Koop achieved significant notoriety among the conservative constituencies who fought for the congressional approval of his appointment when he failed to openly fight for the values of the moral majority and instead pushed for widespread AIDS education and prevention⁴³. This ultimately resulted in the convening of panels of citizen-critics to review the “decency” of any AIDS education literature to be distributed during the late 1980s, and most of these panels concluded that people should be counseled to avoid becoming infected with HIV, but found any specific recommendations on how to do that to violate cultural norms of decency. A conservative estimate of this failure to care for neighbors within our borders would be deaths from AIDS numbering in the thousands⁴⁴. Perhaps the greatest tragedy is that there were physicians and scientists prepared to devote themselves to the study of this new infectious agent, but they were unable to garner support, financial or otherwise, to stem the tide of AIDS during the earliest years of the epidemic⁴⁵.

Some may argue that an agonizing death from AIDS would be a just demise for a person who willfully chooses to live contrary to Scriptural precepts by engaging in homosexual intercourse or other illicit behaviors. There are, however, both Scriptural and scientific reasons to reject this argument. Scientifically, genetic analysis has recently clarified the origins of HIV-1 as a chimpanzee population in west-central Africa⁴⁶. It is likely that HIV/AIDS began as a disease of heterosexual bush hunters in Africa; it is equally likely that the sexual revolution that occurred within gay and lesbian communities in the United States during the 1960s and 1970s set up the perfect conduit through which this new virus could be spread. Thus, the first appearances of HIV disease in the United States were not consistent with the global portrait of AIDS during the same period, as the global portrait was that of a disease affecting primarily heterosexual populations⁴⁷; although the disease was easily spread among American homosexual populations, it was not first visited upon them. This is not what you’d expect of a disease meant to be a judgment against a specific people group (although the same people who argue that AIDS is justice for sinful people might also say that any “innocents” who die from AIDS are blessed to join Christ in eternity even faster).

We must also reject the argument that AIDS is a just punishment for the sinful based on Scriptural principles. Although the Old Testament records instances in which God did use

⁴² Blendon RJ, Donelan K, Knox RA. 1992. Public opinion and AIDS: lessons for the second decade. *JAMA* 267(7):981-986.

⁴³ Martin W. 1996. *With God on our side: the rise of the religious right in America*. New York: Broadway Books.

⁴⁴ Allen PL.

⁴⁵ Shilts R. 1987. *And the band played on*; Bayer R, Oppenheimer GM. 2000. *AIDS doctors: voices from the epidemic (an oral history)*. New York: Oxford University Press.

⁴⁶ Stine GJ. 2008. *AIDS update 2007*.

⁴⁷ Garrett L. 1994. *The coming plague: newly emerging diseases in a world out of balance*. New York: Penguin Books.

disease to punish the unjust or sinful⁴⁸, Christ set a new and decidedly compassionate example for His followers. As noted above, He dined with the undesirables of his day, and routinely interacted with people in need of physical healing, including the leprous. The result of these interactions is that those “tax collectors and sinners” repented of their sins and took on the new life offered by Christ. The fact that Jesus spent time with the “sinful” and fully integrated physical healing into His ministry, treating the sick with compassion, suggests that we should do the same. Indeed, while there is a time and place for confrontation within Christian community, we do not sit in judgment over our neighbors, and thus should treat each and every one with the compassion and respect that we would desire for ourselves⁴⁹. In summary, we can deny neither the existence of sin, nor the command to love⁵⁰.

What then is an appropriate response for a Christian bench scientist to an infectious disease spread among our neighbors by sexual—and often sinful—contact? Following Christ’s example, those that are called must offer the scientific equivalent of a cup of cold water by actively pursuing knowledge about the biology of any infectious agent, with the hope that basic knowledge will enable the future treatment of infected individuals. It is all too easy to concern ourselves with *how* people become infected with such agents, and in so doing to turn our back on neighbors who are worthy of Christ’s love. Instead, we must remember that all sin, and none are worthy except as they have been saved by grace. The transforming power of grace to change lives does not grab hold until we turn to Jesus for forgiveness, and so we must always treat any around us who do not yet follow Christ as if that redemptive moment is at hand. I had a friend in college who embodied this principle: she refused to think of those not following Christ as non-Christians but instead called them pre-Christians, thus acknowledging that *at any moment* they may join Christ’s Kingdom and should be treated accordingly. In summary, to fail to study diseases that disproportionately affect “sinful” people groups is to indirectly tell those affected that they are not worthy of God’s grace; to turn our backs on those in need stands in opposition to the disciple-making calling given to all Christians⁵¹.

⁴⁸ The Old Testament records several instances in which God used disease (leprosy) as punishment (e.g., 2 Chronicles 26 describes King Uzziah’s punishment of leprosy).

⁴⁹ Ref from Matthew (?) about how to confront; refs for not judging others

⁵⁰ It doesn’t take a thorough reading of Scripture to determine that God is neither whimsical nor sloppy. In fact, He is characterized throughout Scripture as “slow to anger, abounding in love,” even while He is the ultimate judge and arbiter of forgiveness (e.g., Numbers 14:18). Given that God’s ways are above our own, and that He loves His creation, it is critical to distinguish between God’s judgment and what we might call “just desserts.” While HIV/AIDS may not be an unexpected consequence of various behaviors that are contrary to Scripture, I can’t conclude that HIV/AIDS is either God’s judgment or any kind of justice. Major Scriptural precedents for large-scale judgments (e.g., the exile from Eden (Genesis 3), the flood (Genesis 6-9), the judgment on Sodom and Gomorrah (Genesis 19), or the plagues visited upon Egypt (beginning in Exodus 7) appear to be both *universal* (affecting everyone that fit into the judged group) and *precise* (affecting only those that belong to the judged group). In contrast, HIV/AIDS would be a very messy kind of judgement indeed, as it is neither universal (affecting ALL homosexuals or injecting drug users, for example), nor precise (affecting ONLY homosexuals, injecting drug users, and others who engage in high-risk “sinful” behavior). We have been instructed to love and serve, and to leave the judging to God—it is not our business to interpret an infectious agent as God’s gavel.

⁵¹ Matthew 28:16

Finally, fast-forward nearly 30 years to 2008. The church has finally awakened with respect to AIDS, and is reaching out especially to the African continent⁵². There are, however, hurdles which remain within our borders, and within the walls of the American church. As was seen with the Tylenol poisonings and the 1976 outbreak of legionnaires' disease, it remains much easier to have sympathy for the infected and affected who are perceived as innocents—such as the young or the impoverished in Africa. In contrast, American homosexuals and AIDS sufferers are still vilified (albeit at a much lower rate than in the 1980s) by certain factions within the evangelical church. Perhaps the most striking examples of this are “Hell Houses,” staged as dramatic experiences that are alternatives to secular Halloween celebrations. These events capitalize on appeals to fear in order to scare sinners into the arms of Jesus; it is common in these productions to include a vignette in which a gay man dies of AIDS and is whisked off to hell by attending demons⁵³. Of course, there are examples of care and compassion coming from American churches to those in our midst who suffer because of HIV/AIDS⁵⁴. Collectively, the church has begun to love its challenging neighbors vis-à-vis the national HIV/AIDS epidemic, but work clearly remains. Initially, science was able to assuage many of the public's fears regarding the modes of transmission for HIV, thus paving the way for individuals affected by and infected with HIV to return to churches. At this point, however, with the fear of contagion essentially gone but the sense that a person with HIV/AIDS is somehow contaminated intact, the scientific work of the mind to intellectually alleviate fear must be completed by God's work in the hearts of His people to welcome all who seek Christ's truth and redemption.

The Invisible Neighbor

Unfortunately, undesirable neighbors are not the only ones who suffer from stigmatizing infectious diseases. As with the undesirable neighbor, the invisible neighbor also belongs to a group that would be categorized as “other” by majority populations. In contrast to the undesirable neighbor however, the invisible neighbor may not be perceived as particularly immoral or sinful. Indeed, when invisible neighbors are revealed to a wealthy majority, the wealthy often feel intense sympathy and compassion⁵⁵. Instead, the primary deficit of the invisible neighbor is an inability to attract and maintain the focus of majority populations. This deficit is due in part to the extreme poverty in which most invisible neighbors live, such that even those who live in proximity to urban areas do not have the financial means to procure even rudimentary medical care. It isn't hard to argue that the most significant modern illustration of the impact of infectious diseases on the invisible is the current crisis of neglected tropical diseases.

⁵² Some of the most visible efforts are those of World Vision, such as materials provided to *Acting on AIDS* groups on college and university campuses (see <http://www.worldvision.org/aoa.nsf/aids/home>, accessed 04 September 2008).

⁵³ Jackson B. 2007. Jonathan Edwards goes to Hell (house): fear appeals in American evangelism. *Rhetoric Review* 26:42-59.

⁵⁴ The most poignant examples of HIV/AIDS outreach involve local churches reaching out to their own communities. One such example is that of Emmanuel's New Mount Zion Christian Center in Ohio, described at <http://www.thebody.com/content/living/art29513.html> (accessed 28 August 2008).

⁵⁵ Consider here the outpouring of aid to the Asian tsunami victims in late 2004, ongoing efforts to serve the areas of the gulf coast decimated by Hurricanes Katrina and Rita in 2005, and the postponement of major activities of the 2008 Republican National Convention due to the approach of Hurricane Gustav.

The World Health Organization (WHO) has identified fourteen neglected tropical diseases, and although each disease is caused by a separate etiologic agent there are a number of critical commonalities: (i) they are physically disfiguring, causing significant morbidity and permanent disability; (ii) they are all associated with poverty and the corresponding absence of safe housing, clean water, and adequate sanitation; (iii) there is substantial geographic overlap among the diseases in endemic tropical regions, such that those living in these regions are simultaneously exposed to more than one of these diseases; (iv) they are not transmitted by direct contact, but instead require intermediate vectors such as mosquitos or other insects, which typically ensures that the diseases will remain geographically restricted (i.e., will be maintained only in their endemic areas). While it is difficult to obtain an accurate census of these diseases, it is estimated that one billion people—one-sixth of the world's population—harbor at least one of them⁵⁶. The true impact of these neglected tropical diseases on affected populations is dramatically demonstrated by malaria; although this mosquito-borne illness is now the focus of renewed study by both natural and social scientists in both the public and private sectors, it was largely neglected for most of the latter half of the 20th century.

Malaria is one of a triad of microbes, the other two being tuberculosis and HIV, that collectively cause more morbidity and mortality than any other infectious disease. Of these three infectious diseases, malaria is the most relevant contrast to the constellation of neglected tropical diseases because, like the neglected tropical diseases, malaria infections are generally localized to the same geographic regions. Unlike the neglected tropical diseases, however, malaria formerly spanned a much larger territory, reaching into both sub-tropical and temperate zones. Its range even included much of the southeastern United States until the 1960s, and the impact of malaria on the history of the United States has been well documented⁵⁷. A global malaria eradication campaign which spanned three decades was ultimately abandoned in the 1970s, when it became apparent that eradication would be impossible in the tropical regions where malaria continues to rage today. By this point, malaria had been at least controlled if not eliminated in temperate and the wealthiest sub-tropical regions, and when the United States military left Vietnam in 1975, the disease quickly became irrelevant to the politicians (and as a result the scientists) of the wealthiest nations⁵⁸.

It is perhaps because malaria was the subject of a failed eradication campaign, followed by a period of neglect, that we can see the devastation that can be visited upon entire countries by infectious diseases. Presently, nearly 40% of the world's population live in regions in which malaria is endemic; most of these regions are also impoverished. More than half a billion people contract malaria, which is spread from person to person by mosquito bites, annually. These infections result in up to three million deaths annually, most of these in children⁵⁹. The work of economist Jeffrey Sachs on the interrelatedness of poverty and disease has contributed significantly to the resurgence of political and scientific interest in malaria over the last decade.

⁵⁶ World Health Organization. Neglected tropical diseases frequently asked questions [Internet; information © 2008; accessed 13 August 2008]. Available from http://www.who.int/neglected_diseases/faq/en/print.html.

⁵⁷ These events were summarized by Paul Farmer. 1999. *Infections and inequalities: the modern plagues*. Berkeley: University of California Press.

⁵⁸ Ibid, and Sachs JD. 2002. A new global effort to control malaria. *Science* 298:122-124.

⁵⁹ Sachs J, Malaney P. 2002. The economic and social burden of malaria. *Nature* 415:680-685; and WHO. Malaria fact sheet number 94 [Internet; published May 2007; access 11 August 2008]. Available from: <http://www.who.int/mediacentre/factsheets/fs094/en/print.html>

His work suggests that causal relationships run in two directions, both from poverty to malaria and from malaria to poverty. Economic development in the United States and Europe demonstrated that poverty and poor living conditions can increase the spread of malaria, as development which occurred after the Great Depression through the 1950s corresponded to the ability to provide safe housing (e.g., screened doors and windows). Malaria eradication/control measures were further aided in these regions by the temperate climates in these regions as the malaria-carrying mosquito population dies off in the winter. The causal link from malaria to poverty is demonstrated by the present crisis in many tropical regions, in which economic growth rates are dramatically suppressed, productivity is lost in the workforce due to illness, and high fertility rates (which families use to ensure that some of their children will survive to adulthood) reduce the per-child investment in education—thus propagating this vicious cycle⁶⁰. Furthermore, many of these malaria-endemic regions are further challenged by geography: they have little or no access to sea trade (and thus must rely on dramatically more expensive transport by land or air), and a tropical climate which ensures that malaria will be a year-round phenomenon⁶¹.

Considering that twice as many people suffer from one or more of the WHO-designated neglected tropical diseases when compared to malaria, some have argued that the infectious triad should become an infectious tetrad, with the constellation of neglected tropical diseases being added to malaria, HIV and tuberculosis when wealthy nations consider their responses to the global impact of infectious diseases⁶². In spite of the resurgence of interest in malaria, the National Institutes of Health still devote a relatively small level of financial support to investigators studying this devastating disease. For fiscal year 2008, approximately \$140 million was allocated for the study of malaria and potential malaria vaccines; furthermore, none of the fourteen neglected tropical diseases are specifically named by NIH research initiatives. In contrast, greater than 10-fold that amount (over \$1.7 billion) was allocated to investigating the *potential* threat of bioterrorism, nearly 15-fold that amount (\$2.1 billion) to the study of heart disease, and a similar amount (\$123 million) to the study of smallpox—a disease that was successfully eradicated in the 1970s⁶³.

Given the global impact of diseases like malaria, why do those afflicted remain invisible? Several of the primary determinants are (i) proximity, and (ii) the ability to communicate and organize. In considering proximity, it is the nearness (or potential nearness) of the disease in question rather than the nearness of the people currently affected or infected that seem to matter most. One way to pose this question would be, “will the disease ever significantly impact United States citizens?” The factors which affect whether or not the people affected or infected with a

⁶⁰ Sachs J, Malaney P. 2002.

⁶¹ Sachs JD, Mellinger AD, Gallup JL. 2001 (March). The geography of poverty and wealth. *Scientific American* pp. 70-75.

⁶² Talk of the Nation's *Science Friday*. 16 December 2005. National Public Radio.

⁶³ National Institutes of Health. Estimates of funding for various diseases, conditions, research areas [Internet; updated 5 Feb. 2008; accessed 17 July 2008]. Available from: <http://www.nih.gov/news/fundingresearchareas.htm>. There also are several non-government entities which are providing funds or supplies to combat malaria and/or neglected tropical diseases. The most visible of these (at least for anyone who watched NBC's coverage of the summer Olympics) is ExxonMobil (http://www.exxonmobil.com/Africa-English/PA/Responsibility/AF_CR_Malaria.asp, accessed 3 Sept. 2008); others include the Gates Foundation (<http://www.medicalnewstoday.com/articles/34489.php>, accessed 3 Sept. 2008).

certain infectious agent have a voice are greater in number and more diverse than those governing proximity. However, one factor which is observed through all of the history of infectious disease is poverty. Those that were most likely to be stricken by major epidemics in centuries past such as smallpox, plague, and leprosy were the poor—in large part because they did not have the resources to flee the onslaught, to implement proper sanitation measures, or to avail themselves of what limited medical care was available when these diseases ravaged their communities. Indeed, these factors are still relevant among the poor today. Physician-anthropologist Paul Farmer goes so far as to include poverty as a virulence factor when considering the impact of any infectious disease (whereas the bench scientist reserves that term for a property of the microorganism itself)⁶⁴.

In contrast to the status quo, Scripture presents us with a strikingly different paradigm. As discussed above, to love our neighbors means to acknowledge, love and respect even (and perhaps especially) those that are unlike us. With respect to our invisible neighbors, James provides us with an even greater exhortation to see and love: “Religion that God our Father accepts as pure and faultless is this: to look after orphans and widows in their distress and to keep oneself from being polluted by the world⁶⁵.” Thus, from a Biblical perspective, scientific resources should be directed not only at infectious microbes which are (or could conceivably be) significant within the United States, we also should train our minds upon what are currently known as neglected diseases, and the all-too-easily neglected people who suffer with them.

Loving Your Neighbor: The Model in Practice

It is clear that scientists motivated by an ethic of love could have the potential to change the face of infectious disease in the world. Before we consider the possibility of practicing such an ethic of love as a Microbiologist or Immunologist, I would like to summarize the key tenets of this ethic.

- Because the intellectual span of Microbiology/Immunology is so large, individual investigators must focus on one (or at most a few) research topic(s) about which they are passionate (here we could perhaps apply the Christian idea of vocation or calling);
- Investigations should have as their ultimate goal the love of neighbors and tending of God’s creation;
- Collectively, investigations should demonstrate love for *all* neighbors, including those that appear undesirable and/or invisible.

Can it be done? Theoretically, this is absolutely possible. Science is both a way of thinking about the created world, as well as a method for investigating it. The fundamental assumptions of any scientific discipline are that the universe is ordered, and that the human mind is capable of understanding that order⁶⁶. The practice of science is absolutely restricted only by our ability to *test hypotheses* as we seek to answer questions—generally, natural scientists are confined by

⁶⁴ Farmer, P; Allen PL.

⁶⁵ James 1:27.

⁶⁶ This is implicit in every introductory Biology textbook I’ve ever read, and is explicitly stated in Ambrose HW, Ambrose KP, Emlen DJ, Bright KL. 2001. A handbook of biological investigation. 6th edition. Winston-Salem: Hunter Textbooks Inc.

mechanistic questions rather than moral or spiritual ones⁶⁷. To engage in this way of knowing about creation is, in my estimation, at least one way that a Christian can love God with his or her mind. Furthermore, there are virtually limitless research projects that would also allow a Christ-follower engaged in scientific pursuits to care for creation and love one's neighbors. If we look only at the limitations of *science*, then a Christian investigator in Microbiology or Immunology *should* be just as able to pursue the study of African sleeping sickness (one of the neglected tropical diseases) as the study of influenza (a disease which, in its pandemic form, has been called "the slate wiper"⁶⁸).

In practice, however, this is not the case. The primary funding agency in the United States for research on infectious diseases is the National Institutes of Health. Although the NIH has a substantial budget, that money is divided and distributed among investigators based on two key factors: (i) the quality of submitted grant proposals, and (ii) the stated priorities of the NIH. Thus, if a Christian Microbiologist decides to pursue the study of African sleeping sickness (a relatively low priority of the NIH), s/he is much less likely to receive financial support than the investigator pursuing coronary disease, obesity, or influenza. Furthermore, the priorities of the NIH can be intimately connected to politics rather than a Christian ethic of neighborly love. This has been demonstrated in the past, with the failure of many in the Reagan administration to address the HIV/AIDS epidemic in its early years, and more recently with the enormous amount of funding devoted to projects concerned with biodefense⁶⁹. Thus, while scientists collectively tend to pursue knowledge about the created world with great thirst, politics can restrict the options for quenching this thirst.

To change the way that funds are allocated to a model that favors neighborly love over nationalism or political interest would require a radical paradigm shift toward an ethic of love (or at the very least neighborly concern) for those impacted by infectious disease; how this might happen is well beyond the scope of this paper (not to mention my expertise). Such a paradigm shift in research funding would enable at least some Christian investigators to more fully embrace their calling and utilize their minds to both love God by studying His creations, and to love their neighbors by studying conditions that impact them⁷⁰. One thing that must happen before this is possible is that we need to collectively stop blaming the victims of some infectious diseases. The smoker who develops lung cancer is not blamed (either qualitatively or quantitatively) in the same way as the AIDS victim. The community does not wonder or worry about how a person might have contracted tuberculosis, but this is the first thing that one thinks about with HIV/AIDS. If we remove the Pharisaical attitude of superiority, which enables blame of our afflicted neighbors, from the equation, the love and compassion of Christ should be able to flow more freely.

⁶⁷ While a scientist cannot answer spiritual or moral questions with a scientific method, it is quite possible to pursue mechanistic questions for spiritual/vocational reasons.

⁶⁸ Callahan GN. 2006. *Infection: the uninvited universe*. New York: St. Martin's Press. The danger of influenza is that it spreads very rapidly, and in pandemic form can be quite deadly. It is estimated that the "Spanish Flu" pandemic of 1918-1919 killed as many as 60 million people.

⁶⁹ Martin W. 1996. *With God on our side: the rise of the religious right in America*. New York: Broadway Books; and, NIH estimates of funding.

⁷⁰ Here, I say "some" because a finite research budget means that even if an ethic of love becomes a driving force for funding agencies, (i) there will still be more project proposals than dollars, and (ii) there will still be poorly conceived proposals which should not earn funding.

Implications for Teaching and Research at Bethel University: A Personal Response

Since I began attempting independent scientific investigation, I have always been interested in marginalized topics: the potential to implement solar panels in existing urban areas; a rare bone cancer of the elderly; the mechanisms of immune cells some would consider to be of modest importance⁷¹; and most recently immune responses to a neglected tropical disease. Although many of these topics are ostensibly (or at least intellectually) unrelated, they are all connected by an underlying desire to care for creation, and to love neighbors. This ethic is something that I attempt to instill in both my teaching and research at Bethel University, and should also make my teaching and research distinctive from that which might occur in a secular setting.

With respect to teaching, the principles of creation care and neighbor love are manifested in a number of different ways. Perhaps the most significant of these was my successful proposal for a K course entitled, *HIV/AIDS: Anatomy of a Pandemic*. This course focuses very specifically on the issues addressed in this paper, including but not limited to (i) the decision-making process of both scientists and funding agencies; (ii) the role of religion and morality in confronting infectious diseases; (iii) appropriate, Biblical responses to people affected by or infected with HIV/AIDS; and (iv) the development of an integrated Christ-like response to the global AIDS pandemic. In addition to objective assessments which evaluate student knowledge of the scientific aspects of the pandemic, the course also includes assessments which require the students to attempt to climb inside the lives of people with HIV/AIDS. Two key examples of course activities which contribute to the latter goal are: (i) the reading of first-hand accounts written by people with HIV/AIDS who come from various socioeconomic, cultural, and lifestyle backgrounds; and (ii) an integrative assignment which requires students to intentionally investigate the life of one specific person with HIV/AIDS, and to critically evaluate the cultural response to that person at the time his/her diagnosis was revealed (e.g., a student choosing to write about former Olympic diver Greg Louganis would be evaluating the cultural climate surrounding HIV/AIDS of the late 1980s, when Louganis became aware of his diagnosis, and the mid-1990s, when he revealed it⁷²) in light of Scriptural principles.

In the laboratory, my principal interests lie in the study of immune responses to infectious diseases. Specifically, my recent efforts have been directed at understanding some of the mechanisms by which tropical parasites in the genus *Leishmania* either initiate or evade host immune responses. *Leishmania* parasites belong to the WHO-designated list of neglected tropical diseases, and rank sixth among these diseases in terms of the number of cases diagnosed globally. Current estimates suggest that as many as 12 million people are struggling with leishmaniasis, and that 500,000 people in India alone contract the most severe (and often-fatal) form of the disease annually⁷³. It has been my privilege to collaborate with and mentor ten Bethel University Biology majors on research projects concerning host immunity to *Leishmania* over the last four years; I anticipate four additional student collaborations on related projects during the 2008-09 academic year. Research projects of this nature do expose students to the

⁷¹ If you really want to know: macrophages, mast cells, and multiple myeloma.

⁷² Louganis G, with Marcus E. 1995. The Ninth Dive, from *Breaking the Surface*. Published in, *While the world sleeps*. 2003. C. Bull (ed.). New York: Thunder's Mouth Press.

⁷³ WHO. 2008. Neglected tropical diseases FAQ.

scientific method, and the joys and struggles of bench science, but they also have the potential to have an impact on student lives beyond the duration of the actual research project. Discussing the epidemiology of leishmaniasis and related diseases with my student-collaborators encourages awareness of the impact of infectious diseases like leishmaniasis on our all-too-often invisible neighbors. Since many of our students move on to careers in the health professions, it is my profound hope that this type of emphasis in their senior research will help them develop the ability to see and treat all people as true neighbors in Christ.

In closing, and on a personal note, I would like to note my gratitude for the constant exhortation of Bethel's learning community to integrate our Christian faith into every task. I have thoroughly enjoyed this opportunity to intentionally study my own discipline from a Scriptural perspective, and to weave together ideas that have been lurking in the dusky corners of my mind for several years. Someday, perhaps, this will seem as natural to me as breathing itself! It is my profound desire to continue this work, and to continue to lead an ever-more integrated life before our triune God.