
38 Biophysics of Earthing (Grounding) the Human Body

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INTRODUCTION

In medicine, the path to new discovery is often difficult and challenging. When a valuable discovery is made, it can be even more difficult to get it to the people who need it. This is true even for discoveries that could resolve costly and debilitating disorders that affect many people and ruin many national economies, and that, therefore, deserve the highest priority. A discovery of this kind is the topic of this chapter.

In a classic letter to *Science* entitled *Dionysians and Apollonians*, Albert Szent-Györgyi stated it this way:

Wilhelm Ostwald¹ divided scientists into the classical and the romantic. One could call them also systematic and intuitive. John R. Platt calls them Apollonian and Dionysian. These classifications reflect extremes of two different attitudes of the mind that can be found equally in art, painting, sculpture, music, or dance. One could probably discover them in other alleys of life. In science the Apollonian tends to develop established lines to perfection, while the Dionysian rather relies on intuition and is more likely to open new, unexpected

paths for research. Nobody knows what “intuition” really is. My guess is that it is a sort of subconscious reasoning, only the end result of which becomes conscious.

These are not merely academic problems. They have most important corollaries and consequences. The future of mankind depends on the progress of science, and the progress of science depends on the support it can find. Support mostly takes the form of grants, and the present methods of distributing grants unduly favor the Apollonian. Applying for a grant begins with writing a project. The Apollonian clearly sees the future lines of his research and has no difficulty writing a clear project. Not so the Dionysian, who knows only the direction in which he wants to go out into the unknown; he has no idea what he is going to find there and how he is going to find it.²

The book you are holding in your hands can be extremely valuable to any scientist or therapist entering unknown territory. Here you will find scientific concepts that are mostly outside of the mainstream, therefore, they can act as fertile new ground for contemplation, synthesis, and new discovery. The human body is always unknown territory, for when we think we understand one aspect, several other mysteries pop up.

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INFLAMMATION

We now know that many, if not all, of the most common, debilitating, and costly health disorders and diseases are partly or entirely energetic in nature, and are therefore, difficult to prevent, treat, or even comprehend when energy is left out of the discussion. Moreover, cures for the most serious health problems will remain elusive until medical researchers consider energetics. This does not mean textbook biochemical or molecular energetics, it means the energetics as described by the steadily maturing sciences of physics, biophysics, and quantum physics. This fact is documented by one of the most significant advances in biomedicine that has taken place in recent times. Specifically, the study of inflammation has become one of the most active areas of biomedical research, with over 400,000 peer reviewed studies completed during the period 1967–2013 (see Figure 38.1).³ Inflammation is incomprehensible without an energetic perspective.

Chronic disease is the number one cause of death and disability worldwide. Treating patients with chronic diseases accounts for 75% of U.S. health care spending, which surpassed \$2.3 trillion in 2008. The most common and costly chronic diseases are heart disease, cancer, stroke, chronic obstructive pulmonary disease, osteoporosis, and diabetes.⁴ Other significant inflammatory conditions include Alzheimer disease, asthma, bowel disorders, cirrhosis of the liver, cystic fibrosis, lupus, meningitis, multiple sclerosis, psoriasis, and

arthritis. Tragically, many patients suffer from several of these problems simultaneously.

The public has been informed about the inflammation connection in articles published in major news sources (e.g., *The Secret Killer*, *Time Magazine*, 2004).⁵ While abundant research has documented a relationship between chronic inflammation and virtually all chronic diseases, including all of the diseases of aging, profoundly important questions are unanswered. In fact, they are rarely discussed:

- What causes chronic inflammation?
- Precisely why is inflammation associated with so many different chronic diseases, just exactly what is the connection?
- Why have these chronic diseases reached epidemic proportions in recent times?
- What can an individual do about it?
- When an energetic approach is effective for a chronic issue, what is this telling us about human biology that could help us stay healthy and recover from disease should it arise?

This chapter relates to all of these questions. It concerns a natural approach to inflammation and chronic disease that is “of the earth” and that has been recognized since ancient times. Unfortunately, modern biomedicine rarely looks at

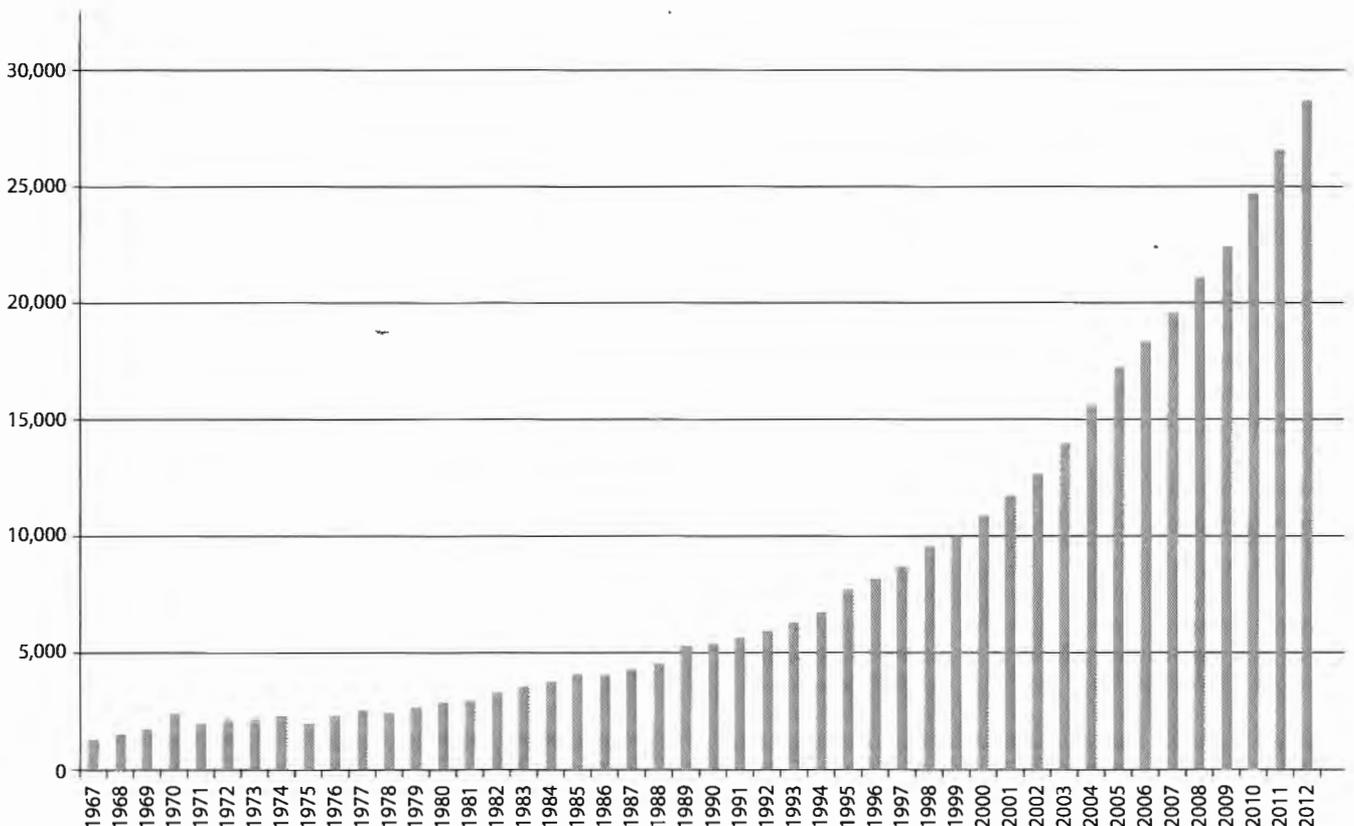


FIGURE 38.1 Growth in number of peer reviewed studies of inflammation, 1967–2012, data from the National Library of Medicine database, PubMed (as of January 20, 2013).

traditional wisdom, focusing instead on the latest pharmacology and high-tech devices. We begin with the benefits of direct physical contact with the surface of the earth, as with bare feet or hands. This is termed “grounding” or “Earthing.” In the process of studying why Earthing is so beneficial, scientists have uncovered some of the missing pieces of the inflammatory response, developed new information on how the immune system works, and described natural methods anyone can use to support their immune system.

BAREFOOT

People who work barefoot in the garden or walk barefoot along the beach often experience a special sense of well-being, just from being in direct physical contact with the earth. Some teachers of ancient practices such as Yoga and *Qigong* recommend that all exercises be done while barefoot on the earth. There is no comparison between walking, running, or practicing any form of movement therapy or martial arts indoors and doing the same activities with bare feet in direct contact with the earth. Why should this be the case?

The significance of barefoot contact with the earth has been known since ancient times. Native American elders have discussed this in their traditional story telling:

It was good for the skin to touch the bare earth, and the old people liked to remove their moccasins and walk with their bare feet on the sacred Earth...they sat on the ground with the feeling of being close to a mothering power...the soil was soothing, strengthening, cleansing and healing.

~Luther Standing Bear (1868–1939)
*Sioux Tribal Leader*⁶

In the late nineteenth century, a back-to-nature movement in Germany claimed many health benefits from being barefoot outdoors, even in cold weather.⁷ In the 1920s, George Starr White, MD, investigated the practice of sleeping grounded after being informed by some individuals that they could not sleep properly, “unless they were on the ground or connected to the ground in some way,” such as with copper wires attached to grounded-to-Earth water, gas, or radiator pipes. White reported that sleep improved with these techniques.⁸ However, these ideas never caught on in mainstream society.

A modern Yoga teacher says that the benefits of walking barefoot on the earth include:

- A better balance in our nervous systems
- Improved circulation
- Reduction in inflammation in our bodies
- It is the ultimate antioxidant!

~Samantha Fox Olson⁹

Recent research confirms each of these points.

Throughout history, humans mostly walked barefoot or with footwear made of animal skins (moccasins). They slept on the ground or on animal hides. We shall see that recent research confirms the health advantages they achieved by this

lifestyle and explains why this happens. Through direct contact or through perspiration-dampened and electrically conductive animal skins used as footwear or sleeping pads, the ground’s abundant free electrons were able to enter their bodies, which are electrically conductive. Through this mechanism, every part of the body can equilibrate with the electrical potential of the earth, thereby stabilizing the electrical environment of all organs, tissues, cells and molecules, and providing a key ingredient needed for the operation of the immune system.

MODERN LIFESTYLE AND DIABETES

Modern lifestyle has increasingly separated humans from contact with earth’s electrical field and free electrons. For example, since the 1960s, we have increasingly worn shoes with insulating rubber or plastic or composite soles, instead of the traditional leather soles fashioned from animal hides. Some have lamented that the use of insulating materials in post-World War II shoes has separated us from the Earth’s energy field.¹⁰ Obviously, we no longer sleep and walk directly on the ground as we did in times past. Moreover, our houses have floors made of wood or acrylic that are also insulating. Even carpets are made from synthetic materials that are nonconductive, and that can cause build-up of harmful static electrical charges on our bodies.

During recent decades, stress related chronic illness, immune disorders, and inflammatory diseases have increased dramatically, and some researchers have suggested that environmental factors are the likely cause. However, the possibility of modern disconnection with the earth’s surface as a cause of chronic disease has not been considered by modern biomedicine. The research summarized in this chapter points in that direction.

For example, we are experiencing a global epidemic of diabetes, and there are compelling reasons to look at the possibility that this may in part be related to our loss of contact with the surface of the earth. Figure 38.2 graphs the escalating incidence of diabetes along with the growth of sales of athletic shoes, virtually all of which have insulating rubber or plastic soles. In the early 1950s, some 95% of shoes had leather soles. Leather is a material that will conduct electrons if it is moist, as from the inevitable perspiration from sweat glands on the bottoms of the feet. Fifty years later, 95% of shoes had insulating soles, mostly made of synthetic or composite materials, electrical insulators that completely disconnect the wearer from the earth. Other lifestyle changes over the same time period included the introduction of fast-food, computers, and cellular telephones. People moved indoors to watch television. Skin contact with the surface of the earth became rare.

Diabetes accounts for 10% of all health care dollars spent.¹¹

The world is losing the battle against diabetes as the number of people estimated to be living with the disease soars to a new record of 382 million this year, medical experts said on Thursday. The vast majority have type 2 diabetes - the

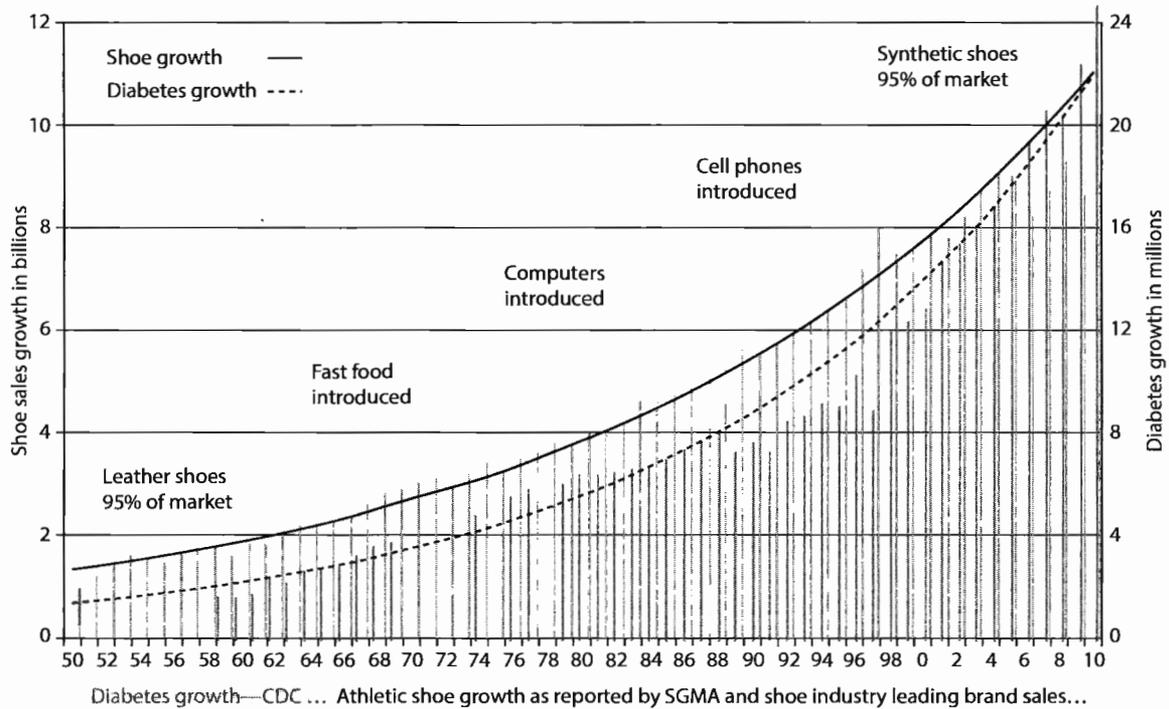


FIGURE 38.2 Sixty years of synthetic soled shoe sales growth correlates with last sixty years of diabetes growth.

kind linked to obesity and lack of exercise - and the epidemic is spreading as more people in the developing world adopt Western, urban lifestyles. The latest estimate from the International Diabetes Federation is equivalent to a global prevalence rate of 8.4% of the adult population and compares to 371 million cases in 2012.¹²

A recent news headline:

Diabetes Ailing 114 Million Chinese Risks Ravaging Budget: Diabetes may consume \$22 billion, or more than half of China's annual health budget, if all those afflicted with the condition get routine, state-funded care. The disease is putting an "overwhelming burden" on the country, according to the International Diabetes Federation, which says China spent \$17 billion, or about \$194 a patient, on diabetes last year. A study released last week found China has 114 million diabetics or 21.6 million more than the Brussels-based federation estimated in November. Extending average care to the enlarged population of diabetes sufferers would wipe out all of China's additional investment in health. The government budgeted spending 260.25 billion yuan (\$42.5 billion) this year, a 27% increase, on basic medical services and subsidies for a state-run health insurance program. China's diabetes costs will balloon, with almost 500 million Chinese at risk of developing the disease. "It's very scary," said T.H. Lam, a professor of public health at the University of Hong Kong. "This only represents the beginning of the diabetic epidemic. The worst is yet to come."

Diabetes costs an average of \$1270 per patient globally and \$8478 in the U.S., according to the International Diabetes Federation. Treatment for the metabolic condition and its associated ailments is expensive because patients with poor blood-sugar control can develop complications

ranging from heart disease and stroke to gangrenous foot ulcers, blindness and kidney failure.

—Bloomberg News, September 12, 2013

At the end of the last century, experiments initiated independently by Ober in the USA,¹³ and cardiologist and neurosurgeon father and son on the medical staff of a military clinic in Poland, Karol and Pawel Sokal,¹⁴ revealed distinct physiological and health benefits with the use of conductive bed pads, mats, EKG- and TENS-type electrode patches, and plates connected the earth outside. These physiological changes included effects on blood glucose regulation.

REDUCTION OF PRIMARY INDICATORS OF OSTEOPOROSIS, IMPROVEMENT OF GLUCOSE REGULATION, AND IMMUNE RESPONSE

The Sokals were seeking regulating factors that are universal in nature and that might be disturbed in the modern environment. Their hypothesis was that interactions between living organisms and the electrical properties of the earth, either by direct contact with the earth's electrically charged surface and/or by field interactions with the earth's electrical field, could be involved in physiological regulatory processes. They mentioned theories about the origin of life involving electrical phenomena that triggered the combining of the elements in the primordial aqueous environment to form stable biomolecules that could reproduce themselves. Perhaps in modern times such electrical phenomena continue to be important for stabilizing various essential regulatory processes.

Their study was designed to answer the question: Does the contact with the earth affect calcium–phosphate homeostasis, concentration of electrolytes, glucose metabolism, proteins, and thyroid function? They conducted a series of experiments to determine whether contact with the earth via a copper conductor can affect physiological processes. The results related to diabetes, osteoporosis, and thyroid function.

Earthing had a direct, statistically significant and beneficial effect on the regulation of blood glucose in patients with noninsulin-dependent diabetes mellitus. This was demonstrated by the decrease in fasting glucose concentrations (means \pm standard error of the mean) from 10.6 ± 1.2 to 7.4 ± 0.8 mmol/L, $p < 0.05$.

Double-blind experiments were conducted on groups ranging from 12 to 84 subjects who followed similar physical activity, diet, and fluid intake during the trial periods. Grounding was achieved with copper plates (30×80 mm) placed on the lower part of the leg, attached with a strip so that it would not come off during the night. The plates were connected by a conductive wire to a larger plate (60×250 mm) placed in contact with the earth outside.

Earthing continually during rest and physical activity over a 72 h period decreased fasting glucose among patients with noninsulin-dependent diabetes mellitus (NIDDM). Patients had been well controlled with glibenclamide,* an antidiabetic drug, for about 6 months, but at the time of study had unsatisfactory glycemic control despite dietary and exercise advice and glibenclamide doses of 10 mg/day.

In another experiment with nonmedicated subjects, grounding during a single night of sleep resulted in statistically significant changes in concentrations of minerals and electrolytes in the blood serum: iron, ionized calcium, inorganic phosphorus, sodium, potassium, and magnesium. Renal excretion of both calcium and phosphorus was reduced significantly. These reductions in blood and urinary calcium and phosphorus directly relate to osteoporosis. The results suggest that earthing for only a single night reduces the primary indicators of osteoporosis. This is a remarkable finding that needs a follow-up study by those interested in public health and the high costs of medical care.

The Sokals drew blood samples from six male and six female adults with no history of thyroid disease. A single night of grounding produced a significant decrease of free

tri-iodothyronine and an increase of free thyroxin and thyroid-stimulating hormone. The significance of these results is unclear, but the logical explanation is that earthing influences hepatic, hypothalamic, and pituitary relationships via adjusting thyroid function.

Many individuals on thyroid medication reported symptoms of hyperthyroid, such as heart palpitations, after starting grounding.¹⁵ Such symptoms typically vanish after medication is adjusted downward under medical supervision. Through a series of feedback regulations, thyroid hormones affect almost every physiological process in the body, including growth and development, metabolism, body temperature, and heart rate. Further study of Earthing effects on thyroid function will obviously be valuable.

The Sokals concluded that earthing the human body influences human physiological processes, including increasing the activity of catabolic processes and may be “the primary factor regulating endocrine and nervous systems.” They also concluded that grounding the human body represents a “universal regulating factor in Nature” that strongly influences bioelectrical, bioenergetic, and biochemical processes and appears to offer a significant modulating effect on the chronic illnesses they encounter daily in their clinical practices.

In another experiment done by the Sokals, the effect of grounding on the classic immune response following vaccination was examined. Earthing accelerated the immune response, as demonstrated by increases in gamma globulin concentration. This result confirms an association between earthing and the immune response, as was suggested in a study of delayed onset muscular soreness (DOMS) to be discussed below.¹⁶ The reason for this association will also be discussed below.

The Sokals also found that earthing patients with NIDDM continuously during rest and physical activity over a 72 h period decreased their fasting glucose levels. This is another profoundly important result. It supports the idea that disconnecting from the earth affects blood glucose and this could be a significant factor in diabetes. Could it be that the simple change in lifestyle from leather soled shoes to electrically insulating plastics and rubber was a major contributor to our epidemics of diabetes and other chronic diseases? Given the scope of the suffering and the financial significance of the global diabetes problem, this idea deserves serious attention from the biomedical research and public health communities, especially in the regions where diabetes is epidemic.

EARTHING, SLEEP AND CORTISOL PROFILES

A modern understanding of the value of contact with the earth began with the discovery that a simple grounding system placed on a mattress enabled a person to sleep better.^{12,17,18} The grounded sleep system (Figure 38.3) consists of a bed sheet with conductive carbon or silver threads woven

* Glibenclamide, also known as glyburide is an anti-diabetic drug in a class of medications known as sulfonylureas, closely related to sulfa drugs. It is sold under the trade names Diabeta, Glynase and Micronase in the United States and Daonil, Semi-Daonil and Euglucon in the UK, and Delmide in India. It is also sold in combination with metformin under the trade names Glucovance, Benimet and Glibomet. The drug works by binding to and activating the sulfonylurea receptor 1, the regulatory subunit of the ATP-sensitive potassium channels in pancreatic beta cells. This inhibition causes cell membrane depolarization, opening the voltage-dependent calcium channel. This results in an increase in intracellular calcium in the beta cell and subsequent stimulation of insulin release.

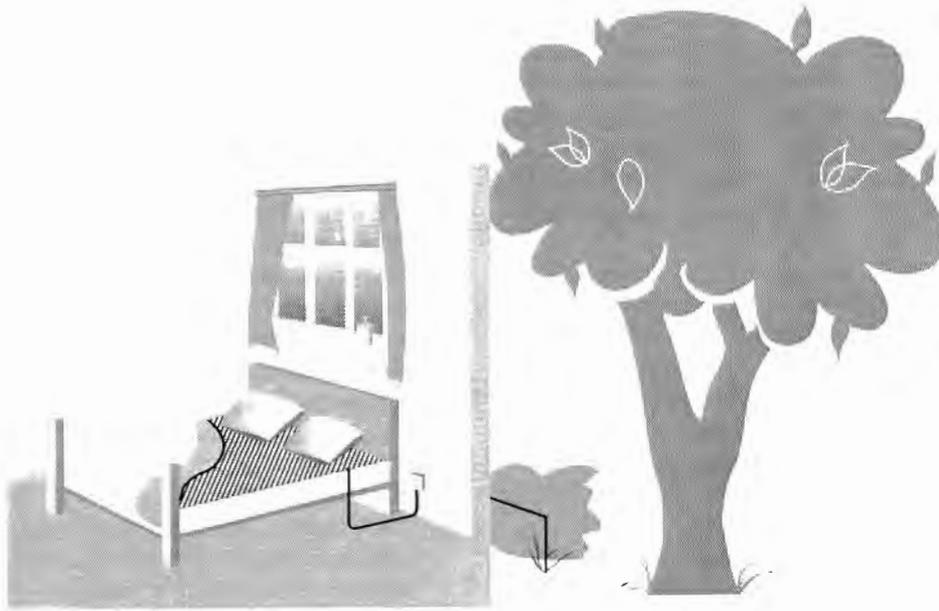


FIGURE 38.3 The grounded sleep system consists of a cotton sheet with conductive carbon or silver threads woven into it. The threads connect to a wire that goes out the bedroom window or through the wall to a metal rod inserted into the earth near a healthy plant. Sleeping on this system connects the body to the earth. A repeated report from people using this system is that sleeping grounded improves the quality of sleep.

into it. The threads connect to a wire that goes out the bedroom window or through the wall to a metal rod inserted into the earth, preferably near a healthy plant. Sleeping on this system connects the body to the earth's electrons and to its electrical field (Figure 38.3). It is an extremely simple change in life-style that can have a huge impact on one's health, as we shall see below.

The grounding or "earthing" story is summarized by the cartoon in Figure 38.4. There is a continuous flow of electrons from the sun to the ionosphere via the solar wind, and thence to the earth's surface via lightning strikes. Lightning keeps the conductive surface of the earth electrically charged.¹⁹ At any given time there are probably about 2000 thunderstorms around the world producing about 44 flashes of lightning each second. About 78% of those flashes occur in the tropics, between 30N and 30S latitude.²⁰

Electrostatics is the branch of physics that teaches that when two conductive objects with different electrical potential touch each other, there is a virtually instantaneous transfer of charge so that the two objects equilibrate to the same electrical potential.²¹ The human body is a conductor of electricity and so is the earth. "Grounded" or "earthed" means that our bodies are conductively coupled or electrically coupled with the surface of the earth and its abundant supply of electrons. This is a natural condition in which earth's free or mobile electrons spread over and into our bodies, stabilizing our internal electrical environment. At the same time, it appears that an earth connection allows rhythms in the earth's electric field to entrain the body's biological clocks. This is the most likely explanation for the fact that a brief (e.g., 15 min) period of standing barefoot on the earth eliminates the effects

of jet-lag, most likely by shifting a person's biological clocks to the rhythms present at their new location.

A repeated report from people using this system is that sleeping while grounded to the earth improves the quality of sleep. Insomnia is a serious problem for approximately half of the people in the USA. The problem is so severe that news

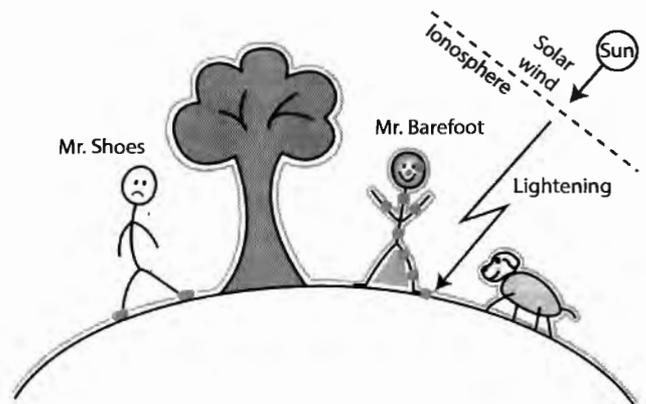


FIGURE 38.4 A continuous flow of electrons from the sun to the ionosphere and to the earth via lightning strikes keeps the surface of the earth electrically charged. Electrostatics teaches that when two conductive objects with different electrical potential touch each other, there is a virtually instantaneous transfer of charge so that the two objects equilibrate to the same electrical potential. The human body is a conductor of electricity and so is the earth. "Grounded" or "earthed" means that our bodies are connected to the surface of the earth and its abundant supply of electrons. This is a natural condition in which earth's electrons spread over and into our bodies, stabilizing our internal electrical environment.

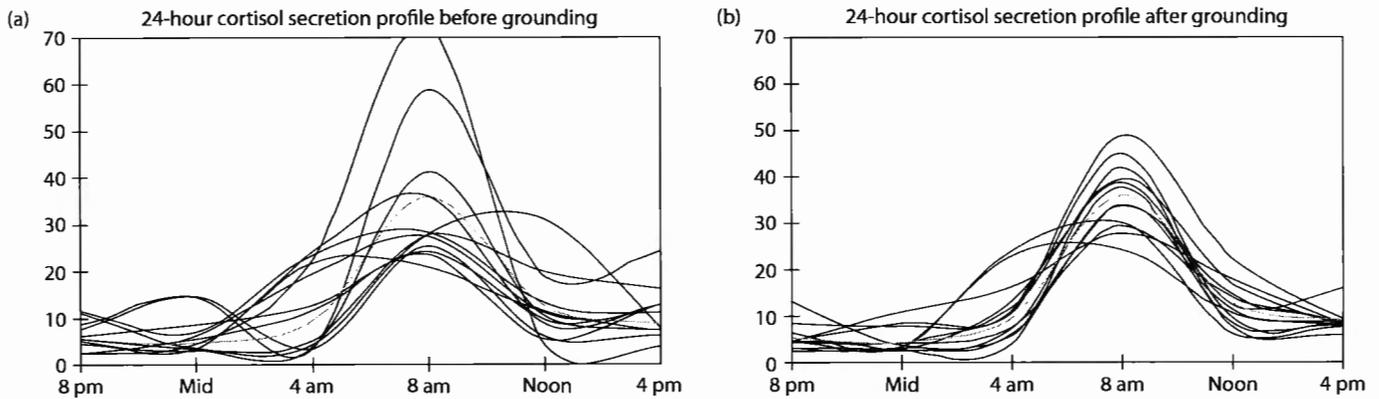


FIGURE 38.5 (See color insert.) Cortisol levels before and after grounding. In unstressed individuals, the normal 24 h cortisol secretion profile follows a predictable pattern: lowest around midnight and highest around 8 a.m. Graph (a) illustrates the wide variation of patterns among study participants prior to grounding, while (b) shows a realignment and normalization trend of patterns after six weeks of sleeping grounded. (From Ghaly M, Teplitz D. *J Alternat ComplMed* 2004;10:767–76.)

and business media take notice.^{22,23} Poor sleep is thought to lead to many automobile, industrial, and other types of accidents, and costs U.S. businesses nearly \$150 billion annually in absenteeism and lost productivity.²⁴ Therefore, further investigations of grounded sleep seem worthwhile.

A pilot study showed that improved sleep was associated with normalization of the day-night rhythm of the “stress hormone,” cortisol (Figure 38.5).²⁵ Cortisol is a stress hormone that is associated with both psychological and physical stress, inflammation, and sleep dysfunction in humans. Chronic elevation of cortisol can result in disruption of circadian rhythms, which, in turn, contributes to a multitude of adverse health conditions, including sleep disorders, hypertension and cardiovascular disease, stroke, decreased bone density, decreased immune response, mood disturbances, autoimmune diseases, and abnormal glucose levels.²⁶

Cortisol rhythms have broad impact on most if not all systems in the body. Cortisol is both a mediator and a marker of the stress response. The finding that grounding or earthing the body during sleep normalizes the day-night cortisol rhythm, while improving subjective reports of sleep, pain and stress²⁴ is indicative of a deep significance to natural contact with the surface of the earth. The convergence of endocrine measures with subjective behavioral data make a strong case for the conclusions reached.

Neurologic effects of chronic elevated cortisol secretion include chronic activation of the sympathetic nervous system (flight-or-fight response) leading to hypertension and cardiovascular disease. The hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system have been utilized as objective markers of stress reactions.²⁷ Previous research has established relationships between cortisol levels and sleep dysfunction, stress, pain, anxiety, depression, irritability,

inflammation, circadian rhythms, the immune response, and various chronic diseases. These relationships are real; they have been the topic of literally thousands of scientific studies. For example, a search of the National Library of Medicine database, PubMed, lists nearly 13,000 studies with key words “cortisol” and “stress” and 1900 studies with key words “cortisol” and “sleep.” A scholarly summary of this science can be found in *Measuring Stress*.²⁸ See, in particular, Chapter 8, on measuring stress hormones.²⁹ Cortisol is widely studied because it is a central, readily measured and an easy-to-interpret factor.

Cortisol-releasing mechanisms seem to be involved in the regulation of sleep.³⁰ Twenty-four-hour hyper-secretion of cortisol has been linked to chronic insomnia.³¹ Evening and nocturnal cortisol levels were significantly increased in patients with severe chronic primary insomnia.³² Power frequency 50–60 Hz extra-low frequency electromagnetic fields and pulsed radiofrequency fields are reported to affect sleep. Sleep disruption has been reported in human populations with nighttime exposure to elevated 50–60 Hz electromagnetic fields.^{33,34} Weak, pulsed radiofrequency radiation at 20 $\mu\text{W}/\text{cm}^2$ has been reported to alter the HPA axis with a slight elevation in cortisol serum level.³⁵ Significantly suppressed sleep electroencephalographic (EEG) and disruption of rapid eye movement (REM) sleep are reported after exposure to pulsed radiofrequencies.^{33,36–38} Pulsed radiofrequency exposure is reported to alter cerebral blood flow, and sleep and waking EEGs.³⁵ Mann and colleagues reported significant sleep differences after exposure to weak pulsed radiofrequency radiation, with a predominance of the parasympathetic over sympathetic tone in the autonomic nervous system.³³ Together, these studies indicated that weak exposures to electromagnetic fields can disrupt normal sleep patterns as measured by various parameters, including direct measurement of hormones, sleep quality, duration of sleep, sleep EEG, REM sleep patterns, parasympathetic/sympathetic autonomic nervous system balance, and disruption of normal sleep spectral-power density ranges. Disregulation of circadian cortisol profiles is also associated with pain.³⁹

A book on earthing presents two decades of accumulated anecdotal cases of people with many types of health challenges whose conditions have improved because of earthing.¹⁵ For example, from the evidence presented here, it is not surprising that there are reports that a vast number of autoimmune disorders are partly, or completely, ameliorated by earthing.

PAIN AND STRESS

Many who had improved sleep with earthing also reported reduction in pain from new or old injuries or from conditions such as arthritis. As more feedback was gathered, it appeared that many other uncomfortable or debilitating conditions were partly, or completely, mitigated by grounding the body during sleep.

When any method seems to have a broad spectrum of benefits, as often happens with sleeping grounded, one can look for a common underlying mechanism. One mechanism is obvious: extensive scientific research from around the world has already shown that lack of sleep stresses the body and has many detrimental health consequences. The cortisol study (Figure 38.5) strengthened the argument that grounding the body reduces stress so that people can sleep better. A procedure that improves sleep could therefore provide relief from a host of disorders related to adrenal exhaustion, stress and the resulting anxiety.

Melatonin is the most important of the pineal hormones. In a previously unpublished study, it was found that melatonin increased in 66% of subject after sleeping grounded for 6 weeks (Figure 38.6). Increases ranged between 2% and 16%. Melatonin decreased by 6% in only one of the subjects. The other three remained the same. Melatonin increases are important because melatonin is a hormone that supports the immune system, promotes deep and restful sleep, slows cell

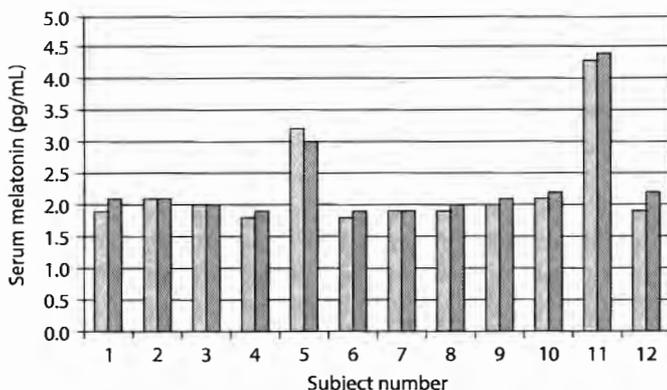


FIGURE 38.6 Melatonin increased in 66% of subjects after sleeping grounded for 6 weeks. Increases ranged between 2% and 16%. Melatonin decreased by 6% in only one of the subjects. The other three remained the same. Melatonin is the most important of the pineal hormones. Melatonin increases are important because melatonin is a hormone that supports the immune system, promotes deep and restful sleep, slows cell damage and aging, improves energy and may even inhibit the growth of cancer cells. (From Jardim-Perassi BV et al. *PLoS One* 2014;9(1):1–11.)

damage and aging, improves energy, and may even inhibit the growth of cancer cells.⁴⁰

Sleeping grounded is the first intervention ever discovered that speeds recovery from the pain of delayed onset muscle soreness.

Looking further, we know that lack of sleep is often the result of pain—people simply cannot sleep well when they are in pain. Hence, reduction of pain might lead to improved sleep, reduction in stress to the body, and relief from a wide variety of unpleasant and debilitating conditions. Many who started sleeping on a grounding pad reported less pain and discomfort, not only during the night, but on the following day.

Pain reduction from sleeping grounded has been well documented in a controlled study of delayed onset muscle soreness (DOMS). This is a well-known result of excessive, unfamiliar, or intensive exercise. Muscle cell breakdown and inflammation occur along the muscle Z-lines (the regions where tension developed within the muscle cell is conducted to the myofascial system and bones, to produce movements⁴¹) and muscle cell membranes become leaky. Muscle soreness begins 24–48 h after the exercise and can last well over 96 h. DOMS is an excellent experimental model for the study of acute inflammation. The excessive exercise can be standardized and it does not produce any permanent injury to the subject. In all measurements after the initiation of the trauma, ungrounded subjects expressed the perception of greater pain. Related to the pain finding was evidence of a muted white blood cell response indicating that a grounded body experiences less inflammation (Figure 38.7). Subjects were also tested with a blood pressure cuff on the calf of the injured leg. Subjects that had slept grounded consistently, at every measurement taken, could withstand greater pressure than controls. Sleeping grounded is the first intervention ever discovered that speeds recovery from the pain of DOMS.¹⁶

INDUCED ELECTRICAL FIELDS

One of the documented causes of sleep disturbance is the environmental electric field from home wiring and appliances. The wires to a lamp or clock radio on a table next to the bed induce measurable voltages on the body, as do wires concealed behind walls. The electric field is present even when the lamp is turned off. These induced voltages were measured by an electrical engineer, Roger Applewhite, who is expert in the design of electrostatic discharge grounding systems for the electronics industry.⁴² Measurements were taken while ungrounded and then grounded using a conductive patch or conductive bed pad. Applewhite measured the induced fields at three positions: left breast, abdomen, and left thigh. Each method (patch and sheet) immediately reduced the common alternating current (AC) 60 Hz ambient voltage induced on the body by a highly significant factor of about 70 on average. Figure 38.8 shows this dramatic effect.

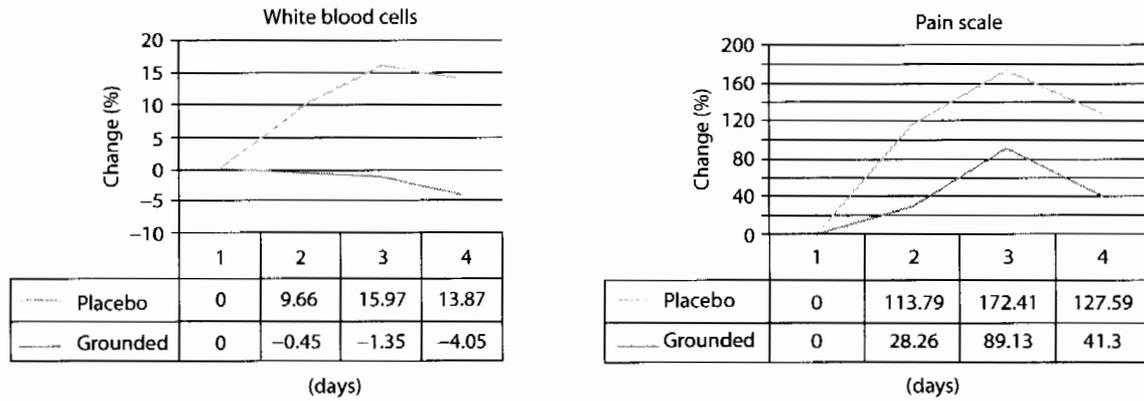


FIGURE 38.7 Delayed onset muscle soreness and grounding. In all measurements, ungrounded subjects expressed the perception of greater pain. Related to the pain finding was evidence of a muted white blood cell response indicating that a grounded body experiences less inflammation. (From Brown R, Chevalier G, Hill M. *J Alternat Compl Med* 2010;16(3):265–73.)

The Applewhite study showed that when the body is grounded, its electrical potential becomes equalized with the Earth’s electrical potential through a transfer of electrons from the earth to the body. This, in turn, prevents the 60 Hz field from producing an AC electric potential at the surface of the body and from producing perturbations or oscillations of charged molecules inside the body. The study confirms the “umbrella” effect of earthing the body explained by Nobel Prize winner Richard Feynman in his famous Berkeley lectures on physics.⁴³ Feynman said that when the body potential is the same as that of the earth (grounded), the body becomes an extension of the earth’s gigantic electric system. The earth’s potential thus becomes the “working agent that cancels, reduces, or pushes away electric fields from the body.”

As pointed out above, the surface of the earth has an abundance of electrons that give it a negative electrical charge. If you are standing outside on a clear day, wearing shoes or standing on an insulating surface (like a wood or vinyl floor), there is an electrical charge of some 200 volts between the earth and the top of your head (Figure 38.9).

Applewhite documented changes in the voltages induced on the body by monitoring the voltage drop across a resistor. The results confirmed the “umbrella effect” described above.

The electrons in the body of the grounded person are not perturbed by environmental electrical systems.

You might ask, “If there really is a voltage difference of 200 volts from head to toe why don’t I get a shock when I go outside?”

The answer is that to experience a shock there has to be a current flow through your body. The air is a relatively poor conductor, and therefore, allows virtually no electrical current flow from the atmosphere, through your head, through your body, and to the surface of the earth. If you are standing outside in your bare feet (the right side of Figure 38.9), you are earthed: your whole body is in electrical contact with the earth’s surface. Your body is a relatively good conductor. Your skin, respiratory and digestive tracts, and the earth’s surface make a continuous charged surface with the same electrical potential. In a later section, we will see that earth’s surface charge reaches the surfaces the red blood cells, where it has important effects by reducing blood viscosity.

Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth. Going outside barefoot is one way to do this. Another is to place a grounding sheet on one’s bed (Figure 38.3) and a third way is to have a grounding mat under one’s feet if they are sitting at a desk. These are exceedingly simple, virtually trivial alterations in one’s lifestyle that can have profound health implications.

Also notice to the right in Figure 38.9 that the charged area is pushed up and away from your head if you are grounded. Any object that is in direct contact with the earth—a person, a dog, a tree—creates this shielding effect (see also Figure 38.4). The object is essentially residing within the protective “umbrella” of earth’s natural electric field. This protective phenomenon also occurs inside your home or office, if you are connected to the earth with an earthing system such as a bed or foot pad.

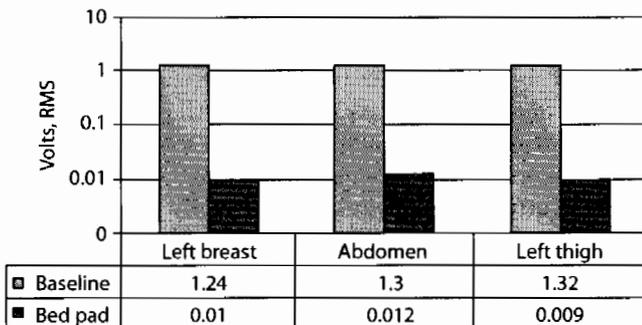


FIGURE 38.8 Effect of grounding with bed pad on 60 Hz induced body voltage. (From Applewhite R *Euro Biol Bioelectromagn* 2005;1:23–40.)

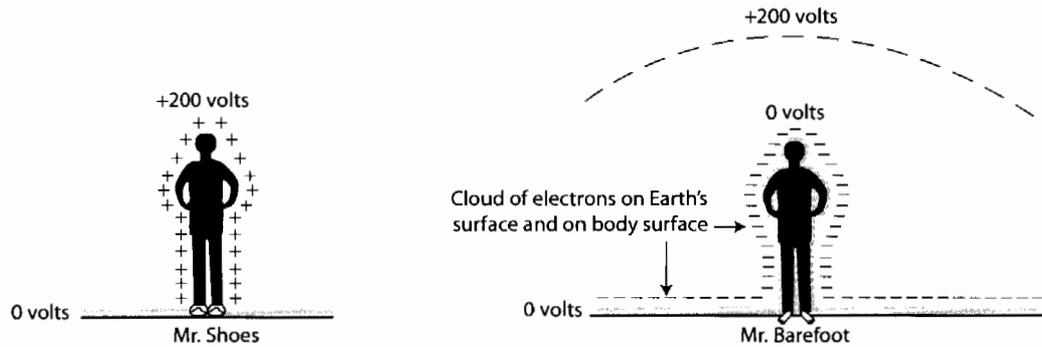


FIGURE 38.9 The surface of the earth has an abundance of electrons that give it a negative electrical charge. Left, if you are standing outside on a clear day, wearing shoes or standing on an insulating surface like a wood or vinyl floor or asphalt, there is an electrical charge of some 200 volts between the Earth and the top of your head. Right, if you are standing outside in your bare feet, your whole body is in electrical contact with the Earth's surface. Your body is a relatively good conductor. Your skin and the Earth's surface make a continuous charged surface with the same electrical potential. Also, notice in the diagram on the right that the charged area is pushed up and away from your head if you are grounded. The object is essentially residing within the protective "umbrella" of earth's natural electric field. This protective phenomenon also occurs inside your house or office if you are connected to the earth with an earthing device, such as a grounding wrist pad or a foot pad. Adapted from Richard Feynman's famous Berkeley Lectures on Physics. (From Ober C, Sinatra ST, Zucker M. *Earthing: The Most Important Health Discovery Ever?* Laguna Beach, CA: Basic Health Publications; Second Edition, 2014, p. 76.)

HEALTH ON THE 10TH FLOOR

Chevalier has discussed evidence that living in high-rise buildings can have adverse health effects.⁴⁴ Specifically, in 2009, Wolinsky and colleagues, using data from a large, nationally representative sample of older people (>70 years) on Medicare, showed that significant stroke risks are associated with living in multi-story residential dwellings versus single-story residential homes. They also reported that in 2005 about 150,000 Americans died from their strokes, placing stroke as the third leading cause of death in the U.S.⁴⁵

Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth in one way or another. Going outside barefoot is one method that many find enjoyable. Another is to place a grounding sheet and/or pillow on one's bed (Figure 38.3). A third way is to have a grounding mat under bare feet while sitting at a desk. These are exceedingly simple, virtually trivial lifestyle changes that have profound implications for health and longevity.

In presenting this information, Chevalier suggested that being disconnected from the ground, that is, from the earth's surface, for prolonged periods of time, supports low key inflammatory processes that take years to develop into chronic diseases. These inflammatory processes are aggravated by the distance from the ground: the higher above the ground a person lives, and the longer they stay there, the more hazardous it is for their health. Grounding appears to eliminate one of the major contributors to these inflammatory

processes and remediates many chronic diseases once they have begun. Stated simply, one of the best things a person can do to lessen the likelihood of developing a chronic disease is to spend at least part of their day connected to the earth. To repeat, going outside barefoot is one way to do this. Another is to place a grounding sheet on one's bed (Figure 38.3) and a third way is to have a grounding mat under their feet if they are sitting at a desk. These exceedingly simple, virtually trivial lifestyle changes can have profound health implications.

Wollinsky and co-workers suggested that the increased stroke risk in multi-story residential dwellings reflects the greater physical, social, and psychological burdens faced by older adults in those settings. Chevalier discussed this and other possible explanations for elevated stroke and chronic disease incidence. On balance, Chevalier's hypothesis seems the most logical explanation. He notes the sum total of the benefits from earthing summarized in this chapter: better sleep, less pain, normalization of daily cortisol levels and circadian rhythms, decrease in inflammation, reduction in stress, normalization of the function of the autonomic nervous system, decreased blood viscosity, faster recovery after injury or from disease, reduction of primary indicators of osteoporosis, improvement of glucose regulation, and more efficient immune responses to trauma. All of these factors are significant for the health of every person, and are especially important for the aging adult. Higher blood viscosity is often correlated with stroke and virtually all of the other cardiovascular issues that are often considered the consequences of aging. Hence, the reduction in blood viscosity found with earthing may have a significant cardiovascular protective effect on older people living in multi-story buildings. Earthing appears to be one of the simplest and yet most profound interventions for helping reduce cardiovascular risk and cardiovascular events.

Consider, for example, a 6 foot tall person standing on the second floor of a multi-story building. Assuming an average of 10 feet per floor and using the typical value of 150 V/m, this person's body will be about 732 V at the top of their head and 457 V at the bottom of their feet. Furthermore, this voltage will increase by 457 V for every floor above the second floor. It is understandable that such a large electric potential the higher one is from ground level could interfere with the functioning of the electrical aspects of the cardiovascular and immune systems.

Take as an example a 6-foot tall person standing on the second floor of a multi-story building. Assuming an average of 10 feet per floor and using the typical value of 150 V/m, this person's body will be at 732 V at the top of the head and 457 V at the bottom of the feet. Furthermore, this voltage will increase by 457 V for every floor above that floor. It is understandable that such a large electric potential the higher one is from ground level could interfere with the functioning of the electrical aspects of the immune system. The constant recharging of the body by positive charges in the atmosphere will neutralize many of the negative charges needed to neutralize reactive oxygen species (free radicals) generated by the oxidative burst—the body's response to injury (discussed in more detail below).

Jamieson and colleagues asked whether the failure to appropriately ground humans is a factor contributing to the potential consequences of electro-pollution in offices.⁴⁶ Considerable debate exists on whether electromagnetic fields in our environment pose a risk to health.⁴⁷ But there is no question that the body reacts to the presence of environmental electric fields. Applewhite's study unambiguously demonstrated that grounding essentially eliminates the ambient voltage induced on the body from common electricity power sources. We strongly suspect, from the evidence we have gathered, that this has beneficial health consequences.

What has a splinter in your finger or a wound on the foot to do with the risk of developing Alzheimer's disease, a heart attack, or contracting cancer of the colon? More than most people think! As we learn more and more about the causes of these and many other serious diseases, it becomes increasingly clear, that there is a link to our old defense mechanism; inflammation—the same biological process that causes tissue around a splinter to turn red and an injured foot to swell. The evidence is piling up and begins to radically change the perception of why we get chronic diseases.

—Dorthe Krogsgaard and Peter Lund Frandsen⁴⁸

INFLAMMATION AND IMMUNE RESPONSE

Going one-step further, there is good evidence that painful conditions that prevent restful sleep are often the result of

various kinds of acute or chronic inflammation—conditions caused in part by highly reactive molecules known as reactive oxygen species (sometimes referred to as free radicals). These molecules are generated by normal metabolism and by the immune system as part of the response to injury or trauma. They are thought to be the immediate cause of the characteristic features or “pillars” of inflammation that have been recognized since ancient times: pain, redness, heat, swelling, and loss of function.

Krogsgaard and Lund Frandsen from Denmark have stated (perhaps over-stated) an example of how a simple injury can lead to serious problems many years later (see box).⁴⁸ At this point, we do not really know enough to verify or refute this statement, but it does tell a story we suspect may be at least partly correct.

The way a small injury can lead to a chronic medical issue has been concisely summarized, again, by Krogsgaard and Lund Frandsen (see box).

Sometimes an inflammation process runs amok and continues much longer than is needed and spreads beyond the originally damaged area. There are several theories about how this happens. Perhaps something goes wrong in the communication between immune cells so that the signal to end the injury response does not arrive. Maybe there are too many free radicals and/or not enough antioxidants or not enough electrons to neutralize them. Degradation products from the inflammation process may bind to proteins in the connective tissue to form a barrier around the inflammation (the inflammatory barricade). When the process is encapsulated in this way, it is at high risk of becoming chronic, because immune cells and antioxidants don't have free access through the wall of the “inflammatory pouch.” Various toxins may leak out from the area and create an irritation that generates further inflammation – and a vicious cycle is started, which, depending on the person's strong and weak sides, can develop into such seemingly diverse conditions as diabetes, bronchitis, asthma, chronic intestinal disorders, atherosclerosis, Alzheimer's, rheumatoid arthritis, multiple sclerosis, cancer....

—Krogsgaard and Lund Frandsen⁴⁸

Inflammation produces heat that can be measured with infrared medical imaging. A study using this approach revealed rapid reductions in inflammation at the same time as pain was reduced (Figure 38.10).

How does grounding the body reduce inflammation? One logical explanation is that grounding the body allows anti-oxidant electrons from the earth to enter the body and neutralize highly charged reactive oxygen species at sites of inflammation. If this hypothesis is correct, one would expect changes in the well-researched profiles in blood chemistry and

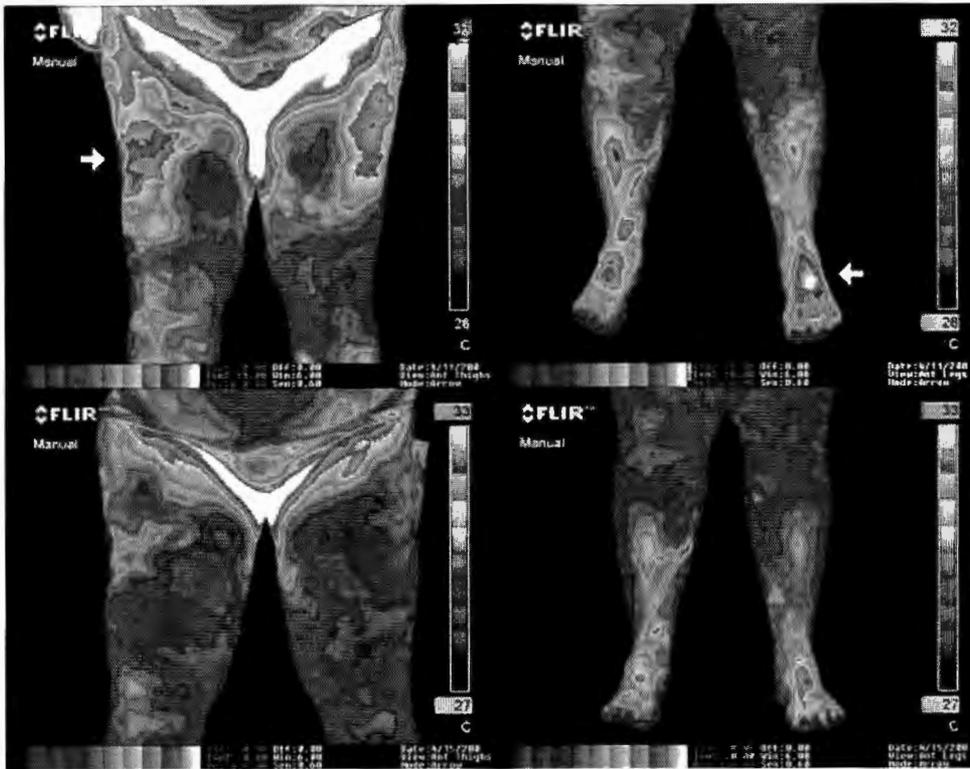


FIGURE 38.10 (See color insert.) Reduction in inflammation and pain after sleeping grounded for four nights. Medical infrared imaging shows warm and painful areas (arrows). Sleeping grounded for four nights resolved the pain and the hot areas cooled. (From Amalu W. Medical Thermography case studies. Clinical earthing application in 20 case studies. Available online from http://74.63.154.231/here/wp-content/uploads/2013/06/Amalu_thermographic_case_studies_2004.pdf.)

white blood cell counts associated with inflammation. Such changes have been documented by Brown and colleagues.¹⁵

PHYSIOLOGICAL EFFECTS OF EARTHING

To follow changes in physiology produced by earthing, the arrangement shown in Figure 38.11a was used. A ground wire was connected to a switch box so that the grounding could be turned on or off during experiments without the subject knowing about whether or not they were grounded. The ground was connected to the subject at the acupoints known as Kidney 1 (Figure 38.11b). Acupuncturists refer to this point as the primary entry point for *Qi*, known in Hawaii as “*mana*” and in Sanskrit as “*prana*.” The point is located near the ball of the foot. Gaétan Chevalier and colleagues performed a series of studies using this arrangement that makes it possible to establish a precisely timed earth connection, and to record changes in various physiological parameters before and after the connection is made. Specifically, changes in pulse rate, respiratory rate, blood oxygenation, perfusion index, skin conductance, emotional stress, heart rate variability, and improved autonomic tone have been documented.

STRESS REDUCTION

The effects of earthing on day-night cortisol rhythms indicated changes in blood chemistry related to stress (Figure 38.5).

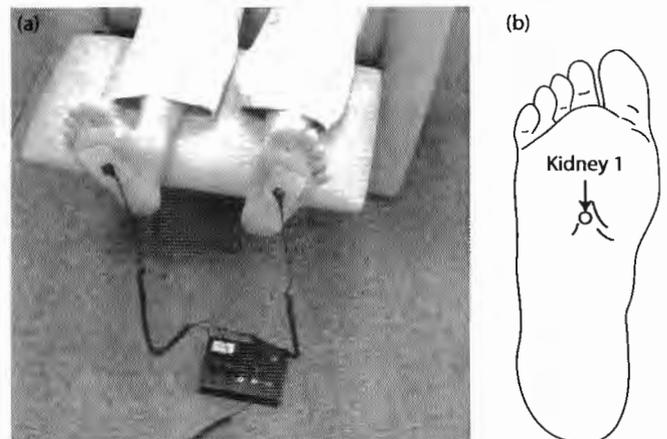


FIGURE 38.11 (a) Technique for studying the physiological effects of connecting the earth to the human body. Conductive patches are placed on the balls of the feet. Wires connect these patches to an earthing rod inserted into the soil outside, near a healthy plant to assure a good connection with the supply of free electrons from the earth's surface. (b) Proximity of the conductive patch to acupuncture meridian point known as Kidney 1. (From Chevalier G, Mori KD. The effect of earthing on human physiology. Part 2: Electrodermal measurements. *Subtle Energ Med* 2007;18(3):11–34.)

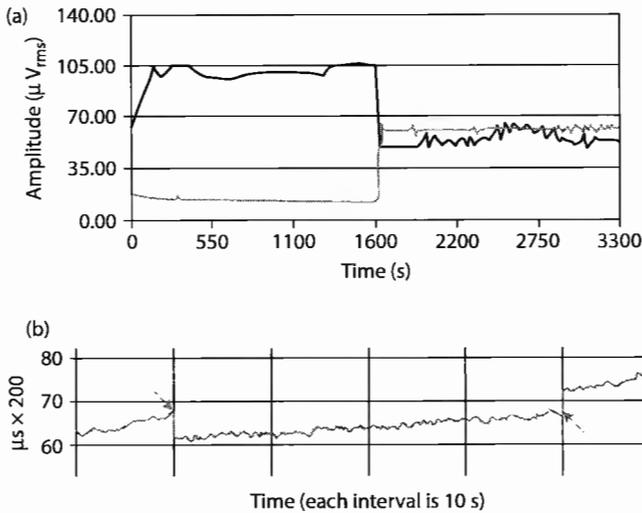


FIGURE 38.12 (a) Virtually instantaneous normalization of muscle tension at the moment of grounding (arrow) measured with electromyography of trapezius muscle. (b) Virtually instantaneous drop in skin resistance, a measure of sympathetic nervous system activity, at the moment of grounding (left arrow), and return at the moment of un-grounding (right arrow). (From Chevalier G, Mori K, Oschman JL. The effect of earthing (grounding) on human physiology. *Eur Biol Bioelectromagnet* 2006;2(1):600–21.)

Further study showed rapid shifts in the autonomic nervous system from sympathetic to parasympathetic dominance and normalization of muscle tension (Figure 38.12a), completing the documentation of the cascade of effects of grounding the body on sleep, inflammation, pain, and the debilitating

consequences of stress and lack of proper sleep. Some of the effects are nearly instantaneous, as shown in Figure 38.12b, showing the rapid drop in skin resistance, a measure of sympathetic nervous system activity, at the moment of grounding (left arrow), and return at the moment of un-grounding (right arrow).

CARDIOVASCULAR EFFECTS

Erythrocytes have a strong net negative charge called the zeta potential produced by the sialoglycoprotein coat such that approximately 18 nm is the shortest span between two cells.

—Wintrobe’s Clinical Hematology⁴⁹

The effects of earthing on the cardiovascular system are profound. A study examined effects of 2 h of grounding on the electrical charge (zeta potential) on red blood cells (RBCs) and the extent of RBC clumping. Ten subjects were grounded with conductive patches on the soles of their feet and palms of their hands. Wires connected the patches to a stainless-steel rod inserted in the earth outdoors. Small fingertip pinprick blood samples were placed on microscope slides and an electric field was applied to them. Zeta potentials were determined using the Smoluchowski equation. RBC aggregation was measured by counting the numbers of clustered cells in each sample (Figure 38.13a). Electrophoretic mobility of the RBCs was determined by measuring terminal velocities of the cells in video recordings taken through a microscope using the system shown in Figure 38.13b. The classic text on zeta potential is *Control of Colloid Stability Through Zeta Potential* (with a closing chapter on its relationship to cardiovascular disease)

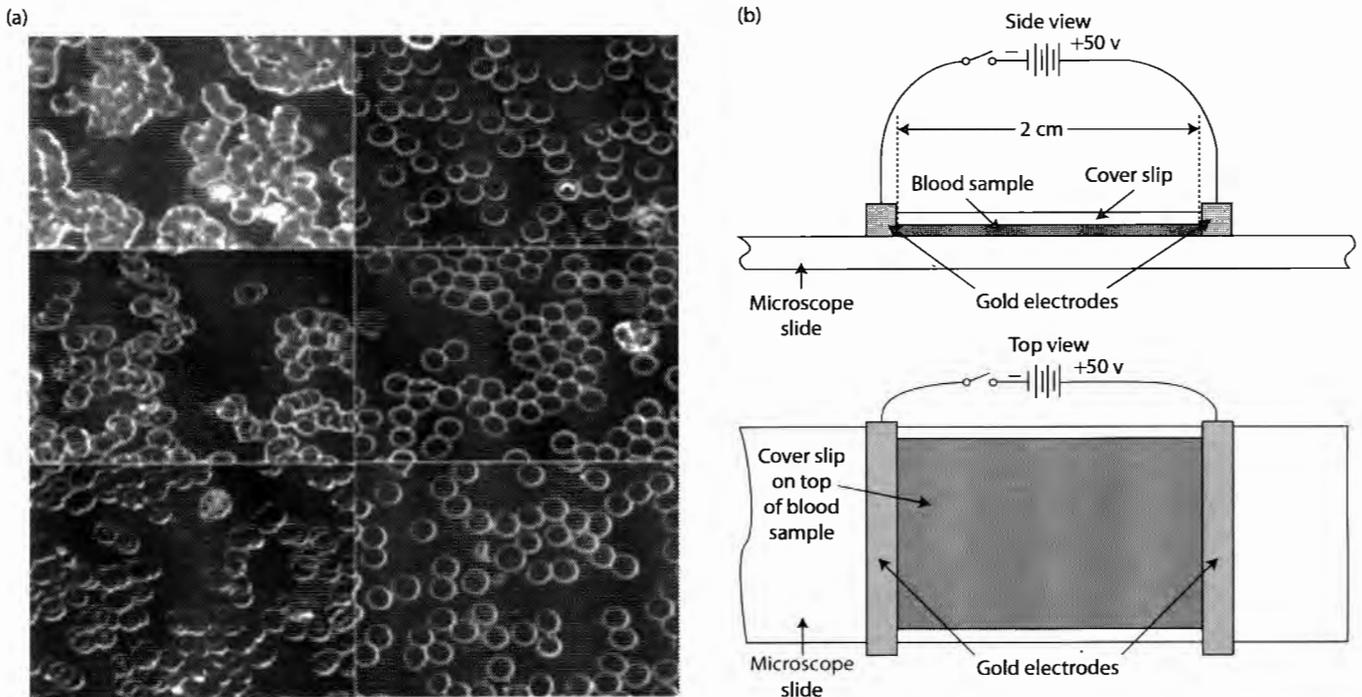


FIGURE 38.13 (a) Reduction in clumping of red cells in three subjects showing before (left) and after 40 min of earthing (right). (b) Apparatus used to measure the electrophoretic mobility (zeta-potential) of red cells before and after earthing.

by T.M. Riddick.⁵⁰ The perspectives Riddick developed on cardiovascular disease are important but have not been widely recognized, probably because rheology is a highly specialized and interdisciplinary subject. Moreover, blood is a very complex material, and many variables affect its ability to carry oxygen, nutrients, and metabolic waste products.

Earthing or grounding significantly reduced RBC aggregation and increased zeta potentials in all samples by an average factor of 2.70. It was concluded that grounding the body increases the surface charge on RBCs, thereby reducing blood viscosity and clumping.

Earthing appears to be one of the simplest and yet most profound interventions for helping reduce cardiovascular risk and cardiovascular events. Elevated blood viscosity has been implicated in virtually every aspect of cardiovascular disease, such as hypertension, left ventricular hypertrophy, peripheral artery disease, etc. Cardiovascular diseases are the number one cause of death worldwide.

MECHANISM OF IMMUNE RESPONSE

We suggest that the mechanism by which earthing influences the immune response to injury is as follows:

- The polyelectrolyte ground substance (Figure 38.14) extends throughout the body. The charged groups on the glycosaminoglycans have enormous capacity to store electrons. In the ungrounded person, these

charge “reservoirs” in the connective tissue ground substance are depleted of electrons (Figure 38.14a). It is thought that electrons in these reservoirs are continually utilized in all the cells and tissues in the body to neutralize reactive oxygen species produced during metabolism and other oxidative processes. Without grounding, the whole body becomes gradually “electron depleted.” When the body connects with the earth, the charge reservoirs in the connective tissue ground substance become saturated with electrons (Figure 38.14b). This is referred to as a state of inflammatory preparedness. An injury to any part of the body will have immediate access to stored electrons in nearby ground substance reservoirs, and this will have a protective effect on healthy tissue.

- It is suggested that the way the ungrounded vs. grounded person reacts to an injury is as shown in Figure 38.15.

Neutrophils are the most abundant white blood cells in mammals. They are the first line of defense of the innate immune system. Neutrophils quickly aggregate at a site of injury, attracted by cytokines. These are small cell-signaling protein molecules produced by activated capillary endothelial cells, mast cells, and macrophages. Neutrophils also release cytokines, which in turn amplify the inflammatory reactions by several other cell types.⁵¹ Electromagnetic interactions

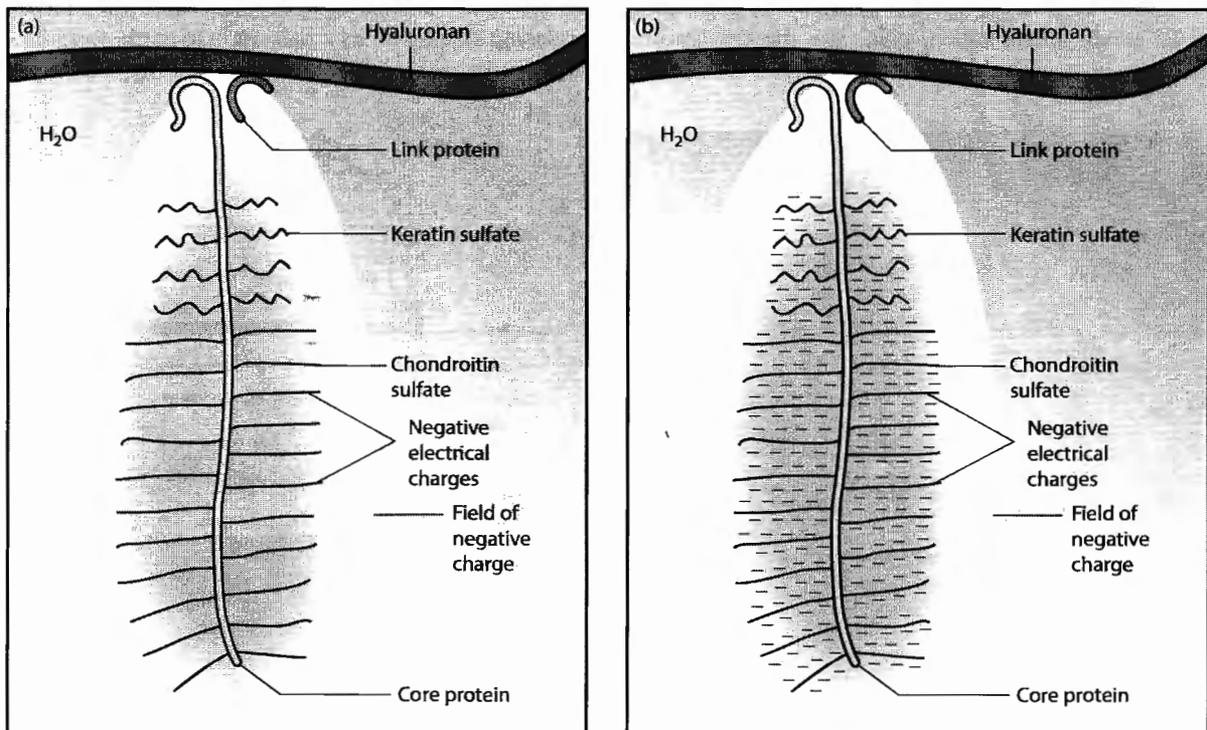


FIGURE 38.14 (a) Ungrounded person: charge reservoirs in the connective tissue ground substance are depleted of electrons. The whole body is “electron depleted.” (b) Grounded person: charge reservoirs in the connective tissue ground substance are saturated with electrons. This is referred to as a state of inflammatory preparedness. (Redrawn from Lee RP. Interface. In: *Mechanisms of Spirit in Osteopathy*. Portland, OR: Stillness Press; 2005. With permission.)

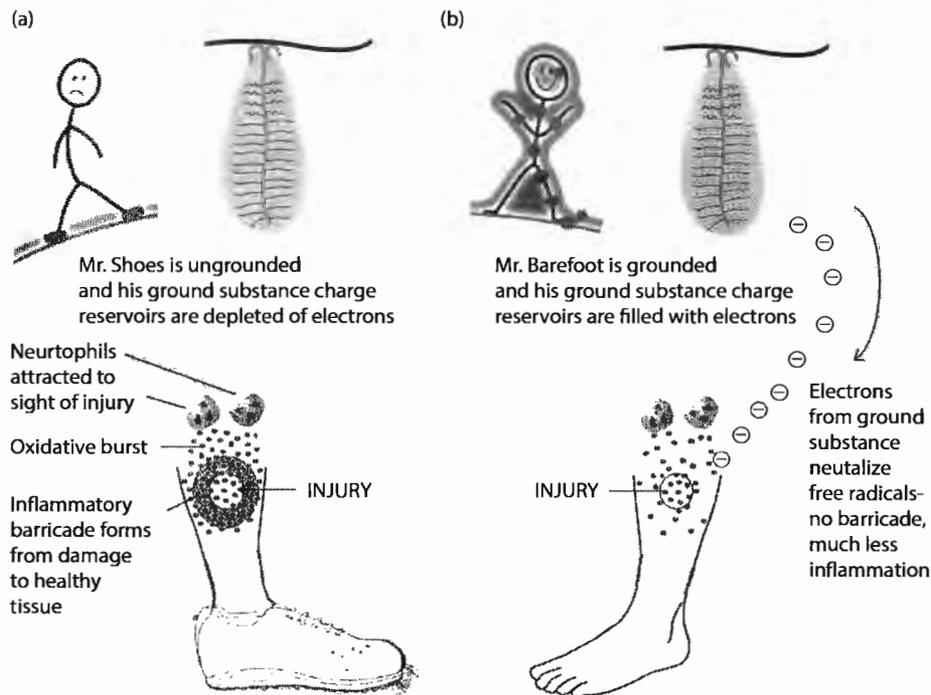


FIGURE 38.15 (a) The ungrounded person will form an inflammatory barricade around the injury site. (b) The grounded person will not form an inflammatory barricade because reactive oxygen species (free radicals) that could damage nearby healthy tissue are immediately neutralized by electrons from the living matrix and from the electron-saturated ground substance.

between the various cytokines may also be involved, as described in the chapter in this book by Oschman and Oschman.⁵² These shifts in activity by white blood cells were documented in the DOMS study (e.g., Figure 38.7).

Neutrophils are phagocytes, capable of ingesting microorganisms or other foreign particles. They can internalize and kill many microbes, each phagocytic event resulting in the formation of a phagosome into which reactive oxygen species (ROS) and hydrolytic enzymes are secreted. The consumption of oxygen during the generation of ROS by various cells of the immune system has been termed the “respiratory burst” or “oxidative burst.” The respiratory burst produces large quantities of two very potent oxidative agents: superoxide and hydrogen peroxide. Most researchers are convinced that superoxide and hydrogen peroxide are the primary active agents in the oxidative burst and the killing of pathogens.⁵³

The inflammatory or Selye or granuloma pouch as described by Selye (Figure 38.16) has been widely used in studies of inflammation.^{54–56} We suggest that the “inflammatory barricade” forming the wall of the pouch is created by damage to healthy tissue in the ungrounded person because of a lack of electrons that would otherwise serve a protective function. If the tissue is healthy and if the ground substance is saturated with electrons as in Figure 38.14b, the tissue matrix will be able to deliver electrons to the healthy tissue surrounding site of injury. In this situation, the inflammatory barricade will not form. This is important because the inflammatory barricade slows or prevents the entry of regenerative cells into the “repair field,” a term introduced by W.D. Kessler.⁵⁷

The mechanism for the movements of electrons in tissues has been described as semiconduction.⁵⁸ Albert Szent-Györgyi made a distinction between E , or energy stored in chemical bonds, and E^* , excited energy that is mobile (Figure 38.17). The basic hypothesis is that the living tissue matrix is a semiconductor network extending throughout the body and is capable of rapidly delivering mobile anti-oxidant electrons, or E^* to any point where a free radical appears. If the matrix is in a healthy state, it will be everywhere conductive to E^* and the mobile electrons from the ground substance reservoirs will quickly migrate toward any reactive oxygen species that form. If the matrix conduction is blocked, or if electrons are not available (electron depletion; Figure 38.14a), the inflammatory barricade will form. When the matrix is healthy and conductive, and when the ground substance is saturated with electrons, healthy tissue will be protected and free radical damage will be minimized.

Selye and others have obtained evidence that necrotic tissue breakdown products from inflammatory pockets can leak into the blood and lymphatic circulation, producing slow but progressive toxicity or atrophy in various organs at a distance from the original site of trauma. For example, on page 161 of the first edition of *The Stress of Life*, Selye describes how he was able to inject inflammatory pouches in rats with irritants or microbes, producing a syndrome characterized by an inflammation of the heart valves (endocarditis) very similar to that which occurs in children suffering from rheumatic fever. Under some conditions, this was accompanied by inflammation of the kidney (nephritis) and excessive stimulation of the blood-forming organs. This inflammatory

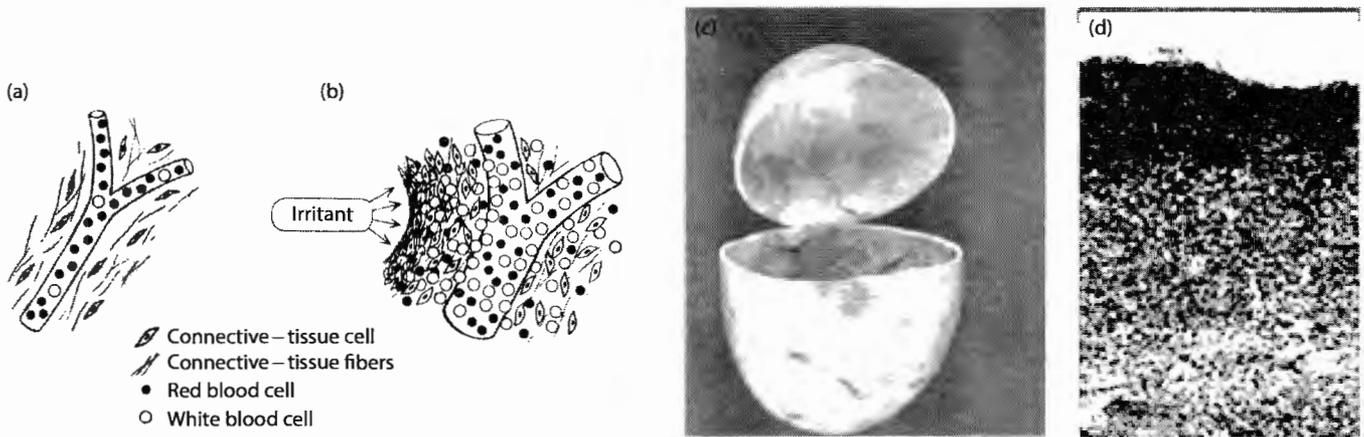


FIGURE 38.16 Formation of the inflammatory barricade, according to Selye.⁵⁵ (a) Normal connective tissue territory. (b) Same tissue exposed to irritant. Vessel dilates, blood cells migrate toward irritant, connective tissue cells and fibers form a thick impenetrable barricade that prevents the spread of the irritant into the blood, but that also prevents the entry of regenerative cells that could repair the tissue. The result can be a long-lasting pocket of incompletely resolved inflammation that can eventually leak toxins into the system and disturb functioning of an organ or tissue. (c) The inflammatory or Selye or granuloma pouch as described by Selye⁵⁵ widely used in studies of inflammation. (d) Histology of the inflammatory barricade: facing the chamber is a wall of connective tissue that is impenetrable to dissolved antioxidants and a barrier to cells that can regenerate damaged tissues (Ben Harrison, WFIRM). Electrons are the ultimate anti-oxidants. It is suggested that electrons can be semi-conducted into the inflammatory pouch where they can neutralize reactive oxygen species (free radicals). (From Selye H. *J Am Med Assoc* 1953;152(13):1207–13.)

pouch concept explains how local pockets of inflammation can trigger a diversity of chronic diseases and disturbances, many of which frustrate the physician because it is difficult to locate the cause. Selye's work tied inflammatory responses with stress, cortisol secretion, and adaptation.

"Silent inflammation" refers to a condition in which the inflamed site is not painful, and may go unnoticed, even though it may be causing problems elsewhere in the body. The phenomenon was described long ago in dentistry, beginning with 25 years of root canal research by Dr. Weston Price,⁵⁹ but currently receives little attention except by "biological" dentists.

The walled off areas as described by Selye may correspond to the dense tissue areas known to practitioners of bodywork, energy, and movement therapies. For example, Ida P. Rolf, in her book, *Rolfing*⁶⁰ stated that: "In practically all bodies, in one muscle or another, small lumps or thickened nonresilient bands can be felt deep in the tissue. The lumps may be as small as small peas or as large as walnuts." Rolf reproduced Selye's picture of an inflammatory pouch produced by injecting air into fascial sheaths (Figure 38.16b). "Some similarly injurious process no doubt gives rise to the lumpy knottings we have noted." Some of the benefits of *Rolfing*® (Structural Integration) and other bodywork, energetic, and movement techniques may derive from their ability to reduce or eliminate these pockets of inflammation, and thereby prevent or relieve chronic illnesses. Likewise, a variety of therapeutic technologies introduce or induce electric currents that flow within tissues. Examples include Frequency Specific Microcurrent,⁶¹ Pulsing Electromagnetic Field Therapies,⁶² Ondamed®,⁶³ and perhaps other devices described in this book. It is worthwhile to explore the possibility that successes with these techniques

may in part be due to induced semiconduction of mobile electrons across inflammatory barricades.

IMPLICATIONS FOR AGING

The leading theory for the cause of aging is the so-called free radical theory. Simply stated, it has been suggested that aging results from the cumulative damage done to cells and tissues by oxidative stress (reactive oxygen and reactive nitrogen species or "free radicals") produced during normal biochemical processes, such as oxidative metabolism, and during the body's natural responses to injury and pollutants. Because the free radical is a molecule with one or more unpaired electrons, it has charge and magnetic properties that make it highly reactive as well as attractive to free electrons. This is the physics that makes these molecules so destructive, they literally rip electrons from pathogens and damaged cells produced during an injury. Key work of Gershman and Gilbert revealed that elevated oxygen atmospheres in incubators were causing retrolental fibroplasia (now called retinopathy of prematurity).⁶⁴ This was one of several clues that led Denham Harman to propose his free radical theory of aging, the most widely studied model of aging.⁶⁵

Today, oxidative stress is being implicated in virtually all of the diseases of aging and in the aging process itself. Recognition of the mobile electron as the ideal antioxidant has led to an explanation of how earthing, as well as a number of clinical devices, are so effective at reducing inflammation and treating chronic diseases. The ability of charges to migrate through the living matrix is relevant to anti-aging medicine because of the potential antioxidant nature of the mobile electrons. While a great deal of research is being

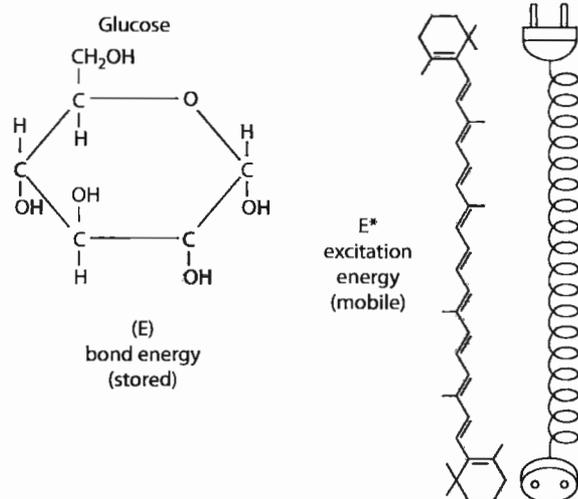


FIGURE 38.17 Albert Szent-Györgyi referred to the immobile electron energy stored in the bonds of the glucose molecule as (E) to distinguish it from mobile excited electrons E*. The carotene molecule on the right contains a series of double bonds, each of which has one electron that is not confined to the bond but is free to move. On the right, he compares the electronically conductive carotene molecule with the power cord for a toaster. The carotene molecule is a semiconductor, whereas the power cord is a conductor. (From Szent-Györgyi A. *Bioelectronics*. New York: Academic Press; 1968. p. 23, Figure 15.8.)

done to correlate inflammation with disease states, there are few theories on the mechanisms involved. The research on earthing has provided a logical and testable theory based on a variety of kinds of evidence. The anti-inflammatory effects of connecting to the earth arise because the earth's surface is an abundant source of excited and mobile electrons.⁶⁶

BRINGING THE EARTH TO YOU

Following on Ober's original discovery¹³ a number of technologies were developed that could simply and conveniently bring the advantages of connecting with the earth into the home or other building (Figure 38.18). These include conductive grounding sheets for the bed, grounding pads for under the feet or wrists when working at a computer, and bracelets that can be worn around the wrist or ankles or chest. Grounding flip-flops and shoes connect people with the earth during the day as they are walking about (Figure 38.18). These shoes have a conductive plug positioned next to Kidney 1 to allow electrons to enter the body. Users of these products report a variety of benefits ranging from improved sleep to reduction or elimination of cardiac arrhythmias. These reports have been summarized in a book by Ober, Sinatra, and Zucker.¹⁵

WHEN IS A RAT A RAT?

The various physiological effects of earthing that have been summarized here bring up the question, "what is a normal organism." The people you see every day vary greatly in their degree of inflammatory preparedness versus electron

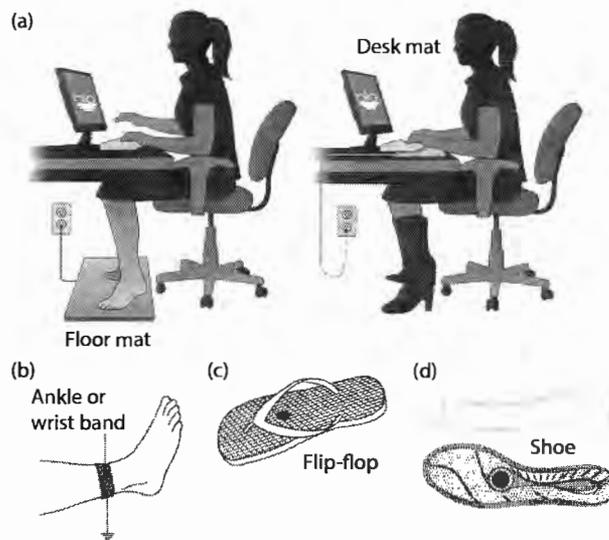


FIGURE 38.18 Methods for bringing earthing into the home or office. (a) Earthing pad for under the feet or wrist in an office. (b) Conductive strap for ankle or wrist. (c) Earthing flip flop with conductive plug at Kidney 1. (d) Women's ballet flat with earthing plug at Kidney 1.

depletion, depending on how long they have been isolated from the surface of the earth. For many, the only contact they have with electrons from the earth is when they take a shower, assuming that the water they are using comes to them through metal pipes buried in the earth. An electron-depleted person may look and feel perfectly normal, just like everyone else. The difference between a grounded and ungrounded person probably does not show up until the person has an injury or is recovering from a disease, or until they begin to age. From our observations, we suspect that the grounded person will heal faster and have a lower probability of developing the chronic diseases associated with aging, compared to the less grounded individual. We also predict that the grounded person will sleep better and show fewer of the well-documented effects of stress. These are hypotheses of sufficient importance for public health and medicine to warrant further study.

In 1906, the Wistar Institute in Philadelphia developed and bred the Wistar rat, the first standardized laboratory animal. The Wistar rat became one of the most popular animals for laboratory research. It is estimated that more than half of all laboratory rats in the USA today are descendants of the original Wistar ratline. The Sprague Dawley rat and Long-Evans strains were developed from Wistar rats. As of December 25, 2013, there are 253,226 peer reviewed studies of Sprague Dawley rats listed in PubMed, and 221,446 articles specifically mentioning the use of Wistar rats. This represents an enormous amount of research. Domestic laboratory rats differ from wild rats in many ways. They are calmer and less likely to bite, they can tolerate greater crowding, they breed earlier and produce more offspring, and their brains, livers, kidneys, adrenal glands, and hearts are smaller.

Much modern research on physiology, biochemistry, genetics, diseases, the effects of drugs, and other topics in health

and medicine has been done with rat models. Laboratory rats have also proved valuable in psychological studies of learning and memory. The historical importance of this species to scientific research is reflected by the amount of literature on it, roughly 50% more than that on laboratory mice.⁶⁷

When research is done with an animal model, the investigators invariably describe the methods they use, including the strain of the animals. This is done so that others can repeat the studies if they wish. An assumption is that all Wistar rats will be genetically and physiologically similar. However, a 1972 study compared neoplasms in Sprague-Dawley rats from six different commercial suppliers. They found highly significant differences in the incidences of endocrine and mammary tumors. There were also significant variations in the incidences of adrenal medulla tumors among rats from the same source raised in different laboratories. The authors of the study “stressed the need for extreme caution in evaluation of carcinogenicity studies conducted at different laboratories and/or on rats from different sources.”⁶⁸

From our perspective, these findings of great variations in animals are not surprising. Among other things, the physiological status and behavior of animals will differ widely depending on the extent of grounding. Are their cages made of metal, and if they are, is that metal grounded? How close are their cages to wires or conduits carrying 60/50 Hz electricity? From the studies reported here, those factors can make a significant difference. In fact, they represent a “hidden variable” that may have affected the outcomes of countless studies, and could have affected the ability of other investigators to reproduce particular studies.

We know that most, if not all, physiological processes involve electrical activities of one sort or another. When nerves conduct, muscles contract, glands secrete, and sensory organs sense electrical processes are involved. These electrical activities are powered by adenosine triphosphate (ATP) generated by the electron transport chain in mitochondria, a system that requires a continuous supply of electrons.

The conventional view is that all electrical activities in a living system involve ionic currents, but there are good reasons, discussed in the chapter by Oschman and Oschman in this book (*Recent Developments in Bioelectromagnetic and Subtle Energy Medicine*), and also in reference 53, to consider electron movements as well. We view the acupuncture meridian system as the most likely candidate for distributing electrons from the earth to the system-wide ground substance material, via the point on the ball of the foot known as Kidney 1 (Figure 38.11b).

A consistent observation is that grounding the human body normalizes physiological balances by equilibrating every part of the body with the electrical potential of the earth, thereby stabilizing the electrical environment for all physiological and regulatory processes. The Sokals referred to the earth as a “universal regulating factor in Nature” that strongly influences bioelectrical, bioenergetic, and biochemical processes. Therefore, we are not surprised by the 1972 study comparing neoplasms in rats from different suppliers or animals raised in different laboratories⁵⁸.

Often researchers struggle to replicate the results of an important study reported by others. They often assume they are doing something wrong. They may not have considered the electrical environment of their experimental animals. A prediction is that some of the variability in outcomes from one laboratory to another would decrease if experimental animals were provided with a standardized electrical environment. For the animals to be fully healthy and “normal,” their cages should be grounded and kept a distance from electrical wiring. This is especially crucial if the study involves measuring recovery from some sort of injury or trauma to the animal being studied. From our experience, the effects of injury or trauma will be very different in grounded versus ungrounded animals.

ELECTRONS VERSUS ANTI-OXIDANTS

Knowing of the potential health effects of reactive oxygen species, commonly called free radicals, and the need to reduce oxidative stress and inflammation to prevent the diseases of aging, it has been easy to convince the public that dietary supplements containing anti-oxidants should keep everyone healthy and prolong lives. An enormous and highly profitable dietary supplement and vitamin business has emerged to meet the resulting demand. Unfortunately, there are fundamental problems with dietary antioxidants.

Dr. David B. Agus is one of the world’s leading cancer doctors and a pioneering biomedical researcher. His book, *The End of Illness*, was number one on the New York Times Bestseller List.⁶⁹ After reviewing the literature on anti-oxidants, he made the controversial statement shown in the box. As an expert on the body as a complex system, he speaks with some authority on the fact that we still do not know enough about the regulation of oxidative metabolism to be certain about what dietary antioxidants do to the body’s normal balancing act between creating free radicals and neutralizing them.

A second issue arises from Agus’ statement that “...once inside the human body, they seem strangely powerless.” One reason for this is the impenetrable inflammatory barricade, a wall of connective tissue surrounding a site of injury (Figure 38.16). As collagen is a semiconductor,⁷⁰ this barrier is readily traversed by mobile electrons, but not by dissolved anti-oxidants.

Since the early 1990s scientists have been putting these compounds through their paces, using double-blind randomized controlled trials – the gold standard for medical intervention studies. Time and again, however, the supplements failed to pass the test. True, they knock the wind out of free radicals in a test tube. But once inside the human body, they seem strangely powerless. Not only are they bad at preventing oxidative damage, they can even make things worse. Many scientists are now concluding that, at best, they are a waste of time and money. At worst they could be harmful.

Recent discoveries on the ways water associates with the surfaces of proteins and cell membranes reveals a fundamental and little recognized aspect of how anti-oxidants and other substances move within the body. The usual view is that they are absorbed across the intestinal wall, enter the circulatory system, then diffuse from capillaries into the extracellular spaces, and thence to the cells. Gerald Pollack and his colleagues have determined that the water adjacent to surfaces is in a so-called “fourth phase” that makes it distinctly different from the familiar phases: solid, liquid, or gas.⁷¹ The water adjacent to hydrophilic surfaces, such as cell membranes, proteins, and many other molecules is highly ordered into a liquid crystalline arrangement that excludes solutes. Pollack refers to this as the “exclusion zone” and to this aqueous phase as exclusion zone or EZ water (Figure 38.19).

There has been a long debate about the nature of water inside of cells (reviewed, for example, by Luby-Phelps)⁷² and it now appears that cells contain little water in which molecules can dissolve and diffuse from place to place. The cell is so filled with highly ordered liquid crystalline proteins/water complexes and exclusion zones that there is little room for the diffusion of solutes. On the basis of Pollack’s work, it now appears that the same may be true of the extracellular spaces in the body, as they are virtually filled with polyelectrolyte

gel or ground substance. Hence, much of the water inside the body is trapped in a gel state.

This raises a new question. Precisely how do antioxidant molecules get from the circulatory system to the places where they are needed to combat inflammation? Exclusion zones may be found throughout the extracellular spaces that were previously viewed as containing “bulk water” through which molecules can diffuse from place to place. Pollack’s work shows that the exclusion zone excludes the protein albumin as well as various dyes with molecular weights as low as 100 daltons, only a little larger than common salt molecules. The inflammatory barricade acts as a further barrier to the diffusion of antioxidants into the “repair field” left behind after an injury.

The free or mobile electron does not have this problem. We view the entire healthy fabric of the body as a semiconductor network. Electrons from the earth can enter this network via the point on the ball of the foot known as Kidney 1, and can be rapidly semi-conducted to any point in the body where they are needed to refill charge reservoirs or to neutralize free radicals.

A final difficulty with the dietary antioxidant story is the manner by which the scientist/entrepreneur demonstrates the value of antioxidant substances. A typical story:

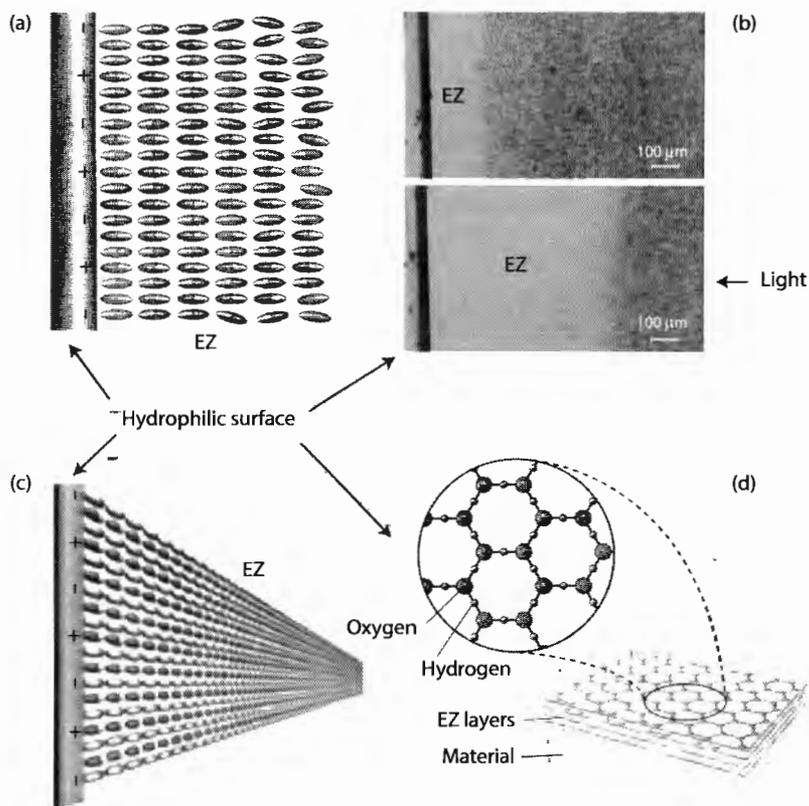


FIGURE 38.19 (See color insert.) (a) Dipolar water molecules (electronegative region shown in red) line up adjacent to a hydrophilic (water-loving) surface. (b) The region close to the surface excludes solutes, demonstrated here with the use of microspheres. The lower picture shows how the exclusion zone is expanded in the presence of light. (c) The exclusion zone extends far from the hydrophilic surface. (d) The water molecules form honeycomb sheets. (From Pollack G. *The Fourth Phase of Water: Beyond Solid, Liquid and Vapor*. Seattle, WA; Ebner & Sons; 2013.)

Someone picks a perfectly innocent plant, like the blueberry. They chemically extract a molecule from blueberries. Then they put cultured cells in a Petri dish or test tube. These poor cells are under severe oxidative stress, as they are being exposed to an oxygen concentration that is 5–10 times higher than they would ever experience *in vivo*. Under these stressful conditions, the cells secrete measurable amounts of reactive oxygen species (free radicals) in an effort to survive. To this nonbiological preparation our investigator/entrepreneur adds a bit of their blueberry extract. The levels of reactive oxygen species (free radicals) drop significantly. Voilà! We have something we can sell. With a combination of this awful science and good advertising, a billion or so dollars' worth of the antioxidant supplement are sold. A lot of perfectly good blueberries are used up in the process, and many unsuspecting people have less money but no less inflammation.

We can make a distinction between physical anti-inflammatory methods (earthing) and chemical anti-inflammatory methods (blueberries, cranberry capsules, Green tea extract, effervescent vitamin C, pomegranate concentrate, beta carotene, selenium, grape seed extract, high-dose vitamin E, pine bark extract, bee spit, and the like). The case for this is put forward succinctly in *The Antioxidant Myth: A Medical Fairy Tale*.⁷³

The flow of electrons from the earth into the body via Kidney 1, located on the ball of the foot (Figure 38.11), and then throughout the meridian system, can explain how the mobile electron can serve as a natural antioxidant. A working hypothesis is that the body is composed of semiconducting materials that form a network (called the living matrix) that extends throughout the body. It can thereby saturate all of the polyelectrolyte polymers or ground substance matrix with electrons that are then available to participate in any inflammatory process, large or small, taking place in any tissue in the body.

This is not to say that earthing does not affect the chemistry of the body. Most, if not all, biochemical reactions are redox reactions involving transfers of electrons. Paul H. Scudder has published a book on organic chemistry in which all of the organic reactions are described in terms of electron transfers.⁷⁴ Scudder breaks down common organic processes into their basic units to explain the electron flow pathways that underlie these processes. The glycosaminoglycan ground substance stores electrons so they will be available where and when needed. This point was confirmed by one of the leading experts on ground substance, Professor Hartmut Heine.⁷⁵ It appears that the ground substance can become depleted of electrons when a person has not contacted the earth for a long time.

CONCLUSIONS

The earthing or grounding studies can be summarized with the statement that connecting with the earth is easy and can have many benefits. It is something anyone can do without cost by simply removing their shoes and socks and walking barefoot on the earth. Various methods have been developed

to bring an earth connection into the home or office. It has been suggested that this is especially important for those living or working in high-rise buildings.

The research on earthing has revealed a new picture of the nature of inflammation and the reason it can lead to chronic diseases. We can see the inflammatory barricade, which was recognized in ancient times and is still accepted by Western medical science as a common response to injury, does not have to form. Prevention of chronic inflammation is accomplished by having the body's ground substance reservoirs saturated with electrons that can prevent "collateral damage" in healthy tissues, provided that the person is grounded and the living matrix is functioning properly.

REFERENCES

- Ostwald W. *Grosse Mdnner*. Leipzig: Akademische Verlagsgesellschaft GmbH; 1909.
- Szent-Györgyi A. Dionysians and apolionians. *Lett Sci* 1972;176:966.
- Pub Med is the database of the National Library of Medicine, USA. Available online from www.ncbi.nlm.nih.gov/pubmed/.
- Swartz K. Projected costs of chronic diseases. *Health Care Cost Monitor. The Hastings Center*. Available online from <http://healthcarecostmonitor.thehastingscenter.org/kimberlySwartz/projected-costs-of-chronic-diseases> (accessed January 18, 2011).
- Gorman C, Park A, Dell K. Health: The Fires Within. Inflammation is the body's first defense against infection, but when it goes awry, it can lead to heart attacks, colon cancer, Alzheimer's and a host of other diseases. *Time Mag* 2004; Feb. 23:38–46.
- Chief Luther Standing Bear. Quoted from McLuhan TC. *Touch the Earth*. New York: Outerbridge & Dienstfrey; 1971.
- Just A. *Return to Nature: The True Natural Method of Healing and Living and The True Salvation of the Soul*. New York: B. Lust; 1903.
- White GS. *The Finer Forces of Nature in Diagnosis and Therapy*. Los Angeles, CA: Phillips Printing Company; 1929.
- Olson SF. <http://www.kauaiyogaandfitness.com/the-awesome-benefits-of-walking-on-the-earth-barefoot/> (accessed December 13, 2013).
- Rossi WA. *The Sex Life of the Foot and Shoe*. Hertfordshire, UK: Wordsworth Editions; 1989; vol. 61.
- Partnership to Fight Chronic Disease 2011. Available online from www.fightchronicdisease.org/issues/about.cfm (accessed January 19, 2011).
- Reuters, London, November 14, 2013, cited from *Huffington Post*, http://www.huffingtonpost.com/2013/11/14/diabetes-worldwide-global-record-cases_n_4269979.html
- Ober AC. Grounding the human body to earth reduces chronic inflammation and related chronic pain. *ESD J* 2003; July. <http://www.esdjournal.com/articles/cober/earth.htm>.
- Sokal K, Sokal P. Earthing the human body influences physiologic processes. *J Alternat Compl Med* 2011;17(4):301–8.
- Ober C, Sinatra ST, Zucker M. *Earthing: The Most Important Health Discovery Ever?* Laguna Beach, CA: Basic Health Publications; Second Edition, 2014.
- Brown R, Chevalier G, Hill M. Pilot study on the effect of grounding on delayed-onset muscle soreness. *J Alternat Compl Med* 2010;16(3):265–73.

17. Ober AC. Grounding the human body to neutralize bioelectrical stress from static electricity and EMFs. *ESD J* 2004; February 22. <http://www.esdjournal.com/articles/cober/earth.htm>.
18. Ober AC, Coghill RW. Does grounding the human body to earth reduce chronic inflammation and related chronic pain? Paper Presented at the *European Bioelectromagnetics Association annual meeting*. Budapest, Hungary; November 12, 2003.
19. Williams E, Heckman S. The local diurnal variation of cloud electrification and the global diurnal variation of negative charge on the Earth. *J Geophys Res* 1993;98(3):5221–34.
20. Christian HJ, Blakeslee RJ, Boccippio DJ, Boeck WL, Dennis E, Buechler DE et al. Global frequency and distribution of lightning as observed from space by the optical transient detector. *J Geophys Res* 2003;108:(D1):4-1–4-15.
21. Bertrand CL. Ed. *Electrostatics: Theory and Applications*. Hauppauge, New York: Nova Science Publishers, Inc.; 2013. p. 332.
22. Kantrowitz B. Why we can't sleep. What science is learning about your 'sleep switch.' *Newsweek* 2002; July 16:38.
23. Weintraub A. I can't sleep. Insomnia and other sleep disorders are sapping our strength and taxing the economy. Help is on the way. *Bus Week* 2004; July 26:66–74.
24. NIH State-of-the-Science Conference on Manifestations and Management of Chronic Insomnia in Adults 2005. Available online from <http://consensus.nih.gov/2005/insomniastatement.htm> (accessed June 13-15, 2005).
25. Ghaly M, Teplitz D. The biological effects of grounding the human body during sleep, as measured by cortisol levels and subjective reporting of sleep, pain and stress. *J Alternat ComplMed* 2004;10:767–76.
26. Alschuler L. Stress: Thief in the night. *Int J Integ Med* 2001;3:27–34.
27. Björntorp P. Do stress reactions cause abdominal obesity and comorbidities? *Obes Rev* 2001;2(2):73–86.
28. Cohen S, Kessler RC, Gordon LU, Eds. *Measuring Stress: A Guide for Health and Social Scientists*. New York: Oxford University; 1995.
29. Baum A, Grunberg N. Chapter 8. In: Cohen S, Kessler RC, Gordon LU, Eds. *Measuring Stress: A Guide for Health and Social Scientists*. New York: Oxford University Press; 1995. p. 175–92.
30. Follenius M, Brandenberge G, Bandesap JJ, Libert JP, Ehrhart J. Nocturnal cortisol release in relation to sleep structure. *Sleep* 1992;15:21–7.
31. Vgontzas AN, Zoumakis M, Papanicolaou DA, Bixler EO, Prolo P, Lin HM et al. Chronic insomnia is associated with a shift of interleukin-6 and tumor necrosis factor secretion from nighttime to daytime. *Metabolism* 2002;51:887–92.
32. Rodenbeck A, Huether G, Ruther E, Hajak G. Interactions between evening and nocturnal cortisol secretion and sleep parameters in patients with severe chronic primary insomnia. *Neurosci Lett* 2002;324:159–63.
33. Akerstedt T, Arnetz B, Ficca G, Paulson LE, Kallner A. A 50-Hz electromagnetic field impairs sleep. *J Sleep Res* 1999;8:77–81.
34. Li CY, Chen PC, Sung FC, Lin RS. Residential exposure to power frequency magnetic field and sleep disorders among women in an urban community of Northern Taiwan. *Sleep* 2002;25:428–32.
35. Mann K, Wagner P, Brunn G, Hassan F, Hiernke C, Roschke J. Effects of pulsed high-frequency electromagnetic fields on the neuroendocrine system. *Neuroendocrinology* 1998;67:139–44.
36. Borbely AA, Huber R, Graf T, Fuchs B, Gallmann E, Achermann P. Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram *Neurosci Lett* 1999;275:207–10.
37. Huber R, Graf T, Cote KA, Wittmann L, Gallmann E et al. Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG. *Neuroreport* 2000;11:3321–5.
38. Mann K, Roschke J. Effects of pulsed high-frequency electromagnetic fields on human sleep. *Neuropsychobiology* 1996;33:41–7.
39. Korszun A, Young EA, Singer K, Carlson NE, Brown MB, Crofford L. Basal circadian cortisol secretion in women with temporomandibular disorders. *J Dent Res* 2002;81:279–283.
40. Jardim-Perassi BV, Arbab AS, Ferreira LC, Borin TF, Varma NR et al. Effect of melatonin on tumor growth and angiogenesis in xenograft model of breast cancer. *PLoS One* 2014;9(1):1–11.
41. Bobbert MF, Hollander AP, Hulling PA. Factors in delayed onset muscular soreness of man. *Med Sci Sports Exerc* 1986;18:75–81.
42. Applewhite R. The effectiveness of a conductive patch and a conductive bed pad in reducing induced human body voltage via the application of earth ground. *Euro Biol Bioelectromagn* 2005;1:23–40.
43. Feynman R, Leighton R, Sands M. *The Feynman Lectures on Physics*, II. Boston, MA, USA: Addison-Wesley; 1963.
44. Chevalier G. A new factor to consider regarding health risks of living in multi-story buildings. Unpublished manuscript.
45. Wolinsky FD, Bentler SE, Cook EA, Chrischilles EA, Liu L et al. A 12-year prospective study of stroke risk in older Medicare beneficiaries. *BMC Geriatr* 2009;9:17. doi:10.1186/1471-2318-9-17. Available online from www.biomedcentral.com/1471-2318/9/17 (accessed December 16, 2013).
46. Jamieson KS, ApSimon HM, Jamieson SS, Bell JNB, Yost MG. The effects of electric fields on charged molecules and particles in individual microenvironments. *Atmos Environ* 2007;41(25):5224–35.
47. Genus SJ. Fielding a current idea: Exploring the public health impact of electromagnetic radiation. *Pub Health* 2008;122(2):113–24.
48. Krogsgaard D, Lund Frandsen P. Inflammation—Enemy and friend. Available online from <http://www.touchpoint.dk/wss/touchpointuk.asp?page=12915>.
49. Greer JP, Foerster J, Lukens JN, Eds. *Wintrobe's Clinical Hematology*. 11th Ed., vol. 1. Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1167.
50. Riddick TM. *Control of Colloid Stability through Zeta Potential*. Wynnewood, PA: Livingston; 1968.
51. Ear T, McDonald PP. Cytokine generation, promoter activation, and oxidant-independent NF-kappaB activation in a transfectable human neutrophilic cellular model. *BMC Immunol* 2008;9(14):17.
52. Oschman JL, Oschman NH. Recent developments in bioelectromagnetic and subtle energy medicine. In: *Bioelectromagnetic and Subtle Energy Med*. New York, NY: Taylor & Francis/CRC Press; 2017.
53. Pohl S, Tu WY, Aldridge PD, Gillespie C, Hahne H et al. Combined proteomic and transcriptomic analysis of the response of *Bacillus anthracis* to oxidative stress. *Proteomics* 2011;11:1–20.
54. Selye H. *The Stress of Life*. New York: Mc-Graw-Hill Book Company; 1956.
55. Selye H. On the mechanism through which hydrocortisone affects the resistance of tissues to injury; an experimental

- study with the granuloma pouch technique. *J Am Med Assoc* 1953;152(13):1207–13.
56. Davis RH, Pitkow HS, Shovlin KA. Anti-inflammatory effect of tryptophan in Selye pouch. *J Am Podiat Assoc* 1981;71(12):690–91.
 57. Kessler W-D, Oschman JL. 2009. Contracting aging with basic physics. In: Klatz R, Goldman R, Eds. *Chapter 23 in Anti-Aging Therapeutics Vol. XI*. Chicago IL: American Academy of Anti-Aging Medicine; 2009. p. 185–94.
 58. Oschman JL. Charge transfer in the living matrix. *J Bodywork Move Therap* 2009;13:215–28.
 59. Meinig GE. *Root Canal Cover-Up*. 2nd ed. Ojai, CA: Bion Pub; 1994.
 60. Rolf IP. *Rolfing. Reestablishing the Natural Alignment and Structural Integration of the Human Body for Vitality and Well-Being*. Rochester, VT: Healing Arts Press; 1989. p. 129.
 61. McMakin CR. Microcurrent therapy: A novel treatment method for chronic low back myofascial pain. *J Bodywork Move Therap* 2004;8(2):143–53.
 62. Bassett CAL. Bioelectromagnetics in the service of medicine. In: Blank M, Ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Advances in Chemistry Series 250. Washington, DC: American Chemical Society; 1995. p. 261–75.
 63. Oschman JL, Kosovich J. Energy medicine and matrix regeneration. In: Klatz R Goldman R, Eds. *Anti-Aging Therapeutics, Vol. X*. Chicago IL: American Academy of Anti-Aging Medicine; 2007. p. 203–10, chap. 10.
 64. Gerschman R, Gilbert DL, Nye SW, Dwyer P, Fenn WO. Oxygen poisoning and X-irradiation: A mechanism in common. *Science* 1954;119:623–6.
 65. Harman D. Aging: A theory based on free radical and radiation chemistry. *J Gerontol* 1956;11(3):298–300.
 66. Chevalier G. The earth's electrical surface potential. A summary of present understanding. 2007. http://74.63.154.231/here/wp-content/uploads/2013/06/Chevalier_electrical_surface_potential-2007.pdf
 67. Krinke GJ. History, strains and models. The laboratory rat. In: Bullock GR, Buknton T, Series Eds. *Handbook of Experimental Animals*. New York: Academic Press; 2000. p. 3–16.
 68. Mac Kenzie WF, Garner FM. Comparison of neoplasms in six sources of rats. *J Natl Cancer Inst* 1973;50(5):1243–57.
 69. Agus DB. *The End of Illness*. New York: Simon & Schuster, Inc.; 2011.
 70. Gascoyne PRC, Pethig R, Szent-György A. Water structure-dependent charge transport in proteins. *Proc Natl Acad Sci USA* 1981;78(1):261–5.
 71. Pollack G. *The Fourth Phase of Water: Beyond Solid, Liquid and Vapor*. Seattle, WA: Ebner & Sons; 2013.
 72. Luby-Phelps K. Cytoarchitecture and physical properties of cytoplasm: Volume, viscosity, diffusion, intracellular surface area. *Int Rev Cytol* 2000;192:189–221. [Review].
 73. Melton L. The antioxidant myth. August 2006; *NewScientist.com news service*. www.newscientist.com/channel/health/mg19125631.500.html.
 74. Scudder PH. *Electron Flow in Organic Chemistry: A Decision-Based Guide to Organic Mechanisms*. 2nd ed. Hoboken, NJ: Wiley; 1913.
 75. Heine, H. *Personal Communication*. Baden-Baden, Germany; November 2008.
 76. Amalu, Medical Thermography case studies. Clinical Earthing Application in 20 Case Studies. http://74.63.154.231/here/wp-content/uploads/2013/06/Amalu_thermographic_case_studies_2004.pdf
 77. Chevalier G, Mori KD. The effect of earthing on human physiology. Part 2: Electrodermal measurements. *Subtle Energy Med* 2007;18(3):11–34.
 78. Chevalier G, Mori K, Oschman JL. The effect of earthing (grounding) on human physiology. *Eur Biol Bioelectromagnet* 2006;2(1):600–21.
 79. Lee RP. Interface. In: *Mechanisms of Spirit in Osteopathy*. Portland, OR: Stillness Press; 2005.
 80. Szent-Györgyi A. *Bioelectronics*. New York: Academic Press; 1968. p. 23.