The Theology of Medicine and the Unique Design of the Human Body

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Edited by

Michael Henein

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FOREWORD

O Lord, our Sovereign,
how majestic is your name in all the earth!
what are humans that you are mindful of them,
mortals that you care for them?
Yet you have made them a little lower than angels
and crowned them with glory and honor.

(Psalm 8:1,4-5)

We are pleased to commend this volume of essays on the mystery and miracle of the human creation by Professor Henein and his distinguished colleagues. They examine all the systems of the human body in their complexity and in their interdependence, and show us how remarkable the created order is. The human being is the crown of creation.

The Christian faith has always understood the human body to be holy, for we are made "in the image and likeness of God" (Gen. 1:26-27), and therefore our bodies are "members of Christ" (1 Cor. 6:15) and "temples of the Holy Spirit" (1 Cor. 6:19). We know from the resurrection of our Lord Jesus Christ that we too shall be raised, body and soul, in the age that is to come. As Saint Paul affirms, "if we have been united with him in a death like his, we will certainly be united with him in a resurrection like his" (Rom. 6:5).

God himself was pleased to take upon himself our own human flesh and to be born as one of us: "the Word became flesh and lived among us, and we have seen his glory" (John 1:14). Just as God shared in our humanity, so we shall come to share in his divinity.

The Church Fathers asserted that human persons, by virtue of our creation in the image and likeness of God, are born to enjoy communion with God, to stand in special relationship with God, and to have within ourselves the unique capacity for *deification* – union with God himself. In our physical bodies we are invested with this divine longing and capability. As Saint Gregory of Nyssa says in *The Great Catechism*, the human person has "something in his nature akin to that in which he is to participate."

In contrast to the Greek philosophers, who emphasized the "measure" of the body and its parts, the Christian faith emphasises the body's unity and harmony. "For just as the body is one and has many members, and all the members of the body, though many, are one body, so it is with Christ" (1 Cor. 12:12).

Professor Henein and his colleagues have done us a great service in showing to us the wisdom of God as it is revealed in the human body and the manner of its functioning. As always, science is not a war with religion, nor religion with science. They are mutually informative to us of the mystery of creation. In the human body is the ordered universe in microcosm, and as we contemplate it we are filled with awe and wonder.

With our Patriarchal Blessing.

Theophilos III
Patriarch of Jerusalem

PREFACE

FROM THE CREATOR'S WISDOM

God created heaven, earth and everything therein in such a meticulous way with physical rules binding the universe together. Such immaculate and precise discipline has taken man thousands of years, generation after generation, to comprehend only in part. The full secrets behind the formation of the universe, however, remain a mystery.

A striking pattern is clearly seen in our solar system with the way the planets circulate around themselves and the sun. The planets closest to the sun are the hottest due to the unbearable heat generated by the sun's gases, while the distant ones are the coldest. Hence the Creator chose the earth as the most suitable heat environment for the creations to live on and enjoy life. Additionally, the gravitational pull of the sun against the gravity of the planets made the earth the only suitable planet for creations to walk on and fly within range with stability, so life can develop and be sustained. Furthermore, the unique speed at which each planet rotates around itself for all parts to be exposed to the sun, made the earth a unique inhabitant for all creations. While the earth rotates around itself once every 24 hours, Venus's full rotation takes 116 earth-days, whereas Jupiter only 10 earth hours. Again, this explains why the earth is the most convenient planet for life, as we know it, to develop. Finally, the amazing speed of and within our solar system points to the great wisdom of the Creator, while for the earth to achieve a one-day circle it rotates at a speed of 1000 mile/hour, the same earth rotates around the sun with a speed of 67,000 mile/hour but the solar system itself travels within the universe at a speed of 448,000 mile/hour.

Following the same wisdom in creation, one can think of the amount of water and its distribution on the earth, its evaporation with heat, and cloud formation which makes the rain needed to maintain life on earth. This cycle can not be fully understood without recognizing the pressure difference in the firmament of heaven and the presence of the winds and their speed and change of direction.

This brings us to the order of the creation on the earth and how it is precisely and orderly described in the book of Genesis and the impossibility of having any of the creations in a different order. For example, plants and vegetations had to be created before the animals and the birds which were to live off them. Similarly, the animals and the sea kingdom had to be created before the humans who would feed on and have companionship with them.

Now, let us narrow the angle further and look critically at the human body which was created in the image of God as stated in the Book of Genesis. It is very clear that human creation is quite different from the rest of the creations, although all living creatures on earth share their DNA, according to recent scientific discoveries. It is said "Let the earth bring forth plants, animals, birds…but on the sixth day, God said 'Let us make man in our image,' so God took dust and blew in it the spirit of life and formed Adam." Thus, God in His full wisdom had designed man's body in a certain way, sharing some features with other earthly creatures, such as two eyes, two ears, etc., but unique in many others, having been formed of the additional spirit of life from the Creator Himself. This full knowledge of the human body is confirmed by the words of Lord Jesus: 'And even the very hairs of your head are all numbered' (*Luke 12:7*). This is the basis of the famous prayer of the ill, which is practiced in many churches, including the Coptic, Greek and Syriac churches: 'You are the true physician of our souls and bodies.'

This prayer states that Lord Jesus is the Healer of our soul and our body, irrespective of the type of illness. We can then consider Him in the 21st century medical language a 'multi-disciplinary specialist.' In fact, the life of the Lord and the mysterious miracles described in the four gospels, confirm that view as well as Him being the Maker of the human body.

He revived Lazarus's disintegrating brain cells after 4 days of death and resurrected him;
He created new eye globes for the born blind and touched the eyes of the blind so they saw;
He made the deaf and the dumb hear and speak and fixed Malkhos's ear after being cut;
He cured Bethesda's paralytic's spinal cord and atrophied muscles after 38 years;
He cured the bleeding woman of either fibroid disease or a blood disorder;
He cured the leper's skin and atrophied extremities with fresh healthy tissue; and

He healed Peter's mother-in-law from fever, very likely to have been a serious infection.
Even dead hearts are returned back to life with a word from Him, their Creator.

Michael Henein

INTRODUCTION

PROF. HUGH ROSS

You may be wondering why an astrophysicist would be invited to introduce a book about the human body. *Curiosity* seems the best and simplest answer. As someone who observes and describes the fine-tuned features of the universe, the Milky Way Galaxy, the solar system, Earth, etc., that make possible humanity's existence, I was struck by this question: If the indicators of design in non-living systems prove so numerous, intricate, and complex as to fill multiple books (with more still to come), what design indicators are likely to emerge from close examination of the most complex living system the universe holds?

This book offers a response to my question, raised in conversation with my friend Michael Henein and other medical professionals who specialize in understanding how the human body works. Prof. Henein then brought together a team of researchers and specialists to present their findings, and I know you'll be as fascinated as I am with the insights they provide. In fact, I anticipate that their writings will spur me to uncover still more astrophysical design features both in the wider cosmos and in Earth's 4.5662 billion-year history, features that ultimately support humanity's existence on Earth.

Now, allow me to make another, more personal introduction: Hello. My name is Hugh, and I am addicted to thinking. No matter what I do, I cannot stop thinking. I have tried everything—taking naps, fishing, hiking, gardening, playing cards, chasing my dog, being chased by my cat, watching films and television. Nothing works. I am a compulsive thinker, and I suspect you can relate. All of us humans are addicted to thinking. We appear uniquely designed to think continuously and, sometimes, profoundly.

The human propensity to think at all times has been noted by anthropologists. They refer to us as *Homo sapiens*, which means thinking man. However, *Homo sapiens* in the anthropological literature often

includes not just modern humans but earlier hominins such as Neanderthals, Denisovans, and *Homo sapiens idaltu*. In such contexts, the anthropological term for modern humans is *Homo sapiens sapiens*. Does this repetition suggest that what distinguishes modern humans from all other hominins is that we think twice before acting? I think not.

In my current roles as a professor, author, teaching pastor at a church located between the California Institute of Technology and Jet Propulsion Laboratory, founder and senior scholar at a science-faith organization, I have ample time to study the scientific literature across a wide range of disciplines. Though I am not a medical researcher, I have read extensively on the topic of human exceptionalism. Three recent findings seem particularly fascinating. Research has shown that we humans, *Homo sapiens sapiens*, are unique in our ability not only to continually, effortlessly, and profoundly think but also to communicate what we are thinking to other humans. Please allow me to share these discoveries with you before pointing you toward each of the genuine experts in the wonders of human vitality.

Capacity to Think and Ambulate Simultaneously

During morning hikes or jogs through nearby hills, I'm inclined to ponder recently read research papers, perform calculations, plan articles in progress, and postulate solutions to problems. Sometimes, I get so caught up in these mental endeavors that I end up covering more distance than intended. Among Earth's animals, this capability to multitask by engaging in complex thought while walking or running over rough terrain is unique to human beings. A recent study published by Megan McAllister and four Canadian colleagues establishes the details and scope of this capability.[1]

The team performed a variety of tests on eight adult volunteers who were fitted with an exoskeleton and asked to walk on a treadmill. The exoskeleton leg brace, powered by the researchers, applied varying degrees of pressure to the volunteers' lower limbs. While experiencing variable pressure on their legs at varying treadmill speeds, the volunteers listened to a series of tones and indicated the pitch of each by pressing buttons with either their right or left hands.

McAllister's team observed that no matter how distracted the volunteers may have been by their need to concentrate on the tones, they quickly adopted the most energy-efficient and stable walking stride. In their tonal identification, the volunteers scored just as well when experiencing variable walking speeds and

variable pressure on their legs as when experiencing no variations or when not walking at all. The researchers also noted that regardless of the changes in speed and/or degree of stress applied to the subjects' leg muscles, the subjects were unaware of having adjusted their walking gait. McAllister and her team determined that adopting the most efficient and stable walking gait occurs so automatically as to offer no interference with complex thinking. Apparently, energy optimization while walking involves implicit mental processing that allows attentional mental resources to be fully directed toward challenging cognitive objectives. As McAllister commented, "When people adapt to energy-optimal ways of walking, they do so without having to consciously think about it."[2]

The research group discussed how their experiments show ways that post-injury rehabilitation practices could be improved to deliver faster and more effective recoveries. Beyond this therapeutic application, design and philosophical implications arise.

In addition to engaging in sustained complex thinking while walking at different rates through a variety of terrains, humans also engage in complex communication in such circumstances. I can recall, for example, strenuous hikes with Caltech astrophysicists in the Sierra Nevada Mountains during which we were able to discuss and solve challenging research problems.

Humans' ability to engage in sustained complex thinking and communication while traversing long distances in difficult terrain may help explain the relatively rapid extinction of various bipedal primates upon the arrival of humans. Such a capacity certainly would have given humans a distinct advantage in procuring food and shelter. It may even help explain why humans alone, among the dozen or so species of bipedal primates were not trapped in technological stagnation and, instead, demonstrated rapid, sustained technological advance.

Capacity to Chew, Think, and Interact Simultaneously

Vertebrates' chewing activity dates back 260 million years and is especially prominent in mammals. Mammals possess the bone and muscle structure for the vertical and horizontal jaw movements and precise occlusion required for efficient mastication of food. Their unique jaw, mouth, and tooth design has contributed to mammals' global radiation on the continents and in the oceans.[4]

Mastication contributes significantly to the energy efficiency of swallowing and digestion. Animals need to reduce food into small particles and then mix and lubricate these particles with saliva. The amount of energy required to reduce food from its ingested size down to what's needed for swallowing and digestion significantly impacts the amount of energy available for other purposes.

Mastication engages teeth, jaws, mouth, tongue, pharynx, and masticatory muscles in a highly organized and complex fashion.[5] Teeth mechanically break down ingested food. Several processes combine to force food onto the working surfaces of the teeth: (1) cyclical vertical and lateral movements of the mandible with repetitive opening and closing of the jaws; (2) the tongue continually pushing food onto the incisors and molars; and (3) masticatory muscles causing the cheeks to tense, thereby also pushing food onto the teeth. Multiple pairs of salivary glands and their ducts ensure that just-right kinds and amounts of saliva are mixed into the food being chewed at just-right times.

A multidisciplinary research team led by biologist-anthropologist Adam van Casteren endeavored to measure, for the first time, the true energy cost of chewing for modern humans as compared with the cost for today's great apes and for hominin species that predated humans.[6] To make a fair assessment, the team had to eliminate certain costs associated with metabolism, digestion, taste, smell, and sight. They overcame these confounding factors by having human subjects chew odorless, tasteless pastes or "gums" of varying stiffness and viscosity. The team determined the metabolic costs by having their subjects chew this food in a ventilated hood system where oxygen consumption and carbon dioxide production could be measured.

For the human subjects, base level oxygen consumption averaged 195 milliliters/minute. When chewing soft gum, it rose to 214 milliliters/minute; with stiff gum, it rose to 236 millimeters/minute. Thus, chewing a tasteless, odorless substance elevated human metabolic rates by 10 to 20%, and the stiffer the substance being chewed, the greater the energy expenditure (regardless of variables such as weight, height, age, sex, time of day, among other things). Of course, for mammals, the time spent chewing *per day* is a more important factor than the energy expended *per minute* of chewing. Previous research has shown that the daily chew time for today's humans is low, ranging from 7.2 minutes to 75.7 minutes, with 35.3 minutes as the mean.[7] By contrast, chimpanzees and bonobos spend 4.5 hours per day chewing their food.[8] Orangutans' daily chew time is 6.6 hours.[9] The great apes also expend more energy per minute chewing than do today's humans. As

explained by van Casteren and his colleagues, extinct hominin species would have expended levels of chewing energy similar to those expended by chimpanzees, bonobos, and orangutans.[10]

Plants typically protect their valuable nutrients with lignified (woody) structures that require major masticatory effort to break.[11] Such plant tissue is what the great apes are observed to consume and is most likely the plant tissue that extinct hominins consumed. Early modern humans, on the other hand, engaged in the cultivation of easy-to-chew plant species rich in nutrients and energy. Van Casteren's team further showed that early modern humans' ability to grind, roast, soak, process, and cook their food (as seen in analysis of paleolithic carbonized plant food remains[12]) has liberated us from energy-intensive chewing and lengthy daily chew times. We humans today also possess a unique anatomy designed to take advantage of easier-to-chew food sources.

While our large brains and lengthy maturation time demand extra energy, this energy demand is readily offset by our greatly reduced investment in chewing food. The daily cost of chewing for humans today is only about 0.1% of our total energy expenditure. With increased brain capacity, bipedal capability, and manual dexterity, we modern humans gain a huge advantage when it comes to acquiring calories and essential nutrients.

This efficiency sets us free to engage in science, engineering, mathematics, art, music, literature, recreation, social discourse, philosophy, and theology. We can engage and enjoy all these pursuits even while eating. When we want intimate social times with one another, opportunities to consider and discuss the most important issues and problems we face, we often do so over a meal together.

Capacity for Exceptionally Clear and Complex Communication

While other creatures use a variety of simple-to-complex signals and sounds to communicate with others, only humans are capable of developing and using language—words, complex grammatical structures, multiple verb tenses, varying intonations, and symbolic shapes, signs, and systems. New research also confirms the obvious, that body movements involving nearly our entire anatomy assist us in complex communication.

In one study at the Max Planck Institute for Psycholinguistics, Hans Bosker and David Peeters performed experiments on six sets of human volunteers to determine the degree to which hand gestures augment the effectiveness of vocal communication.[13] Given the enormous vocabulary of many languages (English, Japanese, and Korean speakers use more than 500,000 words), spoken communication is subject to misunderstanding. For example, shifting the emphasis from OB-ject to ob-JECT makes an enormous difference, and when spoken words are delivered rapidly, a listener may not recognize the distinction between *coat* and *code*.

In Bosker and Peeters' experiments, volunteers watched videos of speakers who used varying degrees of hand beat gestures. The linguists noted that the volunteers were much more likely to hear emphasis on a syllable when it coincided with a hand beat gesture, whatever the language spoken.[14] Their work further validated research done by Harry McGurk and John MacDonald showing that visual input powerfully influences the perception of speech sounds. According to "the McGurk effect," mouth and lip movements play a significant role in the comprehension of speech.[15] Head nods, eyebrow movements, and facial expressions also contribute to speech comprehension.

In their paper, Bosker and Peeters noted that a wide range of body movement assists in comprehension, such as the use of one's arm and finger to point to the object being addressed. Speakers also use their hands to mimic the shape or the action of an object, providing listeners with visual pictures of the object. This study is part of a growing body of scientific evidence showing that language comprehension is a broad synthesis of the human senses and human anatomy.

One reason why human speech communication is so powerful, complex, and efficient is that the human body is anatomically designed for the task. The human lungs, larynx, pharynx, vocal cords, mouth, and lips are optimized for uttering a wide range of distinct sounds at a rapid pace. The human brain is designed for processing complex language, as well as for multilingual capability. Human legs and feet set the arms and hands free to assist in communication during locomotion. Human arms and hands are capable of amazing dexterity, and hand-eye coordination allows for rapid, repetitive movements. Human eyes, with irises and pupils set against large white spheres (a feature distinct from nonhuman primates), permit signaling between humans over distances of many meters. The human face is capable of a wide range of communicative expressions.

The human body allows not only for verbal communication involving just a few people in a quiet setting but also for what researchers call "cocktail party listening." Humans gathered in a crowded space where many are talking at once and with music and other background sounds can still communicate verbally. Researchers have noted how well-designed human brains and bodies are for selective listening.[16]

A vast array of anatomical and neurological features facilitates the uniquely complex, efficient, sustained verbal communication enjoyed by humans. Furthermore, it seems increasingly evident that these human anatomical and neurological features are optimized for this kind, extent, and energy efficiency of communication on which advanced culture and civilization depend.

More Wonders Await

My hope is that this introduction will serve as a teaser, a tiny foretaste of what readers will find in the pages to come. Each chapter, presented by a specialist in some human organ(s) or system(s) essential to human wellness and uniqueness, offers insight to details and features so often taken for granted. Some address our exceptional anatomical and developmental features while others address our extraordinary behavioral characteristics. A perusal of the Table of Contents seems more than sufficient to wet the appetite of virtually any curious soul.

May you be filled with awe as you gain fresh perspective on how "fearfully and wonderfully" (in the ancient psalmists' words) we humans are made. May you marvel at what research has revealed and be inspired to see it continue. May you be moved to contemplate what it means about human worth and destiny.

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THE HUMAN BRAIN

DR. AMY ESKANDER

Abstract

It is bewildering how the human brain, a 1.4 kg organ, is responsible for sensing, voluntary movements, coordination, thinking, memorizing, learning, emotions, consciousness and many more other complex functions. The coming paragraphs will briefly run through how the brain orchestrates different systems, such as the cardiovascular and the endocrine. It will also explore the connection between the mind and the brain. The chapter then covers various major parts of the brain and their roles, common diseases affecting the brain, and importantly the ability of the brain to adapt and recover.

Do you think there will ever be brain transplants?

In this day and age, heart, liver, kidney, and pancreatic transplants have almost become routine procedures. Moving to the next level, plastic surgeons have started performing face transplants—a horrendous breakthrough in the world of organ donations and transplant surgery. *One finds it hard to fathom*, but it could have an unimaginable impact on a person's life. Yet will the day ever come that scientists invent brain transplants, replacing all of life's experiences, memories, joys, and sorrows? Moreover, knowledge and values. "The brain is the only unique and irreplaceable organ in the human body, as the orchestrator of all organ systems and the seat of personality" (Goldenring, 1985).

Point to ponder: Our brains determine how we lead our lives, for believers that would in turn destine our afterlives.

The uniqueness of the human brain

It is baffling how the human brain is the most superior in cognitive ability. It has defied all evolutionary laws. With nearly 100 billion neurons, and 10-

50-fold more glial cells. It is not the number nor the size that makes the human brain distinguished. You might think that the larger the brain size, the higher the number of neurons, the most cognitively able. But that is how the human brain defines all logical laws. As we do not rank highest when it comes to brain size. No other primate has travelled to space, or invented robots. It is believed to be the synergy, the connection between the neurons that deems our brain cognitively exceptional. It is our brain that has actually enabled it to study itself.

Receiving information and sending instructions

Starting with balance, how are we able to stand on our two limbs? Our brain receives messages (sensory input) from the eyes, as they visualize the surrounding environment and provide the brain with information about distances and objects in the vicinity. This is integrated with information from the balance centre in our ears, in addition to sensation of our legs themselves telling the brain how far the floor is, and whether it is steady or sloped, slippery or rough. The brain processes this information and gives commands (motor input) to the muscle groups. It might sound simple, and certainly we never think about how to stand or how to walk. But it definitely is a complex process where all those sensation impulses are received, interpreted in the sensory cortex, then relayed to the motor cortex, which works to give instructions to the different muscle groups. As this takes place the nerve passes through other areas, one that acts to condition those movements rendering them nice and smooth and another that is responsible for coordinating the movements, as for example some muscles bend whilst others are extending as you move, meanwhile the arms are swinging. It is almost as though there is a little director inside allocating roles to each party, and ensuring each part does its bit in a timely fashion.

Spinal reflexes

These, on the contrary, do not involve the brain, as the name reflex implies, they are involuntary. For instance, when you touch a hot object, the pain receptors in the skin send impulses via the sensory nerves to the spinal cord, that connects directly to the motor neurons within the spinal cord that will result in the muscles contracting and therefore withdrawing from that hot object, which represents a danger.

Cerebral cortex

The region of the human brain that best distinguishes us from other animals is the cerebral cortex. It is present in the outermost part of the brain. It includes the frontal, parietal, temporal, and occipital lobes. The cerebral cortex contains between 14 and 16 billion neurons. Broadly speaking the frontal lobe is responsible for memory, speech formation, personality, and movement control. The parietal lobe is situated above the temporal lobe and in between the frontal and occipital lobes. It is responsible for the perception and integration of sensation, co-ordination of movements, and visuospatial awareness. Other very interesting functions of the parietal lobe are language, mathematical calculations, and body image. The temporal lobe centers around auditory stimulation, language comprehension, face and object recognition, and memory and emotions. The occipital lobe is the most posterior and smallest of all lobes. It is the visual processing area of the brain. It is associated with visuospatial processing, distance and depth perception, color determination, object and face recognition, and memory formation.

The role of the frontal lobe in human personalities

There was an incident when a mayor of San Francisco, who was well known for her good character, was one day found to have confiscated two million dollars of public funds. That was seen as completely out of character for her. Afterwards there was a significant deterioration in her health; as she was being investigated, they found a massive tumor in the “orbital frontal cortex.” This area of the frontal lobe specifically plays a major role in value-based decision making. In other words, the tumor led to impairment in her morals and consequently, she took the wrong decision. This mayor was pardoned indeed.

You may be surprised that at the beginning of his ruling, King Henry VIII was a kind, fair, and sensible monarch. It is believed that the atrocious change in his personality followed a traumatic brain injury. It was a jousting accident, where he was unconscious for hours. This led to frontal lobe personality changes, mainly antisocial behavior, disinhibition, and impulsivity.

Limbic nervous system

Moving on from different areas of the cerebral cortex to the specific systems: many of us wonder how our brain works when it comes to emotions and behavior. The next topic will explain the set of particularly exciting structures forming what is known as “the limbic nervous system.” The structures of the limbic nervous system surround the boundary between the cerebral hemispheres and brainstem, hence the name limbic from the Latin word “limbus” meaning border. This is the nervous system responsible for our feelings, motivation, learning, and memory. It is involved in the functions we need for survival such as feeding and reproduction, as well as fear and fight responses.

How carefully the brain is created

Each structure in the limbic system has its own characteristics and functions. For instance, the amygdala stores olfactory memory, and releases emotions of fear, rage, and sexual attraction. This beautifully made almond-like part of the brain means female mammals can sense the proximity of their predators, as certain smells could trigger the sense of fear, both interlinked within the same area, therefore enabling them to anticipate an attack. Other odors could be interpreted in the amygdala as sexually arousing. Hence it is larger in females than in males in humans and animals.

The hypothalamus, another part of the limbic system, can release certain hormones. This is known as part of the neuroendocrine system. For example, stress leads to an increase in the level of corticosteroids and glucocorticoids that may result in a rise in blood pressure.

Point to ponder: Have you ever been attracted to someone not knowing quite how? You try to reason an explanation and you cannot. Well, that is the amygdala doing its magic. Or how is it that when two girls live under the same roof, their periods sync? It is indeed this cheeky nut shaped structure.

The unconscious nervous system

The autonomic nervous system is what regulates our body’s reflexes involuntarily. For example, we don’t control our heart rate or blood pressure, nor our pupillary responses, digestion, or sexual arousal. It is classified as sympathetic and parasympathetic. The former is responsible

strenuous physical exercise. The latter controls activities that allow the body to "rest and digest." Contrary to the sympathetic, the parasympathetic conserves the body's energy, acting on visceral organs and glands, e.g., salivation, lacrimation, digestion, and sexual function.

The brain stem

This is the lower most part of the brain connecting the cerebrum to the spinal cord and cerebellum. It consists of 3 parts: the midbrain, pons and medulla oblongata. The brain stem controls many vital functions such as breathing, heart rate, consciousness, and sleep**.** Therefore, physicians, health care workers, members of the clergy, and laypeople throughout the world have accepted fully that a person is dead when his or her brain is dead. In other words, brain death is *death. Brain death is the irreversible loss of all brain functions including the brain stem, and although the vital functions such as breathing can be maintained artificially, the heart will stop beating when the brain has died.*

The brains of infants and young children have increased resistance to damage and are more likely to recover substantial functions even after exhibiting unresponsiveness for a long period of time. When applying neurological criteria to determine death in children younger than one year, longer observation periods are required. This takes us to the interesting question of whether our brain ages?

Aging causes changes to brain size, circulation, and cognition. The brain shrinks with increasing age and there are changes at all levels from molecules to morphology. Like grey hairs and wrinkles, they start to appear later in life. The incidence of stroke and dementia also rises with age, as does the level of memory impairment, and there are changes in levels of neurotransmitters and hormones. It is not all doom and gloom though, as there are protective factors that reduce cardiovascular risk, namely regular exercise, a healthy diet, and low to moderate alcohol intake. These behaviors significantly help the aging brain, as does increased mental exercise in the form of education or occupational attainment. "A healthy body is a healthy mind."

Disorders of the brain and nervous system (central and peripheral)

1. Vascular: due to a problem with circulation, e.g., stroke, brain hemorrhage, or venous thrombosis.
2. Inflammatory: inflammation can affect the central nervous system (at the brain or spinal cord) as is the case in multiple sclerosis, leading to loss of the outer protective layer called myelin. It can also involve peripheral nerves causing damage to either the myelin (outer cover) or axon, that can be likened to electrical wire.
3. Infection: this can be bacterial or viral, e.g., encephalitis, which is a serious inflammation of the brain that can be life threatening if medical treatment is not provided urgently. Another example is meningitis which is an inflammation of the membrane coverings of the brain that is marked by a severe headache, high fever, intolerance to light, and other constitutional symptoms.
4. Tumors: brain and spinal cord tumors could be benign or malignant.
5. Degenerative: degenerative disease refers to the process when cells lose their function and ultimately die. The likelihood of this increases with age. The most famous examples of these disorders are Parkinson's disease, Alzheimer's, and dementia.

Stroke

In very simple terms, a stroke can be likened to a "heart attack of the brain." It is the second leading cause of death worldwide. Approximately 1 in 4 adults will have a stroke in their lifetime. Most strokes are caused by a shortage of blood supply to a certain brain territory (ischemia), either due to a blockage of the artery by a clot or a narrowing. This leads to cell death and loss of function of the affected area. In a typical ischemia stroke nearly 2 million neurons are lost every minute. The other type of stroke is known as hemorrhagic: this is when a blood vessel has ruptured and bled into the brain.

Age is the greatest non-modifiable risk factor for strokes. Other risk factors are uncontrolled hypertension, diabetes, smoking, and obesity. Eating a healthy diet, exercise, refraining from smoking, and consuming alcohol within moderation certainly play a crucial role in reducing the incidence of stroke. Over the last four decades there has been a 42% reduction in stroke in high income countries, and a greater than 100% increase in incidence in