Intro – From College to Helicopters

It is September 16, 1996 and the weather in Ithaca, New York is getting cool already, the students are heady and reinvigorated from summer break, the streets are buzzing, bars are packed at night. And I am bored to death.

I wanted the full college experience of an education, a social life, motivation, freedom, artistic expression - plus I wanted satisfaction, scientific learning, a good helpful career, and intense fun. I was typical, but I wanted something a little more out of life. I was chasing a girl, and I was chasing happiness. My girlfriend had dumped me for Colorado (that's a whole other novel) but we were still in touch but I was miserable. I was annoyingly loyal.

But the routine college experience, where you take classes, choose a major, study something in detail, have a fun social life – – I am not certain that this was for me, well it was for me but it wasn't quite enough for me. I was more interested in why the world works, why are tables hard, why is organic chemistry such a difficult field, why do people die from cancer, what causes cancer, what causes heart disease, what are the laws of nature, what is the brain made of?

My family has a long tradition at Cornell University going back to the 1860's when Cornell was short courses only and morphed into the University it is today later in the 1900s. I have direct family lineage attending there consistently since then. One of my cousins went to Cornell, and early during my career at Cornell University my cousin pointed out that there is a brain specimen collection in one of the anatomy departments. I went there right away. All kinds of brains, normal brains, psychotic brains, cancer brains, unusually intelligent brains, criminals brains were preserved in jars on display for viewing; this fascinated me. I wanted to be a smart brain, I was not full of myself, but I wanted to make the most of myself. I knew ahead the intellectual curiosity and the "chops" to achieve this but it was going to take a mountain of work.

I started on a routine track, studying History and French, I think I made the most of it, but I hit a wall. I didn't see myself in a routine career like business or teaching or academics, I wanted more. I was naturally good at math, science, physics I just sort of excelled in those concepts. I was a reader, but literature and language arts were never my strong point. At one point I was younger my teacher had to call a conference with my mother, telling her that I didn't speak much in her English class. My memory of it is that I was shy, and that particular teacher made me want to stuff cotton balls in my ears when she talked!

But I was lost. I did not know what I want to do in my life. I was 20 years old. Computer science was fascinating, I enjoyed coding, but it didn't have the patience for it. History was also very interesting to me, and I enjoyed studying various different types of history, including the history of wars, European history, history of art and science, music, food. I didn't take the standard history classes, I took classes about the history of bread for example, in history of music, and romantic love. Do you think humans always kissed from the beginnings of time itself? When did humans begin to make out? Important questions!

I had always been a musician – – drums – – but not good enough to make a career out of it. I continue to play multiple different percussion instruments and have been parts of several bands in the past, amateurish rock bands, organized jazz bands, concert band at the state level, it was competitive. My friends will say these bands sucked but to me there were moments of greatness. But music school was not for me. I had always had a knack for learning languages, and studied French during high school and did very well in those classes. My French training translated into 300 and 400 level French classes early on during my college career. Therefore picked up a minor in French and used the French professors as a source of advice and counseling.

Believe it or not it was one of my French counselors, an older man named Jacques (I never thanked him – Jacques B -thank you!) who noted my interest in science and math, and music, he sort of combined this with a story I told him about my brother, who had cancer, and I had deep appreciative feelings about his doctors, how much they saved his life, how credible they were, and my French teacher, both Counselor and one my professors, said “why don’t you become a doctor?” He mentioned that many doctor seemed to have similar interests like me, music, academics. I don’t think I had ever seriously entertained the thought that I could be a doctor – I had actually thought about it a lot because of my brothers history but I think I was partially afraid because of how raw it was. When I was a child I had experiences with my brothers cancer roommates, sometimes they came to our home on weekends, one time my brother and his cancer roommate had a sleepover. I was fascinated with him, Bryan, and I want to share as much time as possible not only with Brian but with my brother, both under active treatment. My brother had no hair, and Brian was missing a limb due to amputation to treat an aggressive tumor of the bone. I remember feeling afraid that his amputation stump would hit me when we were horsing around in my brothers room. Brian could run almost as fast me with one leg up and down the hallway in my house. Brian died a few months later, while my brother lived another 35 years (see future book number 3 dedicated to a remarkable life…).

My beret wearing professor had caught me at a unique moment in time, his comments crystallized in my mind. My energy focused, I had found something interesting, exciting and rewarding, noble, challenging, maybe impossible. Not everyone could become a doctor, the path is long, challenging, soul wrenching, expensive, disruptive. I used to think only doctor’s children who had been groomed since birth with academic connections got into medical school. It was not going to be easy. I did not have any doctors in my family or even really know any doctors, other than my primary physician from childhood and my brothers oncologist, a model doctor and amazing man.

A few days later I was volunteering at a local emergency room doing simple tasks, helping move patients, changing dirty sheets, all the basics of a community hospital volunteer. A man in his 50s came to the hospital in distress, clutching his chest, his wife or girlfriend was at his side, almost in tears. In comes the local ER doctor, a young, energetic, dark haired man with confidence and black wire rimmed glasses. He had taken me on and was trying to teach me what it’s like to be a doctor in emergency room. He did an EKG on this poor soul who was having a large heart attack, he showed me the EKG and the now all-so-familiar “tombstones” indicate an imminent death or serious lifelong damage to the heart. The educated doctor, in the perfect teaching moment which we all crave in medicine, wearing his smart looking black wire rimmed glasses, told me that he would likely be OK after administration of blood thinning drug called tissue plasminogen activator, TPA for a short. Sure enough, the cool doctor was right, the patient stabilized after administration of the blood thinner, the deadly clot had been dissolved, the patient's EKG got better. The the patient survived, at least until he could be put into a helicopter medivac and sent for a definitive therapy with coronary stenting or angioplasty.

The patient have been saved.

My decision had been made.

I was going to be a cardiologist.

PART I: Why write a book?

I decided to write a book about my experiences in the field of Cardiology for all different types of people for several reasons. Not only do I feel that I've acquired some fairly unique and helpful knowledge over the last 25 years, but maybe, just maybe it can help a few people along the way communicating and spreading knowledge in terms of symptomatology, pathophysiology, prevention, recognition, education, and harm avoidance and treatment. If I can help one patient to reduce their risk by a sliver, or help another to stimulate an ounce of motivation to train in medicine or other medical field, then one of my goals will have been met. Further, there is a counterculture against mainstream preventative cardiology, a distrust in medicine in general, and a disbelief in modern medicine which has cropped up in a more persvasive form in 2020-2022. I think a deep dive into cardiology and the underlying science behind it, could help dispel some of these myths and expose them for the harm they can do to preventative efforts which have made so many gains over the last 30 years.

I also have come to love writing over time. During my medical school years I did my best to write a novel, it's mostly crap fiction, really not entertaining for anybody but me to read. I never really tried to publish much before other than some attempts at short stories (see future short story collection). Maybe my children will find some versions of my writing when I am dirt underground, years from now, and have some fun times reading them. Writing gives a quiet peaceful meaning to time and a permanence to thoughts that can rarely be found in text messages or social media. I enjoy writing as much as I enjoy sitting around reading books, usually multiple books at the same time, switching from one to another, with books lying around non-strategically around the house in various quiet relaxation spots.

Then there's part of me that wants to broaden the mission. The mission is to educate myself, take care of patients, and save lives. I feel profoundly good on days when I can help patients, and I feel profoundly bad on days when I have realized that our system, our healthcare system, insurance system, the economic system that we live in, puts many patients at a disadvantage. Our system is not really all that well equipped to handle high-volume good quality preventative care. Every doctor knows this. Some doctors scream it from the tree tops. Other doctors just plug away, ordering one mammogram at a time, one cholesterol check at a time, making a difference, sometimes not making a difference. And yet other doctors and scientists partake in intensive profound system changing and mindbending research, that changes the rules of medicine, leads to drug discovery, saves lives, cures cancers, changes the system. I always wanted to do that, but I found it extremely daunting. I could spend the rest of my life to doing bench or translation research, discover nothing, and have wasted my time. So I chose clinical medicine. Along the way I will try to give examples, fictionalized of course, of cases that left me a changed person, and helped educate me along the way. The cases that change a doctors practice and mindset area very profound, at least for me. So, in order to broaden the mission…what if I could reach thousands of people all at once, imagine millions, now really imagine hundreds of millions of people really got the message to check their hearts, take care of them, eat well, get a heart check lipid check or stress test or coronary calcium score at an earlier stage of life and continued that care throughout their lives, would that move the goal lines? How do we engender this in the human population, forever, to change cardiac disease rates? Moving goal lines is damn hard work.

I did a little bit of bench research in my time, I worked in an allergy lab, under a famous allergist who is often cited in the New York Times. Bench research means working in a laboratory, usually involving experiments that take detailed technical work and analysis including assays and tests that provide non-subjective data and its interpretation. In medical school I then leanred clinical research, which is drastically different in design, application, and interpretation. This was a well-funded powerhouse research lab with groundbreaking studies in peanut allergy, cows milk allergy, asthma and atopic dermatitis amongst other projects, and this afforded me the basic skills of bench medical research, and presentation skills in the lab. I was in charge of initially labeling tubes, a plebeian task which anybody can do. Eventually, they realized that I was skilled and a self starter, and before not too long I was hired, and I was in charge of running and completing experiments to investigate innovative cures for child peanut allergies. After a year or two, I changed direction and wanted something more directly clinical. I went to work for a groundbreaking gene therapy study, well-funded, with a goal of fixing a single gene defect disease with a gene therapy viral vector. The challenge here was to get enough data to support a rapid approach to a targeted gene therapy clinical trial for real kids that were suffering from rare neurodegenerative diseases, one in particular was a single gene defect, meaning if you replaced that one single gene product, a protein, it could cure the disease. It was tantalizing, and brought me one step closer to making a real difference in the world. It was time pressured as well and I was fascinated. My small part was to design the initial studies, proving that the gene therapy worked and expressed gene in tissue. That worked. I then left and went to medical school but these intial efforts helped lay the ground work for real studies in really sick kids. Small things over and over again maybe could make a difference. That was good, not great but a step in the right direction. I was a small cog in a big machine.

Then there is the heart itself. After two decades of working on the heart, feeling its beats and power, squirting dye in its flowing arteries, seeing its weaknesses and its resilience, without being grandiose, or overly career centric, or selfish – the heart is life. The heart literally feeds the body, brain, and circulates the essential blood force of life. The heart pushes forward despite adversity and stress. The heart motivates one to action, can help you climb a mountain, or give birth. The heart is warm, powerful, and inspirational, but can also be erratic, glitchy, and burdensome when there is malfunction. Some with weak hearts carry a burden of pain and suffering, yet the heart persists, even when weakened, if you support it it will carry on. I have seen congenital defect patients who are not supposed to live ride a bike across the country. I have seen cardiac surgery patients run marathons and lift their and other's lives into an elevated state of living. The heart gives you life but provides the limits on life.

So my goal is to light the flame of cardiac and general medical care in those who read this book. Maybe you have a newly diagnosed heart condition, maybe you're applying to medical school, maybe neither of the above. If I can convey a small sliver of my passion for heart disease, and a basic understanding of some of its nuances, then this book may be for you. This is not meant to be a concise manual of the heart, more of an insiders guide, what you may learn if you shadowed me on rounds for a few months, or were one of my more curious patients and asked all the right questions over time. I hope it helps.

Chapter One: The Heart Beats Fast, Sometimes

Case # 1: Gina was 20 years old and had been hiking regularly on the Adirondack trail in northern NJ. She felt feverish for a few days, had a rash on her leg, and presented to the hospital after fainting while driving, luckily hit the guardrail only with no major trauma, and had a pulse rate of 20, and a temporary external pacemaker was placed with mild sedation and tenuous vital signs. Cardiology was called for management of the low pulse rate.

For the first chapter let's learn about what makes a heart tick: What is a heartbeat? How does the heart beat and feed itself? What are the normal cardiac structures? What is abnormal? What are some early pathologies or abnormalities that need evaluation? And some further explanation of why Cardiology is so important.

First of all, the heart is the heart. Nothing can replace a human heart. As some say, it's "the heart that matters." "Get to the heart of the matter." "The Heart of the Matter" is a Graham Greene novel as well as a Don Henley album. "Heartbreaker" is a Led Zeppelin song, one my personal favs.

You might say yes one day there's going to be artificial hearts, and I know we can almost grow a heart inside of a pig and then transplant it into a human, but for now, everybody needs a heart. You can live without kidneys, you can go on dialysis (an artificial way of purifying the blood done with a machine hooked up to your blood vessels, not a pleasant thing but absolutely necessary if you do not have good effective kidneys that function normally) you can even get an artificial heart in some cases.

As I tell all my patients the heart is defined as (my definition): an electromechanical self-sustaining self-regulating self-powered self-feeding independently-operating instruction manual free non-leaking blood pump and life sustainer for every single part of the entire human body, including the heart itself. The heart nourishes itself and has its own power supply. If the heart stops, the entire body dies, fast. That also goes for some other organs, but no other organ induces death of every other single organ with minutes. The heart is the master of the system. One could argue that the brain is all powerful, as it controls all aspects of the human body. But all the organs maybe except for the eyes, work just fine without a brain. I mean that's not entirely true because you cannot eat or walk or use the bathroom effectively without a brain, but you get the point. Without a brain, the heart does go through some stress – the heart needs a functioning nervous system to pump normally. Why? The heart is essentially inline or connected to a large network of blood vessels. These blood vessels have an enormous ability to constrict or dilate, like a boa constrictor does, causing blood to be at higher and lower pressures depending on the tone of the nervous system – the enlargement or shrinkage of a blood vessel size under the control of usually muscular fibers in the wall of the artery which can contract or loosen to change size, thereby raising or lowering pressure in an artery. Thus, the heart is connected to a constantly changing blood vessel system.

Imagine the pipes in your bathroom drained into a shrinking toilet drainage pipe, you might find your toilet suddenly overflowing, or not draining at all due to sudden pipe pressure changes. That wouldn't be fun first thing in the morning as you try to start your day! Imagine a night's urine overflow shooting backward in your face like a regurgitant heart valve or a failing heart all because of the changing diameter of pipes. No thanks! For toilets, the pipes stay the same. For the heart, all the pipes get bigger or smaller all the time all day long.

The human heart does not come with an instruction manual. To some extent this book is my best attempt to write it. The human heart has certain nominal operating variables, which mostly must be adhered to, but there is a wide array of normal and a hugely variable tolerance amongst human beings – meaning some people can live at the extremes of cardiac function, others perish quickly outside those normal operating values. For example, some people walk around with a pulse rate of 20-30, with little symptoms, noting of course that they sometimes require treatment, sometimes pacemakers, which are artificial electrical systems to create a pulse. And yet others die suddenly with a pulse rate of 20-30 due to poor bloodflow to the brain, kidneys, or intestines, or die from complications of traumatic injuries due to falling due to a low pulse rate and loss of needed blood pressure to ensure bloodflow to the brain. Another example is the wide variance in normal blood pressures that exist in people, for example one of my family members and many others thrives at a blood pressure of about 90/50 and runs marathons, yet others walk around at 160/100 and barely suffer any consequences. We will go over these variations.

And yet for a patient who feels good, with a few exceptions which we will cover, usually the extremes are well tolerated – except for disturbances of the QT interval (see electricity chapter), silent ischemia (see the coronary problems chapter), the Brugada syndrome (also electricity chapter) amongst a couple other entities such as the feared Vfib and Vtach that can cause death or other serious problems with little warning.

So let's get down to brass tacks. What is a heart and what makes it beat?

At its simplest the heart is a pump. It provides the force to move blood, at a certain pressure, in certain cadence, to an enclosed system of blood vessels. The heart is not unlike a pool pump, which pumps water through hoses or tubes into a larger body of water through the exit jets like in a hot tub, which then filters back to the pump through skimmers and then into return tubes (veins) back to the heart/pump, then repeat the cycle.

However, in some ways the heart is not just simply a pump, because the heart does not work alone. It works in concert with kidneys, adrenal glands, the blood, and nervous system in a well-coordinated system to pump blood effectively, and at a stable pressure.

The Coronary Circulation and Microcirculation

The heart, like all organs, needs energy. It obtains its energy by pumping blood to itself. About 5% of the blood exiting the heart, immediately out of the gates, traverses the aortic valve, the outflow valve of the heart, and immediately after that valve closes the coronary arteries themselves are exposed for flow. Included in this is a neat little trick. The aortic valve has three flaps, and is shaped like a Mercedes Benz sign or peace sign and looks like this in the closed position:

The neat trick is that as these leaflets open, they block forceful high pressure flow to the coronary arteries, avoiding excess trauma to these all important small pipes – about the size of drinking straws. If coronary artery pressure is too high, it can theoretically cause damage, strain, or what is called dissection of the arteries – or tearing apart at the seams. So, it it quite helpful to have control over the pressure that they get exposed to. Then when the aortic valve leaflets close and return to how they look in the picture above (yet another cool trick how that happens), the remaining pressure inside the garden hose connected to the valve outflow is enough pressure to backward perfuse or push flow into the coronary arteries themselves. So the heart not only has a system of blocking over pressurization of the coronary arteries to protect them from trauma and high pressure, but also has a system of ensuring that there is enough backward pressure to get flow into the arteries.

The coronary arteries also self-regulate flow in other ways. Coronary arteries are not simple tubes, like drinking straws or garden hoses. The feed into a microcirculation: think of a picture of a river delta from space, or a tree branch. As blood flows into muscle tissue to provide necessary oxygen and nutrients, the branches get smaller and smaller. These smaller branches have reactive circular muscles in walls of the arteries themselves, called microtoarterioles, and form the basis of the coronary microcirculation, the system that gets blood from the coronary arteries into the heart muscle itself. The purpose of these microarterioles is to increase, or decrease, coronary flow, to provide the proper pressure and amount of blood, for the heart is far from static. As we mentioned before, it is a self-regulating self-feeding pump. When it needs to pump harder and push more blood to your big blood hungry and energy hungry quad muscles, in case you're running like Carl Lewis did in the 1980's, the heart will need more blood. This comes from increasing the pulse rate, the blood pressure, and opening up of the flood gates so to speak, to allow more flow, down the microarterioles. The microarterioles can increase coronary flow rates from 5-10 times at rest.

Coronary microcirculatory processes are important to know about because it is the primary reason why people can have serious forms of heart disease in the form of coronary blockages, and have no symptoms for years and years, or ever, and this in some ways causes harm. It partially explains the phenomenon of silent ischemia, or coronary disease blockages with life-threatening restriction of blood flow to the heart, with no symptoms at all! The coronary microcirculation is there to help, but by no fault of its own sometimes it hides the problem quite well. It also is helpful to recall when we discuss how stress testing works because we need to outstrip the coronary microcirculation flow adaptations. It is also helpful to understand how we treat chest pains due to heart blockages (angina), and much more. More on this later.

Cardiac Muscle Fibers – The Superstars

Cardiac muscle tissue is nothing to scoff at. It's serious muscle tissue with superstar features as we will tell you below. The average human heart will beat 2.5 BILLION times in a lifetime. That's a lot of beats. Most of the hearts out there, if they can escape evil Lyme disease ticks which try to paralyze and block the heart[2], can beat that many times without missing a beat, so to speak.

The muscle itself is kind of like the muscles that make your biceps looks like Arnold Schwarzenegger or make you run fast in your thigh muscles, but they are specialized. We call this myocardium, or cardiac muscle, as opposed to skeletal muscle in your arms and legs. It is different.

One major difference is this: focus real hard and make your biceps contract. Everyone can do it. Cue "pump it up" Saturday Night Live Arnold jokes from Hanz and Franz[3]. Now, focus again and try to make your heart muscle contract. Can't do it? That's because cardiac muscle is involuntary – it ain't under your control. It's under it's own control, and it marches to the beat of its own drummer.

Cardiac muscle is different from skeletal muscle. Notice the fine motor control you have of your skeletal muscle. Cardiac surgeons use these finely tuned muscle to operate on pumping live coronary arteries, requiring moment to moment fine motor skills, contractions and relaxation under your control every second you are awake. Cardiac muscle, on the other hand, is an all or none phenomenon. When was the last time you had a half or one third heart beat? It doesn't happen, it either contracts, or doesn't, it's all or none.

Cardiac muscle works kind of like a ratchet, successive rapid contractions with microscopic interaction of troponin, an internal cardiac protein, with tropomyosin, a microscopic

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[2] This refers to borrelia burgdorferi, or Lyme disease and/or Lyme carditis, a nasty tick borne disease in which corkscrew shaped Lyme buggies can in some cases get caught up in the cardiac electrical system and cause heart block, or the inability of the heart to make itself beat on cue – see electrophysiology section for descriptions of heart block and the management of Lyme disease related heart block.

[3] See: dhttps://youtu.be/7Mk1nykjnYA

cardiac ratchet, results in shortening of the cardiac cell, and thus contraction. Picture a zip tie, you can only pull the zip tie one direction, because it has barbs or catches. Imagine those bars or catches can be actively released using energy to release the tension on the zip tie. That's kind of how cardiac muscle contracts, over and over again, billions and billions of times.

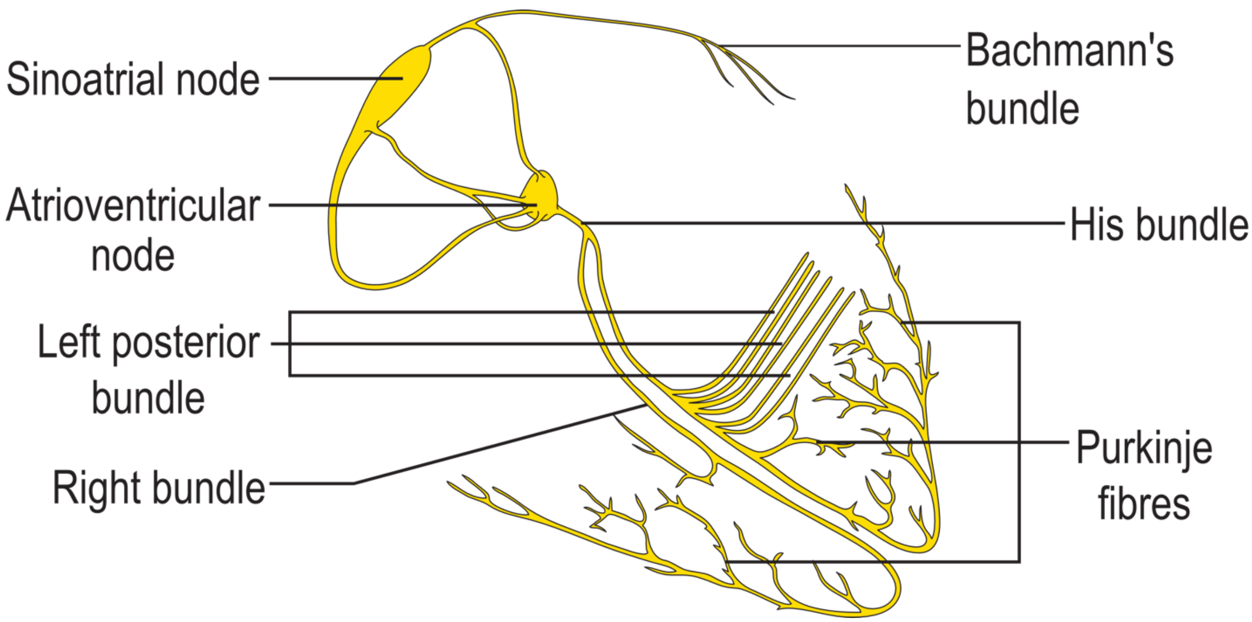
Cardiac muscle cells aren't immortal either. They live and die in a natural cycle, some of them being replenished by something called stem cells, progenitor cells that can develop into new healthy cardiac cells over time. Most cardiac cells are superstars however, with as many as 70% living a full human lifespan! Some cardiac cells are swapped out after 4-5 years, then are replaced.[4] I wish doctors had that kind of refreshing backup replacement! Thank god for coffee to replenish our energy when needed! Some of those cardiac myocytes have never had a single break from work for a single second in their entire lifespan. True superstars!

Electrical Wiring and Firing

The below diagram is a rough drawing of the heart's electrical wiring system. It helps to have a road of map of it. Don't expect to understand it early on, it takes reading 10,000-20,000 electrocardiograms to fully understand the cardiac conduction system, and even then…there is always someone who knows more than you do, they're called electrophysiologists, and they are some of cardiology's biggest brains (also known as cardionerds, or nerds for short).

The heart's electrical conduction tissue, or wiring, is amazing in how it is embedded, how it times the heart's contraction just right for efficient pumping, proper pressure, conductance of blood, and proper valve functioning and overall cardiac functioning. Improper electrical functioning naturally causes improper mechanical functioning, and vice versa. Weakening of the heart causes electrical malfunction, and weakening of the electrical system can cause cardiac pump weakness. Amazingly interconnected system.

[4] Bergmann et al (no relation), Dynamics of Cell Generation and Turnover in the Human Heart, Cell, Volume 161, Issue 7, 2015, Pages 1566-1575, ISSN 0092-8674, https://doi.org/10.1016/j.cell.2015.05.026.



To summarize how a heart beats you need to think of it like a light switch. But not a light switch to illuminate a room, a light switch to send a signal to a waiting station, and if that waiting station is ready to transmit a signal or electical beat, then it gets transmitted. The reason the heart needs this, is that it has its own internal automatic rhythmicity. In other words the heart does not bear at random. Rather a highly coordinated set of electrical signals conducted down very specific pathways, and subject to control of various sorts, is what makes the heart beat.

I suspect primordial beings like slime molds and simple bacteria used electricity or electrically charge features of molecules in simple ways – to open and close channels for example to obtain nutrients, or to communicate for example. Picture a gross blob bacteria living in a sea of slime. It wants some elemental material in the primordial slime to enter its body so it can continue to live, perhaps sodium (salt), or potassium (another salt or ion). It develops a miniature machine in the wall of its outer protective membrane, that only opens when let's say potassium, or magnesium ions are present just outside it. Or, when it opens, only one thing scan come through, the target nutrient. What I'm trying to introduce is the concept of an action potential.

Action potentials are amazingly complex things that achieve one simple thing: they transmit electrical charge or energy gradients, in a specific direction. Hearts or muscle tissue that lacked directional control of electricity would be like revolting blobs of quivering Jello, useless other than for entertainment value. Hearts or muscle tissue, however, that have good directional control over its electricity, and linked to a neural network like a brain or Ryan Reynolds humorous intellect on the other hand, have enormous potential for creating walking, moving, thinking, purposeful and consistently predictable human beings.

An action potential is simply a moving wave of electricity, but has become the medicoscientific way of describing the passing of electricity at least in nerve, heart, and muscle tissue. Bacteria and other organisms may use electricity more simply, as bacteria were recently described to use ions to communicate with each other to form a bacterial city called a biofilm. They do not need as much directional coordination as a heart or muscle, so they simply use the fact that sodium or potassium carries an electrical charge, and use that a fast communication, basically the internet of bacterial biofilms!

Heart tissue, however needs communication of information in specific direction, to allow coordinated contraction of a specific muscle fiber bundle, for example the front wall of the heart, to work in coordination with the posterior wall of the heart, to create pumping force. To do this it needs a specific route, and specific link to form the route. The heart dose this through specialized nerve tissue, that only activates and transmits electrical signals according to a passed wave of what we call action potential, essentially the same as an email or text message from person to person, or from electrical cell to electrical cell, to pass the message. “Hey Bobby, text me when you’re ready for me to pick up my kids at your house in time of dinner.” “OK Bobby I will text you.” “Hey Bobby your kids just broke my glass table, time to come get them.” “OK I’ll be right there.” Electrical signal sent, signal received, action initiated, same as an action potential.

Back to Gina

Back to Gina, our first case. Gina clearly is suffering from acute Lyme carditis with heart block. The management of patients with low pulse rates from heart block due to Lyme disease infiltrating the cardiac conduction system is simple: they need temporary pacemakers if the low pulse rate is insufficient to sustain life until appropriate antibiotics can be given to kill the Lyme organisms. Heart block usually resolves, although anecdotally I have seen pacemakers and ICU level of care needed for up to 7-10 or more days, but eventually cardiac conduction usually improves and most patients will walk out of the hospital with good cardiac health.

Chapter Two: Understanding Cholesterol in General

Case #2: Arthur is 45 years old. He presents for a routine visit to a cardiologist because of abnormal dermatologic structures ("weird lines") near his eyes noted by his primary care doctor. His doctor told him it may mean he has a high risk of heart attack. He has not had his cholesterol checked ever, but has relatives in his family who died young from heart attacks in their 40s. He has been putting off seeing a cardiologist for about 5-10 years, and has no other medical history.

The first question a cardiology consult patient asks is usually – how is my cholesterol? Everyone always equates this with cardiac health, and as you will see in future chapters, this is true sometimes, other times it is a symptom of other problems such as diabetes, pancreatic problems, overeating, alcohol abuse, or medication side-effects. Equating health with cholesterol is like equating engine oil with car health – yes it is an essential part, but it is not the only part that determines the health of the vehicle. On a side note, vehicle and engine metaphors will predominate in this book, a useful metaphor that most people have become more familiar with than cardiac pressures and valve function. But in general cholesterol IS important. Why?

Because our current understanding of why people have heart attacks is summarized in what doctors call the lipid hypothesis. The lipid hypothesis states essentially, and more on this later, that imbalances of cholesterol types cause or contribute to arterial inflammation, formation of dangerous plaques in the walls of arteries, which attract the immune system. When fatty streaks, or lipid accumulation in arterial walls, occur and heal and recur, they sometimes heal like a scab, can accumulate inside arteries, and cause lack of blood flow, sometimes slowly, sometimes rapidly, as in a heart attack. As we will delve into in future chapters, cholesterol is only part of the problem, however in some people it is the largest problem, in other patients it is a bystander or even a good thing to have around, as we will discuss.

The cholesterol molecule itself is of course worth some discussion, so you can understand what we're dealing with, and why doctors spend so much time and effort assessing, controlling, analyzing, and treating disturbances of cholesterol to reduce the risk of heart disease. Cholesterol is necessary for many bodily functions including in the formation of cell membranes, or the fatty layers that make humans cells able to hold shape, steroid and vitamin D building blocks, a precursor to digestive bile juices, and is essential for the human body[5]. The body is able to make most of the cholesterol it needs, the rest is obtained from the diet. The human body alse needs cholesterol to synthesize almost all hormones, these are molecules that have dramatic

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[5] Craig M, Yarrarapu SNS, Dimri M. Biochemistry, Cholesterol. [Updated 2021 Aug 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513326/