

# 1 THE SCIENCE AND MYSTIQUE OF CANNABIS

*John agreed to an evaluation of his cannabis use to appease his mother. The 10th grader cautiously acknowledged experimenting with cannabis after his best friend had been given some pot by his older brother. John asked his friend for a joint and they had smoked together half a dozen times over the past 4 months. He sheepishly admitted liking marijuana, but he also knew pot carried some vague risk for people his age. His mother was terrified when she saw her son looking at websites about cannabis, but when confronted, he was honest with his parents about his use. After talking with John, I wasn't concerned that he was in any real danger. I taught him the signs of using cannabis too frequently, and we reviewed the reasons why he should delay use until he was a few years older.*

*John's parents had completely opposite experiences with cannabis, so it was no surprise that they held differing opinions on John's use. His mother, Carol, had watched helplessly as her older brother began smoking cannabis all day, every day, eventually dropping out of college and developing a serious addiction to harder drugs. Naturally, she was panicked by John's interest in marijuana. His father, William, had smoked marijuana on most weekends during his college years and felt it opened his mind in helpful ways, but he had lost interest in it soon after graduation. He dismissed his son's cannabis use as just a passing phase. I tried to soothe Carol's fears while helping William understand the difference between the weaker marijuana he used and the much*

*stronger cannabis available today, as well as how John's younger age put him at increased risk. They both wanted to know the best way to respond to John's use. I encouraged them to keep the conversation going so John didn't have to hide his interest, to trust their son's current judgment, and to learn as much as they could about the science of cannabis.*

*"What can we read to educate ourselves?" they asked.*

*I didn't know what to tell them. Everything published at the time was based more on opinion than scientific fact and either strongly promoted or demonized cannabis.*

*So, I wrote the following book to help people like John, Carol, and William.*

I have been curious about cannabis from the first moment it altered the texture of my experience in 1967, when I was only 22 years old. I was fascinated by how a simple plant, a "weed" that grows in the wild nearly everywhere, could change my experience of the world so dramatically. What did its chemistry do to my brain to make me feel so comfortable, relaxed, hungry, and spellbound by even the smallest details? How did it slow time and make the world look so fresh and new? And how did it vivify flavors and music, sending their sensations throughout my whole body? Even the seeds-and-stems, 3 percent THC marijuana of the 1960s could do all this without the numbing fogginess or blistering hangover I experienced with alcohol. I wanted to understand what was happening that made me feel so different, and what it all meant.

There were no believable answers to these questions available in 1967. Some of my friends gravitated toward mystical explanations during what they called the Age of Aquarius. They believed that cannabis possessed numinous qualities, suggesting a divine spirit dwelt within its buds. Consuming the plant supposedly transferred this spiritual energy into humans. Such ancient beliefs were widely held when the world seemed infused with spirits. Christian

ritual continues to speak of the transfiguration of bread and wine into a spiritual force that can infuse the faithful who ingest it. Despite the sense of awe I felt following a good joint, the notion that ingesting cannabis transfers spiritual energy struck me as more metaphorical than factual. During my senior year of college, I switched from studying philosophy to pursue a career in psychiatry. As a result, I wanted to know more about what rigorous scientific research tells us about cannabis and the brain.

One solid fact about cannabis had been firmly established by that time. The identity and structure of cannabis's main psychoactive chemical – THC – had been discovered 3 years earlier, in 1964. We all mastered THC's complicated full name,  $\Delta^9$ -tetrahydrocannabinol, and we repeated it endlessly, as though chanting this scientific term would give us understanding. The truth was that we still knew nothing about what THC does once it enters the brain. What *does* THC do in the brain to change our experience in its unique and characteristic ways? Can it be used safely? If so, how? I was eager to know more, but the understanding I sought was still almost three decades away.

While scientists were slowly grinding away in their laboratories to unlock the mysteries of cannabis, its recreational use rapidly gained popularity in America, despite increasingly harsh prison sentences during the politically motivated War on Drugs. Law enforcement drew no distinction between classifications of drugs. "Illicit" drugs were all lumped together and outlawed. Illegal is illegal, and the criminal justice system was the hammer that treated everyone using an illegal drug as a nail. Because cannabis was the most frequently used illicit drug, more users of cannabis were arrested and imprisoned than heroin or cocaine users. One drug enforcement agent wryly explained his enthusiasm for busting pot smokers by noting that they do not shoot back as often as users of harder drugs. Racial disparities pervaded the enforcement

of cannabis prohibition during the War on Drugs, leading to disproportionate rates of arrest and imprisonment of minorities. Still, more and more people tried cannabis, and many continued using it. Today, more than half of Americans have used cannabis at least once. General acceptance of cannabis in American culture has led to the phrase “social use” gradually replacing “recreational use” to parallel language describing casual alcohol consumption.

The cultural acceptance of cannabis received a significant boost when California relegalized its medical use in 1996 after 59 years of prohibition. This policy reversal resulted from an unlikely coalition of advocates for the compassionate use of marijuana, including caregivers of AIDS patients, drug policy reformers opposed to the drug war’s harsh treatment of drug users, aging hippies, grandmothers on chemotherapy, political radicals, scofflaws, future entrepreneurs, and marijuana advocates who saw its medical use as poking the camel’s nose under the tent toward full legalization. Tactically, medical marijuana was the greatest Trojan horse since Troy. To the surprise of many, the National Academies of Sciences, Engineering, and Medicine issued a report in 2017 documenting the proven benefits of medical cannabis. Today, the future looks brighter than ever for developing safe and effective cannabis-based medicines for a variety of diseases.

I abandoned my quest for answers to the mysteries of how marijuana works while America was passing through decades of its punitive approach to cannabis. I had also decided that meaningful answers did not lie in repeating its use. After finishing medical school, I served as a general practitioner in the Indian Health Service, and then began psychiatry training at Stanford University. Although I tried my hand at research in a neurophysiology laboratory for a couple of years, I soon discovered that my personality is more suited to clinical work. I like talking to people more than performing repetitive experiments with laboratory

animals. I was particularly drawn to addiction medicine. Strange as it may seem, I found working with alcoholics to be comfortable and fascinating, largely because my own father had suffered from alcoholism. For the next 20 years, I focused on the lasting impact a parent's alcoholism has on their child's personality. It was a personal exploration, but at the same time, I helped bring attention to a forgotten and neglected population by cofounding the National Association for Children of Alcoholics in 1982 (now the National Association for Children of Addiction). NACoA continues to raise awareness and advocate for services for those affected by familial addiction.

## **An Avalanche of Scientific Discoveries**

Lightning struck when I least expected it. I heard the late Billy Martin (a professor at Virginia Commonwealth University, not the baseball manager) speak at a meeting of the California Society of Addiction Medicine (CSAM) in 1996. His lecture summarized the scientific discoveries about cannabis and the brain that had recently emerged from research laboratories around the globe, and I learned that researchers had begun solving the mysteries as early as 1988 that had intrigued me since the late 1960s. Monumental discoveries with far-reaching implications had proven that our brains are wired to respond to cannabis. THC, which is found exclusively in cannabis, produces its effect by mimicking our brain's natural chemistry and enhancing certain brain functions. This is analogous to putting high-octane fuel in your car or adding power assist to the brakes, additions that energize the normal function of the engine and brakes, respectively. Being high is the result of THC's mimicry of natural chemistry and its subsequent impact on the brain's chemical systems. To better understand cannabis, I first needed to learn more about the brain and how it typically functions. What parts of the

brain are thrown into overdrive and out of normal equilibrium by THC? How do these changes lead to the experience of being high?

I was afire with excitement when I realized there was far more to know about cannabis than I had realized. Although I had been reading clinical research about cannabis use, I had not been following the basic laboratory science literature. Clinical literature describes research on patients – people who are negatively impacted by their cannabis use. Basic science research delves more deeply into the minute details of molecules and nerve cells, and the findings are published in dense journal articles that are difficult to decipher and almost impossible to find outside medical libraries. At the time of the CSAM conference, there was still no recognition or understanding of cannabis dependence in the clinical literature. Scientific literature, however, had already reported changes in the brain that were characteristic of addiction, caused by frequent cannabis use. I left Martin's lecture committed to learning as much as I could from journals not usually read by practicing doctors.

Fate conspired to open a path for me to study the basic science of cannabis. A couple of weeks after the conference, the California public was scheduled to vote on the Compassionate Use Act to legalize medical cannabis. At the society's business meeting, I naively asked if CSAM had taken any position on the proposition, only to discover that our public policy committee had not even discussed the issue. I soon found out that whoever asks a question will be recruited to find the answer, and I became the unofficial cannabis guy for CSAM. My first task was to write background papers on what the scientific literature said about the potential medical benefits of cannabis and the special risks of cannabis use by adolescents. For the next two and a half decades, I conducted a monthly survey of both clinical and basic science literature in pursuit of answers.

I have learned so much, but I also understand that science never gives us ultimate answers. Those are left for theologians and philosophers. Science is much better at continuing to push the frontiers of knowledge until the next layer of questions is revealed. For example, when scientists discovered that THC mimics the brain's natural chemistry, they next needed to examine the normal function of the THC-like chemicals discovered in our brain.

How do these THC-like chemicals typically function? Where are they concentrated? Why does our brain chemistry resemble cannabis? Or should we ask why the chemistry of cannabis resembles our brain? The first two questions have been answered, while the last two still remain dangling.

## Science: The Public Realm

I first studied the public and private realms of the human experience in a freshman humanities class. Science exists in the public realm, where facts are objective realities, while our direct, subjective experience lies in the private realm. We all live in both realms simultaneously. For example, when asked about the drive from San Francisco to Los Angeles, one person may say it is a ghastly long way, while another may say they breeze between the two cities easily. Subjective experience exists in the private recesses of our mind. We can communicate about the private realm, but no one can prove whether the drive feels long or short, and disagreements cannot be resolved. However, everyone agrees that the two cities are 381 miles (~613 km) apart because objective, concrete facts exist in the public realm. Whether you experience the drive as long or short, your car will need enough gas to drive 381 miles.

My previous book, *From Bud to Brain: A Psychiatrist's View of Marijuana*, detailed the science of cannabis and focused on the public realm. I wanted to provide health professionals

and educators with the objective facts about cannabis, complete with a god-awful number of footnote references. I felt the book was necessary to give doctors, nurses, therapists, and educators relevant answers to patients' questions about the safety of social/recreational cannabis use and its potential medical benefits. As soon as I finished that book, I knew I had to turn my attention toward the general public, to answer Carol and William's question about where they could find clear and understandable information about cannabis. The public's scientific literacy about cannabis remains confused by biased and misleading websites and is limited by the lack of a dependably accurate source of understandable scientific information.

Responsible personal and policy decisions require a solid foundation of science literacy about cannabis and the brain. The importance of possessing greater science literacy is only increasing as more people across the USA and around the world gain legal access to cannabis. In the words of astrophysicist and popular science commentator Neil deGrasse Tyson, "Science literacy is an outlook that you bring with you in your daily walk through life. It's a lens through which you look that affects how you see the world." Science literacy means knowing more than just the basics; it means understanding the key scientific concepts and methods that create confidence in the facts established by scientists. It helps us make healthy personal decisions and participate in reasoned political debate in an increasingly complex world.

Science is a communal process. Scientific facts require corroboration from others using the same methods for observing the world. While science may be advanced by an individual's private experience, such as how August Kekulé's dream of a snake devouring its own tail gave him an intuitive understanding of the cyclic structure of benzene, intuition becomes scientific fact only after others are able to reproduce the result. The path of science relies



on the transparency of methods for making objective measurements, followed by confirmation by others. The goal is to minimize opinion and unconscious bias by subjecting observations to the scrutiny of others' skepticism.

Accurate measurement is at the core of the scientific method. Nineteenth-century physicist Lord Kelvin said, "When you can measure what you are speaking about, and express it in numbers, you know something about it. When you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science." Once something is measured, scientific research and experimentation can begin in earnest.

## **Experience: The Private Realm**

Understanding how cannabis influences brain chemistry is fascinating, but science is only one part of the cannabis story. It is a mistake to believe science is the only lens for observing the world. While a book intended for the general public needs to translate complex scientific concepts about cannabis and the brain into simple terms, it also needs to explore the mystique this plant holds for many people. The private realm contains the meaning people ascribe to their experience of being high and motivates the Cannabis Culture that has developed around cannabis use. This culture often ignores or cherry-picks scientific facts about cannabis because understanding the basic mechanics of the plant's effect on the brain is of little relevance to the metaphysical meaning many see in the cannabis experience. Ultimately, both the science and mystique of cannabis must be explored to fully understand the role it plays in today's world.

While our individual experience of meaning, beauty, morality, and spirituality is entirely subjective, it often holds more sway than scientific fact. Direct experience

of our existence as part of the infinite universe is highly individual and ineffable, but it is as important to our sense of identity as an intellectual understanding of our evolution from earlier primates. Scientific fact and subjective experience are different lenses, each perhaps more associated with the left and right sides of the brain, respectively. Each perspective is valuable, just as both feet are necessary to walk forward into the world. Using only one foot while ignoring the other leads to walking in circles, a sensation of motion that leads nowhere. Science alone lacks humanistic meaning and values, while subjective experience alone can be unmoored from the concrete world we all share. Ignoring the concrete facts established by science increases the risk of experiencing negative consequences from cannabis use. However, our private realm never resonates as strongly with scientific facts as it does with a good story or emotional anecdote about cannabis.

## **Overview of *Marijuana on My Mind***

A book is different from the Internet, which tends to present information in factoids. This is useful when looking for quick answers to specific questions, but it often leads to being able to recite facts without understanding how we know they are true. This thin layer of knowledge is useful for Trivial Pursuit, like knowing the scientific name for THC without having the slightest understanding of how THC works, but factoids lack the depth needed to achieve meaningful understanding. Books can reveal the bigger picture and establish a basis for the facts used to support its conclusions.

*Marijuana on My Mind* tells the story of the impact of cannabis on both the brain and the mind. It is best to read the book sequentially rather than skip between chapters, as each chapter is built upon information already presented. The next three chapters describe the basic mechanism of

cannabis interactions with the brain. Chapter 2 provides the background needed to understand the cannabis plant and the mind-altering products extracted and manufactured from it. Chapter 3 describes the basic architecture and function of brain cells, called neurons, in order to make sense of how THC alters communication between cells. Chapter 4 puts all this information together to trace how THC's impact on the brain results in the experience of being high.

The next two chapters put the impact of cannabis on society into perspective. Chapter 5 explores how many people use cannabis and how often they use it. To better understand the epidemiology of cannabis use, the chapter compares patterns of use and attitudes about alcohol and cannabis. Chapter 6 examines the lens of Cannabis Culture and its appreciation for the mystique of cannabis. Grasping the full meaning of the mental effects of cannabis requires exploring why mystics have used cannabis in their spiritual practices for millennia. The chapter takes a serious look at the important role the plant plays in the spiritual life of Cannabis Culture.

Cannabis Culture deserves much of the credit for keeping awareness of the medical benefits of cannabis alive and reawakening California's interest in legalizing its use. The next three chapters are devoted to exploring the evidence supporting the use of medical cannabis. Chapter 7 reviews the history of medical cannabis, places the value of anecdotal evidence into proper perspective, and assesses the medical benefits for which substantial scientific proof exists. Chapter 8 explores a wider range of benefits for which there is considerable suggestive evidence that does not yet rise to the level of proof needed for acceptance by the general medical community. Understanding the impact of cannabis on the brain and body lends credibility to many scientists' belief that cannabis-based medications will gain acceptance as treatment for a wide array of diseases. Finally, Chapter 9 explores the

unique qualities of CBD in order to separate fact from fad and explore its legitimate medical use.

All medications have potential side effects, and this is true for cannabis as well, whether it is used to treat illness or for social/recreational pleasure. The next couple of chapters explain two overlapping negative effects of continuing to use cannabis beyond the brain's ability to maintain its normal chemical balance. Chapter 10 focuses on the five signs that indicate cannabis is being used too frequently. Awareness of these signs is essential for using cannabis safely. Chapter 11 explains the changes in the brain that lead to cannabis addiction. Although many in the Cannabis Culture strongly resist the idea that cannabis can be addictive, scientific evidence proves that it is. Accepting this inconvenient truth goes a long way toward knowing how to use cannabis without becoming addicted.

Not everyone recognizes the signs of using cannabis too frequently or avoids addiction. This is especially true for adolescents. Most people understand that cannabis can harm the developing brain, but few understand the significance of this catchy phrase. Chapter 12 lays out the reasons adolescents become addicted to drugs, including cannabis, more often and more quickly than adults. Chapter 13 explores the subtle but pervasive effects of long-term, daily (or near daily) cannabis use. A large body of evidence reveals a wide range of measurable intellectual and emotional impacts on adults who use cannabis frequently, whether overt addiction exists or not. Chapter 14 explores the process of quitting cannabis once an individual decides it has become a problem. It answers the following questions: What can be expected of recovery? When is treatment useful? What does treatment look like? How can family members help a loved one, especially a child, who is harmfully involved with cannabis?

During the COVID-19 pandemic, we all gained a new appreciation for the importance of a robust public health

policy. Chapter 15 looks at the impact of public policies governing cannabis on both society and individuals. As medical cannabis becomes widely available in the USA and full legalization expands, it is increasingly important for the public to understand the complexity and difficulty the states face in regulating the cannabis industry. In Chapter 15, I describe my experience on the California Cannabis Advisory Committee to shed light on some of the issues legalization must confront.

Finally, what will be the future of cannabis? The Epilogue speculates on future developments for cannabis, medically, recreationally, and as the leading edge of a more humane approach to all drug use. Well-balanced natural cannabinoid brain chemistry is essential for optimal health, so exploring non-cannabis ways to enhance our natural THC-like brain chemistry will become a part of general wellness programs. As access increases, knowledge of how to use cannabis safely will be widespread, although still not always attended to. Whatever changes occur in the future of cannabis, human nature is likely to remain the same. The impulse to overuse a good thing will continue to produce harm.

Three addenda offer additional assistance to readers: a glossary, suggestions for further reading, and the source references for the included illustrations. For ease of reading, I have not included footnotes throughout the text. The Further Reading section provides additional resources to expand and document selected topics of interest. More extensive and detailed references can be found in *From Bud to Brain: A Psychiatrist's View of Marijuana*.

## Conclusion

My first experience with cannabis left me with an enormous number of questions with no clear answers. The following chapters use plain language and simple

scientific concepts to walk readers through the most interesting and substantiated answers available today. In order to provide the most reliable information possible, my greatest goal is objectivity. The bottom line is that cannabis *can* be used safely by most adults, but only if they do not get so lost in the pleasure and awe that they fail to respect their brain's finite ability to maintain a healthy chemical balance. Understanding what is currently known about cannabis and the brain will help readers make healthy and informed decisions. I hope this information satisfies and stimulates your curiosity as much as it has mine.

While there are a few black and white truths in life, we mostly inhabit the vast area in between these two extremes of certainty. Welcome to the beauty, freedom, and responsibility of the gray zones explored in this book.