

**Problem/Testable Question:** What negative and positive effects does THC have on the body?

(Question is based from background research)

- When researching the species we realized they all had different effects on the body, making us wonder what THC, the most active principle in cannabis has on the brain and the body.

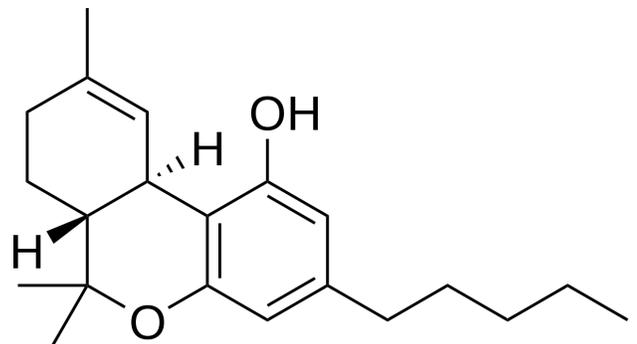
### Background Research:

Cannabis, more commonly known as marijuana, and by many other names, is a psychoactive drug from the Cannabis hemp plant usually used for recreational or medicinal purposes. It is currently one of the world's most regularly used drugs, and one of the most concerning, because it has just begun to be researched in depth. It is consumed in varying methods, including:

- pressed resin from the flowers or leaves of the plant. referred to as 'hash' or 'hashish'
- dried flowers of cannabis plant, referred to as 'buds' (marijuana)
- non-pressed loose resin from flowers or leaves of plant, referred to as 'kief'
- resin extracted with solvent, which is concentrated (hash oil)

The hemp plant has leaves, seeds, flowers, roots, and a stalk, which are used in various different ways, main ones listed above. The method that is most used is marijuana. Marijuana is the dried flowers of the plant and are from the Cannabis Sativa strain.

There are 3 species of the cannabis plant including Cannabis Sativa, Cannabis Indica, and the last, Cannabis Ruderalis. All, when cooked into food or smoked, induce incomparable feelings of a 'high.' Sativa has an invigorating, energizing effect that leads to strong feelings of more happiness, increased productivity, or unusual creativity, unlike its more sedating counterpart, Indica. Indica acts more like a sedative and puts your entire body into a state of relaxation. It can ease pain, and even nausea. Cannabis Ruderalis is the uncommon species and it is rarely used. It is not known to be highly psychotropic. Marijuana can be smoked in rolled smoking papers called *joints*, in water pipes, and sometimes blunts (rolled in cigarette wraps). It is also commonly incorporated into food, including cookies, candy, brownies, etc. These are referred to as *edibles*. These cause pressing problems in today's society. They play a large role in overdoses in countries that have legalized cannabis. Edibles are highly concentrated and individuals usually just eat the whole cookie or candy, without caring how many grams or milligrams they just pumped into



their system. This is highly dangerous because the 'high' will last for up to 8 hours and can result in accidents or your body may not be able to handle the amount of THC or CBN in its system.

The main mind-altering chemical in cannabis, overseeing the main intoxicating effects that are sought after, is *delta-9-tetrahydrocannabinol*. THC was discovered and separated in the 1960's. The formula for THC is  $C_{21}H_{30}O_2$ . Other cannabinoids include *cannabidiol* (CBD), *cannabinol* (CBN), *tetrahydrocannabivarin* (THCV), and *cannabigerol* (CBG). THC is responsible for most of marijuana's psychological effects, more than physical or social side effects. It rests in between the Cannabis sativa plant. It is the principal ingredient, causing the longest-lasting and most effective (negatively or positively) 'high'. It is found in the resin produced by the leaves and the buds of the female cannabis plant. The hemp plant itself has over 500 more cannabinoids, one-fifth of them acting similarly to THC. Concentrations themselves, of THC, range widely through generations, but usually contain 4-8% of THC. Resin products are much more heavily concentrated, and can be as concentrated as high as 80%. During the 1960's, the concentration of THC in cannabis was around 2%. Recently, concentrations have soared, leading to unresearched negative effects. THC is used recreationally but is still undergoing tests to become part of the medical industry. Pharmacology of cannabis is expanding, but is widely underdeveloped. There are marked differences in the knowledge of the medical use of cannabis, and its many cannabinoids. So far, THC improves the effectiveness of chemotherapy drugs when given together. It is used for psychiatric and neurological symptoms. It is used for psychiatric symptoms of PTSD, Anxiety, Depression, ADHD, bipolar disorder, chronic pain, insomnia, and schizophrenia. It is also used for neurological conditions such as agitation in dementia, and specific seizure disorders that lack response to therapy. There is evidence that says THC improves short term sleep in individuals with sleep disturbances. Involuntary observations have led to the fact that it has large therapeutically useful effects in many illnesses, diseases and syndromes. It also aids in soothing nausea, vomiting, movement disorders, anorexia, pain of any type, glaucoma, asthma, withdrawals from other hard drugs, autoimmune diseases, and miscellaneous symptoms of other problems. THC also facilitates with the extinction of conditioned fear response. Most reports conclude that the "high" is an integral part of overcoming all these symptoms and illnesses. After even limited exposure and consumption of THC, it can be identified in the body 2 weeks later. The euphoria and 'high' may wear off, but the chemicals still remain in your body for a long period of time.

Cannabis is usually consumed with many other drugs, such as alcohol, and/or nicotine. This is a very large affecting factor that may throw off research and case studies done on cannabis. Research in Australia found that 95% of the time, cannabis is associated with other recreational or 'hard' drugs such as methamphetamine, cocaine, heroine, etc. An experiment was also conducted that proved alcohol makes THC absorb faster into your blood plasma, compared to if you were not to combine cannabis with alcohol. Your blood plasma is the part of your blood that moves your proteins and cells all around

your body. Cannabis is referred to as a 'gateway' drug, meaning that it encourages the use of other drugs. A cannabis user is 75% more likely to try nicotine, than a non-user. It is associated with nicotine addiction in millions of teenagers today. If you began using cannabis at an early age, particularly in your teens, your reward system, which is discussed in our principles, reacts slower to THC. To summarize, as you age, your dopamine centres react less and less, releasing less dopamine for your reward centers than before, which makes you crave more of the drug to feel the original feeling. The 'high' that was originally induced through the excess amount of dopamine triggered in your reward centers, is no longer as strong. You will still be impaired when you are under the influence, but the effects on dopamine levels wear off while growing up. You crave the feeling that you first felt, leading to excess use and addiction/drug disorders.

**Hypothesis or Thesis:** We believe that THC has more long-term negative effects than positive.

- Based on the fact that when THC is ingested, the chemicals remain in your body for up to 2 weeks. We realized that this will most likely harm us and based off of little research, discussed up there. There are also many underlying factors that affect the extent of these effects. Our assumption is that mostly all drugs are not beneficial to the body, but THC also has underlying positive effects when researching our topic below.

### **Research:**

When you ingest or smoke marijuana, THC travels into your bloodstream, through your body into your brain. You can smoke it, drink it, eat it, or vape it. The person begins to feel the effects almost immediately. It consists of mind-altering chemicals that affect your brain and your body. It can be harmful and even addictive. It is used recreationally and under extensive research for further use in pharmacology. Since THC activates the part of your brain that responds to pleasure, it releases dopamine, a chemical that gives you that relaxed, euphoric feeling. The feelings also dampened on what type of cannabis strain you ingest. Marijuana is not as pleasant as perceived, and can also cause many side effects, whether negative or positive. It can cause you to become anxious, panicked, and afraid. Using cannabis, of any kind, also increases your risk of being diagnosed with clinical depression or taking the symptoms of your already existing mental or health disorders and worsening them extensively. There is no research that explains as to why this response may occur. During the usage of high doses, you can come to realize you feel paranoid and have lost with reality, and see, hear, or experience things/actions that are not actually there. Marijuana, THC significantly, obviously clouds your senses and judgment, either positively or negatively. The side effects differ depending on how secure your cannabis is, how you ingested it, how much of it was ingested, and how much you've ingested in the past.

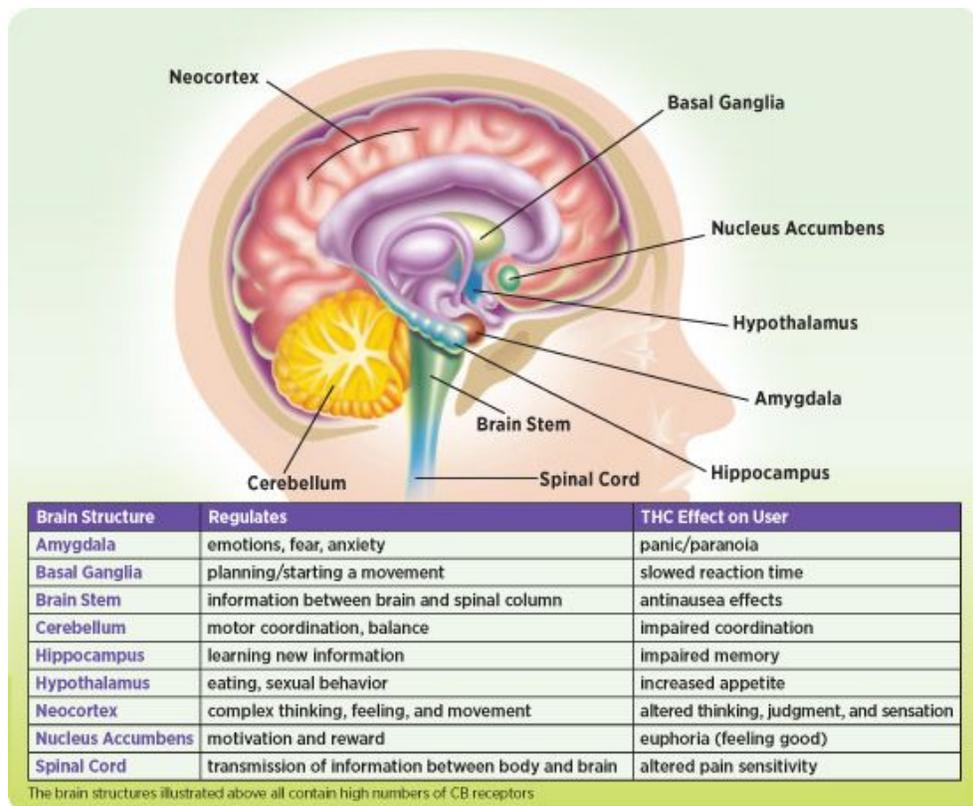
## SHORT-TERM EFFECTS

### - Psychological Effects of THC (negative and positive)

When THC binds to the cannabinoid receptors, it replicates Anandamide, the natural binding chemical for these receptors, as discussed in the background research. This binding of chemicals results in changes in the measure of many different neurotransmitters, significantly dopamine and norepinephrine. These are neurotransmitters that are largely responsible for the acute effects of cannabis (THC) ingestion, for instance euphoria and anxiety. Other effects may incorporate a general cognizance/consciousness, feeling of relaxation and euphoria, reduced stress levels, more inclined to humor, more appreciation for music, enhanced memory/recollection (episodic memory), escalating sensuality, heightened sensitivity, more creativity, etc. Episodic memory is often associated with THC, without known reasons. Episodic memory is a type of long-term memory that calls for the recollection/awakening of past experiences together with their time, place, and linked emotions. Cannabis also causes many more cognitive effects, referring to a higher enjoyment for the taste of food and its aromas. Cannabis (THC) also causes distorted time apprehensions, which create an

induced reality in which time is passing abnormally fast around you. Your distorted perception of time originates from that certain “rush” of ideas that flood you when you are under the influence. When increasing your dose of cannabis, the psychological effects become more hallucinative, and alters your senses, including your body image. You may begin to experience illusions, either audible illusions or visual, and pseudohallucinations. Pseudohallucinations are spontaneous, unintentional sensory experiences that are realistic enough to be considered as hallucinations. They are described by the person as ‘unreal and unlike’

hallucinations, almost like you cannot believe they occurred. Cannabis is also known to induce a sense of depersonalization and derealization. Depersonalization is when you feel as though you are watching yourself in third-person, floating outside of your body.



Your mind has created this illusion that nothing is real, including yourself. Extensive stress, anxiety, and depression are triggers for DPDR. DPDR also can trigger panic attacks and severe paranoia. Your panic attacks are caused by your heightened senses (colors are brighter, sound is louder), which are even more heightened while you are 'high.' Cannabis, a psychoactive drug is considered a stimulant, depressant, and hallucinogen, all in one. Although it carries more psychedelic and hallucinative properties. CBD, the most important cannabinoid after THC, also plays a significant role in the psychological effects, but THC plays a much more important role.

## **NEGATIVE PSYCHOLOGICAL EFFECTS**

- **Temporary Hallucinations / images**
- **Panic attacks - heightened senses**
- **Altered senses**
- **Impaired vision**
- **Mood swings**
- **Extreme Paranoia**
- **Sleepiness - depression, anxiety**

Even though THC induces more anxiety, depression, and paranoia, it also has healing properties. For example, Cannabis (THC), has the power to (when attached to the cannabinoid receptors) to release endorphins. Endorphins are chemicals that communicate with the receptors in your brain to reduce your awareness of pain. They also trigger positive emotions throughout your body, similar to morphine. With regular use of THC, you can slowly steer your depression and anxiety away. There is also a study where Cannabis has proved to enhance your cognitive abilities. All of this research also depends on which strain of cannabis you are consuming, since sativa is more invigorating than indica. It's almost a therapeutic medicine that can improve your mental health, and train your thought process to not disconnect or overwhelm you with negativity. THC in Cannabis also revitalizes the electrical activity in the brain. It has anti-seizure capabilities that improve the health of the brain. There was a case study done on THC reducing seizures. It was mainly done using a placebo and was done to find a mix of medication that could reduce seizures in children. Half of the participants were given oral THC medication everyday for a 14 week period, the other half were given a placebo. Ones that were given the medication decreased seizures from 12.4% to 5.9%. The participants given the placebo faced a 0.9% drop, and overall, 5% of the participants became seizure free. There was no change in emotional activity. Cannabis also plays a vital role in patients with severe PTSD. Post Traumatic Stress Disorder is a traumatic past experience that your mind can't seem to let go of. When treating PTSD, you need to increase your serotonin levels. This is where cannabis comes in. It is known to replicate the feeling of serotonin on your brain, which calms you down and helps you deal with insomnia nightmares related to your PTSD. The relaxing and calm mindset that THC induces (depending on strain) also enhances the quality of your sleep

that helps your body generate and function more evenly. The 'high' essentially provides a rest to the body, making you feel sleepy. Sleepiness, although can be associated with depression and anxiety. There are positive and negative aspects. Overall, the upliftment of your brain, aids in soaring stress levels, and more importantly, your mental health.

### **- Physical effects of THC (negative and positive)**

The short-term physical effects of cannabis are daily cough and phlegm, resulting from irregular breathing, impaired body movement, an increased heart rate, red eyes, reduction in intraocular pressure, cold and hot sensations throughout the body, a negative impact on fertility (sperm count), child development during pregnancy, etc. The smoke that is a result when you're smoking cannabis, irritates your lungs, resulting in the cough and phlegm. You are also at a high rate for developing lung illnesses, including bronchitis and pneumonia. When you are under the influence, your heart is more elevated than normal. This may make you feel lightheaded, experience heart palpitations, fluttering in the chest area, tightness in the chest (angia), difficulty in breathing, and you are at a higher risk for experiencing a heart attack. Cannabis makes your heart work harder, which is a danger for individuals who already have pre-existing heart conditions. Very limited research has led to believe that cannabis causes testicular cancer, because of its impact on your fertility, This is not confirmed, and is undergoing further research. Men who may smoke/ingest cannabis on a regular basis, are more likely to have a low sperm count, which may cause complications in the future when trying to conceive a child. If and when you ingest cannabis while pregnant, you are at a risk for giving birth to an underdeveloped or underweight child. We don't know enough to believe that pregnant mothers who ingest cannabis are more likely to give birth to children who are addicted to cannabis as they get older, or may have other drug problems.

There was a study conducted that measured your reaction time and performance for motor responses, while under the influence of cannabis. Six experienced cannabis users were each given different amounts of doses of THC. The results showed that reaction time was not heavily influenced by low or high doses, but there still was miscommunication, grasping information. Movements were found to be followed slower after smoking, and as doses were increased, movement became impaired, and sluggish, Through this evidence, we can conclude that cannabis does affect motor skills, which makes you prone to physical injuries, and a danger while driving. Because your reaction is affected, even if it's the slightest change, you are going to move slower, think slower, and grasp methods or a red light slower. When it comes to your eyes, they become bloodshot when under the influence, which is a very visible sign that you are 'high'. Your conjunctival blood vessels become congested, resulting in that red eye. Your intraocular pressure (IOP), is the fluid pressure in your eye and is used to evaluate patients who are at risk of having glaucoma. If your pressure drops too low, you are at a

high risk for several eye problems, including your cornea swelling, which results in blurred vision. This makes you impaired and unable to perform daily activities.

### **- Neurological effects of THC**

Neurologically, you face short-term memory and learning problems after heavy use of cannabis. All of the studies and trials that are conducted on cannabis and memory are affected by dose, confounding drug use, and etc. The most relevant and effective information on cannabis and memory is on its short-term negative effects. In a study, in 2001, researchers conducted a neuropsychological performance on pre-existing cannabis users. They discovered that after 7 days, there were visible cognitive deficits after strong doses of cannabis. Although, they were found to be reversible deficits and caused no long-term harm. There was an impairment in individuals' mental processes and had trouble acquiring knowledge and understanding of activities occurring around them. In a study by Harvard professor, Harrison Pope, through neuropsychological tests, he discovered that long-term cannabis users appeared to demonstrate increased difficulty with verbal memory after a couple of weeks they had stopped smoking. Shockingly, around 4 weeks later their difficulty with memory disappeared and there were no underlying permanent effects. Cannabis does affect your perception of a lot of things, but there is no permanent brain damage. Chronic cannabis users only had a small impaired memory and learning. Their reaction time, overall ability, and language were completely unaffected. Other studies show that there is only a reduction in your neurocognitive performance/understanding, through large and long-term doses of marijuana, even if you stop ingesting it. There are varied studies on if cannabis induces short-term or long-term neurological problems.

Although on your neuron level, you experience other side effects. Even after or during cannabis(THC) use, you can experience temporary hallucinations/images. This occurs because when your Endocannabinoid System starts to launch in other parts of your brain that are not required, such as the Occipital and Temporal lobe. Your neurons are fired where they are not needed, creating hallucinated images. Your occipital lobe is responsible for your vision/eyesight and your temporal lobe handles and processes your memories, merging them with your taste, sight, sound, and touch. Other than hallucinations, you will experience sleepiness/drowsiness through long-term cannabis use. When our Endocannabinoid system fires off different parts of our brain, it also fires off our hypothalamus as well. Your hypothalamus is responsible for your body temperature, appetite/weight control, your sleep cycles, your sex drive, childbirth, blood pressure, heart rate, etc. So, when your EC system fires off your hypothalamus, which transitions your brain into sleep mode. Through constant THC use, your brain slips off into sleep mode more frequently. Your paranoia is also heightened. Your paranoia is

caused by negative feelings and change in perception. When we ingest THC, we become worried and negatively think of ourselves. This state of mind is activated by excessive firing of the Temporal Lobe. We begin to feel inferior to the drug as we focus on the side effects and place ourselves in our own “placebo.” A placebo is a treatment that has no visible or therapeutic value.

### **- Social effects of THC**

Consuming THC (cannabis) also causes negative social/intellectual effects. The excessive paranoia caused by the THC, leads to distrust of the people around you. Your intellectual level also is significantly impacting your learning/knowledge. If you are addicted, addiction impacts the type of people willing to stay around you, also indirectly affecting social status, and how people act towards you. You also experience random panic reactions that impact your daily tasks. Your lack of concentration/memory on simple tasks results in failure. Cannabis is highly associated with low achievement. It can also cause aggression/rebellion which in result causes poor relationships with your parents/family. Highly technical tasks require concentration which affect workplace situations. Overall, your social life is heavily affected.

### **NEGATIVE SOCIAL EFFECTS**

- **Paranoia leads to distrust of people around you**
- **Reduced intellectual level**
- **Addiction impacts type of people that are willing to stay around you**
- **Random panic reactions impact your daily tasks**
- **Lack of concentration on simple tasks results in failure**

### **LONG-TERM EFFECTS**

Long and heavy cannabis usage does result in long-term damage to the body because you are still developing as a person, physically and mentally. Research done on rats being exposed to THC, before birth, after birth, and during development creates heavy problems with memory and learning throughout life. Although, if you expose yourself to cannabis heavily after birth, you are at a decreased chance, especially if you cease to consume after heavy use. In that case, there will only be short-term effects. All long-term effects are caused by constant exposure to cannabis throughout your whole life cycle. Adult rats that were exposed to THC, developed cognitive deficits that interrelated with functional/structural changes in our hippocampus. Remember, our hippocampus controls our learning and memory. Your memory is affected long-term when you are a daily user, because of THC. THC attaches to receptors in the brain that

are vital for memory formation, which disrupts the process. There were imaging studies done on the human brain regarding cannabis use, and all of the results, worldwide, are varied and different. Certain imaging studies showed that daily cannabis intake during teenage years alters specific areas of the brain that control a wide portion of our important functions, including our learning, memory, and impulse control. The changes are heavily significant when differentiating between people who use and don't. Other studies that were conducted have shown no significant functional changes between people. There were other studies that informed us that THC use and long term effects are based on how long you've been using, your age/how your body is developing, and how much is being ingested. There were other long-term effects associated with clinical depression and tumbling anxiety that only got worse when they constantly kept using. Cannabis was also associated with a decreasing IQ. This change was only significant in people who began usage in teens and continued to use throughout their life. Even though decreasing IQ was connected with long-term cannabis use, we should always consider other factors involving somebody's IQ. For example, genetics, age when they were exposed to cannabis, having a history of addiction with cannabis or other drugs, everyday environment, etc. A study conducted in New Zealand showed that frequent/constant cannabis use that began in teenage years, was linked with losing up to 8 IQ points, in mid-adulthood. Even if you quit cannabis/THC after that, there is no research that shows us that they recovered those IQ points. All of this research is largely affected because participants could also be using other substances with THC and throughout studies, new products were being brought on the market, and THC doses were increasing along with it. As you grow older, you lose neurons in your brain, specifically your hippocampus, which limits your potential to gather and process new information. When you are chronically exposed to THC, you lose these neurons faster than the average person, resulting in the decreasing capability in memory and learning. Other brain processes are also impacted when losing neurons, including decision-making and intellectual concept formation. Chronic usage is also associated with social life problems, in your family, workplace, and school.

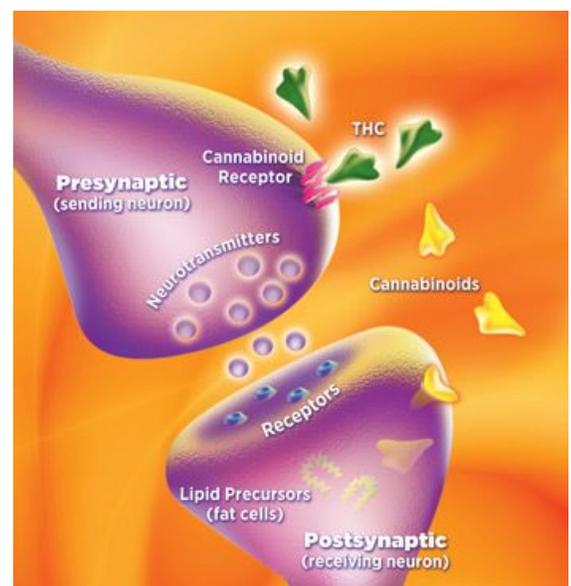
### **- Long-term problems related with disorders and non-cognitive areas**

Research and evidence has proved that long-term cannabis use is correlated with cases of acute psychosis, worsening psychotic symptoms, and encouraging hallucinatory/illusional episodes with patients with a history of any psychosis. Referring to a study, heavy use also encourages psychosis itself in individuals who have significant genetic or social fragility. It encourages and heightens the risk of psychosis, but it is not the cause of it. There are also other preexisting factors that may affect the extent of the psychosis including previous trauma, family genetics, and the environment in which you grew up. A second study was conducted and found that THC can cause

other prominent psychological disorders. For example, anxiety, decreasing cognitive ability, chronic paranoia, chronic depression, etc. Research shows that based on an individual's history, it changes if THC would reduce or amplify your chances for getting or reducing depression, anxiety, or any psychological disorders.

There is also inadequate research that points in the direction of the development or reduction of schizophrenia, through chronic cannabis use. Existing schizophrenia patients have shown that through heavy daily intake of cannabis, their cognitive abilities are more enhanced than non-users. The extent of their schizophrenia is a factor that affects its worsening or increasing. If use of cannabis began in teenage years, there is proof that it heightens the risk of schizophrenic disorders in adulthood, since chronic use started early. Although the percentage of individuals who have developed schizophrenic disorders is insignificant, there are still existing risks. The risk is advanced in individuals who have certain copies of certain genes related to psychological disorders. When there is a high percentage of THC in cannabis, there is a higher chance of psychological effects in an individual. THC has been found to cause more negative/positive psychological effects than any other cannabinoid. CBD, another main, but less important cannabinoid acts as the opposite of THC, not causing as many psychological/cognitive effects.

There should be more attention given to the connection between cannabis and depression. Although, this lack of awareness may be because the majority of the population refuses to seek out help and suffers in silence. Through chronic use of THC, one is more likely to develop depression, or worsen their existing depression. Research has proved that through early ingestion, one is at an increased risk for developing depressive disorder(MDD) in adult stages. There is not enough thorough research that proves THC causes depression itself, but symptoms and behaviour of depression are more often than not seen in chronic cannabis users. The numbing effect on your emotions and state of mind is what individuals seek for when already experiencing mental health issues. This is dangerous, since this lack of emotion can increase the depression, making you fall into this hole farther. Statistics also show that individuals who have committed suicide, have a higher chance of using cannabis throughout their life, than non-users. Cannabis is also linked to cancer. Cancer is not a short-term problem, it is a long, exhausting one. Chronic users are at a heightened



risk for lung, bladder, neck, and head cancer. There are numbers that prove that long-term users that have ingested for more than 20 years have cancers in the head and neck, than ones who have not had any experience with the drug. It is completely uncertain because of the limited research on cannabis. There are so many factors and effects that have not been discovered and/or acknowledged. The lung cancer, that is discussed, is often caused by lung diseases, since they have inhaled an extensive amount of THC. Cannabis is consumed through a variety of methods, but smoking is one of the most harmful. The constant inhalation of the drug can cause heart and lung problems that start off as heavy coughing and phlegm.

The research on cannabis today is very insignificant, and there are many more underlying effects that are being researched at this very moment, but through the current given research we can establish a solid base when it comes to cannabis and its cannabinoids.

### **Principles and Concepts:**

THC works with our body differently than any other cannabinoids. It proves to provide a stronger high and causes us to deteriorate or become healthier depending on usage and other important factors. The cannabinoid acts similarly to the cannabinoid chemicals that our bodies naturally produce.

### **Cannabis and the Nervous System:**

Cannabinoid receptors centralize in specific areas of the brain correlated with our thinking, pleasure, pain, memory, coordination and perception of time, but they also centralize in so many other different areas in the body, which results in various side effects throughout our bodies. Endogenous cannabinoids such as Anandamide act on CB receptors to keep them active and moving. Anandamide functions as neurotransmitters because they send messages through neurons in our nervous system. THC, being largely similar to Anandamide, attaches to the cannabinoid receptors and activates them, initially throwing the natural cannabinoids off balance. Cannabinoids influence how cells communicate, how they send and receive messages and carry them out. They act as a “dimmer switch” between cell communication when flooded. This causes natural chemicals to be unable to carry out functions. Once it attaches to these receptors the message travels to the presynaptic and postsynaptic neurons and eventually to neurotransmitters. Presynaptic neurons are ones that send messages by releasing a chemical when signalled to do so. Postsynaptic neurons are ones that receive the message when their receptors are activated by specific chemicals (neurotransmitters). Neurotransmitters are chemical messengers that travel from one brain cell to another. Receptors are activated by neurotransmitters. They trigger a set of events that allows a message to be passed on to other neurons. These parts are all part of the Endocannabinoid system. When THC overcomes, the communication between

neurons slows down, delaying signals, which slows down a person's reaction time, disrupts their short term memory, and affects their overall judgment of any situation occurring internally or externally. This slow effect also takes a toll on the release of your dopamine, slowly overcoming the release of those as well. Dopamine is a type of neurotransmitter that plays an important role in how we feel pleasure, in our ability to think, and plan. THC also activates our body's reward system, which is associated with pleasure and food. So, when an unnecessary amount of dopamine is triggered to be released, it causes that 'high'. This 'high' can be explained in various ways.

Neurons communicate when neurotransmitters are released from the presynaptic neurons, travel across the synapse (the space between the 2 cells), and attach to the receptors located on a nearby postsynaptic cell. This all occurs in our Endocannabinoid system. The Endocannabinoid system is a communication system located in the brain that controls how a person reacts, moves, and feels. It is mainly located in the hippocampus and cerebellum of the brain. The hippocampus is a brain structure that is embedded in our temporal lobe of each cerebral cortex. It is an S-shaped structure that is densely packed with neurons. It plays an important role in controlling learning, memory encoding and consolidation, and spatial navigation. It also harbors our short term memory and coordination, and this is where the THC attaches to the cannabinoid receptors. The EC system communicates its messages in the 'reverse' way. In short, when the postsynaptic neuron is activated, cannabinoids are made instantly from fat cells (lipid precursors) that were already in the neuron. When produced, they travel backward to the presynaptic cell and attach to the cannabinoid receptors. This is important because now that the cannabinoids act on the presynaptic they have full control on what happens when they are activated. Since cannabinoids act as 'dimmer switches' on presynaptic neurons, it decreases how many neurotransmitters are released. In result, this affects how the messages are sent, received, and processed by the cell. THC also impacts the Limbic System which aids in your "feeling good" emotions, resulting in that "high." The system includes many structures that handle our emotions and memory. It also modulates our endocrine and or autonomic function response to emotional stimuli and also reinforces our behaviour.

### **Cannabis and the Digestive System:**

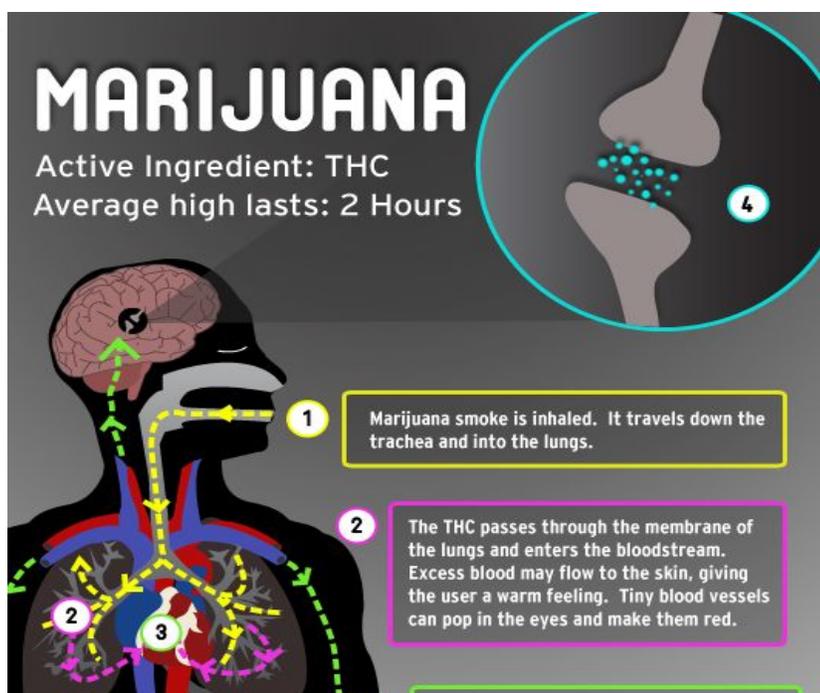
Your Endocannabinoid system plays a large role in your appetite, eating, salivation, and your digestive system overall. Your CB receptors (cannabinoid receptors) are significantly distributed in your digestive system. The excessive receptors in your digestive system can either be a positive or negative thing. People who may have gastrointestinal disorders such as inflammatory bowel disease (IBD), or irritable bowel syndrome (IBS) can use cannabis to overcome them, since cannabis plays a large positive role in these disorders, according to research. Your endocannabinoids such as anandamide also exist in the GI tract, along with enzymes associated with the metabolism of your endocannabinoids. We have 2 different types of CB receptors in our body, CB1 receptors and CB2 receptors. Each of them determine which affects we may

experience through the use of THC. Your CB1 receptors are the dominating receptors in your digestive system. They rest on your submucosal and myenteric nerve plexus, which is along your GI tract. They are known to relax your lower esophageal sphincter, which can result in acid reflux. Acid reflux is particularly known as heartburn or a burning sensation throughout the chest caused by stomach acid flowing back up your GI tract. When you consume cannabis orally, you can experience this, quite strongly. When you overwhelm your GI tract with cannabinoids it can induce unusual and negative effects. Sometimes you can even experience acute vomiting syndrome, which is known as cannabinoid hyperemesis syndrome. There are many undiscovered symptoms and affects associated with cannabis and the digestive system.

Individuals who have a hard time gaining appetite or eating less can get 'high' to activate your reward system, which induces a starving hunger. This is often referred to as the 'munchies.' When you are extremely hungry, you feel 'pangs' of hunger which cause a hormone named ghrelin to be released. Ghrelin is a hormone produced in the GI tract and is known as a 'hunger hormone' because it encourages food intake. When ghrelin is released, it activates certain nerves that move up the gut-brain axis into the brain, where they reach the hypothalamus. This is where these pangs originate. THC, when ingested, activates these ghrelin receptors which sends messages into the brain, which creates pangs of hunger. These are what cause the 'munchies'. This hunger has solved a lot of modern problems including eating disorders and loss of appetite from cancer. It has aided in anorexia, cachexia, IBD, IBS, fibromyalgia, Crohn's, etc. The fight between if cannabis causes more negative or positive effect on the GI tract is controversial, since there are strong arguments supporting each side.

### **Cannabis and the Respiratory System:**

The effects cannabis has on the respiratory system are primarily caused by smoking cannabis, not eating it. Smoking cannabis has the same, maybe even worse affects, as smoking cigarettes. It has been proven that cannabis smoke inhibits four times greater respiratory problems than tobacco smoke. This can lead to lung cancer, bronchitis, COPD, etc. The effects are more serious because cannabis, particularly THC is inhaled longer to experience a stronger 'high'. When inhaling THC, it causes your airways to widen for a couple of hours. Anandamide, an endocannabinoid, attaches to CB1 receptors in the lungs, relaxing your bronchial muscles. Although since your bronchial muscles are always relaxed, it will do the opposite and narrow your airways. This will cause bronchospasms, compromising your airway, making it more and more



difficult to breathe. You will begin to wheeze and cough. Through chronic use of THC, you will cough and wheeze more often everyday. A lot of the symptoms caused by cannabis smoke are still unknown, which should cause us to be very careful when inhaling excessive amounts of THC. These are short-term symptoms on the respiratory system and can be reversed through uncontinuing use of smoking. If you continue to inhale THC daily, your symptoms will worsen and eventually become chronic and irreversible. The coughing and wheezing will turn into shortness of breath, beginning of asthmatic symptoms, pharyngitis, chest pain and tightness, the beginning of chronic bronchitis, etc. Chronic bronchitis is the swelling of your bronchial tubes. Your bronchial tubes are responsible for transporting the air to and from your air sacs. When they swell, it causes a build-up of mucus. This creates a blockage in your airways, resulting in the difficulty to transport oxygen to your cells and taking away the carbon dioxide. When comparing an individual smoking cannabis and an individual smoking tobacco, the respiratory symptoms of a cannabis smoker were very identical to the individual who had been smoking tobacco 10 years longer than the cannabis smoker.

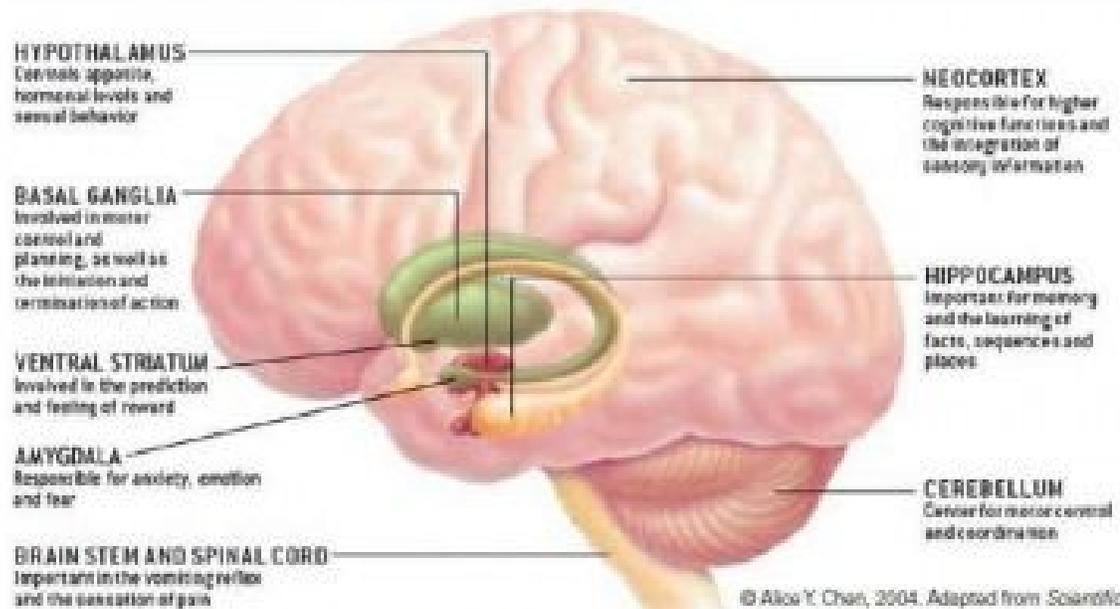
Cannabis smoke and lung cancer are still being researched further, but when biopsying individuals with a history of chronic cannabis use, they contain carcinogens, putting them in a pre-cancerous area. There is inconsistent evidence associated with lung cancer and cannabis, but there are case studies that have proven chronic users have a very high risk for developing lung cancer. Cancer and its association with cannabis have not been confirmed, but there is a platform, which can we base the extent of it from.

### **Cannabis and the Cardiovascular System:**

The cardiovascular effects are not significant but still exist when it comes to cannabis and the heart. Long-term inhalation or ingestion of THC can cause an elevated heart rate, high blood pressure, and a high cardiac output. A cardiac output is the amount of blood your heart pumps each minute. Chronic cannabis users with an increased cardiac output are at risk for chronic anemia, hyperthyroidism, hypercapnia, etc.

Hyperthyroidism is when your thyroid gland begins to produce too much thyroxine, which can cause an irregular heartbeat and unexpected weight loss. Hypercapnia is when you have an excessive amount of carbon dioxide in your blood and it builds up. This can cause shortness of breath, headaches, fatigue, seizures, and random fainting episodes. Anaemia is when your body does not have enough red blood cells, which provide oxygen to your tissues. There is a lot of weakness and dizziness associated with anemia. You feel short of breath and exhausted quite frequently. Cannabis affects heart health because there are CB receptors in our heart cells as well. CB receptors are everywhere, causing effects still being researched today.

## Marijuana's Effects on the Brain



© Alice Y. Chan, 2004. Adapted from Scientific American.

When marijuana is smoked, its active ingredient, THC, travels throughout the body, including the brain, to produce its many effects. THC attaches to sites called cannabinoid receptors on nerve cells in the brain, affecting the way those cells work. Cannabinoid receptors are abundant in parts of the brain that regulate movement, coordination, learning and memory, higher cognitive functions such as judgment, and pleasure.

### What Next?

To take our research further, we could access a larger variety of sources, and interview chronic cannabis users for accurate information. Analyzing more case studies and experiments throughout the world would upgrade our research and provide more proof of the results. We could interview researchers, scientists, past cannabis users, and/or individuals who have been hospitalized due to cannabis use. All of these ideas would further our information and aid us in grasping the concepts and extent of THC. We could experiment with cannabis users, adjusting their doses and monitoring their behaviour and conducting daily tests. To conclude, our research would be more advanced if we accessed more in-depth sources and experienced in-person interviews with users and researchers.

### Sources of Errors

When researching our topic and viewing many websites, we realized that all of this information is affected by hundreds of underlying factors. For example, we only viewed websites and articles, did not interview researchers, and all of the given research was still undergoing trials. THC is still being heavily researched and experimented. there are

millions of case studies being conducted as we speak. Even though we have provided so much research on THC and cannabis, it has not been reviewed completely. The legalization of cannabis was very hesitant because there are so many undiscovered principles when it comes to THC. Our errors began when we did not extend our research into books, researchers, journals, written articles, and THC users. What we have written is just the beginning of THC. We may have gone further when it came to the 'how' and the 'why,' but we only established the base. In the future, we should be expanding our research beyond what is given online and into the real life experience, providing 100% accurate information when it comes to cannabis.

## **CONCLUSION:**

Cannabis is becoming more controversial throughout the years. Overall, more negative long-term effects are presented through chronic use. Our thesis was that THC causes more long-term negative effects than positive effects. This is proven when we discussed the long-term psychological, neurological, physical, and social effects. The effects being permanent cognitive impairment, loss of memory, difficulty with breathing, mobility issues, etc. When compared to the amount of benefits, THC has been proven to create many more negative impacts. Although, THC is still being thoroughly experimented and researched as we speak. Of course, there are proven benefits, but those have many underlying factors such as other drug use, amount of use, duration of use, etc. There are many more developed drugs that have numerous case studies and would be far more effective in replacement of THC. We are not certain how far it can exceed over its known risks. It has not been successfully developed to a point where doctors can precisely monitor the overall impact of the drug on the patient. There will always be unknown factors when THC is supplied for medical patients and for everyday recreational use. No considerable amount of evidence has shown us that THC is more inclined to produce positive effects. In short, cannabis contains a number of significant chemicals and thousands of undiscovered underlying effects.

- Based on the fact that THC is still highly unknown and has not reached its full potential in research, we assume through what has been provided, that THC overall has more negative impacts than positive.