



Candidates must complete this page and then give this cover and their final version of the extended essay to their supervisor.

Candidate session number

Candidate name

School number

School name

Examination session (May or November)

May

Year

2013

Diploma Programme subject in which this extended essay is registered: Biology

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: Seasonal Depression: The Winter Blues'
link to Vitamin D Deficiency

Candidate's declaration

This declaration must be signed by the candidate; otherwise a grade may not be issued.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature:

Date:

March 4, 2013

Supervisor's report and declaration

Supervisor:

Candidate:

Candidate Number:

I began working with _____ on her extended essay in the Spring of 2012. Initially we discussed an inquiry and lab based approach to the extended essay. After researching several topics, _____ continued to express her interest in the topic of Seasonal Depression. She decided on a research based approach in order to answer her research question; "To what extent is Vitamin D deficiency the cause of seasonal depression?"

After identifying her research question, _____ researched information regarding Vitamin D, Vitamin D deficiency, depression, and seasonal depression. She also researched clinical trials and journal articles regarding seasonal depression and Vitamin D deficiency. _____ was able to identify proper sources and work through these texts with little help.

During one of our final meetings, I began to question _____ on her knowledge of not only Vitamin D and depression, but also the link between the two. This conversation led _____ to perform additional research on the role of Vitamin D in the brain. After researching this specific topic, _____ had a better understanding of Vitamin D and its relation to serotonin levels.

Assessment form (for examiner use only)

Criteria	Achievement level					
	Examiner 1	maximum	Examiner 2	maximum	Examiner 3	
A research question	<input type="text" value="2"/>	2	<input type="text"/>	2	<input type="text"/>	
B introduction	<input type="text" value="1"/>	2	<input type="text"/>	2	<input type="text"/>	
C investigation	<input type="text" value="2"/>	4	<input type="text"/>	4	<input type="text"/>	
D knowledge and understanding	<input type="text" value="2"/>	4	<input type="text"/>	4	<input type="text"/>	
E reasoned argument	<input type="text" value="2"/>	4	<input type="text"/>	4	<input type="text"/>	
F analysis and evaluation	<input type="text" value="1"/>	4	<input type="text"/>	4	<input type="text"/>	
G use of subject language	<input type="text" value="3"/>	4	<input type="text"/>	4	<input type="text"/>	
H conclusion	<input type="text" value="1"/>	2	<input type="text"/>	2	<input type="text"/>	
I formal presentation	<input type="text" value="3"/>	4	<input type="text"/>	4	<input type="text"/>	
J abstract	<input type="text" value="0"/>	2	<input type="text"/>	2	<input type="text"/>	
K holistic judgment	<input type="text" value="2"/>	4	<input type="text"/>	4	<input type="text"/>	
Total out of 36		<input type="text" value="19"/>	<input type="text"/>		<input type="text"/>	

Seasonal Depression: The Winter Blues

To what extent is Vitamin D Deficiency the cause of Seasonal Depression?

Biology

Word Count: 3865

Abstract:

Light, as seen through the centuries is one of the most powerful qualities of life. It provides all living things with a basis for bodily functions, and is noted to have a great effect on the effectiveness of these functions. However without sunlight there are many negative effects on the human body, one which will be focused on throughout this paper is Vitamin D Deficiency and its correlation to Seasonal Depression.

Vitamin D, which is an essential element for achieving optimum health, is produced by human's exposure to sun's rays. However, when those are not exposed to the sun for duration of time, they often are seen to not have a stimulant for the production of this essential element, and therefore become deficient.

Vitamin D Deficiency is one of the main and if not most probable cause of Seasonal Depression, as the decreased amount of Vitamin D causes many health complications in individuals such as mood change. The validity of this statement however will be proved throughout this paper, and contradicted in some ways.

Many researchers have either accepted the idea that Vitamin D Deficiency is the answer to Seasonal Depression, and in some cases this was proven true but others, oppose of this idea. Other medical researchers have performed tests within sample populations and have found that there is no direct correlation between the two. At the conclusions of these studies it was ruled that more tests needed to be performed for more accurate results.

Despite other causes of Seasonal Depression, Vitamin D Deficiency is continued to be the central focus and remains a strong contender for the main cause of Seasonal Depression.

Table of Contents

Title Page-----	pg. 1
Abstract -----	pg. 2
Introduction -----	pg. 4
Body of Paper-----	pg. 4
Depression: The Broad Term-----	pg. 5
The Change of Seasons-----	pg. 6
The Power of Light-----	pg. 6
What is Vitamin D? -----	pg. 7
Vitamin D Deficiency-----	pg. 8
To what extent is Vitamin D Deficiency the cause?-----	pg. 10
Other Causes of Seasonal Depression-----	pg. 11
Treatments of Seasonal Depression-----	pg. 13
Conclusion-----	pg. 14
Work Cited-----	pg. 17

Introduction:

I was first familiarized with the effects of Seasonal Depression (Seasonal Affective Disorder) at age 8. As I noticed that my neighbor traveled to Florida in the winter, then returned in the spring, I began to question why. The answer I received as a child was that my neighbor didn't like the cold weather, although I didn't understand why everyone didn't like the snow. As I grew up however, I began to realize that my neighbor's dislike towards the winter was not just because she didn't like the cold or the hassle of cleaning up her driveway after a snowstorm; it was because at this change in season, she had a downturn in mood. She had the winter blues. After learning of this type of depression, I began to research the entirety of it ranging from the particular individual it affects to the causes of this seasonal disorder.

Seasonal Affective Disorder, also known as Seasonal Depression, is a type of depression that coincides with seasons of shorter days and daylight, particularly the winter however some who suffer from this seasonal disorder are affected by the summer season in addition to or instead of the fall and winter. Many incidences of this depression increase in people living farther from the equator hence the decreased amount of sun exposure (Edwards 1). Humans, who suffer from this disorder, often start experiencing a downturn in mood starting in the fall, continuing into the winter, where the shortest days of the year occur. Therefore, the major cause of this type of depression is the lack of sunlight and sun exposure that individuals receive during the winter.

As there is a lack of sunlight in the winter, a correlation between Vitamin D Deficiency and Seasonal Depression can be noted. This deficiency is due to the fact that Vitamin D can be produced in individuals when there is a high exposure of the ultraviolet

rays of natural sunlight, but during the winter seasons, a smaller amount of Vitamin D may be produced due to the lack of sunlight. Therefore in many patients who experience symptoms of Seasonal Affective Disorder, the first step is to determine the levels of Vitamin D in their body.

While in many cases Vitamin D Deficiency seems to be the major cause of seasonal depression, there is much opposition to this statement through other investigations. Therefore, the scope of this research will examine the extent to which Vitamin D Deficiency is a cause of Seasonal Depression.

Depression: The Broad Term

Depression is a psychiatric disorder characterized by the inability to concentrate, feelings of extreme sadness, guilt, helplessness, and thoughts of death. (Mayo1) Seasonal Depression embodies the characteristics and some of the symptoms and causes of clinical depression but differs due to the fact that this depression coincides with the seasons. Seasonal Depression is a mood disorder, in which people that have normal mental health throughout most of the year experience depressive symptoms in the winter or summer, spring or autumn, cyclically. (Pick 3) Many who suffer from Seasonal Depression experience the same symptoms of clinical depression but during specific time intervals, noted at the change of seasons. Therefore, after understanding the causes and effects of clinical depression, a firm understanding of Seasonal Depression can also be grasped.

The Change of Seasons:

Having it known that Seasonal Depression is caused by the change in seasons, most notably from fall to winter, there are many symptoms that can be addressed at this time. Although it is most common in sufferers in the winter than in the summer or spring, individuals can suffer from this disorder throughout the whole year, or just in the summer. At this point where the seasons are changing, one may notice that they are experiencing serious mood changes, something that is a common symptom to clinical depression. Mood changes at the change of the seasons are one of the first signs of Seasonal Depression, accompanied by restlessness, and other symptoms of clinical depression known as helplessness, extreme sadness, and the inability to concentrate. Although it has been noted that Seasonal depression is a form of depression caused by the turn in the seasons, many may still question why this intangible thing can have such a huge impact on our bodies. This is where we can point to light as our answer.

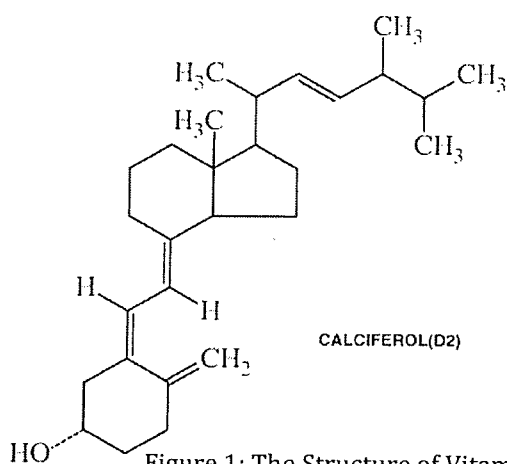
The Power of Light

“For the rest of my life I will reflect on what light is,” wrote Albert Einstein in 1917. Light is the source of life, and it is also at the very core of our way of life. Whether the source of light is romantic candles or tropical sunshine, the power of light to affect our mood and well-being is tacitly accepted by all of us (Marshall, Cheevers 10). The nature of light was what would help transform Einstein from an unknown patent clerk to the genius at the center of the twentieth-century physics (Harris 5). This focus on light by Albert Einstein shows the power of light, in the holder, and in those that receive it from wherever it may be, in this case the sun. Due to winter however or in places farther from

from Seasonal Depression and the theory of the power of light can be fully addressed. The lack of sun exposure results in many health defects such as depression, which we are examining, osteoporosis, and in this case some types of cancers all due to the lack of essential elements from the sun's rays. The importance of light in individuals is due to the fact that the sun's rays provide individuals with essential elements that are needed to achieve optimum health such as vitamins and minerals. And, within these vitamins and minerals, one in particular that will be examined is Vitamin D.

What is Vitamin D?

Vitamin D also known as the Sunshine Vitamin is a group of fat-soluble secosteroids



(structures which share a close structural and functional resemblance to steroids) responsible for the intestinal absorption of calcium and phosphate. (This vitamin is unique due to the fact that it can be ingested as cholcalciferol (vitamin D3) or ergocaliferol (vitamin D2), as seen in the figure to the left.

This figure demonstrates the basic structure of vitamin D2, which is one of the ways that Vitamin D is ingested into the body. Another particular way that Vitamin D is absorbed in the human body is through the synthesizing of cholesterol under adequate sun exposure conditions. Vitamin D plays many important roles in the human body and is one of the most essential vitamins to maintain and achieve optimum health. One of the major biological functions of Vitamin D is to maintain normal blood levels of calcium and phosphorus (Mayo 1) As it is known that calcium

of Vitamin D is to maintain normal blood levels of calcium and phosphorus (Mayo 1). As it is known that calcium aids in preventing osteoporosis, which is a weakening of bones which leads to an increased risk of fracture, Vitamin D is essential to provide protection against this disease. Vitamin D is used in a combination with calcium to increase mineral bone density and to decrease fractures (Mayo 2). Vitamin D is also important due to the fact that it promotes cell growth, which is one of the key facts in preventing cancer, while it also is directly linked to forms of depression due to the deficiency of such an essential vitamin.

Vitamin D Deficiency:

After examining the structure and function of Vitamin D in the body, one must realize that all humans often do not produce adequate amounts of this essential nutritional element for their body to function for various reasons, one being the lack of sun exposure. It has been stated that one major cause of Vitamin D Deficiency is caused by the lack of sun exposure due to the fact that the sun's rays stimulate the production of Vitamin D in the skin and with decreased exposure there are often decreased levels of the vitamin produced. This deficiency lends to the connection of Seasonal Depression, and

other forms of disorders that prevent optimum health.

Healthy Ranges of Vitamin D

TABLE 1

Level of Vitamin D	Clinical Significance	Effects
< 12ng/mL	Significant Deficiency	Risk of osteomalacia in adults
12-20 ng/ml	Deficient	Not enough to maintain healthy bones or the other health benefits associated with Vitamin D
> 20ng/ml	Normal	Optimal level for bone, respiratory, immune, and neuromuscular health

ng= nanograms mL=milliliters

Figure 2: Healthy Ranges of Vitamin D

Adapted from the National Institute of Health Vitamin D Fact Sheet (2011): <http://ods.od.nih.gov/factsheets/vitaminDHealthProfessional/> Retrieved April 2012

According to figure 2 seen above, a normal and healthy range of Vitamin D in the human body is greater than 20 ng/ml. At this level there is noted to be optimal bone, respiratory, immune, and neuromuscular health. At levels lower than this, such as between 12 and 20 ng/ml there is not enough of the vitamin to maintain healthy bones or other health benefits. Therefore a lack of Vitamin D in the body can have major health effects on humans ranging from Osteoporosis to forms of depression to cancer. It is also important to note, that all individuals are not affected in the same way by the lack of sunlight and Vitamin D in their body, therefore many other causes of this type of depression must be noted before drawing conclusions that this deficiency is the main cause. In conclusion, a major symptom of Seasonal Depression is the lack of Vitamin D in the body because during the winter seasons, and in locations that lack sunlight, the body is not able to produce adequate amounts of this essential element for proper function. As previously stated, although all do not experience Seasonal Depression in the winter season but rather the spring or summer, Vitamin D Deficiency still stands as a major cause of this

depression to some extent because this lack of Vitamin D production also correlates with the production levels of serotonin in the brain, a neurotransmitter that plays an important role in mood. Brain Chemistry correlating to the production of Vitamin D is a dominant reason to why Vitamin D Deficiency may cause Seasonal Depression.

To what extent is Vitamin D Deficiency the cause?

While there is noted to be a direct link in some sufferers of Seasonal Depression to a lack in Vitamin D, this is not the only cause. Therefore, it is difficult to be certain to the extent to which Vitamin D Deficiency the cause of Seasonal Depression. It has been tested with the basic facts of whether Vitamin D has a major impact on the role of the brain and was preformed in multiple studies by scientists to test whether supplementing with Vitamin D would help those patients with Seasonal Depression. In these studies preformed by Dr. John Briffa, it was determined that some patients who suffer from Seasonal Depression (Seasonal Affective Disorder), may respond to the nutritional approach of an increased intake of Vitamin D. At the conclusion of this study, after five days of treatment with Vitamin D, (at a dose of 400 or 800 IU per day) an improvement in the winter mood was noted. (Briffa 3) By controlling this level of Vitamin D in the body, there was an increase in mood, therefore showing that in some cases there is a direct correlation between Seasonal Depression and Vitamin D Deficiency.

Although there are many cases, which state that Vitamin D Deficiency is the cause of this depression, many also oppose to this. According to Dr. Oscar Franco, and his team of medical researchers at Warwick Medical School, they have discovered that the low levels of Vitamin D in the blood may not be connected to depression. In a study

depression to some extent because this lack of Vitamin D production also correlates with the production levels of serotonin in the brain, a neurotransmitter that plays an important role in mood (Wiki 1). Brain Chemistry correlating to the production of Vitamin D is a dominant reason to why Vitamin D Deficiency may cause Seasonal Depression.

To what extent is Vitamin D Deficiency the cause?

While there is noted to be a direct link in some sufferers of Seasonal Depression to a lack in Vitamin D, this is not the only cause. Therefore, it is difficult to be certain to the extent to which Vitamin D Deficiency the cause of Seasonal Depression. It has been tested with the basic facts of whether Vitamin D has a major impact on the role of the brain and was performed in multiple studies by scientists to test whether supplementing with Vitamin D would help those patients with Seasonal Depression. In these studies performed by Dr. John Briffa, it was determined that some patients who suffer from Seasonal Depression (Seasonal Affective Disorder), may respond to the nutritional approach of an increased intake of Vitamin D. At the conclusion of this study, after five days of treatment with Vitamin D, (at a dose of 400 or 800 IU per day) an improvement in the winter mood was noted (Briffa 3). By controlling this level of Vitamin D in the body, there was an increase in mood, therefore showing that in some cases there is a direct correlation between Seasonal Depression and Vitamin D Deficiency.

Although there are many cases, which state that Vitamin D Deficiency is the cause of this depression, many also oppose to this. According to Dr. Oscar Franco, and his team of medical researchers at Warwick Medical School, they have discovered that the low levels of Vitamin D in the blood may not be connected to depression. In a study

performed and published in the *Journal of Affective Disorders*, the team recruited more than 3,000 people and tested levels of Vitamin D in the blood, then carried out a questionnaire with the participants to assess the prevalence of depressive symptoms (Science Daily 2). After this was performed the researchers found that there was no clear correlation with the amount of Vitamin D in the blood and depressive symptoms in the patients. Although this research contradicts the idea that Vitamin D Deficiency is the cause of Seasonal Depression, it does not eliminate the possibility that it remains a dominant cause due to the errors and limitations of such experiments. In the experiment performed by Franco and his medical researchers, the population was taken from residents aging from 50-70 in China as part of the Nutrition and Health of Aging Population in China. Therefore, this study is noted to have limitations due to the fact that a small sample was being tested. Another limitation that can be addressed is the fact that the study was not performed at the change of the seasons, which is most notably the time at which those who suffer from this disorder experience a downturn in mood. In conclusion, as suggested by Franco, more studies must be performed to see any stronger correlations between Seasonal Depression and Vitamin D Deficiency being the answer to this disorder. The causes of Seasonal Depression are also still being studied, but the lack of sunlight hence the lack of Vitamin D, remains as the potential answer.

Other Causes of Seasonal Depression:

Due to the lack of sun exposure in humans there are multiple effects this has on the human body, in turn causing Seasonal Depression. The first that can be addressed is the disruption of Circadian Rhythm. When there is a reduced level of sunlight in the fall

and winter, this may cause a disruption in one's body's internal clock, which lets one know when to be asleep or awake (Mayo 1). Due to this disruption in the rhythm, one may start to experience symptoms of depression such as drowsiness, and restlessness. Another noted cause of Seasonal Depression is due to the imbalance of serotonin levels in the human body. A drop in serotonin, which is a brain chemical (neurotransmitter) that affects mood, is noted as a potential link to Seasonal Affective Disorder. Because of the reduced sunlight in the winter, there is seen to be a drop in serotonin levels in some individuals. As seen in the graph below, this evidence is further supported.

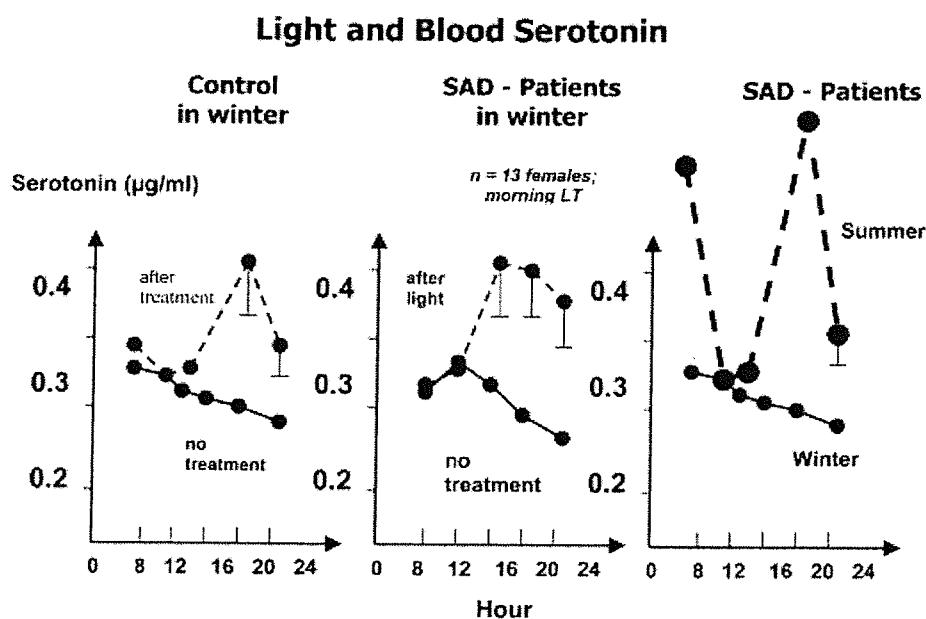


Figure 3: Light and Blood Serotonin Levels

This test was performed on 13 females pre- and post-treatment for Seasonal Depression. It proves that before treatment of this depression, those who were suffering had smaller amounts of serotonin in their body compared to after the light therapy treatment (one of the major and most effective ways of treating Seasonal Depression). In the above figure, the graph to the left depicts the control of the experiment, while the graph in the middle depicts the patients increased serotonin levels after treatment. This further justifies the effects of the winter, hence the lack of light, on serotonin levels, and Seasonal

Depression. The right most graph concludes the idea, that most of the sufferers experience their symptoms at the turn of the winter, instead of the summer due to the increased amount of serotonin levels in the body when the sun exposure is the greatest. In conclusion, the levels of serotonin in the body are a direct link to Seasonal Depression.

The final cause of Seasonal Depression that will be discussed is levels of melatonin in the human body. At the change in seasons, an imbalance of the levels of melatonin can also be seen (Mayo 2). This natural hormone plays an important role in the sleep patterns and moods of individuals, which ultimately causes Seasonal Depression. It is also important to realize however that these may be the causes of Seasonal Depression in most, but some may vary. These additional causes of Seasonal Depression justify that Vitamin D Deficiency is not the only cause of Seasonal Depression, but is focused as a primary one. Therefore, to a great extent, it can be said that Vitamin D Deficiency is a cause of Seasonal Depression.

Treatments of Seasonal Depression:

There are many known treatments for Seasonal Depression some of which are more similar to the treatments of clinical depression, while some are not. The common treatments for depression of any kind range from medications to psychotherapy. One common treatment for Seasonal Depression is the use of antidepressant medications. The antidepressant medications, which are prescribed to those with Seasonal Depression, particularly those from the serotonin selective reuptake family (SSRI) family have been found effective disorder present in the summer as well as the winter (Edwards 2). Some that belong to the SSRI family include fluoxetine (Prozac), sertraline (Zoloft), paroxetine

(Paxil) and citalopram (Celexa) (Edwards 2). Along with antidepressant medications a common treatment for any type of depression including Seasonal Depression is psychotherapy. Psychotherapy tends to accentuate the effectiveness of medical treatment. Due to the enhancement of effectiveness, many who suffer from this disorder are encouraged to include psychotherapy in their treatment process.

The way that treatments do differ with Seasonal Depression however is with phototherapy, which is a form of light therapy. Phototherapy is commercially available in the form of light boxes (Eagles 1). The light required must be of sufficient brightness, approximately 25 times as bright as a normal living room to treat patients successfully (Eagles 1). This treatment is successful for many people with Seasonal Affective Disorder due to the fact that the sufferers are getting a larger amount of sun exposure during the seasons where there is a lack in sunlight. Some side effects however that were noted in patients being treated by light therapy were irritability, insomnia, headaches and eyestrain (Edwards 1).

Lastly, one of the simplest ways to quickly ease the symptoms of depression is to expose oneself to natural sunlight during the day. This will help the production of Vitamin D in the body as well as make it possible for the human body to function at optimal health.

Conclusion:

Through the scope of this research, there is an evident correlation between Seasonal Depression and Vitamin D Deficiency to a great extent however some question this correlation. Seasonal Depression, also known as Seasonal Affective Disorder as

previously stated is a type of depression, which occurs at the change of the seasons. In some sufferers, their downturn in mood is experienced during the winter, where in some it is more prevalent in the other seasons of the summer fall and spring. Although some experience the symptoms of Seasonal Affective Disorder during one season, particularly the winter, others are noted to experience these symptoms throughout the whole year.

There are many known causes of this type of depression, all most notably being associated with the lack of sunlight during seasons of low sun exposure. It has been stated that the effect of Vitamin D Deficiency is caused because of the decreased amount of sunlight available to stimulate production of this essential element. This element is necessary for many bodily functions and for optimum health is noted to be limited by the lack of sunlight during the winter seasons, hence causing depression in individuals. Due to this strong effect of Vitamin D in the human body, one who suffers from Seasonal Depression is almost always tested for the levels of Vitamin D before being examined further. While most studies agree with the idea that Vitamin D Deficiency resulting from the lack of sunlight, is the answer to Seasonal Depression, there were noted however to be others who objected to this statement. In Dr. Franco's study he performed, he and his medical team did not find a direct correlation between Vitamin D Deficiency and Seasonal Depression in the sample population they tested from China.

In conclusion, a major answer to Seasonal Depression lies in the deficiency of Vitamin D in the human body. The prevalence of this vitamin D allows humans to reach optimum health, as the seasons turn however and there is a decreased amount of sunlight, this can be questioned as this is noted to cause Seasonal Depression.

As Albert Einstein, and those who lived centuries before us have shown, there is a strong power in light. This power, affects the way individuals live their lives due to the productions of Vitamin D, and in turn affects much of how they do this. Vitamin D Deficiency is therefore concluded to be a main cause of the winter blues, also known as Seasonal Depression.

Works Cited:

Adams, Mike. "Seasonal Affective Disorder Sufferers Need Natural Sunlight, Not Antidepressants or Artificial Light." *News*, 28 July 2004. Web. 20 Oct. 2012. <http://www.naturalnews.com/001541_Seasonal_Affective_Disorder_natural_sunlight.html>.

Eagles, John M. "Seasonal Affective Disorder." *The British Journal of Psychiatry* (2003): 174-76. Print.

Madsen, Helle O., Henrick Dam, and Ida Hageman. "Study Protocol: A Cross-sectional Survey of Seasonal Affective Disorder in Danish Populations with and without Severe Visual Impairments." *BMJ Group* 2.2 (2012): n. pag. Print.

Dryden-Edwards, Roxanne, MD. "Seasonal Affective Disorder (SAD) Symptoms, Treatment, Causes and Facts by MedicineNet.com." *MedicineNet.com*. MedicineNet Inc., n.d. Web. 20 Oct. 2012. <http://www.medicinenet.com/seasonal_affective_disord

Staff, Mayo Clinic. "Seasonal Affective Disorder (SAD)." *Mayo Clinic*. Mayo Foundation for Medical Education and Research, 22 Sept. 2011. Web. 20 Oct. 2012. <<http://www.mayoclinic.com/health/seasonal-affective-disorder/DS00195>>.

Briffa, John. "Vitamin D and Its Role in Preventing and Treating Seasonal Affective Disorder." *Drbriffa.com*. Dr. John Briffa, 3 Oct. 2004. Web. 20 Oct. 2012.

Science Daily. "Vitamin D May Not Be The Answer To Feeling SAD." *ScienceDaily* 18 Mar. 2009. Web. 20 Oct. 2012. <<http://www.sciencedaily.com/>>.

Pick, Marcelle, OB/GYN. "Depression, Anxiety & Mood." *Womentowomen.com*. N.p., 2012. Web. 21 Oct. 2012 <http://www.womentowomen.com/seasonalaffectedisorder/>

Figures Cited:

Figures 1,2 : "What Is Vitamin D?" *The Vitamins Blog By SLX Nutrition*. N.p., 6 May 2012. Web. 12 Dec. 2012.

Figure 3: Adapted from the National Institute of Health Vitamin D Fact Sheet (2011): <http://odnh.gov/factsheets/vitamind-HealthProfessional/> Retrieved April 2012