



# MITOSIS

The Academic Journal of the RGS HW Biology Department  
Spring 2021





**Welcome to our new biology academic journal, Mitosis. The aim of this work is to provide a platform for those with an endearing passion for biology to express themselves, whether that be through essays, book reviews or articles.**

**With this in mind, we hope to spread our collective enthusiasm for this fascinating subject to all corners of our school community. Enjoy!**

**Abhishek & Mohsin  
Biology Subject Ambassadors 2020**

In this edition we have contributions from:



**Louis Bonnefoy - *Is there a Relationship Between Macroalgae and Hard Coral Percentage Cover in Several Different Benthic Communities in Utilia, Honduras?***

Louis is a Year 12 student aiming to study Medicine at university. He has always been interested in genetics and how the body grows, develops and functions by decoding DNA's complex structure and how this DNA is passed on and mutates through generations.



**Shazain Baig - *Can Nigella Stavia Cure COVID-19 Patients?***

Shazain is a Year 12 student whose specific areas of interest include the efficacy of alternative medicine and traditional forms of medicine including pharmacognosy, ethnomedicine, ethnobotany and medical anthropology.



**James Murray – *The Placebo Effect.***

James is in Year 12 and is studying biology, chemistry, maths and further maths. He has aspirations to study medicine at university and so he thought the placebo effect was an interesting concept to explore.



**Ahmed Raja – *A book review of 'War Doctor' By David Nott***

Ahmed is a Year 10 student who loves learning about Biology and its use in the wider world. He is looking forward to doing it as one of his A-Levels. In the future, he wants to use it in the field of medicine and explore how it can further impact our future.



**Arun Sreenivasan - *Cancer and the chemical compounds involved in its creation and treatment.***

Arun is a Year 13 student who is applying to study Medicine at university. One topic which interests him is genetics and so he has written a piece on how genetics can cause cancer as well as touching on the link between cancer and chemistry.



**Shanker Narayan – *Meet your second brain, the gut.***

Shanker is a Year 13 student who enjoys exploring Biology within and beyond the curriculum which has certainly strengthened his resolve to become a doctor. He has a further passion for integrating maths within biology.

**“Is there a Relationship  
Between Macroalgae and Hard  
Coral Percentage Cover in  
Several Different Benthic  
Communities in Utilia,  
Honduras?”**



By Louis Bonnefoy

## Abstract

In this study, hard coral and macroalgal percentage cover will be measured and compared in Utilia, Honduras from 2012 to 2019 to identify whether there is a relationship between there development and to determine whether dumping chemicals such as nutrient rich fertilisers should be made illegal all around the world to prevent further damage to the already declining number of hard coral colonies in the world.

## Introduction

Coral growth depends on several important abiotic factors including a water temperature of between 18°C and 24°C, a sufficiently high level of light intensity on the sea floor (for photosynthesis) and a sufficient salt concentration in the surrounding columns of water. On the other hand, macroalgae have a much higher resistance to fluctuations in water temperature and can survive and develop in water temperatures between 5°C and 25°C meaning macroalgae development can occur in most of the sites on which a coral colony has settled. This can be used to identify the relationship between hermatypic coral and macroalgae.

In sites where there is high nutrients in the the surrounding water columns you tend to see significant macroalgae cover at the expense of the size of the surrounding coral colonies, and eventually a phase shift occurs to macroalgae dominance. However, in sites where the surrounding water columns are much lower in nutrients and all of the other abiotic coral factors for development are met, coral populations can develop. Due to the coral's symbiotic relationship with the microalgae zooxanthellae, which provides the coral with 80% of its energy requirements, hexacorallia corals can develop in large quantities in low nutrient water. Over time, these reefs attract several species of marine animals causing the surrounding bodies of water to increase significantly in nutrients. The higher levels of nutrients in the surrounding columns of water causes macroalgae coverage to begin to develop however the coral colonies control the macroalgae blooms due to their symbiotic relationship with herbivorous marine organisms such as:

- The surgeonfish (Acanthuridae) which removes up to 70% of total daily macroalgal growth
- The parrotfish (Scaridae) which remove algae in large quantities, facilitating coral domination

On the other hand, when coral reefs are overfished and exploited, herbivorous marine organism populations are depleted meaning that the macroalgae blooms are no longer controlled. This causes the macroalgae coverage to increase extremely rapidly which has a disastrous effect on the coral colonies because the macroalgae absorbs all of the nutrients from the water preventing the hermatypic coral polyps from forming their protective calcium carbonate corallites. The macroalgae also depletes the oxygen levels in the surrounding columns of water and causes the pH of the surrounding water to become more acidic as the macroalgae releases carbon dioxide in the water which may prevent the coral colony from developing any further, destroying the coral reef entirely.

Evidence also suggests that contact with algae has been linked to bleaching, disease, and tissue death in adult corals (Nugues et al. 2004; Rasher and Hay 2010), potentially harming coral through diverse mechanisms, including allelopathy, oxygen depletion, and destabilization of coral-associated microbial communities (microbiomes) (Rasher and Hay 2010; Barott and Rohwer 2012; Zaneveld et al. 2016; Morrow et al. 2017). This causes a severe effect on the ratio between macroalgae and coral cover because it prevents any future shift between

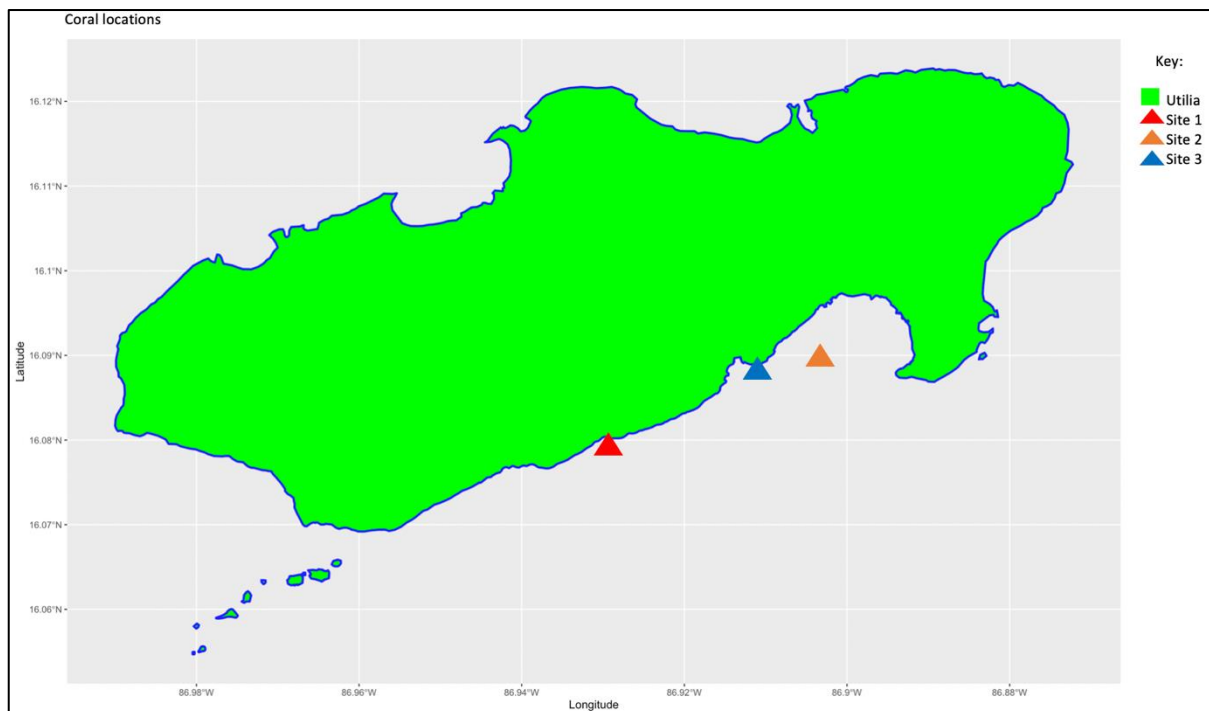
macroalgal and coral dominance causing nutrient rich sites to be depleted by macroalgae without ever being replenished by the existing coral colony.

In this report, I will be studying the relationship between macroalgae and hard coral percentage cover in several different benthic communities. My hypothesis is that where hard coral populations are high, macroalgae cover will be low and where hard coral cover is low, macroalgae cover will be high.

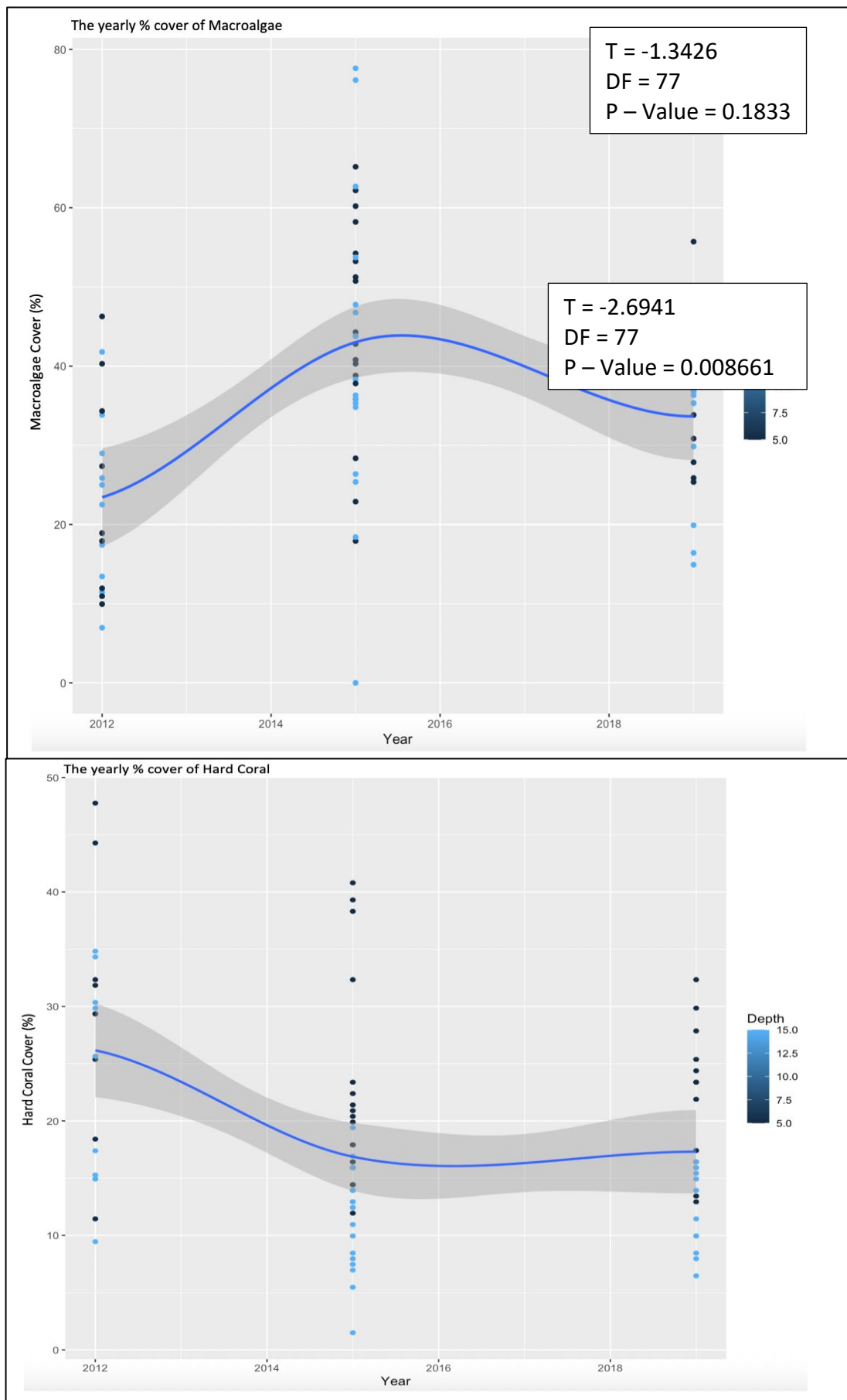
### Method

- Divers placed a 20m tape on the seabed.
- Using a 2 lensed camera, the divers swim across the seabed and film the seafloor.
- The recording was then watched and stopped every 25cm.
- Every 25cm, the number of hard corals and macroalgae in that area was recorded.
- A mean average was recorded in the form of percentage cover.
- Statistical analysis was then conducted in R.

### Map



## Results



The graphs above demonstrate the negative correlation between hard coral and macroalgae cover from 2012 to 2019. They show how during years where hard coral populations are high, macroalgae cover will be lower and during years where hard coral cover is lower, macroalgae cover will increase. This agrees with my hypothesis and therefore proves that there is a significant relationship between hard coral and macroalgae cover. The reliability of these results can be proven by a p-value of less than 0.2 meaning that there is over a 98% chance that the correlation is not due to chance.

Although this proves that these results are accurate, more time points would be required to demonstrate a consistent fluctuating pattern between macroalgae and hard coral cover. In addition to this, these results can only be applied to the coral reefs of Utilia meaning this relationship may change from site to site.

These results also show that although the reef cover shifts for macroalgal to hard coral dominance every 3-4 years, hard coral tends to develop in shallower waters (from 5m to 10m deep) whereas macroalgae tends to develop in deeper parts of the reef (from 10m to 15m) especially when hard coral cover increases. This may be due to the symbiosis between hard coral and species of herbivorous marine organisms such as the surgeonfish (Acanthuridae) and the parrotfish (Scaridae) which hugely limit macroalgal growth in the shallow parts of the reef.

### Conclusion

To conclude, my results show that there is a negative correlation between macroalgae and hard coral percentage cover in several different benthic communities in Utilia, Honduras from 2012 to 2019. Moreover, it shows that macroalgae tends to develop in deeper parts of the reef (from 10m to 15m deep) where it is less at risk from species of herbivorous marine organisms which live within the coral colonies and coral tends to develop in shallower parts of the reef (from 5m to 10m deep). These results also demonstrate that there is a significant shift between hard coral and macroalgal dominance in Utilia, Honduras every 3-4 years.

These results show that it is essential to prevent chemicals such as fertilisers from entering the ocean to maintain healthy hard coral populations in the surrounding benthic communities and to prevent allelopathy, oxygen depletion, and destabilization of coral-associated microbial communities (microbiomes) (Rasher and Hay 2010; Barott and Rohwer 2012; Zaneveld et al. 2016; Morrow et al. 2017) in the surrounding hard coral colonies.

For this relationship to be established as a recurring phenomenon, this study should be replicated in coral reefs all over the world so that dumping household, commercial and industrial waste into the ocean can be illegalised on an international scale to help protect our rapidly declining coral populations.

### Bibliography

[Nugues et al. 2004](#)

[Rasher and Hay 2010](#)

[Barott and Rohwer 2012](#)

[Zaneveld et al. 2016](#)

[Morrow et al. 2017](#)



# **Can Nigella Sativa Cure COVID-19 Patients?**



By Shazain Baig

Medicinal plants have been used through the course of human, sociological history. They acted as herbal medicines and provided ailment prevention on the basis of the property of the plant and were often found through serendipitous discovery after multiple trials. Furthermore, in the modern day, herbal medicines are preferred by many compared to modern day allopathic medicines considering them organic and safer to use. Research has surged in pharmacognosy and the search for cleaner, safer, organic medicine that can be sourced from herbal origins. *Nigella Sativa* is a well-known medicinal plant seen throughout the Mediterranean, North Africa and Asia. It comes under the Ranunculaceae family of flowering plants of the Ranunculales Order. The plant, according to the American Botanical Council, can grow up to '30cm long, with divided, linear leaves with five to ten petals of a pale blue and white colour.' Furthermore, the fruit of the plant is 'large, inflated capsule' which contain a large number of seeds which is often used in the culinary sector, especially, in the Middle East and South-East Asia and is known as Kalonji or Kalojeera.

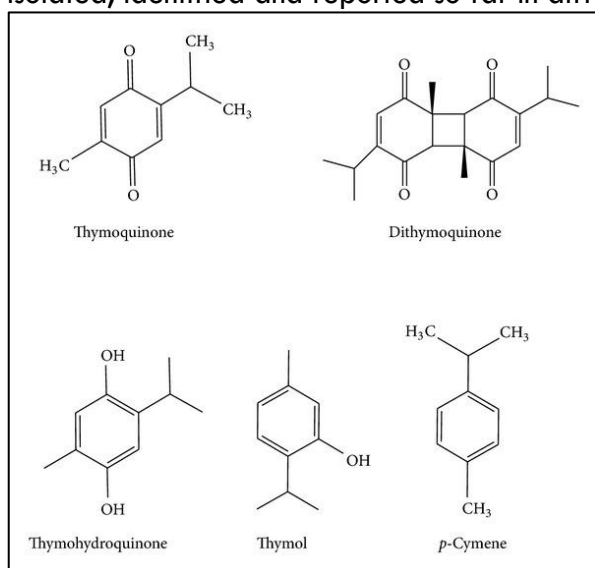


*Nigella Sativa* has a deep historic and religious background before its medicinal, pharmacological benefits were discovered. They are first recorded to have been used in the Greek and Ayurveda health tradition for 'Agni' which is the strengthening of metabolism and respiratory benefits. Furthermore, after the tomb of Tutankhamun was opened, historians and scientists found the tomb to contain seeds from the *Nigella Sativa* plant as it was believed to have helped the coffin to 'breathe' easier in the

afterlife. Furthermore, in the Bible, the seeds of the plant are referred to as 'the curative black seed.' However, it received the highest precedence in Islam. Muslims often refer to *Nigella Sativa* being the greatest form of medicine. The founder of Islam, Prophet Muhammad (PBUH), stated that *Nigella Sativa* is the cure to everything except death. The Prophet Muhammad (PBUH)'s use of medicinal treatments – as well as advice regarding ailments, sickness, treatment and hygiene – was compiled into a source known as 'Al-Tibb al-Nabawi' in which *Nigella Sativa* was the herb which received the most eminence.

### Chemical Properties

The chemical composition of the plant, according to a study by Al-Jassir on a desert *Nigella Sativa* plant from the Arabian Peninsula confirmed that: 'Many active compounds have been isolated, identified and reported so far in different varieties of black seeds. The most



important active compounds are thymoquinone (30%-48%), thymohydroquinone, dithymoquinone, p-cymene (7%-15%), carvacrol (6%-12%), 4-terpineol (2%-7%), t-anethol (1%-4%), sesquiterpene longifolene (1%-8%)  $\alpha$ -pinene and thymol etc. Black seeds also contain some other compounds in trace amounts. Seeds contain two different types of alkaloids; i.e. isoquinoline alkaloids e.g. nigellicimine and nigellicimine-N-oxide, and pyrazol alkaloids or indazole ring bearing alkaloids which include nigellidine and nigellicine. Moreover, *N. sativa* seeds also contain alpha-hederin, a water soluble pentacyclic triterpene and saponin, a potential anticancer agent.'

The main ingredient sourced from the *Nigella Sativa* plant is what is known as Black Seed. This seed is the fruit found from the capsule of the plant and is used in alternative medicine as well as a spice in cuisine. The Black Seed itself was first recorded as useful for its respiratory functions backed by evidence in 1025 by renowned scientist Avicenna (Ibn Sina) in his exegesis of medicine, 'Canon of Medicine' – this book has been used as a syllabus for medicine for the last 800 years. In this, he recorded that the use of the seeds helped ease symptoms of dyspnea as well as clear the respiratory tract.

### Properties of *Nigella Sativa*

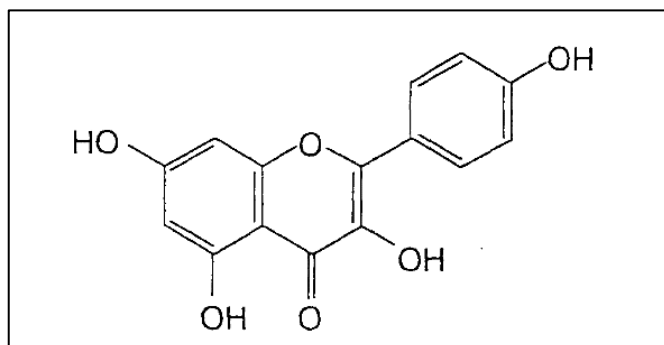
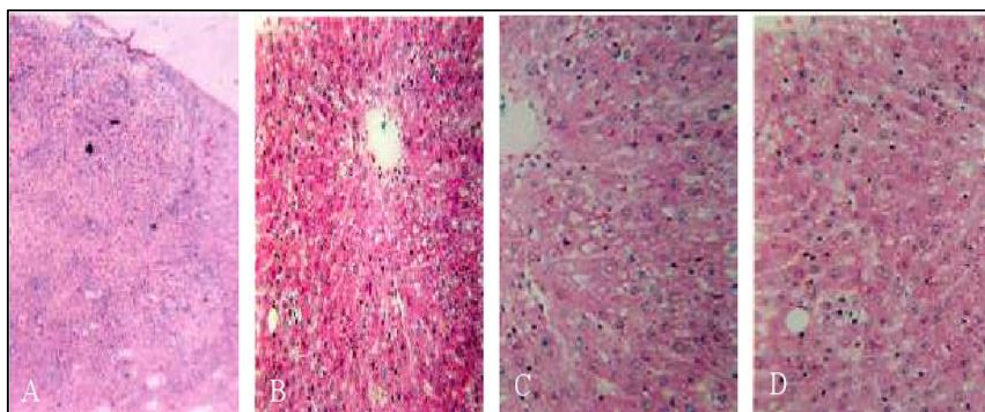
Scientists first researched *Nigella Sativa* and its relation to COVID-19 in April 2020 in which they recognized its antiviral, antioxidant, anti-inflammatory, anticoagulant, immunomodulatory, bronchodilatory, antitussive, antipyretic, analgesic and antihistaminic properties and was taken into account as a potential candidate for usage in COVID-19 patients,



especially in obese and comorbid patients who would benefit from the anti-diabetic, anti-obesity, anti-ulcer, antihyperlipidemic and antineoplastic activities found in the plant seeds. As well as this, previous research into the seeds and its correlation in SARS CoV (characteristically similar to COVID-19), found the nigellidine and  $\alpha$ -hederin found in the plant acted as potential inhibitors of the virus.

### Antiviral Properties

With the COVID-19 virus being a present-day and ongoing virus with little time to have proper clinical trials, scientists have referred to previous major viruses such as HIV, SARS CoV, Hepatitis C virus and a few more to

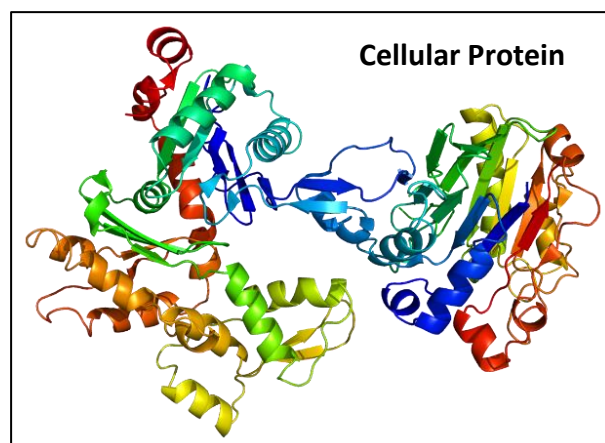


compare the results and see if they are compatible to the virus in question. The anti-viral properties are, according to clinical studies, highly effective in treating patients with viruses. A clinical trial with HIV patients in Nigeria in 2011 showed that 51 HIV-positive patients were administered with an herbal concoction of *Nigella Sativa* seeds and honey for 16 months. All

patients were relieved of the symptoms only after 4 weeks of the medicine being administered in which an undetectable viral load was noted in 41 patients and less than 1000 copies per millilitre in a viral load in 10 patients. The CD4 cells, which are memory cells, had increased. Therefore, the use of the plant seeds could be useful in a long term scenario for COVID-19 as it can help ease symptoms of the virus, increase memory cells and potentially cure the virus itself if the results of the HIV clinical trial is in correlation with the COVID-19 virus.

### Antioxidant Function

Furthermore, the antioxidant activity of the *Nigella Sativa* plant is said to be very effective. According to Delgado-Roche, who researched into the SARS-CoV virus, found in their research that the virus was associated with the overproductive nature of the reactive oxygen species (known as ROS) such as  $H_2O_2$  etc. through the immunocytes being stimulated such as neutrophils and macrophages. Due to the increased ROS, multiple organ failure can occur which causes the cellular proteins and membrane

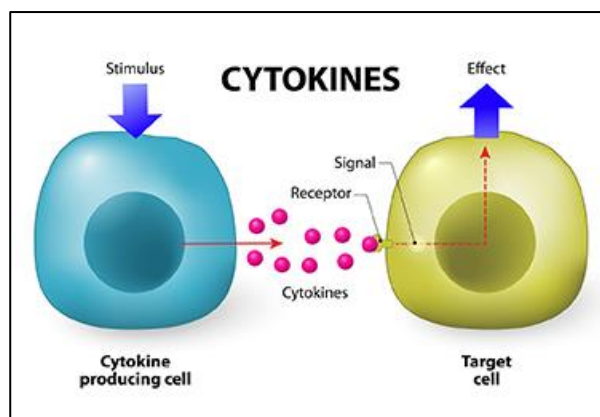


#### **Honey**

lipids to oxidize and destroy the normal cells in the lungs and other major organs such as the heart which can cause major fatalities. Therefore, scientists have found it reasonable that antioxidants will be vital to use to ease and prevent the overproduction of ROS and the antioxidants researched by scientists in a 2020 COVID-19 clinical trial include ascorbic acid, better known as Vitamin C, as well as a moderate quantity of Vitamin E which could be used to prevent organ damage. The *Nigella Sativa* plant seeds contains high levels of ascorbic acid as well as Vitamin E. It also contains bioactive constituents such as carvacrol, *l*-anethole, thymoquinone and 4-terpineol which, under clinical trials in August 2020, played major roles in the recovery of COVID-19 patients through the demonstration of high, variable antioxidant activity.

### Anti-inflammatory Properties

As well as this, *Nigella Sativa* has a high anti-inflammatory property. Inflammation plays a major role in the damage of tissue due to problems such as asthma, cancer, diabetes, cardiovascular problems, epilepsy and rheumatoid arthritis. After a review of 'Pathological inflammation in patients with COVID-19: a key role for monocytes and macrophages' in April 2020, patients who had endured severe COVID-19 symptoms had high levels of circulating inflammatory cytokines such as IL-6 and IL-7 as well as a tumor necrosis factor. Previous studies show that the use of *Nigella Sativa* reduces a cytokine 'storm' and the use of the plant's oil capsules in 40 patients showed 38 had a lower inflammation level compared to before.





### Immunomodulatory function



A very essential and fundamental part of the COVID-19 'treatment' in hospitals is the use of ventilators as well as ECMO (extracorporeal membrane oxygenation) which is needed to help the patients' respiratory system. The overactivation of the immune system was seen in COVID-19 patients who were suffering from a cytokine storm. The use of aggressive immunomodulatory treatment could be used early to avoid the use of ventilators as well as ECMO. Certain active ingredients of the

Nigella Sativa plant are said to have had beneficial immunomodulatory effects with immune responses relating to the T-lymphocytes and natural killer cells. With the use of Nigella Sativa many problems relating to the immune system could be avoided through the use of immunomodulatory treatment which can be achieved through the use of the Nigella Sativa plant.

### So, is there a benefit?

Overall, the Nigella Sativa plant can be considered a 'miracle seed' if used on a wide scale clinical basis in response to the COVID-19 virus and will help in the easing of severe symptoms. Previous research shows the miraculous results in previous, major viruses and pandemics and how it can make the effects of a virus on the body much easier to endure, causing patients to recover and return – gradually – to their normal lives. However, the COVID-19 pandemic is a current, ongoing virus with major implications. It has caused social and economic catastrophes globally aside the fatalities and major health problems so, therefore, research is still ongoing and full, valid results based on the current virus are still being researched and tested. On the other hand, its medical, scientific benefits have been extensively researched upon and will definitely, in the near future, have a major benefit to the treatment of COVID-19 patients and may be a part of the cure of the deadly virus.

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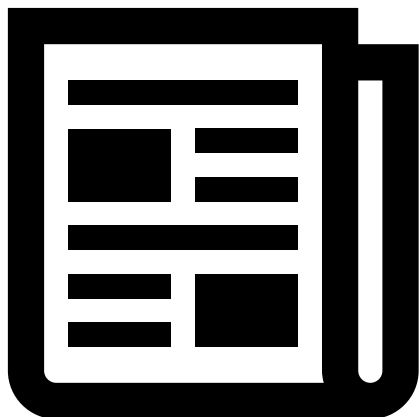
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# The Placebo Effect



By James Murray

The placebo effect in medicine is a concept that has been debated frequently since it was first used in 1799 by a British physicist, John Haygarth (Jütte, 2013). It raises the question of whether taking something with no chemically altering substance can have not only a psychological effect on the subject, but also a physiological one. This concept has been a key factor in drug testing as it can be very helpful for distinguishing between actual effects of a drug, or just effects that have been influenced by the solemn act of taking a drug. There has been a plethora of examples where the process of taking a fake drug has tricked the brain to such an extent that there is a change in the physiological response; for example, the release of hormones could contribute to fighting a disease or infection. (Hamzelou, n.d.)

The act of taking a sugar pill, or anything that someone may think has a chemical effect on them, is still being revolutionised not only in the drug testing industry, but also in sport and other industries. For example, some athletes such as cyclists take sugar pills, most knowingly, which in majority has been proven to still have a positive effect on their performance just by the act of taking a pill (Jagatia, n.d.). This concept can even be seen in everyday life. If someone has a superstition (Dömötör et al., 2016), for example wearing a certain pair of socks in a football game, they may think this has a genuine effect, despite it not changing anything physically, and lead to them playing better than without the socks.

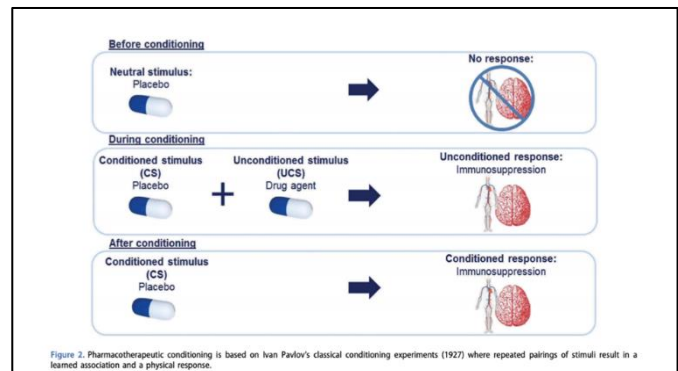
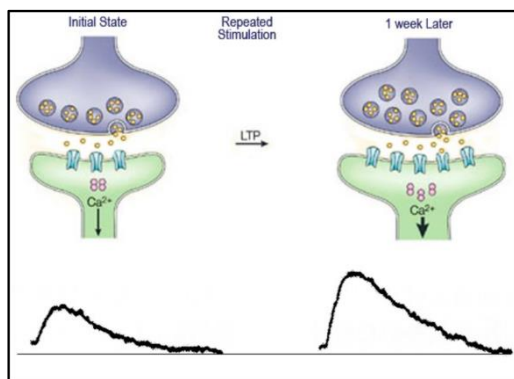


Figure 2. Pharmacotherapeutic conditioning is based on Ivan Pavlov's classical conditioning experiments (1927) where repeated pairings of stimuli result in a learned association and a physical response.

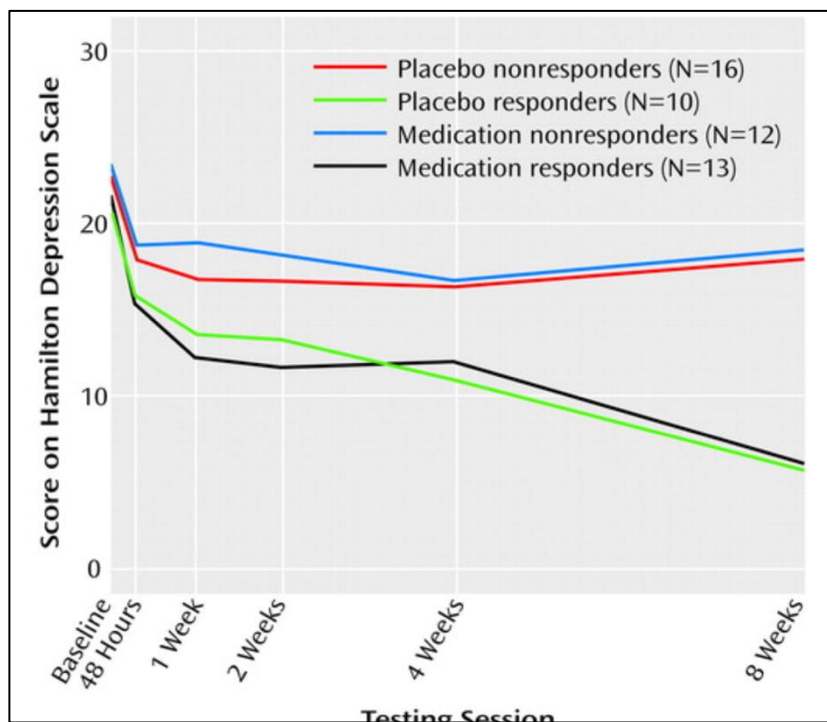
A placebo is usually an inert pill that holds no significant substance but can change a person's wellbeing and sometimes also their health. It can also be in the form of injections or even procedures. The placebo effect works by your brain associating certain experiences, or stimuli, with an effect that comes from that experience, e.g. the pain killing effect of aspirin. This concept is known as associative memory. If your brain is convinced it is subject to a stimulus, then it'll develop a response accordingly, whether there is an actual drug present or not. It is this process of conditioning (Dispenza, 2014) that allows, for example, a pain killing effect of aspirin even if a sugar pill is used instead. The brain would fire the same neural circuits as it would if chemicals were actually released into the body. If you look at the brain's chemistry during this, you see that the relationship between neurones becomes stronger as you think the same thoughts. This is called synaptic potentiation (Purves et al., 2001) which is a persistent strengthening of synapses based on recent activity, which can create a long-lasting increase in signal transmission between two neurones. Therefore, as you convince yourself that sugar pill will work, the relationship between neurones becomes stronger and stronger- integrating the thought into your brain.

There are examples of this effect being used in practice, even over 75 years ago, in World War II. Henry Beecher, an American surgeon was serving on the front line and had ran out of morphine due to its short supply. A badly wounded soldier had come in and was in urgent need of a pain killer for surgery, which without could lead to cardiovascular shock. With no other option, the nurse injected the soldier with saline, a mixture of sodium chloride and water,



and the soldier calmed down straight away. Beecher then performed the operation where the soldier felt little pain and didn't go into shock, despite no actual pain killer being used (Dispenza, 2014).

Placebos, in many cases, are excellent for improving wellbeing and can have significant psychological effects. 46-year-old Janis Schonfield had lived with depression since she was a teenager and had many suicidal thoughts. Therefore, when the UCLA Neuropsychiatric institute was looking for volunteer subjects, Janis jumped at the chance to participate in order to improve her condition. She knew that roughly half the group of 51 subjects were getting the drug and half the placebo in a double-blind trial but was excited and hopeful to fight her depression. She returned every week of the 8-week trial and recorded how she was feeling, along with recording her brain wave activity on an EEG monitor (electroencephalogram). She discovered that she felt dramatically better and actually slightly nauseated, which was a common symptom of the drug. However, when the trial came to an end, it was revealed that she was actually on the placebo. The results showed that 38% of the group on the placebo had felt better compared to 52% of the group on the actual drug and the EEG recordings also showed that there was a significant increase in activity of the prefrontal cortex, which in depressed patients typically has very low activity. Therefore, the placebo didn't just develop significant psychological responses, but also physiological ones. (Dispenza, 2014)



The following graph is a portrayal of the results of the programme. It shows that the responders to both the medication and placebo are closely linked in a negative correlation, with the non-responders also closely linked. It also displays that the average depression score was very similar by the end, for both responders on the drug and the placebo. This may show that the drug wasn't that effective and the solemn action of thinking that you are taking the antidepressants was the main contributor to its effects. (New UCLA

Imaging Study First To Show Placebo Alters Brain Function In Individuals With Major Depression -- ScienceDaily, n.d.)

Therefore, these examples, along with many more out there, demonstrate how strong the placebo effect can be, and how it can be instrumental in developing a response, even without any significant chemicals. Just allowing a change in mindset, and creating that higher synaptic potentiation, can make the placebo effect as effective as some drugs. The brain is really just a structured network of chemicals working to help the body and this chemistry can quite easily be altered and manipulated at a person's will. Obviously, there are limitations to this, and it won't work in all cases, but that doesn't draw away from its relevance in drug testing and even helping patients, with their consent.

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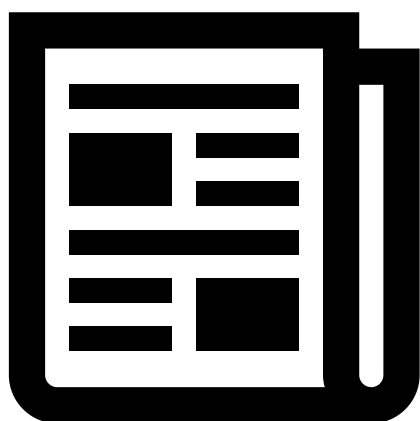
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# **Cancer and the Chemical Compounds Involved in its Creation and Treatment**



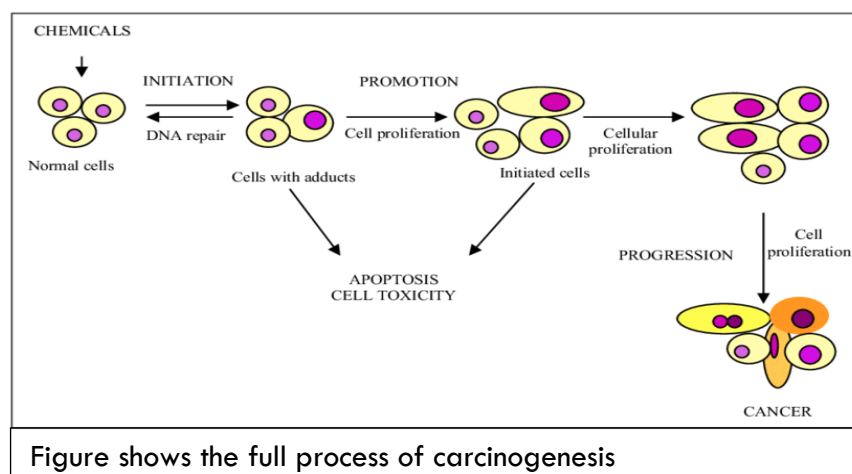
By Arun Sreenivasan

## Introduction

Chemistry has a critical and often underrated role in both the creation of cancers in the body. Cancer is defined by the World Health Organisation as “a large group of diseases that can start in almost any organ or tissue of the body when abnormal cells grow uncontrollably, go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs.”. Cancers are caused by genetic mutations through a mechanism called carcinogenesis which is often caused by quite a few chemical compounds. These roles of chemical compounds are not the only role of chemistry in the creation of cancers, but chemistry is even more intertwined with cancer while treating it. The most common method of treating cancers is through chemotherapy, and while other methods are used as well, they are used in tandem with chemotherapy.

## Carcinogenesis

The uncontrollable division of cells that is cancer is often as a result of point mutations. The process by which this takes place is called carcinogenesis. Carcinogenesis can be split up into 3 stages: Initiation, Promotion and Progression.



During initiation, chemical compounds have a major role to play. This is because during initiation, for the DNA to be damaged by mutations, certain genes have to be activated or deactivated. These are the proto-oncogenes and the tumour-suppressor genes of which the most famous, is the p53 tumour suppressor gene found on chromosome 17. The activation of proto-oncogenes into oncogenes and the deactivation of tumour suppressor genes is what results in proliferation, as if the defect isn't detected by housekeeping genes, and destroyed by apoptosis, it will progress to the next stage, promotion. The chemical compounds that increase the risk are known as carcinogens. Known human carcinogens include Asbestos, Arsenic, Benzene, Beryllium. Each one causes the proto-oncogene activation and tumour suppressor deactivation in different ways:

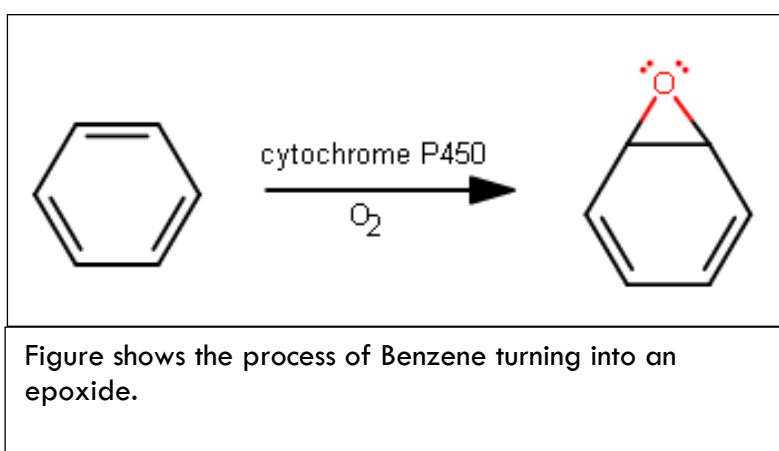
Asbestos is a naturally occurring mineral that is made up of fibres. Asbestos mainly affects the lungs, as its entry into the body is through the airways and so it is known to cause mesothelioma. Mesothelioma affects the lining of the lungs and is exclusively caused by asbestos exposure. The process by which asbestos causes the cancer is “programmed cell necrosis”. This, as seen on the diagram, is the main group of processes that apoptosis falls under. While it may seem like an effective way to prevent mutations that result in proliferation, the cell death releases an inflammatory chemical called HMGB1 which starts a



particular type of inflammatory reaction that causes the release of factors that activate and deactivate proto-oncogenes and tumour suppressor genes respectively.

Arsenic, atomic number 33 is an element that is found in both minerals and in its pure crystalline structure. But it is its inorganic arsenic compounds that are carcinogenic. The inorganic compounds interfere with DNA repair mechanisms. This means that a higher proportion of oncogenes are going to pass through the cell cycle without being regulated by the housekeeping genes and being forced into the  $G_0$  phase to repair resulting in an increased frequency of chromosomal aberrations meaning a higher likelihood of developing cancer.

Benzene is an aromatic hydrocarbon with the chemical formula  $C_6H_6$ . It is mainly associated with causing leukaemia and other cancers of the blood. Benzene is carcinogenic because Benzene rings in general can oxidise in the body with the help of the enzyme cytochrome P450 to form epoxides which are known to enter the pathway of carcinogenesis.



There are 2 ways an epoxide can enter the carcinogenesis pathway: It can be attacked by a nucleophile or be rearranged into a phenol, a harmless compound. Usually, the nucleophile that attacks is 2'-deoxyguanosine which has an  $NH_2$  on it that can act as a nucleophile. These forces open the epoxide ring and attaches to it resulting in it becoming a carcinogenic compound. With regards, to the rearrangement of the epoxide into a phenol, it is to do with the speed of the reaction. If it is too slow, or too fast, it becomes carcinogenic. This results in benzene causing haematotoxicity. The exact mechanism through which this is done is not exactly clear, though studies have shown that benzene targets the proto-oncogenes and the tumour suppressor genes through the introduction of genetic abnormalities and genomic instability, in a haematopoietic stem cell (HSC) which results in the apoptosis of HSCs and altered proliferation and differentiation of HSCs which leads to blood cancers.

### Treatment of Cancer: Chemotherapy

Chemotherapy is a cancer treatment where a mixture of different chemical compounds is used to kill cancer cells. It is often used if the cancer has metastasised or if there is a high likelihood of metastasis. The compounds used in chemotherapy also have a strong connection with chemistry. There are over 100 chemotherapy chemicals, but they can be grouped into 7 main groups. However, only 1 group is made of chemical compounds, though the range of chemicals in the group is quite extensive:

### 1) Alkylating Agents

These are most active in the resting phase of the cell. These types of drugs are cell-cycle non-specific and so will fix genetic mutations in all phases of the cell cycle.

- Mustard gas derivatives: Mechlorethamine, Cyclophosphamide, Chlorambucil, Melphalan and Ifosfamide
- Ethylenimines: Thiotepa and Hexamethylmelamine
- Alkylsulfonates: Busulfan
- Hydrazines and Triazines: Altretamine, Procarbazine, Dacarbazine and Temozolomide
- Nitrosureas: Carmustine, Lomustine and Streptozocin (unique as they can cross the blood-brain barrier, useful in treating brain tumours)
- Metal salts: Carboplatin, Cisplatin and Oxaliplatin

Since alkylating agents were one of the first drugs to be used for cancer, the mechanism by which it combats cancer is well known. The process of alkylation takes place which is when the drug attaches to the negatively charged atoms of DNA resulting in a DNA molecule with a chain of carbon atoms attached. The negatively charged atoms are Phosphorous, Oxygen, Nitrogen and Sulfur atoms in the DNA. This extra strand impairs replication and division of strands of genetic matter meaning that a mutated cell, with activated proto-oncogenes, would not be able to duplicate thus stunting the growth of the tumour and eventually destroying it.

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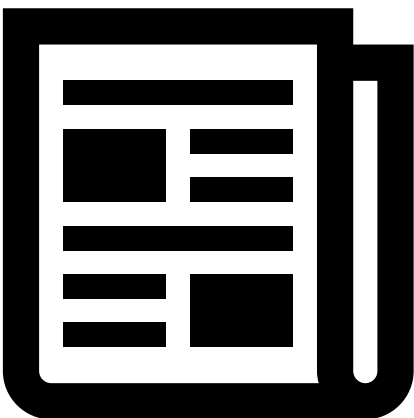
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# A Gut Feeling

By Shanker Narayan





We all have a brain. Well, most of us, anyway. Here is a hypothetical question: what if we had a second brain?

This question is not as speculative as one may think.

Meet your second brain: the gut.

Depression. The World Health Organisation classes this debilitating disorder as the number one cause of disability worldwide. 322 million people. 322 million lives consistently succumb to repeated stabs of depression (Anderson, 2019). We are yet to find a panacea for this societal cataclysm. However, our medical elixir could potentially be hiding in our “second brain”. Undoubtedly, the perfect pathway for rewiring our actual brain would require a detour through our gut. Let us delve deeper into the connection between our two brains, or as scientists like to call it, our gut-brain axis.

Scott Anderson depicted the associations between the brain and the gut through a very relatable analogy. What kind of behaviour does one display when they have a “stomach bug”? “Sickness behaviour” of course. This “sickness behaviour”, synonymous with short-term depression, highlights the undeniable link between our brain and our gut. Lisa Kilgour brilliantly expanded on this notion with her clinical correlations. She illustrated how a significant proportion of her patients with gastrointestinal problems also had issues with their mood. Of course, our temperament is fickle at the best of times, swinging to and fro, and yet this seemed like more than just a coincidence. Therefore, she inferred that an over-stimulated brain resulted in anxiety. In contrast, an over-excited stomach foreshadowed an incoming wave of diarrhoea, bloating, and cramps (“Microbes, Mental Wellness & Mealtime | Lisa Kilgour | TEDxKelowna - YouTube,” n.d.). This biologically plausible evidence is even further corroborated by Megan Rossi’s account of the Australian synchronised swimming team during the Olympics. She noted that deterioration of gastrointestinal symptoms was mirrored by heightened anxiety during performances (Thomson, 2019). Coincidence or what?

However, let us be sceptical of these examples. After all, what about the golden rule of statistics: correlation does not imply causation (Greg Attwood, Alan Clegg, Jane Dyer, n.d.). Unfortunately for statistical pedants, this correlation has been justified by various underlying biochemical mechanisms which allow for interplay between our brain and our gut.

The functionality of this gut-brain axis is all down to over a hundred trillion miniature companions which reside in our gut. Some are itinerant; some like to stay for the long-term. They dominate our human cells in a freakishly high 10:1 ratio. If you are tough to impress, then have a hear of this: their genetic information exceeds ours in a highly commendable 99:1 ratio (“Gut bacteria and mind control: to fix your brain, fix your gut! - YouTube,” n.d.). And yet they all manage to fit inside of our intestines. These creatures go by the notorious name of bacteria. Believe me, these are not your average microbes. They have very little to do with meningitis, they do not wish to cause peptic ulcers, and they most definitely do not want to serve you a nasty shock of pneumonia. Murderers; pests; intruders – call them what you will. The truth is, these minute companions have a more substantial impact on your mental health than you would initially like to think.

Say hello to Dave for me. Dave’s government name is *Lactobacillus rhamnosus*, but I like to call him Dave for short.

Put yourself in the shoes of Dave. You want to communicate with the brain all the way from the gut. You have a dilemma here: no microbial teleportation-wormhole machine has been

invented as of yet (although it is mathematically possible!), and the brain is practically a million microbial light years away from the gut (Kurzgesagt, 2018). Luckily for you, the human body has evolved to offer you myriad pathways between the brain and the gut. The issue now is: which one to choose? Put simply; you are spoilt for choice.

You could manipulate the vagus nerve, which runs down from the brain to the gut. It is connected to the “thermostat” of the brain, alongside our systems involved in emotional responses, memory and learning (Rege & Graham, 2017). By synthesising an active chemical compound, you can secrete it into the mucus lining of the small intestine. This chemical will travel to a special type of intestinal cell, which then cleverly detects the chemical and fires a sharp electrical pulse up the vagus nerve. This saves you from having to journey too much around the body, heightening your chances of survival and allowing you to remain in your humble mucosal intestinal abode. If you are feeling fancy today, then you can discharge chemicals which squeeze through the intestinal walls and swim up to the brain via the bloodstream.

Since it has been altogether a monotonous day in the gut, you have the freedom to play around with the immune system. Immune cells secrete chemicals: this is how they communicate with each other. These immune chemicals can either increase inflammation to fend off infection or decrease inflammation to prevent chronic damage to organ systems (Rogers et al., 2016). By assuming control of the circulation of these pro and anti-inflammatory compounds, you have the power to guide the inflammatory response of the brain cells. Brain inflammation is fatal and can easily lead to death. Think about it this way: your skull's volume is fixed. If your brain is inflamed, your brain is going to expand.

Think of a swollen leg: it is swollen due to an inflammatory response. So, putting two and two together, if your brain expands and your skull remains the same volume, then there is potential for the brain to expand to a volume beyond that of the skull. Therefore, there will be no space for the expanding brain, meaning it will be forced downwards through a tiny hole, causing the bottom part of the brain to be pulverised to pieces. And of course, this is not an ideal situation for any human (Norden, n.d.). Therefore you, as a fellow microbe, can potentially prevent brain inflammation by lowering the levels of pro-inflammatory compounds.

However, if you, as a microbe, have had far too much coffee, then you might like to take a more invigorating pathway to the brain. By secreting various molecules, you increase the permeability of the intestinal wall, which is usually maintained by tight junctions. This allows for gaps to emerge between intestinal cells, allowing you to escape the claustrophobic terrors of the small intestine and to encounter the immune system directly: face to face. Instead of dampening the immune system response, why not excite it into overdrive. The immune system, bewildered and stunned by your arrival into their biological “no man's land”, will induce a system-wide inflammatory response, causing chronic organ damage which can extend up to the brain (Chu et al., 2018). Of course, this is not so fun for the human and certainly does count as a violation of the whole “mutualistic” agreement between you and the human you dwell in. However, it is still a viable pathway for accessing the brain.

If you long for some direct, intense action, then be sure to penetrate the blood-brain barrier. This military fortification constitutes of tight junctions which are considered by many of your microbial inmates to be insurmountable. Inevitably, you rise to the challenge of impossibility and attempt to overcome the barrier. (Anderson, 2019) But how? You could utilise the biochemical factory which inhabits your bacterial cell body. Molecules produced by bacteria known as short-chain fatty acids have the potential to perforate this supposedly impermeable barrier.

Orthodox psychiatry has always been focused solely on the brain. Hopefully, gut-brain research will shift the spotlight onto our second brain. I call for a neuro-gastroenterological revolution!

Brain and gut. Gut and brain. Hand In hand.

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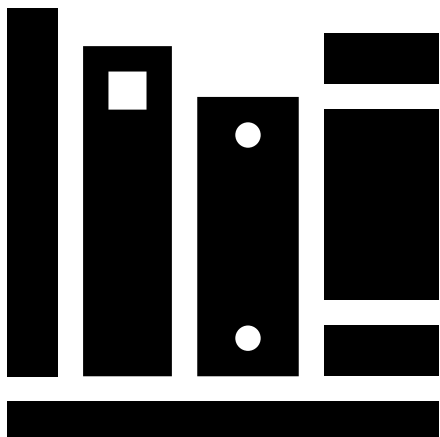
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# **‘War Doctor’**

## **By David Nott**



A Book Review by Ahmed  
Raja

“Is the practice of medicine a business or is it a vocation? Where does the balance lie between doing well and doing good?”

Perusing through Waterstones, I picked up this book. Being interested in medicine, I read through the blurb and decided it was one to try, especially after the revelation that had been Adam Kay's 'This is Going to Hurt'. It promised an extraordinary story and it certainly delivered. 'War Doctor' documents general and vascular surgeon, David Nott, and his experiences through more than twenty-five years of volunteering in some of the world's most dangerous war zones, including those of Sarajevo and Eastern Aleppo. As well as being a surgeon in the NHS and having to experience those general hardships, Nott chooses today to take unpaid leave in order to help affected people and aid them during wartime. A sign of a true hero. Many would believe this book to include heavy topics, such as death and trauma. While this is the case, the author also interweaves aspects of his own life, giving a more relatable outlook on things. Nott was certainly affected by these experiences and this is evident as to how he reacts to them in the book "It was very difficult not to get involved in the reality of the experience for the people on the ground, whose lives were being torn apart...it is the vulnerability of human life that - when it is stripped down to its basics - makes us all the same." My overall conclusion is that 'War Doctor' is certainly a book to read. Its tone, and the way it is written, lend itself to being both engaging and giving the reader an outlook of war that isn't normally documented by the media. It gives insight into both the hard work of doctors on the front lines as well as how war affects individuals and for that reason I, once again, highly recommend it to people as it is a new take on the subject of war and medicine.

