

5D Thinking on The Nitrogen Cycle



“Has anyone explained how dumb carbon, hydrogen, and oxygen molecules could have, by combining accidentally, become sentient—aware!— and then utilized this sentience to acquire a taste for hot dogs and the blues? How any possible natural random process could mix those molecules in a blender for a few billion years so that out would pop woodpeckers and George Clooney”
(Robert Lanza (2010): *Biocentrism*)

Life could not exist without nitrogen. It is essential element for the building block of living cells. The good news is that nitrogen is everywhere. It is in plants we eat, in the water we drink, and in the air breath. It is the most abundant element in our planet. However, we could not use it if microbes do not process it for us. Even then, we have to use it in balanced way. Plants cannot grow with too little nitrogen and they can die with too much of. Nitrogen has strange properties. It can support life or destroy it if it is used to bombs such as the massive one exploded in Beirut. Let’s explore nitrogen and its amazing journey to support living beings through five-dimensional thinking.

First Dimension : Analytical Thinking

SCIENTIFIC UNDERSTANDING OF THE NITROGEN CYCLE

Nitrogen is a nutrient required by all living organisms. It is found in soil, water and the atmosphere. Like carbon and water, nitrogen cycles between biotic (living) organisms and abiotic (non-living) matter.

In the atmosphere, nitrogen exists as a gas molecule made of two nitrogen atoms. In fact, the air is 78% nitrogen! The air also consists of 21% oxygen gas, less than 0.1% carbon dioxide and an average value of 1% water vapour. Nitrogen gas is both colourless and odourless.

Nitrogen is an essential component of all living things, making up DNA- Deoxynucleic acid- the blueprint of our cells. Nitrogen is also found as nitrates (NO_3), nitrites (NO_2) and ammonium (NH_4^+).

The nitrogen cycle consists of several interconnected stages.



Nitrogen Fixation

The main actors in the Nitrogen Cycle are bacteria. Bacteria living in the soil and in the roots of certain plants are designed to convert **nitrogen** in the air into **ammonium**. Aquatic algae are also capable of nitrogen fixation.



Nitrification

In this stage, **ammonium**, produced in the process of nitrogen fixation is changed to **nitrates** by the action of nitrifying bacteria. The plant can then absorb the nitrates.

Assimilation

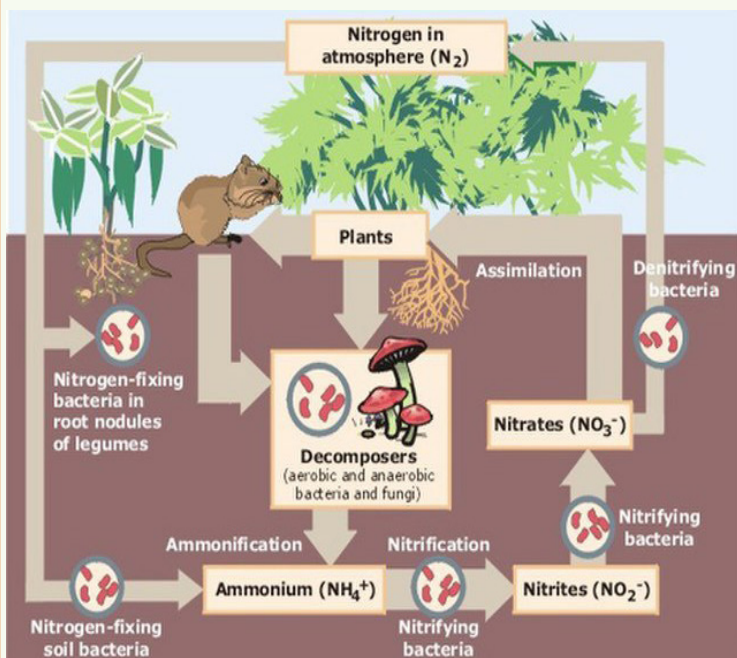
Assimilation is the process in which plants absorb the **nitrates** through their roots and used them to make building materials such as **amino acids** (building blocks of protein, **chlorophyll** and **DNA**).

When a plant dies, it decomposes with the assistance of denitrifying bacteria that are designed to break down the ammonium molecules into nitrogen gas once again.

Denitrification

This is the process in which extra nitrates or nitrites in the soil are converted into nitrogen by the action of denitrifying bacteria.

Nitrogen is an essential element for living beings. It makes up amino acids- the building blocks of proteins, and our DNA. Plants use nitrogen to make the pigment chlorophyll- which is designed to be used to make glucose and energy in a process called PHOTOSYNTHESIS.



The Nitrogen Cycle



<https://youtu.be/PfqvACMyg68>

Amazing Scientific Facts

-Nitrogen Cycle-

1.

Did you know that nitrogen is used by scuba divers to prevent painful gas bubbles from entering their bloodstream? It combines with helium gas, preventing the gas bubbles from forming.

2.

Did you know that although nitrogen is critical for survival, when combined with oxygen it can be toxic? Nitrogen dioxide, produced by the burning of fossil fuels, results in inflammation of our airways, wheezing and asthma attacks, particularly in children.

3.

Did you also know that nitrogen is used to make laughing gas? Laughing gas is used by dentists to make dental procedures less painful.

4.

Did you know that 3% of our body is nitrogen? Indeed, we cannot live without nitrogen since it is the main ingredient for living cells.

5.

Did you know that nitrogen is used in the manufacture of stainless steel? Stainless steel is used in the construction of buildings, medical devices and cutlery.

6.

Did you know that there are various Nitrogen compounds such as Trinitrotoluene that are extremely explosive? Yes, it is the infamous TNT bombs!

7.

Did you know that what two German scientists were awarded Nobel Prize for discovering how what germs have been doing for thousands of years in converting nitrogen into ammonia? In fact, the chemical process for industrial fertilizers was developed by German chemists Fritz Haber and Carl Bosch. Haber and Bosch were given Nobel Prize in 1918 and 1931 respectively, for their work of developing a fertilizer technology.

8.

Did you know that nitrogen was once referred to as 'the lifeless gas'? This was because the scientists who discovered for the first time removed oxygen and carbon dioxide from the air completely, but noticed the leftover gas was not supporting life. He called it 'noxious gas' though he did actually know what he discovered.

Second Dimension : Analogical Thinking

NITROGEN CYCLE VS. PAPER RECYCLE

As mentioned in the previous dimension, nitrogen is an essential component of living (biotic) and non-living (abiotic) matter. Let us now compare the cycling of nitrogen in the Nitrogen Cycle to the man-made process by which paper is recycled.

Where does paper come from? From an early age, we learned that paper is made from trees. It is an essential resource that many of us take for granted. While it is now easier to limit the use of paper thanks to many paperless technologies, the process of recycling paper is essential to minimise the harmful effects caused by producing it.

Let us begin by examining how paper is produced.

Improve Paper Recycling



<https://youtu.be/sd4HGA4lSc>

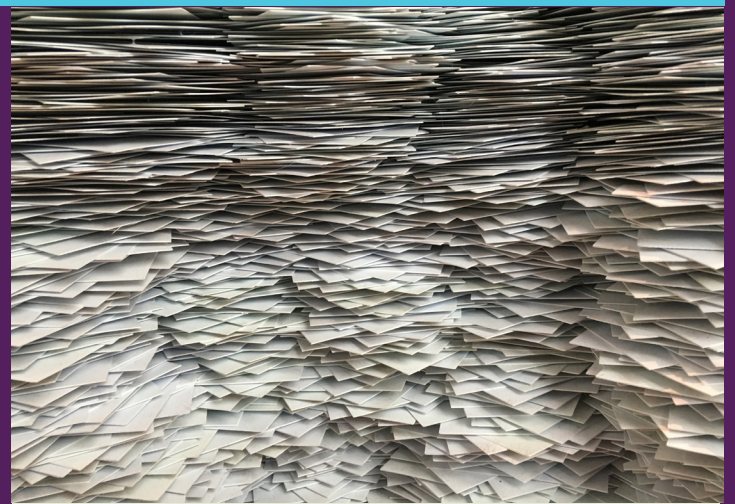


First, trees are cut down to produce logs. The logs are then transferred to a paper factory. At the factory, a process called 'de-barking' peels the bark from the logs. The logs are then sent to a 'chipper' where they are chopped into tiny pieces. The pieces are then processed in a thermochemical refiner by boiling them and mixing them with chemicals.

The pulp that is produced is then sent to a paper making machine. In this machine, the pulp is poured onto a wire mesh that filters out the liquid. The pulp, which is now thicker in consistency, is squeezed between rollers to absorb the extra liquid and dry it out. It is then passed repeatedly through hot rollers to produce long, thin paper rolls.

The paper rolls are used to produce newspaper and other printed materials. After human use, paper can be recycled to produce newspaper once again.

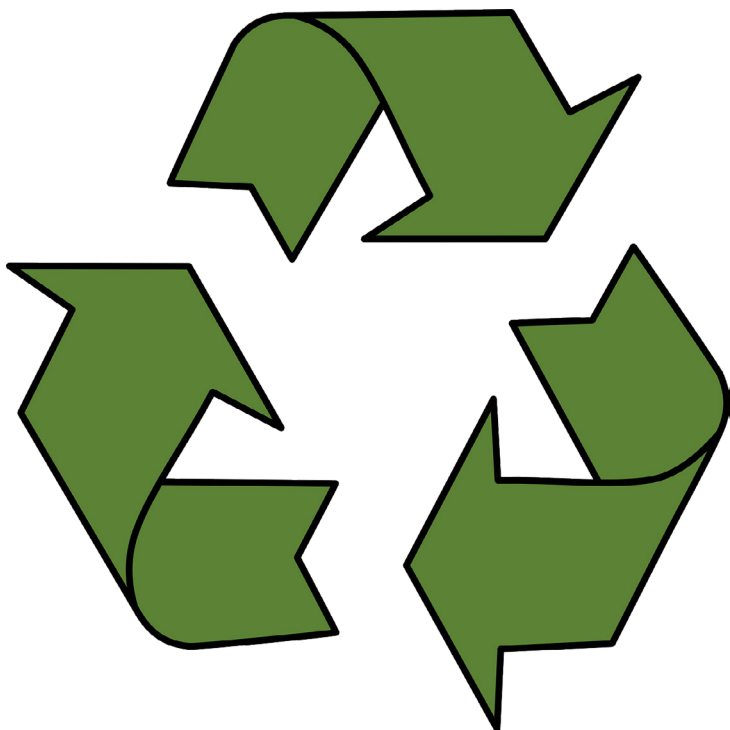
When it comes to the recycling of paper, there are different challenges to consider depending on the type of paper being recycled.



In developed nations such as the United States, almost 70% of paper that is available for consumption is recycled! This reduces the space needed by landfills. The reason such a large amount of paper is recycled in developed nations is because of easy access to paper recycling facilities such as curbside bins for home pick up.

If we compare the process of recycling paper to the Nitrogen Cycle, we can see that in a similar way, nitrogen cycles from one form to another. Let's revisit the Nitrogen Cycle once again and see how it compares to the cycling of paper.

Remember, nitrogen is found in abundance in our atmosphere. However, only a few organisms are designed to utilise nitrogen fixation- to tap into and use this supply of molecular nitrogen. These organisms, such as blue-green algae, soil bacteria and bacteria found in the roots of legumes, are designed to change or 'fix' molecular nitrogen into



ammonia (NH_3). This is an energy consuming process where organisms need to oxidise sugars to obtain the energy to break strong triple bonds between two atoms of nitrogen that make the N_2 molecule. This takes place under aerobic conditions where oxygen is readily available. Nitrogen fixation also occurs during lightening that is designed to provide the high pressure and energy needed to start the process. Only after nitrogen fixation occurs can it be available for consumption by other organisms.

We can liken the first step of the Nitrogen Cycle to the manufacture of paper products. Only after wood pulp is processed into paper can it be used by human beings to produce newsprint and other printed materials. Trees cannot magically transform into paper. They must first be de-barked, broken into smaller chips and then heated and mixed with chemicals



before they can be passed into a paper making machine.

In the same way that the triple bonds between nitrogen molecules need to be broken before nitrogen is converted to ammonium, de-barked wood must be broken into smaller chips before the addition of chemicals. Whereas nitrogen fixation requires the use of oxygen, the process of papermaking requires the addition of chemicals.

Furthermore, we can compare the process of decomposition to the processing of used newsprint by recycling centers. Just like old newspapers and used paper products are converted into paper once again, nitrogen-containing organisms are essentially recycled from one form to another in a process called decomposition. When an organism dies, nitrogen is released by fungi and bacteria. The fungi and decomposing bacteria then convert the nitrogen that makes up the dead bodies into ammonium (NH_4) once again. This process is called nitrification. This

process can be likened to recycling of newsprint. The process of de-inking of the newsprint followed by its conversion into a slurry and eventual conversion into new paper products can be compared to the process of nitrification.

As you can see, the process of recycling paper involves a number of carefully calculated steps and efficient machinery. The cost of recycling paper has fallen over the years, but it is still far from being considered efficient at solving the problem of accumulated paper waste.

Moreover, like plastic recycling, the paper recycling process itself may have a negative impact on the environment. The emissions produced by trucks used to pick up recyclables from people's homes may reduce the beneficial outcomes that result from the recycling process itself.

Can you now see the resemblance between the man-made paper recycling system and the Nitrogen Cycle? Which process is more sophisticated?



The Paper Recycling Process



<https://youtu.be/jAqVxsEgWIM>

In short, it took thousands of years to come up with recycling after collaborative works of thousands over the ages. Meanwhile, we have discovered that more efficient recycling such as "carbon cycle" have been in place to support life.

“Can you now see the resemblance between the man-made paper recycling system and the Nitrogen Cycle?”

Third Dimension : Critical Thinking

EXPLORING THE MAKER OF THE NITROGEN CYCLE

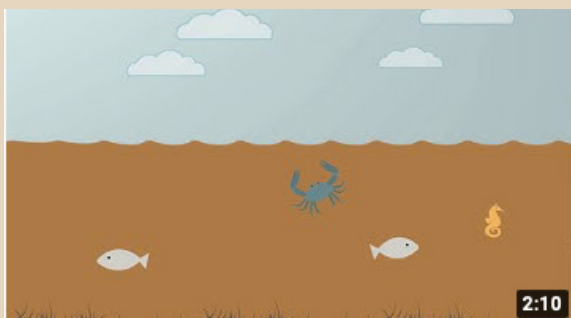
We have just explored how the Nitrogen Cycle is one of the ways the Earth's resources are kept in check. We learned how nitrogen moves between the living and non-living components of our planet. We discovered how human interference in the Nitrogen Cycle by the addition of nitrogen to the soil via fertilizers affects ecosystems and harms the environment. We also compared the Nitrogen Cycle to a man-made recycling process- the recycling of paper products.



Let us think about how such recycling processes came to be. What inspired human beings to recycle in the first place?

Humans have recycled commonly used materials for thousands of years. However, the need for recycling products on a mass scale became necessary with the advent of the industrial revolution. Not surprisingly, recycling became even more important after economic depressions around the world in the 1930s and 1940s (but less important after postwar prosperity). In recent years, as the global human population booms and the Earth's resources become less plentiful, there is an even greater need to conserve and recycle than ever.

What is Nitrogen Pollution?



<https://youtu.be/Gv5kfXRARN0>



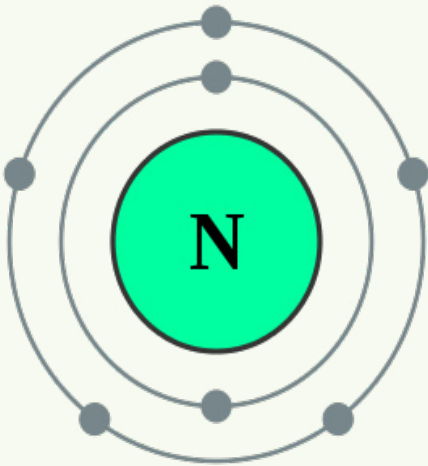
The process of recycling paper requires the physical transportation of the paper products that need to be recycled to the recycling site. The process also requires machines to sort the material that has been brought via trucks into different types of paper. It also involves the addition of water and chemicals to wash and transform the paper into a product suitable for human use. All the steps in the process above require supervision, physical resources and knowledge in addition to the cooperation of the public to achieve the ultimate goal of efficient recycling of paper products. It is clear to us that wind with power without consciousness and knowledge could not come up with paper recycling system even if we wait for thousand years. We also know those countries which do not have paper recycling could not get it randomly if they do not plan and practice what other countries are doing.

How about nitrogen recycling? If we compare any artificial recycling process to the Nitrogen Cycle, what can we observe? Unlike man-made recycling processes, the Nitrogen Cycle occurs continuously and relentlessly without the use of electrically operated machinery and without the physical delivery of resources or human supervision.

In trying to emulate the efficiency of an elegant system such as the Nitrogen Cycle, should not we think of its origin? How does such a flawless cycle exist? Can we attribute the process by which nitrogen moves between living and non-living things on our planet to the humble nitrogen atom? To answer this question, we must understand what a nitrogen atom is made of.

Let us take a closer look at its structure. Nitrogen has an atomic number of 7 with 5 electrons in its outer ring. Structurally, there is room for 8 electrons in the outer ring of an atom, so nitrogen atoms tend to bond with other nitrogen atoms, sha-

“ Can we attribute the process by which nitrogen moves between living and non-living things on our planet to the humble nitrogen atom?”



ring electrons to fill up the outer ring to form a strong triple bond. Remember, electrons are so small that they do not contribute to the weight of an atom- which in nitrogen's case is 14 amu. Can atoms so tiny and seemingly insignificant control a system that works on such a massive scale such as the Nitrogen Cycle? What about hundreds of such atoms, thousands, or even millions? Are these atoms conscious of the role they are assigned to, or is there something bigger at work here? Can a nitrogen atom be conscious of itself in the first place?

It does not seem possible that trillions of miniscule nitrogen atoms are aware of their state of being. It does not seem plausible that they know when to be fixed by nitrogen-fixing bacteria or lightening or when to leave a decaying animal's body. It is highly unlikely that a tiny nitrogen atom would know where to place itself within an

amino acid inside a protein molecule. However, it is a scientific fact that nitrogen atom works like an intelligent worker, after going through fixation, they are employed in the bodies of plants and animals to fulfill various complex and essential tasks. Given each type of plants and animals are like different factories requiring various engineering skills, how did nitrogen atoms learn to work in all without any problem? Can plants and animals teach them how to perform? No! Indeed, it is highly unlikely that plants are even aware of just how much nitrogen is required at any given point of time in order to support the formation of proteins that make up their form. They are not conscious of how much ammonium is needed for nitrifying bacteria to transform the ammonium into nitrates. After all, bacteria and plants themselves are simply more sophisticated combinations of atoms such as nitrogen and carbon. Obviously, neither nitrogen atoms nor the organisms that contain them are capable of creating or sustaining an elegant cycle such as the Nitrogen Cycle.

When we realize that the artificial recycling systems that exist today (such as paper recycling systems) were invented by scientists with access to cumulative knowledge, technology, resources and manpower, we are led to wonder about the Maker of one the Earth's flawless recycling systems- the Nitrogen Cycle.



Fourth Dimension : Meditative Thinking

CONNECTING AND COMMUNICATING WITH THE MAKER OF THE NITROGEN CYCLE

How can we know the Maker of the Nitrogen Cycle? How can we be sure about our knowledge of its Creator? We believe the answer lies in the very nature of the Nitrogen Cycle.

When we look closely at the Nitrogen Cycle, we can see the marks of its Maker within its inner workings. It is possible to see that material causes and natural laws are not the source of the Nitrogen Cycle since they are not conscious of themselves nor are they equipped with knowledge or power. As we look closely at the Nitrogen Cycle, we should be able to see that it takes infinite knowledge and power to create such a system. This is why it is impossible to recreate such a flawless cycle on a scale such as the Earth's

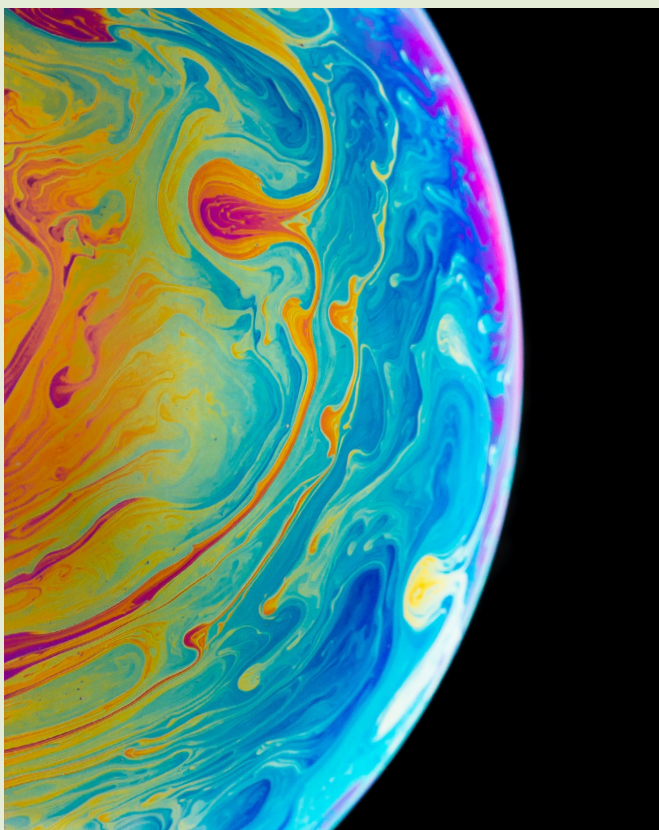
no matter how much we try. As human beings, we are limited in our knowledge, power and will.

If we reflect on the initial formation of nitrogen, we will understand that the Earth's systems are intricately connected to the solar system and to the universe at large.

To do this, let us take a closer look at how nitrogen atoms are released from stars. Deep within a red giant star, light atoms such as carbon are smashed together producing massive amounts of energy that leads to the burning of the star. Heavier atoms such as nitrogen atoms that are left over are released into space when the star explodes. The exploding star becomes a supernova. Nitrogen



Nitrogen is essentially created through the burning of stars in the universe.



moves into space within a cloud of space dust called a nebula. To conclude, nitrogen is essentially created through the burning of stars in the universe. They were not part of our planet at the beginning.

Scientists believe that nitrogen came to the Earth by being pulled by the Earth's gravity. What caused gravity to pull nitrogen towards the Earth? Who commanded the stars to burn and release the nitrogen within them? When we reflect on these questions, it is reasonable to come to the conclusion that there are no coincidences or 'chances' driving these events to occur. For life to originate on our planet, these occurrences must have been timed in perfect synchronicity. It is hard to believe that it was just a random occurrence which became the source of life on the Earth.

When nitrogen was apparently pulled towards the Earth by the force of gravity and subsequently used to make proteins of the first living cells of organisms, it must surely have been a purposeful act.

Our universe is like an interconnected living being. It does not make sense to look at any part of this being in isolation. Just like our heart cannot pump without the apparent assistance of the brain, it is not possible for the Nitrogen Cycle to exist without its connection to the universe at large. Indeed, nitrogen cycle is connected to the structure of its atom, properties of other elements, size of explosion among stars, and strength of the Earth's gravity among millions of others at both micro and macro levels.



Thus, the Maker of nitrogen must be the Maker of stars in which it is originated. The Maker of nitrogen must be the Maker of gravity that pulled it towards the Earth, and the Maker of the other atoms that combine with nitrogen to make the building blocks of living cells. He must be the one who equips the nitrogen-fixing bacteria with the tools to extract nitrogen from the air and convert it into ammonium and the one who teaches the nitrifying bacteria to convert the ammonium into nitrates. He must be the one who allows the plants to absorb the nitrates to make the building blocks of essential proteins such as DNA and chlorophyll. He must also be the Maker of the mechanism through which an organism decomposes back into the matter from which it was made.

It is clear that to claim ownership over the Nitrogen Cycle, one would need to have the knowledge and power to make a nitrogen



“ The Maker of nitrogen must be the Maker of stars in which it is originated.”

atom with its outer shell of five electrons that allows it to bond with other nitrogen atoms and maintain its stability in the atmosphere. He must have infinite knowledge and power to make other atoms and combine some of them with converted nitrogen to turn to living cells.

Despite the incredible knowledge some scientists have attained, they still cannot understand what drives electrons to travel from one atom to another. Obviously, even if all scientists come together, they cannot even create one single nitrogen atom from the scratch. They do not even have full knowledge of the inner functioning of an atom. Just as we cannot create or even control the subatomic microscopic universe, we cannot possibly believe that we can control the universe on a macroscopic scale.



No Nitrogen Fixation and Nitrification?

Remember, nitrogen fixation is the process where bacteria in the soil or living in the roots of some leguminous plants such as peas and beans convert molecular nitrogen to ammonium. If this process does not occur, the ammonium cannot be converted to nitrates by nitrifying bacteria and plants and animals would have no access to nitrogen in their environment. Without nitrates, plants cannot make the chlorophyll they need, cannot photosynthesise and will eventually die. If plants die, their dependents including human beings would be eradicated as well leading to mass extinction.

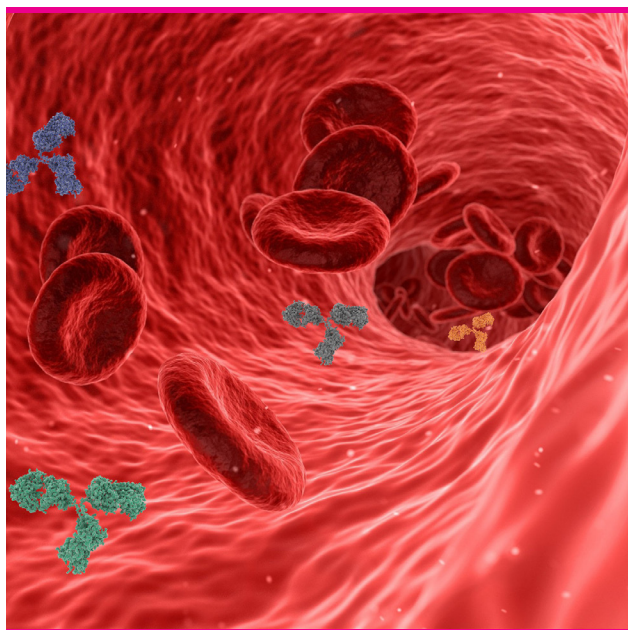
No Denitrification?

As we learned in the first dimension, denitrification is the process where denitrifying bacteria break down nitrates and nitrites to nitrogen gas. If this does not occur, nitrogen will remain trapped in the soil within the nitrites and nitrates and will not return to the atmosphere. An excess of nitrates and nitrites in the soil will eventually wash into lakes and rivers, contaminating sources of water. This leads to excess growth of aquatic plants such as algae. When the algae die and decompose, the oxygen level of the water decreases leading to anoxia. The lake eventually turns green or milky white and becomes inhabitable for fish and other aquatic organisms. This process is known as **eutrophication**.

What Is Eutrophication?



<https://youtu.be/6LAT1gLMPu4>



It is clear that the Maker of nitrogen is the Creator of the Earth and all that lives in it. This is because our Creator knows the need of the inhabitants of this Earth for nitrogen. The Maker of nitrogen must also be the Creator of the universe from which it originated.

The All-Wise, All-Knowing, All-Powerful and Most Merciful Maker created nitrogen as an essential component of all biological and chemical systems here on Earth. He created nitrogen to form essential molecules such as amino acids, DNA and parts of chlorophyll and hemoglobin. Recall- hemoglobin is the oxygen carrying protein of our red blood cells. Without the oxygen-binding ability of hemoglobin, we would die.

We can see how the roles of nitrogen and oxygen are linked. Nitrogen is used to build a structure that is then used to hold oxygen- the element scientists refer to as the essential

biomarker of life. It is quite interesting that biological body of living beings is largely built through the use of three neighboring elements (carbon, nitrogen, and oxygen).

It is clear that the Designer of the nitrogen atoms used to make hemoglobin is the Designer of the oxygen molecules to which hemoglobin binds. It is evident that the Maker of all biological organisms is well-aware of the chemical components needed to sustain them.

The systems in which carbon, nitrogen and oxygen work cannot be separated from each other. Similarly, the movement of nitrogen from one form to another in the inanimate part of our planet is linked to the movement of nitrogen compounds within our bodies.

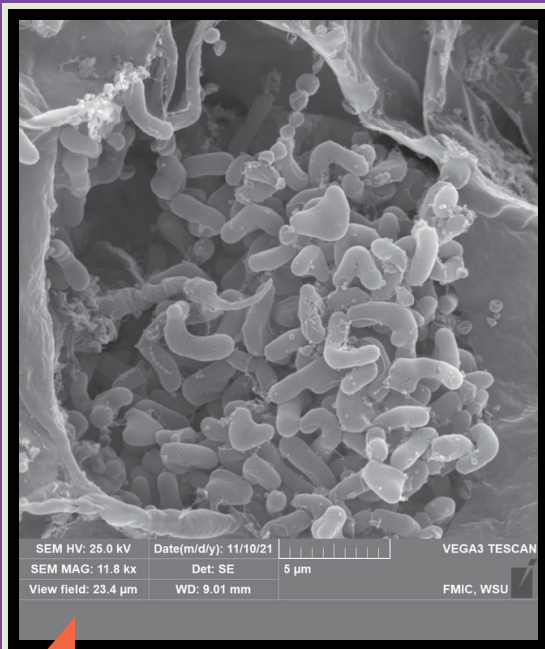
The Nitrogen Cycle is one of the many systems on the planet where loss equals replacement- in other words, a balance of elements is continuously maintained.

By reflecting on the how the Nitrogen Cycle remains in balance and is associated with multiple beneficial outcomes, we should reach the conclusion that there must be an All-Encompassing Power that controls the balance between the release of nitrogen in the atmosphere and its uptake into the soil. The Maker of the Nitrogen Cycle must know of the most minute fluctuations in levels of nitrogen in the soil and atmosphere. He must know the amount of nitrogen that needs to be held in the atmosphere or taken up by bacteria and plants in the soil.

Fifth Dimension : Moral Thinking

RESPONDING WITH BETTER CHARACTER

“Appreciation is understanding the value of our flawless Nitrogen Cycle”

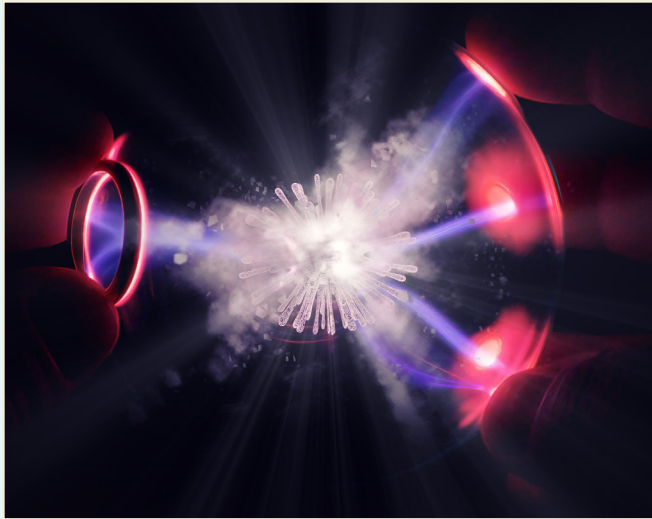


Nitrogen fixing bacteria in legume root.

The continuous cycling of nitrogen from one form to another in the Nitrogen Cycle is designed for our survival on Earth. **Appreciation** is understanding the value of our flawless Nitrogen Cycle. If we granted Nobel Prize to those who came up with a system to convert nitrogen into ammonia, shall we not offer our appreciation to the one who employ billions of bacteria to do the same job for free for millions of years?

The Creator of Nitrogen Cycle does not need prize or price. He is the true owner of everything. However, the Most-Generous wants in return for the precious gift of the Nitrogen Cycle three things: one is remembrance, another is reflection, and the third is gratitude.

Remembrance is to be mindful of the Maker of nitrogen cycle. It is not taking anything for granted. It is remembering Him as the true Owner. It is to know that we enjoy nitrogen as a fruit of the universe through the Infinite Power, Wisdom, Knowledge, and Mercy of its Maker.



Reflection is thinking about the apparent causal mechanisms in order to appreciate the knowledge, wisdom and power behind the Nitrogen Cycle. It is to understand what it takes to make nitrogen from the scratch. It is to ponder on the reason behind the interconnectivity of the Nitrogen Cycle with everything else in the universe and to understand that apparent causes are just the veil of the Cause of all causes. It is to think about the countless beneficial outcomes of the Nitrogen Cycle and learn about the Creator of the cycle through the signs He has placed within it.

Gratitude is to be thankful is through being aware of the priceless, miraculous Nitrogen Cycle as a gift of Infinite Mercy. It is to be grateful to Him for keeping nitrogen level in the atmosphere in check. For keeping nitrogen in the soil and water in balance. For making an explosive gas to be extremely important for living beings. For employing zillions of bacteria to work constantly to convert nitrogen in a usable form.

As we gain more knowledge about nitrogen and nitrogen cycle, we will also find many lessons for a better life. For instance, we can learn about cooperation by observing how nitrogen atoms bond with other nitrogen atoms or other elements such as hydrogen and oxygen. The property of a nitrogen atom that allows it to form a triple bond with another nitrogen atom thus making it more stable in the atmosphere shows us that only through cooperation can we gather strength. Just as a nitrogen atom is unstable on its own, choosing to remain isolated from fellow human beings makes us vulnerable and weak. We can learn the importance of diversity as we realize that difference atomic numbers for hydrogen, carbon, nitrogen, and oxygen are necessary for the life on the Earth. As it is clear in the story below, we can learn that nothing is good or bad. It is our use makes something to be good or bad. Thus, it is up to us to use objects or life events for good or bad.

We need to talk about Nitrogen



<https://youtu.be/eJOGGvH9xkg>

1. Remembrance is to be mindful of the Maker of nitrogen cycle.

2. Reflection is thinking about the apparent causal mechanisms in order to appreciate the knowledge, wisdom and power behind the Nitrogen Cycle.

3. Gratitude is to be thankful is through being aware of the priceless, miraculous Nitrogen Cycle as a gift of Infinite Mercy.

How can we express our gratitude and appreciation for the Nitrogen Cycle in our daily life?

Let us consider the steps we can take to remember, be grateful and reflect:

Remember the value of nitrogen. When it comes to choosing between organic and inorganic produce, think about the agricultural impact of commercial farming. Recall that the addition of fertilizers to the soil has disastrous impacts on the environment. Reflect on the value of living in a region that allows you to have access to a wide selection of fresh fruit and vegetables. In some parts of the world, arid climates and poor soil quality make the availability of produce a luxury few can afford.

Grateful citizens of the planet show **generosity** towards others. Being generous means **sharing** our resources with those who are less fortunate. It means being aware of and **reflecting** on the responsibility we have towards others who have not been given an abundance of resources.

To be good citizens means to control our selfish desires and be thoughtful of other beings as well. It means that we control the choices that we make and become aware of the impact our actions make on the environment.

TEST YOUR KNOWLEDGE

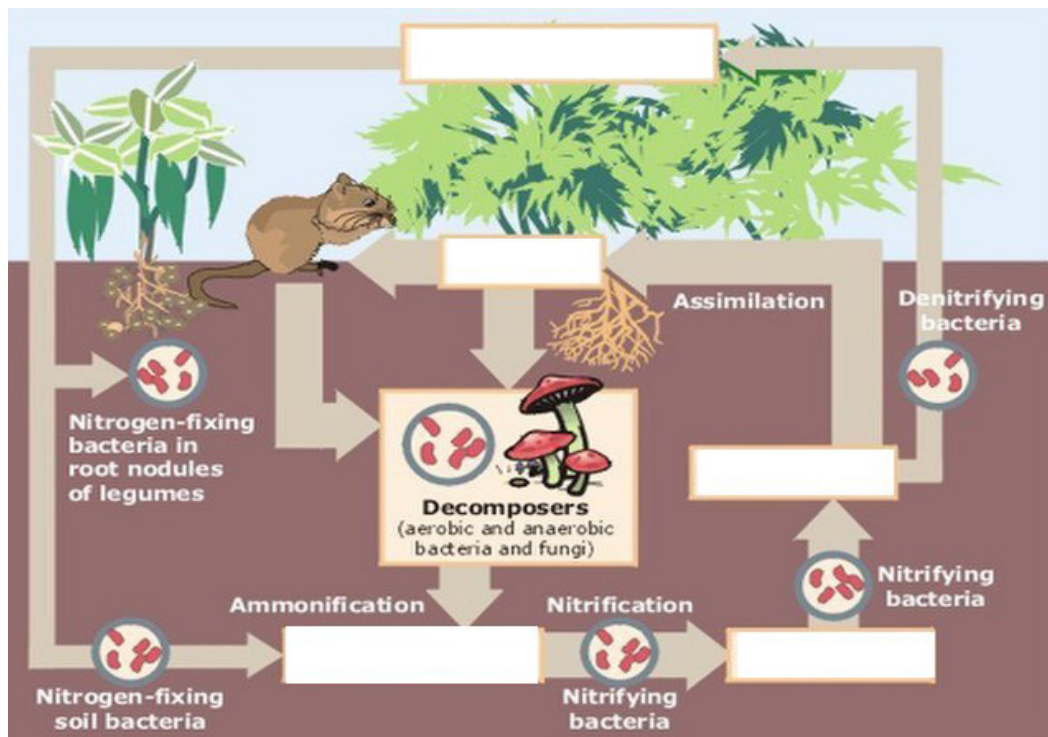
I. UNDERSTANDING SCIENCE TERMS

Complete the following sentences with a word or words from the Science Terms that will make the sentence correct.

Nitrogen Fixation *Assimilation* *Nitrification* *Denitrification* *Eutrophication*

1. _____ is when lakes become inhabitable for fish and other aquatic organisms due to the overgrowth of algal blooms.
2. The stage of the Nitrogen Cycle in which ammonium is changed to nitrates is called _____.
3. _____ is the process in which extra nitrates or nitrites in the soil are converted into nitrogen.
4. The process in which plants absorb the nitrates through their roots and use them to make building materials such as amino acids is called _____.
5. _____ is the process by which bacteria living in the soil and in the roots of certain plants are designed to convert nitrogen in the air into ammonium.

Label the following diagram:



I.CHECKING FACTS

Determine whether each of the following is true or false.

1. Plants use nitrogen to make chlorophyll. _____
2. When an organism dies, nitrogen is released. _____
3. Nitrogen is the second most common element in the air. _____
4. More than half of used paper is recycled in the United States. _____
5. Nitrogen has an atomic number of 6. _____
6. Nitrogen dioxide is a harmful chemical. _____

III.UNDERSTANDING CONCEPTS

Write a short answer for each question or statement.

- 1.Name the organisms involved in the process of nitrogen fixation.

2. List the seven steps of paper recycling.

3. How can human beings harm the Nitrogen Cycle?

4. How do you know that there is a Hidden Hand behind the design of the Nitrogen Cycle?

5. List two hidden messages found within the workings of the Nitrogen Cycle from its Maker.

6. Why is it an offense to deny the presence of the Creator of the Nitrogen Cycle?

IV. APPLYING CONCEPTS

Write a paragraph to answer each question.

1. How is the process by which paper is recycled different from the cycling of nitrogen in the Nitrogen Cycle?

2. Describe how your daily life would be impacted if there were flaws in the Nitrogen Cycle.

3. Why do you think the electrons and protons that make up individual nitrogen atoms could not have created the Nitrogen Cycle?

4. The One who creates the Earth's Nitrogen Cycle has to be the Creator of the Earth. Why?

5. Why do you think the Nitrogen Cycle is an extremely valuable gift? Describe two things that make you appreciate the value of this gift.

6. How can you show your gratitude to the One who granted you the gift of the Nitrogen Cycle?



V. THINK-THANK GAME

In this “think-thank” game, we want you to think about nitrogen cycle and give thanks to their Maker. We also call it the “play to praise” game. The goal of this game is to think of at least five things about the nitrogen cycle that you are thankful for.

Number of players: At least two.

Directions:

Player 1 repeats an appreciation phrase loudly and quickly. **Player 2** responds, without pausing, with something to be thankful for. This is repeated **five** times.

To win:

Player 2 needs to respond five times (without pausing) with different things about the Earth to be thankful for in order to win the game.

Here is an example of two rounds of this game:

Player 2 needs to respond five times (without pausing) with different things about nitrogen cycle to be thankful for in order to win the game.

Here is an example of two rounds of this game:

1. Player 1 repeats the appreciation phrase loudly and quickly. For example: “Thanks to the Maker of nitrogen cycle!”
2. Player 2 responds, without pausing, with something about nitrogen cycle to be thankful for. For example: “creating an efficient system to cycle nitrogen without wasting a single piece”
3. Player 1 repeats the appreciation phrase again loudly and quickly. For example: “Thanks to the Maker of the nitrogen cycle!”
4. Player 2 responds, without pausing, with another thing about the nitrogen cycle to be thankful for. For example: “For employing bacteria to convert nitrogen to ammonia!”

This should be continued for another three rounds until Player 2 wins or loses.

