PHOTOSYNTHESIS: THE GREEN MIRACLE

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INTRODUCTION

Plants come in more than 500,000 varieties and occupy a vitally important place in human life. This limitless resource, placed at mankind's disposal by Allah (God), is the source of the fresh air we breathe, the food we consume to survive, and much of the energy we use. Plants are also the self-renewing source of strikingly beautiful sights, delightful scents and stunning colors.

Plants are very specialized living things whose photosynthetic ability turns light into food and energy. Mechanisms in the green leaves constantly produce oxygen, cleanse the air and ensure ecological equilibrium. Their aesthetic features—such as taste, scent and color which appeal mainly to human beings—reveal the infinite knowledge, artistry, compassion and affection for human beings of Allah, their Creator. To date, only some 10,000 species of plants have been studied in detail, along with their unique systems that provide unique benefits. And this research had determined that every plant possesses features of such a kind as to astonish even the informed observer.

For those who wish to know Allah, appreciate His attributes and draw closer to Him, it will be useful to take a rather closer look at the miracles of creation to be found in plants, and even in a single leaf, and at the plants as a whole, a world so full of marvels. In this way we can find a doorway to stunning truths, ones that you may have imagined were reserved for scientists alone, offering genuine interest to any attentive individual.

With the reason and understanding bestowed on them by Allah, believers can see the miracles He has placed before their eyes. But we need to look through a lens of reason and wisdom. All those who learn to regard their surroundings with reason and wisdom will, in addition to perceiving the artistry in a flower's color, shape and perfume, also learn about the systems that make that flower what it is and thereby, bear clearer witness to the sublime knowledge and might of Allah.

He reveals that there are signs—clear indications of His existence—in the creation of Man and other living things:

And in your creation and all the creatures He has spread about, there are Signs for people with certainty. (Surat al-Jathiyya:4)

By examining photosynthesis, a characteristic feature of plants that helps them thrive and also support animals—as well as the flawless design of the leaves that carry out this process—you will witness the miracles that Allah continually performs in these living things.

As you read through this book you will encounter various foreign names and technical details that at first glance may seem difficult, even incomprehensible. However, they are all explained in such a way that even a reader wholly unfamiliar with the subject will have no trouble in understanding them. The important thing here is to realize that Allah has created everything in the universe, right down to the tiniest details, with His superior knowledge and delicate measurements. You can then witness and appreciate the living examples set out in the verses below:

He to Whom the kingdom of the heavens and the earth belongs. He does not have a son and He has no partner in the Kingdom. He created everything and determined it most exactly. (Surat al-Jathiyya:2)

It is Allah Who created the seven heavens and of the earth the same number, the Command descending down through all of them, so that you might know that Allah has power over all things and that Allah encompasses all things in His knowledge.(Surat at-Talaq:12)

Intelligent Design, in other words Creation
In order to create, Allah has no need to design

It's important that the word "design" be properly understood. That Allah has created a flawless design does not mean that He first made a plan and then followed it. Allah, the Lord of the Earth and the heavens, needs no "designs" in order to create. Allah is exalted above all such deficiencies. His planning and creation take place at the same instant.

Whenever Allah wills a thing to come about, it is enough for Him just to say, "Be!"

As we are told in verses of the Qur'an:

His command when He desires a thing is just to say to it, "Be!" and it is. (Surah Ya Sin: 82)

[Allah is] the Originator of the heavens and Earth. When He decides on something, He just says to it, "Be!" and it is. (Surat al-Baqara: 117)

THE GREEN FACTORY THAT WORKS ON OUR BEHALF

A Mechanism Producing Vital Energy

The energy reaching the Earth from the Sun every day is around 10,000 times greater than all the energy that mankind will require throughout that single day. Developed nations spend large amounts of money on research into how sunlight's free energy can be stored.

From the research performed for this purpose, one astonishing truth has emerged; Plants already possess a perfect system for storing this energy from the Sun, in a procedure known as *photosynthesis*. Plants perform photosynthesis thanks to the chlorophyll in their tissues. This chlorophyll produces carbohydrate, the basic foodstuff of all life, by converting solar energy into chemical energy.

Carbohydrates are basic food sources that, directly or indirectly, meet the energy needs of all living things. There is no need to eat plants in order to obtain this energy. Since many animals feed on plants, that same energy can reach human beings by way of animal-based foodstuffs. For example, sheep eat grass. Green grass uses solar energy to synthesize carbohydrate molecules by way of photosynthesis and thus stores the carbohydrates inside its tissues. Grass-eating sheep themselves absorb these high-energy molecules into their own bodies. Digested, the carbohydrate molecules later are oxidized as energy and converted into fat in the sheep's bodies. The energy in these molecules is thus transferred to the animal's tissues. Someone who then eats these animals absorbs this energy, which originally reached the grass from the Sun.

As you have seen, all living things use the energy obtained from solar rays by way of photosynthesis, no matter in what form they manage to digest it.

Not only foodstuffs, but also a large number of the substances we use in our daily lives transfer to us the energy originally obtained by way of photosynthesis. For example, burnable fuels such as oil, coal and natural gas contain hydrocarbons in which solar energy was originally stored by means of photosynthesis. The same applies to the firewood we burn. Just by considering these materials the vital importance of photosynthesis can be better appreciated. The discovery of the secrets of photosynthesis and the unearthing of the mechanisms involved in this process is of great importance to scientists. If this process can be fully understood, it will be possible to increase food production, make the most efficient use of nature, obtain the maximum benefit from solar energy, develop new medicines and design very fast and small machines powered by solar energy.

However, what is currently known about photosynthesis is insufficient for us to produce systems that can imitate it in order to store solar energy. Nonetheless, photosynthesis is a simple, natural process for any green plant, though it lacks reason and

consciousness. It is astonishing that while human beings possessed of intellect, education and advanced technology cannot duplicate this system, hundreds of trillions of plants—from the one-celled algae to towering redwoods—have all been carrying out the process of photosynthesis for millions of years. They have carried out this chemical process without interruption, ever since the day they were first created.

Any spot on Earth hosting the smallest patch of greenery is actually a factory that manufactures sugar out of carbon dioxide and water, using solar energy.

Without you being aware of it, the spinach you eat, the parsley in your salad, and the ivy growing on the balcony are engaged in constant production on your behalf. This is thanks to the compassion that Allah, Lord of sublime knowledge, has for us. Allah has created plants in such a way as to be of use to humans and all other living things. For millions of years, leaves have been implementing this system which human beings with all their advanced technology are still unable to fully comprehend.

In one verse of the Qur'an, Allah reveals that it is impossible for human beings to produce even a single tree out of nothing**:**

He Who created the heavens and the earth and sends down water for you from the sky by which We make luxuriant gardens grow—you could never make their trees grow… (Surat an-Naml: 60)

Allah created the whole universe with His sublime knowledge and artistry. As a result of this matchless creation, all the systems that give rise to life on Earth operate together in complete harmony. Every system and structure, from the stars in outer space to the electrons that revolve around the nucleus of a single atom, are either dependent on some other system or else act to complement it.

In this superior design, photosynthesis occupies a very important place. Using carbon dioxide in the air, and absorbing water and minerals in specific amounts from the soil, and with the help of sunlight, unconscious plant cells create food for all animals. With the energy they receive from solar rays, plants break down these substances down and then recombine them into foodstuffs. A distinct intellect, consciousness and planning can be seen in every detail of this process, summarized briefly here. Clearly this amazing system in plants, with the results it produces, is a source of nourishment specially designed to be of benefit to animals and human beings. The green plants on Earth use solar energy to produce a basic food source that is essential to the survival of all life, and therefore of human beings.

Provisions for all living things are created as the result of a chain process stretching in perfect harmony from the heavens to the Earth. This is also indicated in verses of the Qur'an:

Say: "Who provides for you from the heavens and earth?" Say: "Allah. It is certain that one or the other of us, either we or you, is following guidance or else clearly astray." (Surah Saba': 24)

He Who originates creation and then regenerates it and provides for you from out of heaven and earth. Is there another Allah besides Allah? Say: "Bring your proof if you are being truthful." (Surat an-Naml: 64)

Every plant is an independent food factory and power station, specially created for human beings, making use of the most abundant free sources such as air, water and solar energy. In this system, leaves are both solar panels that collect energy and also factories producing food. In addition, plants' tastes, scents and colors, are also the aesthetic work of a sublime artistry. Before going on to examine the various stages of photosynthesis, whose every aspect has been created with the greatest knowledge, we need to look at the perfect design behind the general structures of leaves. This way, we can see how the structures and systems that carry out the process of photosynthesis have been created with a deliberate design.

How Does the Factory Work?

If you examine a leaf under a high-resolution microscope, Allah's creative artistry will appear before you once again in all its magnificence. A flawless production system has been installed inside each single leaf. In order to better understand this system, compare the structures operating within the leaf to devices we use in daily life. When we magnify and investigate the details in a leaf, we encounter an automatic food factory, operating non-stop and filled with conduits, chambers built for special processes, valves working like a miniaturized pressure cooker, countless triggers controlling thousands of processes, and worker cells in a constant state of activity. If we look more closely, we can also see time regulators installed at specific points, thermostats, humidity gauges, feedback systems and temperature control mechanisms.

The veins that run like a network of pipelines through every part of the leaf permit water and other raw materials to reach the production units, and also allow the carbohydrates obtained from those units to be distributed to the plant's tissues. In a plant with trunks or stems, a separate system of vertical pipelines also sends sap to the leaves and returns sugars to the plant's interior in order for it to be nourished.

These channels are not limited to carrying essential fluids; they also serve as an internal skeleton to support the tree and its leaves. In artificial structures, a building's load-bearing elements (its columns and beams) and its water pipes are constructed separately. The way that these two functions are served by a single system in plants is a marvel of design, whose details we shall be examining in the next chapter.

THE CREATION AND VARIETY IN LEAVES

No matter which part of a leaf we examine, we see evidence of an infinite intelligence and artistry. When a leaf is viewed from the outside, its shape and structures display a design aimed at a particular purpose. For example, the leaf needs to remain flat in order to receive the maximum amount of solar rays but for that to be possible, the leaf must have a special design. Comparing the leaf to a piece of typing paper will give a better idea about its design, essential for the leaf to retain its flattened contour.

When you want to hold a newspaper or piece of paper straight, the paper bends over and folds in two. To keep the paper rigid, you have to impart a slight crease or bend from one side to the other. Leaves also need such a crease in order to stay flat.

Leaves can stay flat and obtain the maximum benefit from solar rays by the main vessels in their structures known as *midribs*. These vessels pass through the center of the leaf and connect it back to the stem. Moreover, other veins also emerge from the midrib and spread to the surface of the leaf. The midrib and these lateral veins constitute a flexible skeleton that permits the leaf to remain relatively rigid.[1]

How did every one of the infinitely many leaves on Earth come to have the venous system necessary for them remain rigid? It is of course impossible for a leaf to realize on its own accord how it can make the best use of solar rays. Furthermore, it is also impossible for leaves to decide for themselves to adopt the requisite crease along their midrib or to form a venous system that will serve as a skeleton. It is definitely impossible for these developments to come about by coincidence. Therefore, the answer to the question is very simple; it is Allah Who has designed and created leaves' venous system and midrib creases.

The average leaf can be compared to a piece of limp cloth laid over the veins that serve as a mechanical support. In order for this system to function effectively, the plant also needs to expend very little energy to support the leaf's tissue at a low level. But this is simply solved, because the midrib, or main support passes down the center of the leaf, and from it, secondary supports or struts stretch from the main out to the leaf edges. It is particularly important for the leaf's weight to be balanced equally on either side of the main vein, which means the placement of that midrib is crucial for balancing the leaf's weight.[2] The midrib's ability to support weight decreases with distance from where it attaches to the plant, and its leverage increases proportionally. As an analogy, if you pick up a heavy book in one hand and then extend your arm, you will find that your ability to hold the book is diminished, and that the book's apparent weight has increased. However, since the main

[1] http://www.botany.hawaii.edu/faculty/webb/BOT410/Leaves/LeafMidrib.htm.

midrib passes down the exact center of the leaf, the weight it must support is distributed equally.[3]

This is no ordinary phenomenon, because no such balance can come into being by chance. Can bricks possibly come together by coincidence to form a building that will not collapse? Or can any bridge remain upright if its center of gravity is not calculated before it is built? In these two examples, as in thousands of similar ones, it is impossible for matter to combine to form a specific order and equilibrium. It is Allah Who creates every entity, living or otherwise, with its particular order. Allah has created both the tiny leaf and the Earth, large enough for billions of human beings to live on, with a sublime design.

Whether something is large or small, there is never any deficiency in Allah's creation. In verses of the Qur'an it is revealed that Allah has created all things in a perfect manner and that no one can detect any deficiency in the universe He has created:

He Who created the seven heavens in layers. You will not find any flaw in the creation of the All-Merciful. Look again—do you see any gaps? Then look again and again. Your sight will return to you dazzled and exhausted! (Surat al-Mulk: 3-4)

In addition, there are a great many miraculous functions in a leaf's structural design. Professor Thomas Givnish, from University of Wisconsin, a researcher into the structural mechanisms of leaves, says this:

If mechanical efficiency were the only consideration, plants would all have triangular leaves.[4]

Along with mechanical structure, a great many other complex factors enter the equation in the design in leaves. Not only are leaves not triangular, but they display other characteristics.

The mathematical calculations that emerge in their sequencing is one example. Leaves are arranged in such a way as not to cast shadows over one another. As Givnish says:

Triangular leaves can't be held efficiently along twigs to harvest sunlight because triangles don't pack. But if the base of the leaf is tapered as well, to a sort of kite shape, then they can be held close together in a circle, or spiral, without overlapping. [5]

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[2] Steven Vogel, *Cats' Paws and Catapults:Mechanical Worlds of Nature and the People*, New York, 1998, pp. 60-61.
[3] *Ibid*.
[4] Lynn Dicks, "The Sinister side of the holly and the ivy," *New Scientist*, Vol. 2218, 25 December 1999.
[5] *Ibid*.

Leaves' special design also changes according to their ambient climatic conditions, their life span and the likelihood of them being exposed to insect or animal attack. Consider holly as an example: Its leaves have sharp thorns along their edges. However, these thorns are mainly found on leaves in the lower parts of the plant. A thorny tip is seldom found in leaves at the top of a holly tree.

The important reason for this design is that the thorns on the bottom protect the leaves against leaf-eating animals. Since the creatures cannot reach the upper parts of the plant, the leaves there have no need to take such a precaution.[6]

Leaves of trees and shrubs that remain green all year round have a very special design. Their needle-like structure has been created with a thick, waxy coating that prevents moisture loss when the ground freezes.

Many climbing plants, such as *Evening Trumpet flower* or vines, are covered with heart-shaped leaves. Rather than grow their own sturdy stalks or stems, these plants use other plants' trunks as supports. Climbing plants must constantly angle their leaves towards the Sun. However, since the plant they climb up to will shade them from light coming from above, the plant changes place according to the most appropriate angle to its stem, rather than remaining at the same level. The leaves thus turn their surfaces in the direction of the Sun.

Another ingenious design in leaves can be seen on windy days. The surfaces of plant leaves are generally broad, letting them receive as much solar energy as possible. However, a strong wind or storm acting on these surfaces could lead to the plant bending and breaking off. Yet this seldom happens, because the leaf's structural features have been created in such a way as to reduce the wind's effects. The cellulose and fibers that serve as any plant's skeleton have a considerable ability to flex. Besides, leaves grow in the same direction with extension of plant. This helps protect against the destructive effect of the wind, as the leaf is thus able to bend in the direction of the wind without breaking.[7]

A second property that protects leaves is that they are able to fold inwards, along their midrib, as the wind's velocity increases. The leaf thus forms an aerodynamic, V-shaped structure that cleaves the wind like the prow of a ship does the waves. Furthermore, leaves are capable of flattening themselves against one another in order to increase the wind resistance of their collective aerodynamic structure. In other words, when the leaves along a branch lean in the direction of the wind, they do so in such a way as to lessen the force on the next leaf in line.[8]

In the same way that terrestrial plants have been designed to resist the wind, plants in water have also been designed so as to reduce the effect of the current to a minimum. The water's current has a similar effect to that of wind; however, thanks to their special design, underwater plants like seaweed are able to resist the power of waves and currents. These plants lack the thick, woody stems of those on land, but the roots that adhere them to rocks

are very strong, and thanks to their flexible stalks and leaves, they can adjust to the force of the current. If the external force reaches an irresistible level, the plant first sacrifices its older, larger leaves. With these gone, the plant's resistance to the current decreases and permits the plant to display greater resistance.[9]

Though every plant species differs from all others in terms of its exact structural characteristics, most green plants produce oxygen and nutrients by making photosynthesis, and perform specific functions thanks to the various features they possess. Thanks to their special designs, some plant leaves can store quantities of water and nutrients, while others' perform defensive functions with their thorny structures, can cling to other supports with their tendrils or aerial roots, and even feed by catching small animals such as insects in complex traps. Therefore, whichever plant we examine, we see that it possesses many extraordinary features, showing the infinite knowledge and artistry in its creation. No doubt, this knowledge and artistry belong to Allah, Who has created all things, animate or inanimate, with a superior wisdom:

It is He Who sends down water from the sky from which We bring forth growth of every kind, and from that We bring forth the green shoots and from them We bring forth close-packed seeds, and from the spates of the date palm date clusters hanging down, and gardens of grapes and olives and pomegranates, both similar and dissimilar. Look at their fruits as they bear fruit and ripen. There are Signs in that for people who believe. (Surat al-An'am: 99)

Leaves That Are Unaffected by the Desert Heat

The word "desert" brings to mind an environment in which no living thing can easily survive. Indeed, the number of species able to survive in deserts is very small. Despite these difficult conditions, however, we still encounter unimaginable miracles in the desert environment. When we examine this arid environment more closely, plants with various attributes draw our attention. With their special designs, these different varieties of plants easily manage to survive in these harsh conditions. Each one is a miracle, specially created for these harsh climatic conditions.

To overcome extreme heat and aridity, desert plants resort to two methods. The first is to employ the resistant water-retentive structure they possess, and the second is to go dormant. Arid climates do not harm these plants, thanks to their fascinating structures and special designs. Their leaves act as stems and as organs for photosynthesis, as well as for food and water storage, and also, with their thickened structures, as a defensive structure.[10]

Some leaves, such as those of the so-called "living stones," are experts in camouflage and imitate the rocks around which they grow. Animals' use of camouflage is a miracle one often frequents.[11] Yet the use of camouflage by plants is less familiar. If you consider the kind of features that a plant able to imitate the rocks around it must possess, you can better comprehend the astounding nature of this phenomenon. First of all, this plant needs to have a perfect adaptation to a desert environment and the conditions it presents. It needs to plan a

specific shape and system of defense in order to save itself from herbivores around it and at the same time, withstand the extreme heat. It must then "decide" that rocks constitute the best model for it to imitate. It must assume that if it can make itself resemble the rocks, it can easily go unnoticed, and must alter its entire physical structure in the light of this.

Clearly plants, with no intellect, consciousness or eyes, cannot take and implement such vitally important decisions for themselves. That being so, what gives them the most suitable structure and shape for the environment in which they find themselves? Evolutionists, who maintain that all living structures came into being by coincidence, claim that desert plants that imitate the rocks also came by this characteristic by chance. These claims are wholly illogical. Can any random event endow a plant with such a flawless imitative ability and the ability to store the water it most needs in desert conditions? It is clear that Allah has created these plants together with these attributes, with His most sublime knowledge and intellect.

Water Storage in Leaves

The leaves of desert plants designed to store water and foodstuffs may be cylindrical, as in the genus of stonecrops known as *Sedum*, or else have a prismatic shape as in the ice plant (*Carpobrotus)*. Due to their water- storing properties, these plants that live in arid regions have a very fresh appearance. Water is stored inside the stems or leaves in broad, thin-walled cells. These leaves' thick upper layer prevents water loss.

Another feature of desert plants' flawless design is their spherical shapes. Because since it possesses the smallest surface area, the sphere is the most efficient volume for storing water. Desert plants' thick stems, spherical shapes and pores that are closed during the day and open at night comprise a structure that reduces water loss due to evaporation.[12]

Many plants store water in different places. For example, the Century plant stores it in its thick, fleshy leaves; the *Cereus* plant that opens at night in its underground bulb; and the cacti in their rounded stems. Plants such as the agave hold their grooved leaves open so as to catch the very infrequent rains that fall. In contrast, the leaves of plants such as *Sarracenia minor* that live in rainy areas, are like umbrellas, protecting the plants from excessive rain. Every plant has features appropriate to the conditions it lives in—a sign of Allah's flawless creation.

Cacti's prickly pears' surfaces are flat. On their surfaces, nearly all have ridges or rows with a large number of thorny spikes. These plants are able to expand and contract according to the level of water stored in their inner tissues.

Everyone will have seen a cactus. However, most cacti have thorns or spines protecting its water-filled stem from animals. Its waxy upper layer protects the plant by insulating the effect of sun on it and reducing evaporation. The shiny wax reflects the majority of the light that falls on them; some are covered with white hairs to reflect more

solar rays. In addition to their beauty, the features of cacti are also great miracles created to serve a variety of ends.

There is a plan, design and purpose in every component of a cactus, from its thorns to the white hairs covering it—all important evidence that cacti cannot have come into being by chance, but were designed by a superior Intelligence.

Some species of cacti, especially the Window Leaves plant, bury their entire bodies just beneath the ground, protruding only the tips of their leaves above the surface. The tips of the leaves are transparent, yet further down, the leaves contain green cells with chlorophyll. These cells, arranged in the form of long lines, capture the light entering from the leaf tips to perform the process of photosynthesis.[13] As a result of their very special design, the plant reduces water loss to a considerable extent and hides from the blazing sun by remaining largely underground. It has no difficulty surviving in an environment that many living things could not endure for any length of time.

In addition to their many other attributes, desert plants have been created to be exceedingly resistant to drought conditions. For example, the American pygmy-cedar tree *Peucephyllum* and the plant *Capparis spinosa*, which can absorb a little moisture at night and remain green under even the most arid conditions, are completely resistant to drought. Many bushes and trees can also withstand drought, because their resistant leaves possess a number of features. Some like the Paloverde, for example, have very small leaves. Other leaves are needle- or bouquet-shaped; thanks to their small size, a reduced surface area is exposed to the drying rays of the Sun.[14]

The leaves of some short-lived plants have pores on only one side, usually their top. This design prevents water loss through evaporation, particularly under conditions of intense wind. Other leaves have pores on both surfaces, which absorb moisture from the air, especially during foggy conditions.

In some plants, especially *Manzanita*, the leaves are supported in such a way as to remain perpendicular. The surface areas are thus less exposed to the Sun, and water loss is reduced. *Paloverde*, which has only vestigial leaves that appear briefly in spring, performs its photosynthesis in the smooth, bright-green branches and twigs. That is because the possession of too many leaves in a desert environment means more water evaporating.

As you have seen, plants that resist the desert climate possess a number of different precautionary measures against the heat. It is clear that plants cannot take these precautionary measures separately from one another, since plants lack the necessary consciousness, reason and information. It is Allah Who creates every plant with the most appropriate and matchless features for the environment in which it exists.

How Desert Plants Remain Dormant

So far we have reviewed examples of plants whose special structures let them withstand drought and aridity. However, we briefly mentioned another method of withstanding the desert environment: remaining dormant. Species that implement this method are known as *ephemeral* plants. They generally live as adults for less than a year, surviving the lack of water by remaining dormant in seed form and then sprouting very quickly in the wake of a rain. Their sprouts grow very rapidly. Flowering takes place in a very brief time thereafter, and thus the plant's entire life cycle can progress from the seed to the seed-production stage in a matter of just a few weeks.

Rainfall in the desert is irregular, and undependable. If the seeds of ephemeral plants were all to sprout after a single rainfall and then wither during the subsequent drought, their species would become extinct. Yet most of these plants possess mechanisms that ensure that the seeds sprout only after receiving a large, soaking quantity of rain. These plants possess a property known as *seed polymorphism*, which is the ability to vary the time of their seeds' sprouting. In addition, a natural chemical in the seeds retards their germinating. When water first reaches the seed, its rising to the surface stage is completed. However, this protective substance must be thoroughly neutralized if the seed is to sprout—which takes place with the seed's second contact with water. But if this second encounter does not take place—in other words, if it does not soon rain again—then the seed will not sprout. Therefore, seeds require two separate stages; the first causes the seeds to float to the surface, and the second rinses away the substance that prevents germination. Sprouting occurs only after this has taken place.

The seeds of other ephemerals—for instance, those of the bitter melon—sprout only in the dark. The external coating of the seeds changes after a series of wetting and drying out and permits oxygen to freely enter the seed embryo. The combination of these essential factors causes the seed to sprout, but only after being buried and receiving moisture a number of times.

In the germination of these plants, there is a flawless design, plan and calculation. Everything, with every stage, is determined in advance. All precautionary measures are taken against possible adverse conditions in order that the seeds should not sprout needlessly.

So to whom belongs the intelligence and knowledge that determine this system for the formation of ephemeral plants, and designs for them in the most ideal form for the conditions they live in? The plant's cells? The seed itself? Or did this immaculate and complete system come into being by chance? The illogical nature of these questions is obvious. These plants, with the ideal characteristics for their habitats, are the sublime creation of Allah, Lord of the Worlds.

Another group of desert plants shed their leaves during times of drought. As their source of water declines, these plants immediately shed their small leaves. One example of

this is the plant *Ocotillo*. This plant goes dormant during drought conditions and remains in that state until it rains. But when rain falls, it immediately begins to sprout a new set of leaves. Some bushes possess this feature also; but they do not become dormant, because they are sufficiently resistant to live on the water and nutrients stored in their special underground rhizomes, until water in the environment increases again. These rhizomes develop horizontally under the ground and live for a long time.[15]

The desert plants we have examined as a whole so far present a most impressive picture. Some are equipped with special systems and structures in order to survive in the desert, by storing water, camouflaging themselves or becoming dormant. Some use various chemical means to stop their seeds sprouting and as we have seen, employ a great variety of methods of protection against a habitat where the greatest obstacles and difficulties prevail. The sublime designs of these plants, thriving in an environment that humans would imagine to be completely inhospitable, once again reveal the infinite knowledge and artistry of Allah.

The Fascinating Leaves of Plants in Watery Habitats

Plants that live in lakes, by the sea, in salt water and marshes with high salt levels encounter similar difficulties to those in deserts. But as is the case with all living things, plants living in such regions have been created with characteristics totally suited to their habitats. These plants' leaves and stem structures, the greater part of which lies under water, have been specially designed to permit them to survive under such conditions. For example, plants that live in salt water have thick, leathery leaves much like desert-dwelling plants. This gives them the ability to store high levels of fresh water in their tissues without being damaged by excessive salt.

In the brackish regions where plants such as *samphir*e, and *seablite* live, they are frequently exposed to flooding, which causes a large quantity of salt to enter the roots of the plant, which will ordinarily be harmful. Yet these plants are not harmed by excessive salt because they have special glands that remove the excess salt from their tissues. Plants that live under such conditions are known as *halophytes*.[16]

Salt marsh plants such as the *glasswort* are regularly surrounded by sea water. Plants of this kind survive thanks to letting their leaves remain on the water's surface, buoyed by the presence of special air-filled structures underneath. Giant Amazonian lilies are one of the species that possess such leaves.

The roots of plants that live in water or in water-logged soil are completely saturated, which raises the question of how such plants can obtain air. Like the other plants we've discussed, species that live with their roots in water possess the ideal characteristics for their environment. For example, a tissue known as *aerenchyma* permits those parts of marsh plants that remain under water to obtain oxygen. Air pockets in these tissues has the ability to expand. In plants such as the *water lily* and Elodea, oxygen is transmitted from the trunk

and leaves, those parts of the plant that lie outside the water, to the lower regions under water.[17]

As we have seen, these plants could not survive without the air pockets in their roots and the systems that carry oxygen down to them from the outside. It is not possible for any plant to develop a tissue that widens air pockets by itself. Neither is it possible for such a structure to develop gradually and by chance. A plant living in marshes or periodically flooded by water has no time to wait for chance phenomena to develop, over the course of millions of years, a system that will carry oxygen down to the plant's roots. That is because it cannot survive and reproduce in the absence of that system! This means that this plant's oxygen-carrying and storage system must have existed, fully formed and perfect, from the moment the plant itself was first created.

This can take place only as the result of a magnificent, flawlessly planned and executed creation, not through blind coincidences.

The Aeration System: Another Miracle in the Leaf

Some plants live with not just their roots under water, but large parts of their stems as well. The roots of these plants, which never contact the air at all, can sometimes lie more than 4 meters (13 feet) deep. It is impossible for oxygen to reach such depths by simple means. However, Allah has created the most appropriate system for these plants. The flawless aeration system in these plants, whose roots lie deep down under the water, can be compared to the structure of a skyscraper 300 meters (984 feet) tall and consisting of a hundred floors. In such high-rise buildings, one of the most important problems that engineers need to solve is that of aeration. Such buildings employ highly advanced technologies to resolve this difficulty. Many details—such as the air-conditioning spaces and their dimensions, the regions where the air conditioning units are to be installed, how fresh air is to be distributed to the different floors, and how used air is to be extracted from them—are all calculated while the building is still in the planning stages, and plans for the project are drawn up accordingly.

Certain regions in the blueprint are left empty in such a way as to form air shafts during the building's construction, and air conditioning pipes can later be installed into them. Finally, the air-conditioning machinery itself and special air-conditioning systems are assembled on the various floors, and especially on the roof.

When a plant's structures are closely examined, they can be seen to employ air conditioning systems within themselves far superior to those used in modern skyscrapers. This, of course, is a great miracle. The fact that an air conditioning system, an architectural and engineering marvel, is built into the internal structure of a plant devoid of any intelligence proves that the plant must have been created by a highly superior Intelligence.

The “engines” of this air-conditioning system are the leaves. Just as in a physical system, some structures must draw in clean air while other vents will expel the used air. Once again, the requisite planning has been carried out for a complete air-conditioning system to exist, and there is a perfect division of labor among the leaves. Younger leaves serve as the motors that draw fresh air into the plant, and older leaves expel the dirty air.

However, the presence of these engines on their own is not sufficient. There is also a need for air channels established in line with a specific plan: While fresh air is drawn in by the younger leaves, it must also be transported to those areas in the plant where it is needed. To fulfill this requirement, microscopic air-conditioning channels have been installed inside the plant to transport air to its very furthest reaches.

Now, to witness the flawless design in Allah’s creation from even closer up, let’s examine the aeration system in the plant and how the young leaves function…The job of the young leaves is to absorb the air when the wind blows, and that of old leaves is to release the air to the outside. The working system in this inhalation and exhalation system is exceedingly complex.

As water evaporates from leaves of this kind, the leaves’ temperature falls. Since wind increases evaporation, the temperature of the leaf thus falls even further—a process that becomes even more effective in strong winds. However, this cooling is not felt to the same extent in all parts of the leaf. The central regions of the leaf stay warmer than its external surfaces. According to researchers, when this temperature differential is greater than 1 or 2 degrees Celsius, it triggers the oxygen-absorbing process.

The triggering takes place in this way: when the inside of the leaf is magnified, the tissues of young leaves that carry out photosynthesis can be seen, along with very small pores leading to the loosely packed tissues underneath them. When the dimensions of these pores reach 0.7 micrometers (1 micrometer equals one millionth of a meter), and when the temperature in the leaf rises above 1 or 2 degrees Celsius, gasses begin to flow from the cold region in the leaf to the warmer region. In this way, oxygen is drawn towards the inside of the plant.

This process is known as *thermo-osmosis*. The greater the temperature differential, the more gas is absorbed into the leaf. For example, the highest level has been measured in the Amazonian lily at 30 liters (8 gallons) of gas an hour.

Thermo-osmosis is based on a physical law known as *Knudsen diffusion.* Under normal conditions, the gasses in two separate sections will pass freely through a porous barrier. However, small pores less than 1 micrometer in size will prevent this passage. Gasses seeking to establish equilibrium in terms of temperature then flow from the cold region to the warmer one. However, small pores less than 1 micrometer in size will prevent this passage.

The thermo-osmosis process draws air inside the plant with such a powerful pressure that gas can sometimes be seen rising from the roots in the form of bubbles. This inhalation/ exhalation phase is completed by gasses being released by the old leaves. These old leaves no longer carry air inside them. Because their pores have widened more than necessary, they can no longer hold onto the gasses, which thus depart to the outside.

As you see, every feature of a plant is of vital importance, and clearly each one has been calculated and designed to serve a specific purpose.

This aeration system is not only important in terms of keeping underwater roots alive, but also ecologically. Sediments that accumulate at the bottom of deep water generally are poor in oxygen. They therefore harbor anaerobic bacteria that produce gasses such as iron hydroxide that are harmful to plants. But water plants neutralize these gasses by oxidizing them with the oxygen that they release from their roots. Thanks to this oxygen leakage, the soil around their roots becomes suitable for living things to live in, and thus the bottom of the lake or river is cleansed. This constitutes part of the complex system that directly affects the entire ecosystem on Earth and allows life to survive.

As you have seen, there are flawlessly inter-related systems in even the smallest details of creation. Each of these details shows those who can reflect the magnificence of the omniscient Allah's creation:

It is He Who made the Earth a cradle for you and threaded pathways for you through it and sent down water from the sky by which We have brought forth various different types of plants. Eat and pasture your cattle. Certainly there are Signs in that for people of sound intellect. (Surah Ta-Ha: 53-54)

Leaves That Are Impervious to the Cold

Much of the Northern Hemisphere is covered with forests. These forests, generally consisting of coniferous trees, are generally exposed to cold climatic conditions. In order for plants to be able to withstand this climate, they need to possess characteristics different from those of other species. For example, in winter, the roots cannot absorb water from the frozen soil. Trees living under these conditions—evergreens especially—have to be able to withstand this winter drought. This resistance is provided by the leaves of these evergreen conifers, which are frequently hard and strong. These leaves' waxy surface reduces water loss by way of evaporation, and that prevents the leaves from falling or withering due to lack of internal water pressure. In addition, most of these needle-shaped coniferous leaves are well able to withstand freezing.

Just considering this point alone—that the leaves' wax-like coating substance prevents them from suffering water loss—will show clear proofs of creation.

Like all living things, leaves are made up of cells. Like all other cells, the cells that comprise a plant's leaves are unconscious and unthinking. The waxy covering on the leaves is also generated by unconscious cells. Yet the leaf seems varnished from the outside, possessing a smooth, waxy layer that looks as if it had been brushed on.

The millions of cells comprising the leaf must therefore have decided to come together to cover the leaf's external surface with this waxy layer. They must then have covered the leaf in a protective layer by working together in the greatest harmony and with enormous care. Any rational person considering this will ask the following questions:

How did the unconscious cells that comprise the leaf come to think of producing this waxy layer?

With what intelligence, information and ability did they so carefully cover the leaf surface, leaving no roughness, spillage or uncovered places?

How do the leaves know that this waxy layer will protect them from the cold?

There is of course only one answer to these questions. The leaf, and the cells that comprise it, have been created by Allah, and all the information necessary has been written in these cells' genetic programs by Allah. In the light of these data, cells produce a waxy substance with an ideal formula, and secrete it in ideal proportions. Thus the surface of the leaf comes to be covered in a completely smooth waxy layer. Unlike those trees that shed their leaves in autumn, these evergreen plants increase their energy by opening new leaves every spring. When the air becomes warm enough, they can perform photosynthesis and concentrate their energy resources for the short summer months.

Another point to be considered is the vertical cone shape assumed by coniferous trees. This, like every other detail in nature, has been specially created.

In the world of architecture and civil engineering, and especially in the construction of roofs, one of the most crucial points that needs to kept in mind is the weight of fallen snow. Roofs that under normal conditions bear merely their own weight and that of the wind are exposed to much heavier weights in the event of heavy snowfall.

In designing industrial structures and bridges in particular, the effect of any snow loads has to be included in the calculations. For that reason, roofs are typically constructed by giving them a special peaked angle, and load-bearing systems are reinforced by adding in the possible snowfall. In countries such as Sweden, Denmark and Norway, which lie covered in snow for a large part of the winter, almost all house roofs are peaked and are built bearing these engineering calculations in mind. Otherwise, the weight of the snow would cause severe damage to the roof and possibly collapse the building.

When you examine the shapes of coniferous trees, you'll see that these trees have already taken the precautionary measures against the weight of snow taken by engineers using mathematical calculations. The angle formed by the tree's conical shape permits the snow falling onto the tree to slide off easily. That means excessive snow does not collect on the tree, and its branches are prevented from breaking. To whom does this intelligence belong, that calculates the effect of the weight of snow on the branches, and that ensures that the branches grow at just the right angle to reduce the snow load to a minimum?

- To the tree?
- To the cells that comprise the tree?
- To the soil?
- Or to random, blind coincidences?

It is of course Allah Who bestows this design on the tree and creates the entire tree, its cells and the soil from nothing.

There is yet another marvelous aspect to this design. The tree's shape does not shed all the snow that falls on it. It permits enough snow not to pose a weighty danger to the branches to remain on them. This serves another purpose. The small amount of snow remaining on the twigs acts as a protective covering against the cold and prevents further water loss by reducing the amount of moisture leaving the needles.

As can be seen from the examples given so far, there are plants particular to every kind of environment. Thanks to the features they possess, these plants protect themselves against extreme heat or cold and can live in all types of environment, from arid to moist. Each of the methods these plants employ is especially designed according to the characteristics of their particular environment, and the superior design employed, as a method by one plant bears no resemblance to the ones used by any other. For example, while the cactus protects itself with thorns, stone plants use the camouflage technique. Coniferous trees do not shed their leaves, while others shed them in autumn. The list of examples could be greatly extended.

Of the more than 500,000 different types of plants in the world, about half of these are flowering plants, and not even 10% of these plants have so far been studied in detail. Of those that have, each one possesses its own unique characteristics, astounding designs and methods of survival. With this variety of different structures plants display Allah's infinite knowledge and artistry. In one verse it is stated that:

It is Allah Who created the heavens with no support—you can see them—and cast firmly embedded mountains on the earth so that it would not move under you, and scattered about in it creatures of every kind. And We send down water from the sky and make every generous species grow in it. (Surah Luqman:10)

Creeper Leaves

Climbing and creeper plants have been equipped with many astonishing features. In particular, climbing plants use part of their energy to form the modified leaves known as *tendrils*, which are a complete marvel of design.

Tendrils are elongated tentacle-like structures that are sensitive to touch. They can extend outwards like arms, and literally seek out objects that can support the plant's growing shoots. When they encounter such an object, they first analyze its stability by touch and begin to encircle it if they consider it suitable.

Many books about biology, zoology or botany refer to plant or an animal as "analyzing," "examining," or "understanding" something. Yet plants and most animals are totally devoid of any ability to analyze, understand, or decide anything at all. That being so, how do tendrils analyze an object? By what intelligence and information do they know whether or not something is worth clinging to? It is the plant's cells carry out this analysis. How do cells, too small to be seen with the naked eye and lacking brains, information and reason, feel the need to analyze things? And then, what equipment and what measures do they employ? Each of these questions shows that Allah has created every living thing with the characteristics it requires, and that it lives in accordance with Allah's commandments.

Recently it was discovered, though only partially, why tendrils perform this astonishing activity. Tendril-bearing vines generally live in thickly forested regions, and climb to reach the sunlight so that they can photosynthesize and grow, reaching greater heights than the plants that support them and thus absorbing more sunlight. This both increases their energy intake and also permits their flowers to be fertilized under more advantageous conditions.[18]

These plants have different methods of climbing specially created for that task. A climber's simplest method is to wind itself around a support. This support may be the stem of another plant or other long, solid body. The way that a tip of a vine circles as it lengthens is due to the effect of this twining process. The mechanisms produced by the different chemicals and organic structures inside the plant permit it to perceive light, gravity, touch and heat. Again thanks to these same mechanisms, the plant reacts, generally in the form of growth.

The way that a shoot grows with circular bends takes place under the effect of this touch. As soon as it touches a support it makes a growth move in the opposite direction to the surface it comes into contact with. That is because the surface the shoot leads it to fold inwards. Thus the shoot begins to grow by winding around the support. Moreover, it grows longer and faster from the first corner it touches. Growth is so rapid that it can even be noticed by the naked eye after just a few hours.

The plant employs a most intelligent method. If it were to grow straight up without clinging to a tree, within a few meters it would be unable to bear its own weight and would bend and fall back to earth. The only way for it to reach greater heights without breaking is to have its weight borne by winding itself around some support. So how does the plant know this? Furthermore, plants all over the world have been growing in just that way, for millions of years, always finding something to wrap themselves around. The way that every vine use this ideal behavior is clearly a miraculous property that these plants have possessed since their original creation.

When a vine's growth around another body is examined through time-lapse photography, one can perceive a very conscious and aware type of trial-and-error behavior. Because of these characteristics, vines have been the subject of myth and legend since the very earliest historical times. A plant must impress human beings if it remains fixed in the ground, unseeing and unhearing, yet examines its surroundings by spreading out its tendrils, becomes acquainted with those surroundings by touch, and makes use of their most available supports. People who saw plants carrying out such apparently conscious behavior believed that inside the plant there must exist some intelligent and conscious entity that controlled the actions of these tendrils and shoots—and made up stories and myths about these plants to explain their observations.

Indeed, it's still astonishing how an unconscious plant can examine its surroundings as if it could actually feel them, and then decide to cling onto a nearby surface. These plants' sense of touch is so powerful that researchers investigating *Bryonia dioica*, a species of wild squash, discovered that the plant's small touch-sensitive structures were actually more sensitive than the human fingertip.[19] Therefore, who causes the plant to engage in such conscious behavior? The answer is evident: it is Allah Who designs the plant, arranges all its actions and mechanisms, and has created it with His infinite knowledge.

Carnivorous Leaves

A carnivorous plant is one that attracts creatures such as insects that catches, kills and then allows its prey to decay, absorbing those nutrients that will be useful. The leaves of carnivorous plants can be shaped like pouches, funnels, ewers, or even tacos. They can trap insects, serve as homes for them, or else store water.

Many plants implement variations on these strategies. For instance, some plants attract creatures such as insects and birds to help fertilize them. Other plants, such as the orchid and the water lily, trap such fertilizing insects for a short space of time, without actually consuming them. They use these insects solely for pollination, but are not carnivorous plants, because they let these animals go free.

Carnivorous plants use their modified leaves for capturing prey. One of the most interesting of these plants is *Dischidia rafflesiana*. Though not regarded as totally carnivorous, this plant implements some of the methods employed by truly carnivorous

plants. Large colonies of ants nest in its pitcher-shaped leaves; the plant feeds them and uses the nitrogen it obtains from the ants' waste products as a nutrient. The ants both enjoy a ready-made nest and also keep the plant free of any harmful organisms. Moreover, the rainwater *Dischidia* collects in its sacs is absorbed by supplementary roots on the inner surface of each sac.[20]

Another truly carnivorous plant, *Pinguicula* (butterwort) trap insects that land on a thready secretion that their slippery, sticky leaves emit.[21] In the secretion, such enzymes as acid phosphatase, protease and lipase enable the insect to be digested by breaking it down.

The sticky leaves of *Drosera* bear long and short hairs that contain a red pigment. An insect that touches the short hairs in the middle of the leaf springs a trap when this signal is transmitted to the long hairs. As if it were the palm of a hand, the leaf folds over the insect, and then digests it.

All plants move to a certain extent, but the movements of carnivorous plants occur quickly and efficiently. Since plants lack muscular systems, carnivorous plants manage this by using two separate mechanisms. The first sort of mechanism is seen in the Venus fly trap, which uses a change in water pressure. This system is triggered when the hairs on its leaves are touched: Cells on the inside wall transfer water to the external cells. This forces the leaf to fold over in less than a minute. The second kind of movement is supported by cell development.

The tendrils of the *Sundew* bend inwards towards the prey, because the cells on the outside of the tendrils swell up more than those on the inner. The insects are drawn to the tendrils by the scent emitted by substances secreted on the end of the tendrils and get trapped by a sticky "dewy" substance there. When the trap goes into action, the longer tendrils on the outside close like a cage over the shorter ones in the middle, trapping the insect inside. The insect is then digested by means of various enzymes inside the "dew."

What does it mean, for a plant to prepare a special trap to catch insects for fertilizer? First of all, how does a plant sense the need to supply itself with nitrogen by developing such an unfamiliar means of trapping insects?

Evolutionists maintain that carnivorous plants acquired this characteristic as the result of natural phenomena that took place by chance. But what kind of chance event can endow a plant with hair-trigger leaves and the enzymes it needs to digest an insect? Furthermore, every carnivorous plant has entirely different characteristics appropriate to the habitat in which it lives. Therefore, *Drosera*, for example would need to have evolved through specific stages before becoming an efficient insect-trapper. It would first have to identify the insects and flies hovering around it and then determine which scents and smells attracted them, their anatomical structures and how they might be digested. Later still, it would need to explore a means to trap these fast-moving creatures where they settle.

But then it would encounter an even greater difficulty: The plant would need to radically alter its own chemical and anatomical structure in line with the data it obtained. In other words, the plant would need pigments to change its color and new secretions to alter its scent. In addition, it would also have to design a trap from which the fly could not escape after landing on it. After carrying out the requisite advance planning studies it would then have to design, one by one, sticky hairs, a bowl with a slippery surface and a bottom filled with water, a cover to complete the trap and the triggers to set it in motion. It would also have to consider how it could digest the insects' corpses and determine the necessary enzymes for doing so quickly.

Any rational person can see how irrational the above scenario is. Like all other plants, carnivorous species possess no brain nor eyes, mind nor consciousness. Such a complex design cannot be created even by scientific experts working together on the subject, let alone by a mere plant. As is plain to see, this superior design was brought into being by Allah, the Creator Who creates from nothing, with His infinite knowledge and might.

Not even the most intelligent beings on Earth can create anything without a previous model. Artists paint and scientists draw on what already exists. Yet our Almighty Lord creates with no previous model before Him. This is set out in a verse from the Qur'an:

The Originator of the heavens and earth. When He decides on something, He just says to it, "Be!" and it is. (Surat al-Baqara: 117)

The Leaves We Eat

Contrary to what most people think, providing the necessary oxygen for life is not the only function of leaves. A significant part of what we eat, drink and inhale is also produced by leaves. The vegetables whose leaves and stalks we eat and the beverages with various aromas and flavors, steeped from dried leaves that we drink are important parts of our daily diets. In addition to being a food source containing vitamins such as C, A, thiamine, niacin, and folic acid, leafy vegetables offer varying amounts of minerals such as calcium, phosphorus, iron, sodium and potassium. Enriched with the fiber in their structure, and containing little fat and few calories, vegetables are specially created for a healthy human diet. That is why doctors regard the consumption of fruit and vegetables as essential for good health. As blessings created for human beings, many of the plants found in nature contain substances used in the treatment of various ailments, from headaches to cancer.

Some 20 amino acids serve as building blocks in the human body. The body is unable to synthesize eight of these on its own, for which reason they have to be absorbed through the foods we eat. All vegetables contain these amino acids in varying degrees. With their structures specially created for the human body, these plants have no side effects and do no harm when consumed properly. They merely bestow health and meet our dietary needs.

The leaves we eat every day, the flowers that adorn our tables and delight us with their appearance, have been specially designed, both in terms of shape and flavor. The rich leaves in vegetables such as cabbage (*Brassica oleracea*), for example, retain their freshness for long periods. Even if the outer leaves wilt, it takes a long time for the inner ones to do so. There are large quantities of calcium and Vitamins A, C, B_1, B_2 and B_{12} in such plants. In addition they contain carbohydrate, cellulose, protein and useful salts that are essential for human body also they are low in calories.[22]

Another example of the healthful leaves that we eat is spinach, which contains high levels of Vitamins A, B_1, B_2, C and K, substances such as proteins and cellulose, and large quantities of iron.[23] No matter which vegetable one takes as an example—chard, purslane, lettuce, artichoke, cauliflower or broccoli—all are marvels of design with their shapes, ease of cultivation and nutrient-storage capacity. In addition, each one is a nutritional blessing with its characteristic flavors and contents that have been specially created for human beings.

Along with these vegetables we eat, there are also leaves we use to add flavors to whatever we eat and drink. A large number of these leaves serve as special natural medicines created for us by Allah. For instance, parsley is one of these, rich in vitamins, especially Vitamin C. Thyme is another scented dried leaf which has been used very often against various ailments and infectious diseases since very ancient times.

Modern research has shown that thyme is an antiseptic, whose oil is a powerful germ killer. Thyme oil, known as thymol, is widely employed in the manufacture of drugs. In addition to its other nutritional properties, thyme is used in the treatment of flu, colds and angina, as well as improving the appetites of sick children and as a restorative for convalescents.[24]

There are so many therapeutic herbs—including bay, basil, tarragon, dill, marjoram and mint—that encyclopedias on the subject mention more than a thousand varieties of such plants and their superior properties. These plants, which are recently being re-evaluated, are being used in the search for cures for a variety of diseases from cancer to rheumatism, from skin disorders to hoarseness.

Leaves whose teas we drink, such as sage, camomile and bergamot, are among these plants used not just for their taste, but for their therapeutic health-giving properties. For example, sage has the Latin name of *Salvia salvatrix*, or life-saving herb. This plant, used as an antiseptic, soothes and prevents night sweats, flu, nervous disorders and tension.[25]

Plants' health-giving properties are the clearest evidence that Allah created them as a blessing for human beings. The fact that a nutrient can be eaten; stores substances that benefit only human beings; can be grown abundantly, widely and easily enough to serve all

of mankind, who need not labor too hard to enjoy all its benefits are some of Allah's great miracles. In the Qur'an, Allah reveals this blessing to thinking people:

It is He Who created you. Yet among you are those who are disbeliever and those who are believer. Allah sees what you do. He created the heavens and the earth with truth and formed you, giving you the best of forms. And He is your final destination. He knows everything in the heavens and earth. He knows what you keep secret and what you divulge. Allah knows what the heart contains. (Surat at-Taghabun: 2-4)

The Leaves We Smell
The Chemistry of Smell

What is the source of the pleasant smells of the herbs we eat, the flowers in our gardens, fruit and vegetables, and the greenery we consume? Scents have many effects on human nature, such as inspiring pleasant feelings, comforting people and improving their appetite. The smells created as great blessings for mankind are complex chemical compounds. Every scent consists of elements brought together in specific quantities. The substances that give plants their distinctive scents are known as *essential oils* and are commonly referred to by the name of the plant they come from, such as oil of roses, or oil of thyme.

Young plants produce more oils than old ones, although old plants contain more resin and thicker oils. After light fluids have evaporated, even at low temperatures, what remains is concentrated oils that do not evaporate so easily.

Research has not yet uncovered all the natural functions of these oils in plants, but it is generally agreed that they are used to attract insects. Plant oils are also used by humans to make fragrances, cosmetics, soap and detergents, and in food and flavorings.

Oils form in the green parts of plants and are carried to other tissues, particularly to the shoots and flowers, as the plant matures. When we examine how these oils come into being, we are amazed at the complex, sensitive nature of the system involved. Research has determined that plants' scent-production varies according to species, as well as season, temperature and light, and some 100 chemical compounds are employed during the process. It is thought that plants also have unique compounds that have not yet been studied, in addition to those already identified.

These compounds are manufactured in ways the likes of which can be found only in chemical laboratories. The sap transports various chemical substances to secretory glands near the rind, where these substances are combined in specific quantities by enzymes, through a mechanism which has not yet been fully understood, and different perfumes result. In other words, the secretory glands work just like chemical factories, combining different compounds. And with these chemical combinations, they give rise to the delightful aromas of the rose, linden and honeysuckle. This is a great miracle. At present, chemical engineers who manufacture perfumes, deodorants and soap scents in advanced laboratories are trying to produce delightful fragrances by imitating these same glands. Human beings possessed of reason, consciousness, education and technology seek to produce something of beauty by imitating the product of a secretory gland composed of unconscious molecules. Yet despite all their superior characteristics, no man-made scent can have the same attractive quality as the originals and can go no further than being a "good imitation" of the aromas of plants.

These scents later blend with the air by being released from the leaf surface through channels linked to the secretory tissues. Special cells undertake this function on the upper

surfaces of rose, lily and lilac plants. In lavender, these cells are distributed all over the plant. Plants use very fine and sensitive secretory hairs to disseminate these perfumes. Cells at the tips of these hairs emit a fluid mixture of oil and resin that evaporates easily. When we add the internal secretory cells, secretory sacs and secretory channels to this system, we are looking at an astonishing design all squeezed into a tiny leaf. The dissemination of the plant's perfume into the air is a great miracle and source of enormous pleasure for human beings. When you enter a garden the delightful fragrance you encounter reaches you thanks to this impeccable design in the leaves. Were it not for this order in leaves, flowers could not be able to give off their scents, which would remain locked inside them.

So to whom do the power, intellect and artistry belong that tell plants to emit these fragrances and that design them in that manner? All of these sublime attributes are the work of our Lord, the infinitely compassionate and merciful.

During the production of scent, the most accurate calculations apply. Molecules with the most highly complex structures are produced during the course of this process. For instance, the Spanish jasmine (*Jasminum grandiflorum*), makes use of 10 different compounds to produce its fragrance. The rose family uses between three and 10 compounds in scent production. The white freesia (*Freesia alba*) and the water lily (*Nelumbo nucifera*) use 10 and six, respectively. The honeysuckle (*Lonicera periclymenum*) that blossoms in gardens in June uses six different chemical compounds. These chemical compounds, shown in the table overleaf, that we have difficulty in even reading, are used as a perfume and chemical formula separately by every plant, in areas too small to be seen with the naked eye. However, everywhere in the world, the same plants have been producing the same scents ever since the moment they were first created. Roses on one side of the world still smell the same as they do over on the other.

The way that plants combine some atoms, produce compounds and manufacture their fragrances as a result is a great miracle. And everywhere in the world, roses combine the same atoms to manufacture the same perfume. The slightest variation in the compound they produce, a difference of even one atom, can completely alter or even eliminate that perfume. However, they never make a mistake in the formula concerned. So who bestows this consciousness, intelligence and information, possessed only by chemical engineers on plants? Could plants all over the world have come into possession of these formulae by coincidence?

Plants have no senses with which to determine whether the fragrances they produce are attractive or effective. Neither do they possess the intelligence or the means to set up a chemical laboratory to produce perfume in a volume just a thousandth of a cubic millimeter in size. The plant's cells produce the compounds that give rise to scent. In other words, certain unconscious atoms use other atoms, just as chemical engineers do, to manufacture the world's most delightful perfumes. These atoms seem to know the characteristics of other atoms around them, the quantities in which they need to be combined, and the kind of scent they will eventually obtain, also know the environmental conditions essential for the

dissemination of those scents and which living creatures will be affected by it. Indeed, they also know the entire chemical structure of the living creature they aim to attract, and thus prepare compounds that match its scent perception.

A great many plants possess these perfume laboratories. Although the world's plants are operating millions of scent laboratories, they never make a mistake while preparing chemical compounds. Therefore, one can obtain the same scent from the same flowers anywhere in the world. It is impossible for chance to account for perfect fragrances being produced by complex formulae carried out by unconscious atoms, or the aesthetic significance of the perfumes that result. Scent and the systems that produce it have been specially designed and created by Allah. In addition to all the many fragrances, the living things that detect these scents and their perceptual systems have all been created in harmony with one another. The countless fruits in the world, bananas, oranges and apples—and flowers such as the rose, tulip, gardenia and oleander that entrance us with their delightful fragrances—are all the result of this miracle.

These scents, present everywhere in the plant's leaves, blossoms, stems, roots, rhizomes and fruits, not only entrance the human soul, but also serve to attract insects for pollination, maintaining temperature and preventing water loss.

Another aspect of these fragrances, created with infinite knowledge and artistry, is the human body's response to them. Delightful perfumes have been created in harmony with our scent-perception system.

Smell and Memory

Smells can bring memories back to life—a frequent phenomenon. When a human being smells something, molecules belonging to that odor have entered the nose. Scent molecules are transported through the air at even quite low temperatures. A light wind will carry these scent molecules to the back of the nose, where they encounter a moist tissue consisting of some 5 million cells known as neurons that detect smell.

Receptors—tiny protrusions, at the end of each one of these cells—traps scent molecules. These sensors are linked to the cell interior. When a scent molecule lands on this trap, it sends a series of signals, and the requisite message thus passes from inside the cell to the olfactory center at the base of the brain, all in less than a second. These signals then leave there and head for the limbic system of the brain thought to be responsible for sensation and motivation.[26]

We can then determine what this resulting smell actually belongs to, and whether it's pleasant or not. Attractive smells lead to senses of pleasure. A familiar smell immediately stimulates memories regarding its source. For example, when you smell a lemon, you may think of lemonade you drank years ago, or upon smelling spices, a delicious holiday meal

[26] "A word about chemistry," http://www.icr.org/goodsci/bot-9709.htm.

may come to mind. The perfume of a flower may cause one to remember the same flower in the garden of an entirely different city many years before. Plants are unaware of the consequences that may arise from chemicals or chemical compounds. Therefore, in the same way that they lack the means to decide to build the necessary facilities to manufacture these scents, they also lack the sensory organs or nerves with which to decide whether a smell is pleasant or otherwise. Also they don't know how scent perception works in human beings. It is clear each of these is the work of Allah, Lord of infinite knowledge and artistry, Who creates all things to be compatible with one another. Allah, Who created all scents and the organs that perceive them, has also created the human soul in such a way as to be affected by them.

Leaves and the Golden Ratio

When we look at the plants and trees around us, we see that their branches are covered in large numbers of leaves and in season, flowers. Looking at them from a distance, we might imagine that these branches and leaves are arranged haphazardly, at random. The fact is, however, that where the branches emerge from the stem or trunk, the sequence of the leaves on those branches and even the symmetric shapes of flowers are all established beforehand by means of fixed laws and miraculous measures. Plants have been implementing these laws to the letter ever since the day they were first created. In other words, no leaf or flower comes into being by coincidence.

Approximately how many branches a tree will have, where they will emerge, how many leaves there will be on a branch and the way these will be arranged are all determined beforehand. In addition, every plant has its own rules regarding branching and leaf order. Scientists can describe and classify plants solely in terms of these characteristic sequences. The extraordinary thing is that a poplar in China, for example, is aware of the same measures and rules as a willow in England, and implements them in the same way. Of course, it is not chance that creates these mathematical calculations unique to each plant, and in the most aesthetic manner. It is Omniscient Allah Who creates this beauty and this design with flawless calculation.

As is revealed in the Qur'an:

He to Whom the kingdom of the heavens and the earth belongs. He does not have a son and He has no partner in the Kingdom. He created everything and determined it most exactly. (Surat al-Furqan:2)

These sequences, which vary according to each variety of plant, may be circular or spiral. One of the most important consequences of this special arrangement is the way that one leaf does not cast shade on any other. The order in the arrangement of the leaves around the stem is set out in specific numbers according to what in botany is known as *leaf divergence*. This sequence in leaves is based on a complex calculation. If *N* is the number of turns from one leaf around the stem until we come to another leaf on the same plane, and if

P is the number of leaves on each turn, then *P/N* is referred to as *leaf divergence*. These levels are ½ in grasses, 1/3 in marsh plants, 2/5 in fruit trees (for example, apples), 3/8 in species of bananas, and 5/13 in bulbous plants.[27]

The way that every tree from the same species implements the ratio set out for its own species is a great miracle. How, for example, does a banana tree know about this ratio and act upon it? According to this calculation, when you start from one leaf and take 8 turns around it, you will come to another leaf on the same plane. And you will encounter three leaves on these turns. Wherever you may go, from South Africa to Latin America, the ratio will remain the same. Just this ratio in the arrangement of leaves is significant evidence that living things did not come into existence by coincidence, but that they were created in line with an exceedingly complex calculation, plan and design. It is Allah, the Lord of sublime knowledge and wisdom Who encodes such a ratio in the genetic make-up of living things and creates this information and feature for them.

One of the most frequently encountered arrangements in trees is pairs of leaves and branches that emerge exactly opposite one another. After the seed sprouts, it opens up two rudimentary leaves, which leaves are set out 180 degrees opposite one another. The two leaves that sprout above these first two also grow opposite one another and at right angles to the first pair, for the greatest possible distribution between them. In this way, there are now four leaves spaced every 90 degrees on the stalk. In other words, if we look at this branch from above, we see that the leaves are so arranged as to constitute a square, and that the upper leaves thus do not shade the lower two.[28]

This is a sight we are quite familiar with. However, most people never think about why it is that seeds germinate up in this way. The fact is, however, that this is the result of planning and design. The aim behind it is to prevent leaves from shading one another and to enable them all to make maximum use of sunlight.

The more complex spiral form is also often to be seen. To observe this spiral action in plants, tie a thread to the base of one leaf and then extend the thread to the branches and knots, make a loop around the base of every leaf you come to, and keep the curves as regular as possible. Using this method, you will see that each leaf on an elm or lime tree is 180 degrees away from the neighbouring leaf on the branch; thus the thread will turn halfway round the branch for every next leaf. Leaves on beech trees are set 120 degrees apart, with 1/3 turns per leaf. The ratio for apple trees are 144 degrees and 2/5 turns, and for black pine, 5/13 turns. If you have an interest in mathematics, you will see that these exact figures cannot be the work of chance, and that each unit is the total of those preceding it (as shown below). Each two numbers exhibit the same simple calculation: 1, 1, 2 (1+1), 3 (1+2), 5 (2+3), 8 (3+5), 13 (5+8), 21 (8+13), 34 (13+21), 55 (21+34), 89 (34+55), 144 (55+89), 233 (89+144), 377 (144+233), and so on.[29]

This special progression is known as a *Fibonacci series*, named after the mathematician Fibonacci who discovered it. This rule embodies aesthetic perfection, and is

used as a basic measure in such disciplines as painting, sculpture and architecture. This same sequence is frequently encountered in nature, and serves as an important key to understanding the fine calculation and design in plants.

Ratios beyond 3/8 can be found in seaweed, cabbage, or in the arrangements of seeds on the head of a sunflower, which go in spirals in both directions. The florets of these plants turn in spirals as they circle around the center from right or left, and the number of seeds per turn in the spirals is determined according to the Fibonacci series. For example, the center of a daisy uses three consecutive fractions: 13/34, 21/55 and 34/89. In other words, the number of florets in each rotation around the center, and the angles involved, are all determined beforehand.[30] The Fibonacci series appears very frequently in nature. The fractions produced using these numbers give us what is known as the *Golden ratio.* In other words, when we write down the consecutive fractions in the Fibonacci numbers, as shown below, the divisions that result possess this Golden ratio, signifying complete aesthetic perfection: 1/1, 1/2, 2/3, 3/5, 5/8, 8/13, 13/21, 21/34, 34/55, 55/89 . . . .

As we have seen, the sequence obtained by this means matches the consecutive numbers in the Fibonacci series. We see this sequencing in pine cones (5/8, 8/13), on pineapples (8/13), in the centers of daisies (21/34) and in sunflowers (21/34, 34/55, 55/89) in the numbers of righthand and lefthand spirals. The ratios emerging as a result imparts aesthetic beauty to flowers, trees, seeds, sea shells and a great many other living things in nature.

The place occupied in nature by the Golden ratio is by no means limited to this, but also manifests itself in the ideal leaf angles. As we know, plant leaves are arranged to make the maximum use of solar rays. For example, the angle between the leaves in a plant with a 2/5 leaf divergence is:

2 x 360 degrees / 5 = 144 degrees.[31]

There are more numerical miracles in leaves. The surfaces of leaves also have designs that can be understood as the result of specific mathematical calculations. The vein from the center of a leaf (or midrib), and the smaller vessels extending from it to the outer edges of the leaf, and the tissues in between that are nourished by these, all endow the leaf with a distinctive shape and structure. Although leaves come in countless different shapes, they still preserve these same precise measurements.

The fact that leaves are arranged and shaped according to specific mathematical formulae is one of the most convincing proofs that they have been specially designed. The sensitive measurements and balance we see in a plant's molecules and in its DNA also appear in the plant's external appearance. In addition to providing such vital functions as receiving maximum benefit from sunlight, these formulae bestow great beauty on the plant, and present an extraordinary picture when combined with the colors resulting from combinations of specific arrangements of molecules. This Golden Ratio is an aesthetic rule

well known to and used by artists. Works of art produced in line with it possess an aesthetic appeal. The plants, flowers and leaves designed in accordance with this rule—in turn, imitated by human artists—are all examples of Allah's sublime creative artistry.

Allah reveals in the Qur'an that He has created all things to a measure. Some of the relevant verses are:

As for the Earth, We stretched it out and cast firmly embedded mountains in it and made everything grow in due proportion on it. (Surat al-Hijr:19)

. . . Allah has appointed a measure for all things. (Surat at-Talaq: 3)

. . . Everything has its measure with Him. (Surat ar-Ra'd: 8)

. . . Allah takes account of everything. (Surat an-Nisa': 86)

What Happens Within the Leaf?

As we have seen in the previous examples, the leaf is a marvel of design created with a sublime knowledge and artistry. If you were to magnify any leaf, no thicker than a few millimeters, to the size of a factory, and if you were able to walk around inside it, then you would be amazed at what you saw there. For example, in a small parsley leaf you would perceive a highly advanced network stretching right throughout it, centers that produce and store more than 20 different chemical substances, energy transformers that constantly convert solar energy into sugar, solar collectors that initiate this process, air conditioning centers, a very powerful security and communications system, and a giant chemical facility containing many sections, many of whose functions are still unknown to scientists.

It is impossible to stop the cells at work there and obtain information from them. That is because the "workers" consist of substances such as fats, carbohydrates and water and have no mouths to speak with, nor brains to understand what we are saying, nor the time to answer our questions. What is obvious at first sight is that this system, its workers, and all the materials and products used in the system are the work of a sublime intellect and knowledge.

Plants have no central nervous system, much less a brain with which to control it. Each part of the plant therefore develops independently of every other; yet every component exhibits unbelievable compatibility and co-operation. It is still not known how the cells inside the plant communicate or how they come to give rise to different tissues. The chain of instructions that emerges as these different structures are created continues to preserve its secrets.[32]

Cells are the basic elements of leaves' flawless design. In fact, when we refer to the properties and activities of a plant, we are actually referring to the properties and activities of its cells. These cells that will constitute the plant begin to form its different tissues when the right time comes. Some of them combine to form leaves and veins, others constitute the woody inner structure that holds the stems erect, and others the green chlorophyll that carries out the chemical processes. Every tissue has a specific design, function and structure. The new organs that emerge as a result of this division of labor among the cells become the components of a new design that complement one another. The process by which the same cells turn into different structures, serving different purposes—which takes place in all living things—is some of the most important evidence of a superior design.

The tissue that constitute the leaves have been designed in such a way as to collect the maximum amount of sunlight, to withstand external damage of all kinds, and to perform the most processes with the fewest materials. In addition, although most leaves are no

[32] Paul Simons, "The Secret Feelings of Plants," *New Scientist*, Vol 136, No: 1843, 17 October 1992, p. 29.

thicker than a sheet of paper, they have been equipped with structures that protect the millions of special cells inside them and control the complex and heavy traffic taking place there.

Let us now have a closer look at some of these tissues:

The Sections in Leaves

***Upper and lower epidermis*:** These two cell layers form a waxy protective tissue. These layers, which constitute the outermost part of the leaf, possess a very different structure produced by special cells forming a waterproof layer over the leaf, top and bottom. Excessive water loss is thus prevented. Excess sunlight is reflected. Thanks to this tissue, when the pores of the plant close, the plant is able to conserve air and fluids. The epidermis is completely transparent.

Mesophyll: This tissue consists of two layers of cells that carry out photosynthesis. The *palisade mesophyll* consists of column-shaped or rod-like cells, and the *spongy mesophyll*, of spherical ones. These cells contain the chlorophylls, which are the facilities that enable photosynthesis. In addition, they also contain structures for various other functions.

Air cavities lie between both spongy and rod-like cells (the soft inner tissue of the leaf). The cavities in the spongy mesophyll are larger and closer to the air holes known as the *stomata*. However, this arrangement is not coincidental. In this way, since their need for carbon dioxide is greater, compared to the palisade mesophyll, the spongy mesophyll receives more of the carbon dioxide.

Pores (stomata) are small holes in the lower surface of the leaf. A few plants also have pores on the upper surfaces of their leaves. These pores are one of the leaves' special components. Like windows that connect the leaf to the outside world, they supervise the gasses that enter the leaf from the air, the vapor that emerges from the leaf, and the pressure inside it. With their other functions and the observer cells that ensure their opening and closing, they are marvels of design.

When a tree wants to receive more or less air, it uses these pores in the surface of its leaves, particularly the underside, which it can adjust like nostrils. These large numbers of microscopic openings are too small to be seen with the naked eye. Each of these is controlled by a pair of guard cells, automatically stimulated in conditions such as moisture, light and heat. When the weather is very hot and dry, the pores remain only ajar, but when moisture increases, the guard cells begin to open. In cold and rainy weather, the pores open up entirely; thus there is more moisture for the chloroplast to evaporate in. By the help of the solar light, the chloroplast obtains the carbon dioxide it needs by absorbing the carbon dioxide through the pores.

There may be 100 to 300 pores in 1 square millimeter of leaf surface, and the total number of pores in the whole leaf may reach millions. Every one of these millions of windows is opened and closed by cells acting independently.[33]Bearing in mind that human beings have communications and decision-making mechanisms for systems of this kind, the astonishing nature of what an ordinary cell does, not being controlled from any one single place, can be better understood.

The oxygen manufactured as a byproduct during photosynthesis can be emitted by the leaf only through an open stoma. Considerable water loss is also experienced during this exchange of gasses. The stomas that cover 1% of the leaf surface are responsible for 90% of the water it loses. On hot days, cotton plants, for example, lose around 400 liters of water an hour. Other environmental factors also affect the stomas' opening and closing. When the water level in the leaf drops below the critical point, the stoma closes in order to prevent the remaining water from evaporating. When the guard cells controlling the stoma absorb potassium ions, water enters the cells and causes them to swell, and thus the stoma opens. When potassium leaves the cell, water again leaves the cell and the stoma closes. This system is regulated and directed by a hormone known as *abscisic acid*, depending on the level of water in the leaf.[34]

Although most plants have stoma that open in the daytime and close at night, those of some species —such as cacti or pineapple that live in hot, dry climates—close in the daytime and open at night. These plants absorb carbon dioxide at night and transform it into 4-carbon acid. In the daytime, when the stomata are closed, carbon dioxide exits the acid and is immediately used in photosynthesis. This process is known as *crassulacean acid metabolism*, and such plants are called "CAM plants."[35] When only the stoma between the leaf sections are examined, an amazing design can be seen. This unit is not just a sentry at the gate, but a security mechanism capable of deciding on its own, which monitors the internal and external environment and an emergency exit with a complete awareness of the entire plant.

Venous groups: The veins passing through the middle of the leaf are known as midribs. These and other veins that branch off from them to cover the leaf surface are made up of venous groups. The *xylem* is a woody tissue that performs very important functions inside the leaf, depending on the various duties required by the entire plant. This tissue acts like the veins in our own bodies, functioning primarily in the transport of water, ions, and soluble food substances throughout the plant.[36] The distribution of these veins in the plant and leaves is not haphazard. Every vein in every leaf has a specific design and form.

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[33] "Cell Types of the Epidermis," http://www.rrz.uni-hamburg.de/biologie/b_online/e05/05a.htm.
[34] "Mechanism and Regulation of Stomata Movements," http://www.rrz.uni-hamburg.de/biologie/b_online/e32/32f.htm#aba.
[35] http://botany.about.com/science/botany/library/weekly/aa020498b.htm.

Enabling the leaf to remain stiff and upright, these veins comply with specific physical formulae for the functions they undertake.

Phloem (the tube-like part of the vein tissues): These pipes bring the organic nutrients such as amino acids to the leaf and also carry the sugared liquid back down the stem of the leaf. Glucose, produced by photosynthesis, is turned into saccharose (sucrose) which is carried to the other parts of the plant via the phloem, or else is transformed into starch and stored.[37]

The vacuole is a plant's treasure chest. This cell, or vacuole, is attached to the cell by a thin membrane and filled with a watery mixture. This fluid is generally mildly acidic and consists of dissolved atmospheric gasses; organic acids, sugars; pigments; oils that constitute the source of perfumes and aromatic fragrances, glycosides that are used in medicines; alkaloids known for their toxic properties; crystals; mineral acid salts; tannins (mainly seen in the tea leaf)' flavones which give flowers and fruits their blue, purple, yellow and violet hues; and much else besides. All these substances wait inside a vacuole too small to be seen with the naked eye, which can be seen only under an electron microscope, for when they can be of service to come. When the vacuole is full, it puts pressure on the cell wall, and enables the plant as a whole to stand upright by pushing the cytoplasm towards the cell walls.

Grass-like plants, which lack thick cell walls and any mechanical support such as a woody stem, use this internal pressure in order to remain upright; and the plants wilt if they are unable to do this. At the same time, the vacuole regulates the cell's angle of incline towards the light and the degree of moisture necessary for various reactions.[38]

How do substances in the vacuole come together to be stored without becoming mixed up with one another? For example, if you were to fill a bowl with perfumes, oils, alcohols, sugared water, dyes of various kinds, liquid rubber and salt water, they would soon mix with one another. This would take place even faster if these substances were confined under pressure. If we then tried to remove them when we needed these materials individually, we would never obtain any results at all. We would need to resort to a refining process in a chemical laboratory in order to make these substances useable once more. Yet vacuoles have been performing this complex process, without any mistakes, since the day they were first created.

When it is time for flowers to assume their colors or to produce a fragrance, they extract perfumes and send them to the requisite locations in the amounts needed. The vacuoles that carry out these processes in a flawless manner consist, like the other cells, of elements like carbon, hydrogen and oxygen, and are structures that can be seen only under the microscope. Although these cells work like storekeepers, they actually possess none of the attributes a human storekeeper does. They behave as if they knew what products they will accept, where they will place them, where these products come from and where they

will go, but they actually have no organs with which to see or have any knowledge of them. To put it another way, we cannot plant a tree in front of a warehouse where we keep valuable substances and make it responsible for the comings and goings of the merchandise. The vacuole is an unconscious component of this unconscious plant, too small to be seen with the naked eye, yet it carries out all these jobs not of its own will or with its own intelligence, but automatically, in the way inspired in it by Allah.

In addition to those just listed, many other structures perform different tasks inside the leaf. Every one of them possesses very complex structures. As we shall soon see, these systems that come together inside a thin leaf create photosynthesis, a most important function for life, and thus make the planet habitable. In conclusion, no matter what part of the leaf we look at, we are still dealing with a delicate component of a special structure designed for a particular purpose. There is no tissue in that design that does not serve a purpose or have a specific job to do. Various different systems, each with its own task, combine together in harmony for a common purpose.

This magnificent machine that works on its own, uses air and water as fuel, whose only aim is to produce nourishment, which can produce copies of itself under all conditions and in all environments in addition to having vitally important fragrance, color and shape, is the work of a sublime artistry—an example of the infinite knowledge and astonishing artistry of Allah.

Evolutionist Illogicalities

As you have seen, a plant contains complex mechanisms squeezed into spaces just millimeters in size. All these complex systems have been working in the same impeccable manner in plants for millions of years. So how have these systems been compressed into such a minute space? How the complex design in leaves come into existence? Can such a perfect and matchless design possibly have arisen spontaneously?

One theory regarding the formation of leaves proposed by evolutionists is the "Telome theory," according to which leaves are the result of separate structures belonging to so-called primitive veined plants coming together and flattening out.[39] However, the extraordinarily complex system in the structure of just one of the many trillions of leaves on Earth is sufficient to demonstrate the illogicality of this claim. Furthermore, this groundless theory can be totally undermined by just a few simple questions. For example:

Why did these branches feel the need to join together and flatten out?

As a result of what process did this combining-and-flattening take place?

By what kind of coincidences did branches turn into leaves that are completely different in their structure and design?

How did thousands of species of plants, trees, flowers and grasses emerge from these alleged primitive veined plants?

Why was any biological need for such a variety?

How did these so-called primitive veined plants come into being in the first place?

No evolutionist has so far been able to provide any logical, scientific answer to even one of these questions.

Some who realized the quandary this theory was in have proposed a new, but illogical, theory regarding the origin of plants. As always, they gave their claim a Latin name to give it a scientific aura: the "Enation Theory." According to these evolutionists who refuse to accept the fact of creation, leaves evolved from nodules along plant stems.[40]

Let us now examine this claim by asking a few more questions:

How did a structure emerge in such a way as to give rise to a leaf in specific sites on the stem?

How did they subsequently turn into leaves? Moreover, how did they turn into countless varieties of leaves, each with its flawless structures?

To go back a little, how did these branches and the stems themselves come into being?

Could the complex mechanisms that caused these nodules to develop into leaves in some species and into flowers in others themselves be the product of coincidence?

As on every other similar question, evolutionists are unable to come up with any explanation other than imaginary scenarios of how plants came into existence.

In essence, what evolutionists are basically suggesting by both theories is this: Plants emerged as the result of coincidence phenomena. Nodules turned into branches by chance. Then another chance event took place, and chlorophyll happened to come into being inside the chloroplast. The layers in the leaves emerged through another coincidence. Chance events followed on one another's heels and finally leaves, with their exceptionally special and flawless structures, came into being.

The fact that all these structures, which are claimed to have emerged by chance, must have done so at the same time is another point that cannot be ignored. Since the structure and systems in leaves are all inter-related and dependent upon one another, the emergence of just one as the result of coincidence would be quite useless, because the system will not

function if some elements of it are missing. Therefore, plants could not wait for the missing components to be completed by accident, and would thus die off and become extinct. Therefore, in order for the plant to survive, all its complex systems—roots, branches and leaves—would have to be present at the same time.

According to the theory of evolution, organs that are not used become "vestigial" and disappear. As we have seen, this rule clearly conflicts with evolutionists' own claims of the components comprising living things coming into being gradually through consecutive small coincidences.

Even if we assume that a few parts of a complex system did not function until all the components were complete, but nevertheless did actually emerge at the beginning, there is still no question of their waiting for the other components to develop with the help of "fortunate" coincidences.

That is because any components or organs that existed before all the others came into being would serve no purpose at all on their own and would be eliminated as "vestigial."

Therefore, to claim that any complex system in living things came about by means of small, consecutive coincidences is a violation of both logic and science, but it also contradicts the laws set out by evolutionists themselves! That being so, we are left with a second alternative: All the complex structures and systems in living things emerged fully formed, flawless and complete in a single moment. That means that they were created by Almighty and Omniscient Allah.

As with every living thing on Earth, totally flawless systems have been constructed in plants, and have come down to the present day with no changes whatsoever. All their features, from the shedding of old leaves to the way they seek the Sun, from their green color to the woody structure in their stalks, from the existence of their roots to the emergence of fruits, are all quite matchless. It is impossible for present-day technology to produce better, or even similar, systems such as the process of photosynthesis.

The Senses in Plants

When we examine any plant closely, we encounter the most fascinating systems. One of the most important of these is plants' reaction mechanisms. Though plants have no nervous systems, they can still be more sensitive than human beings in terms of certain senses. Plants do not possess eyes like ours, but can see more than we do because they possess proteins consisting of light-sensitive compounds. Thanks to that, they can perceive those wavelengths we can see and those we cannot—their sensitivity to light is greater than that of the human eye.[41]

Plants use this ability to determine such conditions as light intensity, quality, direction and duration—all essential for their growth and survival. A plant's daily life

regulation is under the control of an internal clock. In terms of a scientific explanation of what is taking place, there are two protein groups in the plant charged with seeing light. One of these two is the *phytochrome*, which comes in five varieties, and the other is the *cryptochrome*, which comes in two varieties. These proteins are also receptors capable of reacting to light. Thus they are also responsible for adjusting the plant's internal clock according to the changes brought about by the light at every moment.[42]

Plants do not live by sunlight alone; they have no taste buds with which to sample the nutrients they need, yet their roots must still do this in order to absorb minerals and nutrients from the soil. Research into the plant known as *Arabidopsis* (cress) has revealed that a gene identifies areas in the soil rich in nitrate and ammonium salts. Thanks to this gene, the roots grow in the direction of nourishment, rather than haphazardly. This gene that identifies nitrates is known as ANR1.[43]

Apart from this gene, another study at Texas University discovered a new enzyme known as *apyrase*, found on the root surface, which is capable of tasting the ATP (adenosine triphosphate) produced by micro-organisms such as fungi in the soil. The ATP molecule is a short-term energy reserve that is ever ready in nature. Apyrase permits the plant to absorb ATP and turn it into phosphate nutrients.[44] The way that plants collect and use extracellular ATP is a newly discovered miracle.

Like taste, the sense of touch is another perception frequently encountered in plants. Carnivorous plants such as the Venus fly trap (*Dionaea muscipula*) immediately trap the insects that land on them. The mimosa plant (*Mimosa pudica*) can lower its thin leaflets at even the slightest touch. Climbing plants such as peas and beans wind their sprouts around solid supports, thanks to their sensitive sense of touch. Latest research has shown that nearly all plants possess this sense of touch,[45] which they generally use against strong winds that could seriously damage their leaves. Plants exposed to the wind react by hardening their tissues and thus avoid being broken by it.

Researchers are still trying to establish how the sense of pressure leads to the production of reinforced tissues. According to the most popular theory, when the plant is shaken, calcium ions pass from the vacuoles that act as chemical depots to the cellular fluid. The flow of calcium is the first action to take place when the plant moves or is touched. This movement takes place in as short a space of time as one-tenth of a second. The flow of calcium ions subsequently acts on the genes concerned with the strengthening of the cell walls, and the region touched then grows thicker as the result of an exceedingly complex process.[46]

The way that a plant possesses all the features it needs to survive thanks to exceedingly complex systems is sufficient evidence that not even a single leaf could possibly come into being by coincidence. Plant cells are tiny entities with no awareness or information, too small to be seen with the naked eye. These entities cannot wonder how to

escape the effects of the wind and then develop appropriate measures. Furthermore, this system consists of components that set one another in motion, rather like a domino effect. Cells cannot produce this system of their own will, nor can coincidences create such a flawless plan and design. All these things are some of the proofs of the existence of Almighty and Omniscient Allah.

As a result of research performed in various centers, especially North Carolina Wake Forest University, it is also thought that plants can perceive specific wave frequencies or vibrations. For example, one experiment carried out at Wake Forest observed that the normal sprouting level of 20% in radish seeds rose to 80%-90% when they were exposed to sound at a specific frequency for long periods of time. Researchers think that *giberelic acid*, the plant hormone that acts as a vehicle in seed sprouting and shoot elongation is also responsible for sensing sound vibrations.[47]

Another point that must not be forgotten is that plants have no nervous system. When you touch or taste an object various chains of communication take place in your brain and nervous system. The decision for a conscious action is taken when memory will enter the equation. Yet though plants have no nervous system or memory, they still display very conscious reactions. They turn in a specific direction as if they could see sunlight, find the best foundations for their roots as if they could touch, and select the most beneficial substances for themselves from the soil as if they could taste. The apparent conscious intelligence behind this behavior belongs not, of course, to plants themselves, but to Allah, Who created them with a sublime intelligence.

An Intelligent Defense System

Plants resort to various means in order to protect themselves. They use thorns and shells in mechanical defense, and when these arms are not effective, they also employ special methods against potential enemies. Plants produce poisons or chemical weapons with an unpleasant taste. The best example of these is the superior defense system in nettles. The chemicals acetylcholine and histamine are brought together through a marvelous mechanism in *injection hairs,* located at strategic points. When these plants are touched, their hairs inject a painful fluid.[48]

Biochemists have determined that there are more than 10,000 varieties of the toxin known as alkaloid in 300 different plant families. Since it is inefficient to store these chemicals in their very small volumes, many plants produce chemicals such as alkaloid, phenol and terpene only when they actually need them. These chemicals have very powerful effects; and dopamine, serotonin and acetylcholine have very close structural similarities to the nervous transmitters in the human nervous system. A great many drugs used to reduce aches and pains due to illness or surgery are derived from these substances.[49]

It may not be too astonishing for a chemical engineer or a pharmacist to produce different drugs by combining certain chemicals, because a human being possesses

intelligence and consciousness, and moreover, can receive years of pharmaceutical training. In addition, he may have a fully equipped chemical laboratory at his disposal. It is, however, astonishing for a plant that emerges out of the soil to produce chemical substances in its own tissues, with no external intervention. Moreover, every plant produces a chemical suited to its own structure and purposes at the appropriate time, and only when it needs to. There is intelligence, consciousness, will, instant decision-making and technical knowledge in this behavior. And plants have been doing this for billions of years, since before there were any human beings or any technology at all. So what power gives plants emerging from the soil these abilities and equips them with these extraordinary properties? On its own, every piece of information we learn about plants is enough to show us the existence, might and infinite knowledge of Allah. And mankind is still learning about these living creations of the infinite knowledge of Allah.

Researchers have recently discovered a new chemical group known as *jasmonates*, responsible for transmitting alarm signals to other sections of the plant. This signal-transmission system works in a manner similar to that in mammals: When damage occurs in one region, the production is initiated of chemicals that set in motion different reactions in other parts of the body.[50] For example, the tobacco plant protects itself by means of the rather toxic chemical nicotine. Any attack initiates the production of the messenger chemical jasmonic acid. Alternatively, when a caterpillar begins eating, the leaf produces more jasmonic acid, which initiates nicotine production. The nicotine produced is dispatched to the edge of the leaf, and even the most stubborn aggressors are forced to give way as the level of the chemical rises. Some leaves are able to engage in enough production to carry 120 milligrams of nicotine for every gram of leaf tissue—an amount greater than that contained in 100 unfiltered cigarettes.[51]

Some plants identify which caterpillar is eating them by reacting to the secretions they give off and make the appropriate response to the species of caterpillar concerned. Maize, cotton and sugar beet leaves call in help from the outside against the beet armyworm (*Spodoptera exigua*). The alarm signal they emit is the work of a superior intelligence. When the leaves detect the substance known as *volicitin* in the insect's saliva, they give off the soluble compounds indole and terpene: These scents mix with the air and attract wasps (*Cotesia marginiventris*) that hunt parasites. Or when a leaf is damaged, it emits a substance known as *methyl jasmonate*, produced by the defense genes. Neighboring leaves then detect this substance and begin producing other chemicals that will halt the insects' attack, or else attract predators. For example, whenever any of the leaves of the horse bean (*Vicia faba*) are damaged, the neighboring leaves begin to emit compounds that attract predatory insects that feed on leaf mites. In this way they rid themselves of enemies by calling in assistance from the outside.[52]

This stage prompts a number of questions we need to ask ourselves. How can a plant realize that its leaves are being eaten by insects? How can it distinguish these insects'—or other plants'—secretions from among thousands of chemical compounds? How does it

know of the other insects that will prey on these, and which specific scents will attract them —or that these scents will reach those insects by being carried by the wind? Moreover, how can the plant be sure that the insects it calls on will help, and not harm it? These plants have been flawlessly implementing the same defense system for millions of years, since the moment they were first created. Of course, plants themselves have no consciousness or intelligence with which to organize any such complex process in such an ordered, immaculate way, to calculate and plan or to manufacture the necessary chemicals. A plant cannot recognize the caterpillars or insects that eat it. It does not even have the intelligence to know what a scent it. It is clear that the plant has no consciousness-related properties such as understanding or recognizing anything. Certainly, all these attributes have been created and bestowed on the plants by Almighty Allah.

The Fascinating Movements of Leaves

As you saw in the preceding section, plants have been equipped with systems that perceive light, pressure, and flavors, as if they were human beings. When these senses are considered one by one, they can be seen to possess a perfect design. The various movement, growth and defense mechanisms that emerge as a result of these systems in the plant exhibit important evidence of creation.

Plants attached to the soil by their roots are not completely motionless. Mechanisms within the plant not yet been fully understood permit it to react in line with its needs. Plants display movements in order to reach light, water and nutrients, as if they see without eyes and touch without hands. Each reaction has its own particular system and design. Special enzymes, hormones and tissues control these systems, designed to provide maximum development.

One of the main factors that influences plants' movement is their sensitivity to light. The light sensitivity in sprouts, known as *phototropism* (turning towards the light), is akin to the special sensitivity to visible light in the human eye. As in all sensory systems, the first phenomenon to take place is the perception of the stimulus. The only way for light to be perceived is its absorption by pigments. The energy obtained during the absorption process is turned into chemical energy, to be used later to operate other systems. The light-sensitive system in the plant sprout consists of two phases: in the first phase, mechanisms turn the light into electrical and chemical signals. In the second response phase, the systems needed for the growth of the shoot are activated, and the plant turns in the direction of the light.[53]

Plant Movements

Plants move in different ways under different conditions. All movements, however, are controlled by hormones such as auxin, gibberellin and cytokinin. The way in which these substances work has not yet been fully understood. In summary, plant growth movements are as follows:

Orientation (tropism): Reactions to stimuli such as light, gravity, touch and water.

Bending: In leaves or flowers is a form of movement that arises as a result of the motion of the Sun, day length, or swelling (turgor) caused by the pressure of touch.

Morphogenetic reactions are changes that take place in plant tissue in reaction to length of daylight.

Photoperiodism: Changes taking place in response to light duration and the length of day or night.[54]

Geotropism: The lengthening, downward movement of the plant's main taproots in the direction of gravity.

Thigmotropism: A reaction to being touched. As we have already seen in some detail, plants display electrical and chemical reactions to external stimuli. In addition, they also exhibit a tendency to bend toward any support touching them. Creepers such as the Passionflower are examples of this.[55]

Hydrotropism: Plant roots' turning in the direction of water. In soil where water is not abundant, plant roots extend towards lower layers in an exploratory manner.[56]

Every organ in a plant rooted upright in the earth moves in a different direction, in accord with need—an extraordinary state of affairs. Scientists still cannot explain by what decision the different tissues of a plant move in different directions. The above-ground portions of a plant, for instance, turn towards the light. But the main root, as described above, extends downwards under the effect of gravity. Sprouts, on the other hand, head upward, opposite to gravity. It's as if there was polarization inside the plant.[57] Even the very smallest portion of the plant has knowledge of what part should develop in which direction. For instance, even if you plant a branch upside down, roots will still begin sprouting from the downward end.[58] In other words, as the roots of a plant always head downwards, so its sprouts always grow up. If planted in such a way that the sprouting shoot that grows upwards is buried underground, then no rooting will occur. Polarization, which is implemented in every plant, has determined the direction of growth without interruption, ever since the day they were first created. Yet there is no decision-making mechanism in plants, no molecules that are more intelligent or better informed than any others and are capable of imposing their will on the rest. No atom goes to any central body and receives commands regarding the direction in which it will carry out growth. In the same way that some cells constitute leaves, others flowers and still others a branch, they follow a previously determined order when it comes to their direction of growth. Therefore, wherever in the world we plant a particular species, it will have the same shape and taste. Every plant has been behaving in the same way, inspired by the laws of Allah, since the day it was first created.

Like all their other characteristics, plants' movements take place thanks to mechanisms designed for them in an ideal manner. Clearly, it cannot be the unconscious molecules comprising the plant that give rise to these mechanisms. No atom can think of a plant's roots growing in the direction of water, or of shoots growing in the direction of the light. These systems, the workings of which scientists are only now learning in the 21st century, have been discharging their duties, without fail, in the body of every plant for millions of years, in line with Allah's creation.

Turgor Movements

Turgor pressure arises with the pressure on the cell walls from the water that collects inside. This water pressure acts to make the cells rigid and permits the plant to hold itself upright. That is why plants that are not watered wither and droop. Some plant movements that take place in response to a specific stimulus are the result of a loss of this turgid pressure in the leaf.

The sensitive plants fade very quickly. When touched, their leaves suddenly wither. The moment a leaf is stroked, the stimulus travels around the whole plant until all the leaves do so. Both electrical and chemical processes are involved in this mechanism. Under the leaves, there are supporting extensions rather resembling cushions known as the *pulvinus.* When a leaf receives stimulus from a touch, heat or wind, a chain reaction begins in which potassium ions travel from one pulvinus to the next. This is followed by a very fast contraction movement initiated by the water molecules in the *parenchyma* cells in one half of the pulvinus traveling towards the other. This movement leads to a loss of water pressure, and thus to the bending of the entire leaf. The whole process takes place in a matter of seconds.[59]

This pressure variation is used in the system employed in the closing of the traps of some carnivorous plants.[60] Intercellular pressure serves just as important a function in plants as muscles do in the human body. Water raised by special channels in the tree stem, using an astonishing mechanism, up to the leaves at the very tops of trees many meters high fills cavities left empty for it. Since the leaf is covered in a waxy substance and its pores open only when pressure is at a particular level, the leaf's cells swell like balloons. This dynamic system, which in the human body must use dozens of tissues, nerves and fibers, has been designed in the plant using organs planned in line with hydraulic pressure. Fibers that absorb water from the roots—in a manner that has still not been fully unraveled but in a way similar to an air- pressure tank--xylem and phloem that carry liquids to all parts of the plant, organs adapted to the moisture in the air and soil, cells that store the water in the leaves or use it for photosynthesis—all give rise to the portions of a stupendous design.

This system has been working in the same way since the first plant was created. A plant cannot survive in the absence of a single feature belonging to this system. Therefore, no plant can have evolved in stages, as evolutionists claim. All this shows that each plant was designed and created as a whole, together with all its parts, structures and cells.

Communication in Plants

A relationship in the different branches of the same tree—one that had not previously been recognized—recently attracted botanists' attention. When the top part of a pine tree is cut off, for example, it was observed that the side branches immediately underneath the cut bend upwards as if to compensate for the missing branches and begin to grow straight up within a few growth seasons. These limbs, which had previously been lateral branches, allow one or more of the branches to grow to replace the upright trunk of the pine tree. As if they knew that they had been chosen for the purpose, the branches thus selected grow toward a position in the middle of the others, where they can dominate and assume a central position. But how do the other branches know that these one or two branches have been selected to replace the top of the pine tree?

The questions of how the "main" branch is selected, and why and how the other branches abide by this choice, continue to preoccupy scientists. The only thing they can be certain of is that there is a kind of partnership among the branches.[61]

In fact, there is a partnership not just among the branches, but in the entire organism —as in the distribution of tasks inside the tree. If in spring you cut off the branch of a willow and plant in wet soil, it will produce roots and new shoots. This is not just an organism, but also organization. The plant cells literally know from which lower region the roots need to emerge, and the same for the buds that form the shoots. Even a small portion of the tree behaves as if it knew all the details regarding the tree as a whole.

Research into plants has permitted a most important miracle to be perceived. There is a communications system among the unconscious cells of the plant. Just like the cells of humans and animals, plant cells communicate with one another and thus display mass behavior.

Hormones

A hormone is a kind of protein that regulates essential systems in living things. Various hormones are produced in plant cells—miraculous molecules that have been created to determine how the plant should behave under good and adverse conditions.

For example, if new shoots are enjoying good light and air, but the roots endure a dry environment with plentiful sunlight but little water, then the plant requires a deeper, stronger taproot. So perfect is the system inside the plant that the requisite measures are immediately taken. The plant's cells increase the production of a hormone known as *auxin* which, upon reaching the root cells, commands them to divide and multiply. Thus new roots are produced.[62]

How do the cells that produce the hormone *auxin* know that the roots right at the bottom of the plant need to grow longer? How do they learn the chemical formulae that will enable this to happen? And why do the root cells obey this hormone's commands?

The way that unconscious plant cells communicate with one another is a great miracle of creation.

Hormones have assumed duties inside the plant, as if they were managers responsible for running a factory. Molecules too small to be seen by the naked eye resolve with great expertise such complex questions as "Where should the sugar be carried? Where from? Which leaf will grow old and drop off, and which new ones need to be nourished? How long should the branches grow? Is it the accurate time to bloom?"

One of the 50 important varieties of hormone is *gibberellin*, which controls branch growth. The hormone *cytokinin* acts on a more distant part of the plant than does the hormone auxin. While auxin acts on the roots, cytokinin influences the plant's buds. It is agreed that this hormone is responsible for the shape of the bud.[63] An unconscious molecule produced by unconscious plant cells is regarded as "responsible" for the production of buds created with infinite wisdom!

The really astonishing property of these hormones, which manage all the stages of photosynthesis, is that although they are not linked to any central system, they behave in a seemingly conscious manner, as if they received intelligent instructions from a single source.

The Miracle Called Auxin

Within a few years, a tiny seed planted in the ground becomes a bush and then a tree the size of a human being, and within decades becomes a giant plane tree. So what ensures the growth of the tree and its regular and beautiful development?

Responsibility for the growth of an unthinking plant has been entrusted to another unconscious entity, the hormone *auxin*. Therefore, the most auxin is found in the developing regions of the plant. Auxin behaves with an astonishing awareness, establishing growth by directing the branches upward towards the light (phototropism), against the force of gravity, and the roots downward in the same direction as gravity. Cell division, the variety and distribution of cells according to specific tasks, fruit growth, root development from cut areas and leaf shedding are among auxin's other responsibilities. The hormone auxin plays a key role in many aspects of plant growth and development, and with its mysterious chemical structure has been the focus of interest for researchers.

What controls this hormone, which acts like a decision-making center in the growth of the plant and controls in which direction it will grow? Researchers seeking an answer to this question have found themselves facing an insoluble problem. Another question is why all the components of the plant obey this hormone. In fact, the existence of such a perfect decision-making and implementing mechanism within the plant, the like of which can only be encountered in a disciplined army, proves one single truth: Like other living things,

plants have submitted to a single Creator, from their leaves to their roots. This fact is revealed in the Qur'an:

. . . There is no creature He does not hold by the forelock. My Lord is on a Straight Path. (Surah Hud: 56)

Everyone in heaven and earth prostrates to Allah willingly or unwillingly, as do their shadows in the morning and the evening. (Surat ar-Ra'd:15)

THE COLORS OF AUTUMN

With the coming of autumn, we witness a most interesting phenomenon. Trees' green leaves change color in a matter of a few days. Shortly afterward, all the leaves fall off and the tree branches are left bare. The tree now appears lifeless until the return of spring, because all vital functions have now been reduced to a minimum. Leaf shedding and regeneration, which reminds one of human death and of resurrection after death, as stated in a verse, is a transition during which several miraculous events take place. Allah reveals this in the Qur'an:

He brings forth the living from the dead and brings forth the dead from the living and brings the earth to life after it was dead. In the same way you too will be brought forth. (Surat ar-Rum:19)

Before finally dying and dropping off the twig, a leaf undergoes various stages. A great many chemical compounds combine together and put different systems into action to separate the leaf's stem from where it grew. No substance is wasted as this occurs, and leaf shedding becomes a very beneficial process for both the plant and its surroundings. Not only do autumn leaves remind us of death and resurrection, they also once again reveal the infinite knowledge and might of Allah.

How Leaves Become Colored

We do not pay much attention to the green color of leaves in the summer; but when autumn comes, we suddenly become aware of color change. As leaves change their colors and fall from the trees, we find ourselves faced by the brightest of pictures. Bright green trees turn yellow, red, and brown within a few short days. But what causes this color change, and why do leaves fall from the trees?

All leaves, be they yellow, red, purple or green, are colored by the various pigments they contain. The best-known among plant pigments is without doubt chlorophyll, which gives leaves their characteristic green color and also plays a very important role in photosynthesis, as you have seen throughout this book. In moderate climates, leaves begin to change color with the coming of autumn. The yellows, oranges, reds and finally browns that replace the green in leaves are the product of the yellow and orange pigment *carotene*. A pigment called *anthocyanin* also plays a part. Together, these three pigments give leaves and summer flowers their colors.

The green of chlorophyll in leaves is so strong that it masks the existing yellows and oranges of the leaves. Before plants shed their leaves in the fall, they re-absorb the useful substances contained in them. One of the consequences of this is that chlorophyll begins to break down. Since chlorophyll no longer predominates at this stage, the yellow and orange pigments, which had not been apparent before, now begin to be seen.

When leaves come to the end of their life spans, the pigment anthocyanin starts to increase, turning some leaves from their normal green to a light reddish-purple. Anthocyanin pigments vary from red to purple, and the red, blue and purple regions of a plant are entirely their responsibility. When temperatures are low and plants are exposed to extremely bright light, a great many of them tend to increase their anthocyanin levels. That is why the color red increases in many plants in autumn. These pigments generally turn color, from yellow to orange and red. In addition to weather conditions, color change in autumn is to a large extent related to the individual plant species. The strikingly beautiful scenes we see in autumn are thus the work of these pigments.[64]

Leaf Shedding

Is there any benefit to the falling of the leaves?

Millions of leaves fall every year, and reappear with the coming of spring. At first sight, it might appear as if all these leaves fall to earth for nothing. Yet this is a misconception, because the fall of leaves occupies an important place in the ecological system. Nothing has been created for no reason. Whichever system or living thing we examine, we find a purpose and wisdom in its creation. Falling leaves are also a part of this perfect system. The largest falling leaves replenish the soil with nutrients. In addition, falling leaves help with the retention and absorption of rain by forming a humus layer on the forest floor, and many tiny living things find shelter under them. Finally, fallen leaves become a source of food for many organisms living in forests.

Every year, as the leaves fall, some 300 million tons of chlorophyll enter the soil worldwide. Every year, 900 million tons of chlorophyll are broken down in the seas, since seaweeds and algae containing chlorophyll have short life spans. Were it not for this annual loss of chlorophyll, the consequences would be disastrous. Increasing levels of chlorophyll would lead to seaweeds and algae cells able to use less sunlight. As a result, cells would receive insufficient quantities of light, resulting in less photosynthesis. Life would come to an end in the oceans, and thus in the whole world.

One of the most interesting phenomena that take place in leaves about to be shed is the exceedingly purposeful break-down/separation process. Before the leaf falls, useable substances such as protein and carbohydrate are stored in the branches or stems of the plant. Thus the leaf that is due to fall does not take these substances with it, and an important part of the materials necessary to form leaves in the future is retained. As can be seen from these examples, it is ecologically essential for the survival of life on Earth for chlorophyll to be eliminated at the correct time and for the substances a plant needs to be stored inside while it goes dormant. One of the first signs of aging in leaves is that the cells in the base of the leaves beginning to produce the gas ethylene. Shortly afterwards, the ethylene spreads to all

[64] "Leaves of green, yellow & red," http://botany.about.com/science/botany/library/weekly/aa120797.htm.

parts of the leaf, and when it reaches the leaf stalk, small cells where the leaf stem joins to the main body of the plant, the small cells here begin to swell up, leading to a tension in the stem. The number of cells in the section where the leaf is bound to the stem raises and they begin to produce special enzymes. First of all, cellulose enzymes break down membranes consisting of cellulose, then pectinase enzymes break down the pectin layer that binds the cells together. The leaf becomes unable to withstand this increasing weakness, and the stalk starts to separate from the body of the plant.

Long before the leaf falls, a detachment zone forms where the leaf stem joins the main body. The membranes of special impermeable tissue cells known as the *parenchyma* begin to soften and assume a jelly-like state by passing through various chemical changes. This causes the cells to divide from one another. The leaf is soon joined to the plant's main body only by vessels that permit only fluids to pass through. Very rapid changes take place around the fissure as it continues to widen, and the cells begin to produce some kind of fungus essence. This substance gradually places itself in the cellulose in the membrane and stiffens it. All the cells producing fungus essence die, leaving a large empty space behind them. As a result, the leaf breaks off in a light breeze. However, at this point a layer of fungus develops to cover the leaf scar that has opened. These physical and chemical changes are a very carefully planned process that takes place not just in one leaf but in all of them. This system has been created to ensure that leaves fall off when the proper time comes.

PHOTOSYNTHESIS

Photosynthesis is an extraordinary chemical process that should be closely examined by anyone eager to bear closer witness to the infinite knowledge and might of Allah. Photosynthesis is a matchless process that scientists have still not fully understood today. We can never see this process with the naked eye because this mechanism uses electrons, atoms and molecules to function. However, we can appreciate the oxygen given off by the process that permits us to breathe, and see its results in the foods that enable us to survive. Photosynthesis is a system built on hard-to-understand chemical formulae and delicate balances involving units, numbers, sizes and weights the like of which few people have ever encountered before. Trillions of miniaturized chemical laboratories in which this process takes place have been established in all the green plants around us and have been producing the oxygen nutrients and energy that we need, non-stop, for millions of years.

Closer examination of the magnificent design of photosynthesis will afford a closer knowledge of one of the most important proofs of creation. Let's have a closer look at this process that takes place in a space to small to be seen with the naked eye.

The Vital Importance of Photosynthesis to Life on Earth

Before examining how photosynthesis works, we need to understand just how important this process is for life on Earth. Let us consider the results of this process:

Photosynthesis and oxygen

In carrying out photosynthesis, plants absorb the carbon dioxide in the air (CO_2), a gas that human beings cannot use, and break it down into oxygen (O_2). Oxygen, which we take into our lungs when we inhale and which is essential to life, is the main product of photosynthesis. Some 30% of the oxygen in the atmosphere is produced by terrestrial plants, and the remaining 70% by single-celled algae and marine plants also capable of photosynthesis. The striking thing here is that while human beings continually destroy plants on land, they are unable to eliminate those in the oceans—their main source of oxygen—at the same rate. The fact that different living things capable of photosynthesis have been created allows us to possess a source of oxygen that is never completely decimated.

Photosynthesis and nutrients

We humans receive all the nourishment we need either directly from plants or else from herbivorous animals. Sunlight is simply a source of energy; but its raw form is not that practical. It is impossible to consume this energy, or to use it or store it directly in the body. Therefore, solar energy needs to be converted into another, usable form of energy—which is what photosynthesis does. By means of this process, plants turn solar energy into a stored form they can use at some later time. Using solar energy, the *photosynthetic reaction*

centers in leaves converts the carbon dioxide in the air into starch and other high-energy carbohydrates. The O_2 released after carbon dioxide has been used is released into the atmosphere. When the plant later requires energy, it uses the energy it has stored in these carbohydrates. Living things that feed on these plants, in turn, meet their own energy needs through the carbohydrates stored in them, by way of photosynthesis.

As we shall be seeing, photosynthesis is an exceedingly complex process. The fact that all living things acquire the food they need to live as a result of such a complex process is the work of the infinite knowledge and wisdom of Allah:

O humanity! Remember Allah's blessing to you. Is there any creator other than Allah providing for you from heaven and earth? There is no Allah but Him. So how have you been perverted? (Surah Fatir: 3)

Photosynthesis and energy

Your car engine runs on what was once solar energy. Jet planes fly thanks to what was once solar energy. You are using what was once solar energy even as you read these lines.

The first thing that comes into your mind as you read this will be that your car actually runs on gasoline and that jetliners use aviation fuel. You will imagine that you acquired the energy to read these lines from the last meal you ate, not from solar energy. The fact is, however, that both gas and the meals you eat, and even the wood and coal we burn for warmth, all contain energy obtained from the Sun—via photosynthesis. How?

Plants that stored solar energy in their bodies millions of years ago by means of photosynthesis, and animals that ate these plants, gave rise to the petroleum with which we are familiar, underground and under high pressure, after a period of millions of years. Coal and natural gas came into being in the same way. In short, the solar energy stored in plants thanks to photosynthesis was placed at our disposal after millions of years had passed.

Similarly, the energy you obtain from the food you eat is simply the solar energy stored by plants. The energy you obtain from animal foodstuffs is also the energy those animals obtained from plants. The source of energy is always the Sun, and the system that makes this energy useable by human beings is always photosynthesis. You cannot acquire the energy you possess by means of any system other than photosynthesis.

Photosynthesis and side products

Wood is a very important material used not just as fuel but in many fields, including construction. Paper, cotton and other natural fibers, for instance, consist of cellulose produced almost entirely by photosynthesizing plants. Even wool depends on the energy sheep obtain from grass, and photosynthesis. Solar energy, transformed by photosynthesis, is the source of countless vegetable, animal and organic side products.[65]

Photosynthesis and the environment

Living things constantly increase the carbon dioxide in the air and the air temperature. Millions of tons of carbon dioxide are released into the atmosphere every year as a result of the respiration of human beings, animals and micro-organisms in the soil, not to mention burning of fossil fuels. Moreover, the amount of carbon dioxide released into the atmosphere from fuels consumed for heating purposes in factories and homes and used in transport also reaches billions of tons. According to one study, an increase of 42 billion metric tons in the carbon dioxide has been seen in the atmosphere in the last 22 years. One of the main causes of this rise is the fuels consumed and deforestation. The rise in carbon dioxide caused by fuels over the last 22 years is 78 billion metric tons.[66]

Unless this rise is compensated, there will be terrible ecological imbalances. In such an event, the amount of oxygen in the atmosphere will fall to very low levels, and the Earth's temperature will rise, as a result of which the ice caps will melt. Therefore, some low-lying regions will be flooded, while others will turn into deserts, and all life on Earth will be endangered. Yet that will not be the case, because carbon dioxide is constantly consumed and oxygen released in the process of photosynthesis carried out by plants and micro-organisms. Thus the equilibrium in nature can persist. While there has been a rise of 78 billion tons in carbon dioxide caused by fuels, the level remaining in the atmosphere is 42 billion tons. This excess CO_2 is to a large extent cleaned up from the atmosphere by way of photosynthesis and the oceans.

The Earth's temperature is fixed within a specific range. Wide temperature fluctuations do not occur, because green plants also ensure temperature balance.

Photosynthesis ensures the continuity of these balances, which are of such vital importance for life on Earth. Also, there is no other mechanism for the preservation of the level of oxygen in the atmosphere.

In conclusion, it is clear what a great miracle photosynthesis is, and how closely it impacts on our lives. This flawless system was discovered only in the last century. Studying those phases of this mechanism, full of astonishing miracles that have only recently been understood, will increase our appreciation for the infinite knowledge of Allah.

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[66] Sylvia S. Mader, *Inquiry into Life*, William. C. Brown Publishers, 1991, pp. 726-727.

THE MECHANISM OF PHOTOSYNTHESIS

As you know, plants and some bacteria and single-celled organisms use energy from the Sun in order to produce sugar from carbon dioxide and water. As a result of this reaction, the energy in solar rays is stored inside the resulting sugar molecules. Chlorophyll, a green pigment, plays an important role in the conversion of solar energy into useable chemical energy. (Pigment is the name given to substances capable of absorbing light.)

The entire reaction can be summarized in this formula:

$6H_2O + 6CO_2$ ---PHOTOSYNTHESIS---> $C_6H_{12}O_6 + 6O_2$

For those who are unfamiliar with the language of chemistry, this formula may be translated as follows:

6 water molecules + 6 carbon dioxide molecules –as a result of PHOTOSYNTHESIS-- produce 1 sugar molecule + 6 oxygen molecules[67]

This general description appears very simple, but this formula shows only those substances that enter the reaction at the beginning and those that are obtained at the end. The production of these final products is carried out as a result of astonishing and exceedingly complex processes and mechanisms in the leaf.

In order for the carbohydrate molecules we commonly call sugar to be formed from carbon dioxide and water, exceedingly complex and delicate measures and processes must be implemented. These processes involve very complex systems working at the atomic level, and even at the level of the electrons orbiting around them.

In the process, there are a large number of elements, consisting of different pigments, various salts, minerals, trace elements (such as ferredoxin and adenosine triphosphate), sub-catalysts, and other substances and chemicals with various different responsibilities. Bearing in mind that plants need 30 different proteins just to produce a sugar molecule as simple as saccharose, you can see just how complex the entire system is.

Components of the Photosynthesis Process

Chloroplasts: Plant cells and animal cells possess the same general features, but the most important difference between these two is that plant cells also contain a green plastid, the chloroplast, in which it makes photosynthesis. These chloroplasts, which absorb solar light, are the heart of the entire system. With their structures resembling interconnected balloons, chloroplasts give plants their green color.

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[67] "Photosynthesis," http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookPS.html.

In the plant cell, photosynthesis takes place in the chloroplasts, small discs 2 to 10 micrometers thick (a micrometer is 1 millionth of a meter) and 0.003 millimeters (3/1000 millimeter) in diameter. There are around 40 chloroplasts in each cell.[68] Despite being so small, these interesting units are separated from their parent cell by two membranes which themselves are unbelievably thin, just 60 angstroms, or 0.000006 millimeters (about 1/100,000 of a millimeter).The chloroplast contains structures known as the *thylakoids*, which resemble pancakes. These preserve the chlorophyll, photosynthesis's chemical unit, and are protected by thinner membranes. These thylakoids are arranged as discs known as *grana*, which are just 0.0003 millimeters in size, one atop of the other. There are some 40 to 60 of these grana in each chloroplast.[69] All these complex structures consist of proteins and fats that have been brought together for a specific purpose.

Thylakoids: The second component in the chloroplast are these sac-like membranes that contain the green chlorophyll molecules that absorbs sunlight.

Grana: Thylakoids combine together to form grana.

Chlorophyll: The green pigment in the chloroplast that absorbs sunlight.

Stroma lameli: A pipe-like membrane that links the grana in the chloroplast.

Stroma: A jelly-like fluid in the chloroplast.

Photosynthesis and Light

In terms of both its functions and chemical structure, the atmosphere is a perfect covering essential for life. The Sun emits rays of many different wavelengths. Of these, however, only a very narrow range contains the wavelengths of light necessary for life. And here another great miracle is evident: Such is the structure of the atmosphere that it only permits light within the range necessary for life to enter, and all other harmful rays are reflected back. The atmospheric layer responsible for this filtering, of such vital importance for life, is the *ozone layer*, composed of oxygen molecules with the chemical formula O_3. From among all the other 10^{25} wavelengths, the ozone layer absorbs 97-99 percent of the sun's high frequency ultraviolet light which is potentially damaging to life on Earth and admits only light in the visible that are essential for life—a miracle specially designed for us.[70] If the atmosphere did not admit light in that range, or also admitted rays of other wavelengths, then life as we know it on Earth would be impossible. This is just one of the hundreds of thousands of conditions that must be met for life to exist. The fact that all these conditions are flawlessly met means that it is impossible for life to have emerged by chance.

Rays of Different Wavelengths are Perceived as Different Colors

All the colors we see have a specific wavelength and frequency. Red, for example, has a longer wavelength than violet. We can see colors because our eyes have been created

in such a way as to perceive these narrow wavelengths and our brains in such a way as to interpret them.

A wavelength of light is defined by a unit called the *nanometer*—such a small unit that it is impossible for human beings to comprehend, the equivalent of 1 billionth of a meter. For example, the wavelength of red is 770 nanometers, and that of violet, 390 nanometers.[71] These rays also have frequencies, measured in terms of *Hertz*, or number of cycles per second. A cycle is the distance between the top and bottom of a wave. Light travels at 300,000 kilometers/second (186,000 miles/second). If the wavelength is shorter, the photons must travel a greater distance in the same amount of time.

As you can see, the light used by plants possesses a very special structure. This light ——moving at the fastest speed possible—is filtered through a sensitive sieve in the atmosphere, down to a narrow spectrum that we can perceive. In addition, since it moves both as a wave and in the form of particles known as photons, it also causes chemical reactions by striking the atoms that comprise matter.

When light, with its complex structure, travels enormous distances and reaches the plant, it is perceived by a special system, created in such a way as to process light in this very narrow spectrum. If the light had any other speed or frequency then the chlorophyll pigment would be unable to perceive it and the process would come to an end before it had even begun.[72]

The harmony between pigment and light is one of the examples of deliberate creation we frequently encounter. There are countless examples of such harmonious creation, such as the ear and sound waves, the eye and light, and food and the digestive system. Light cannot regulate its own wavelength, nor can the pigment select the wavelength of the light it is to perceive. Clearly, both have been created for this system to work.

The Miracle that Allows us to Live in a Colorful World

All substances, except wholly transparent ones, absorb light, and their colors stem from the wavelength of the light they reflect, and which is not absorbed by the surface in question. Chlorophyll, present in all photosynthetic cells and a variety of pigments, absorbs all visible wavelengths of light except green. This reflected light is what makes leaves appear green. Black substances absorb nearly all the light that falls on them. White pigments, on the other hand, reflect nearly all the wavelengths of light that strike them.

For example, the pigments in plants known as chlorophyll permit the color green to appear and are also where photosynthesis takes place. Pigment molecules are formed by atoms such as carbon, hydrogen, magnesium, oxygen and nitrogen combining together. Considering the properties of chlorophyll, which plays a vital role in the continuation of

life, will afford a better understanding of the sensitive, delicate calculations on which it is constructed.

Organized in groups of 250 to 400, chlorophyll molecules constitute a structure known as the *photosystem*, which carries out vital processes. All the chlorophyll molecules within this system can absorb light, but only one chlorophyll molecule in every photosystem actually uses the chemical energy obtained in this way. The molecule using the energy installs itself in the middle of the photosystem. The other chlorophyll molecules are known as *antenna pigments*, which collect light for the reaction center (that is, "chlorophyll a") by establishing a network around it. When the reaction center receives energy from one of the more than 250 antennae molecules the energy boosts an electron out of place to a higher energy level. In other words, an electron belonging to the "chlorophyll a" moves to one of the other chlorophyll molecules arranged around it. Thus thanks to a chain reaction an electron exchange, photosynthesis begins.[73] Therefore, the organs we call pigments play a vital role in the process of photosynthesis, while these molecules with their very special structure give rise to the green world of plants around us.

Pigments and Unrealistic Evolutionist Scenarios

Visible light, the colors produced by pigments, and our eyes that perceive these millions of hues have all been created through the infinite knowledge and artistry of Allah. The components in this three-part system, which will not function if any one component is missing, are all in perfect harmony.

The material used in the pigments of plants has also been used for the retina, the pigment in the human eye. Yet while the same substance initiates photosynthesis in plants, in the human eye it is responsible for transmitting messages about the image in the eye to the brain. It is extraordinary how a substance consisting of a combination of a few atoms can possess different properties and duties depending on its location.

The retinas are connected to the brain by 600,000 nerves that receive 1.5 million messages, arranges them and sends them on to the optical center at a speed of 500 kilometers/hour (300 miles/hour), at the same time to the brain.[74] Like the complex system in the human eye, the task performed by chlorophyll in plants has a very complex structure. In describing these two systems, evolutionists never raise the fact that every part of the system's complex structure must have been created at the same moment.

According to the classic evolutionist scenario, plants felt the need to make use of solar energy and—in some way—produced pigments. Never forget, these plants had no prior knowledge of any substance such as pigments nor of any system in which they can function. The logical inconsistency in this theory becomes clear when evolutionists' beliefs are actually laid out. According to them, a single-celled organism, needing an energy source for its survival, possessed no awareness or intelligence. Yet somehow it determined that the

Sun is an economical, constant energy source. It later "realized" how it could use this energy and, resolving problems which present-day scientists are still seeking to answer, planned a system to store solar wavelengths as chemical energy. To achieve that goal, it determined solving the wavelengths of the Sun and the chemical formulae that would establish the electron exchange, and then began production by combining specific chemicals in carefully calculated quantities to produce chlorophyll. That is the irrational scenario maintained by evolutionists.

Along with being irrational, this scenario also leads to an impasse in several ways. Recent studies have revealed that plants very definitely did not evolve from a common forerunner. This means that if evolutionists' claims were true, then every species of plant must developed the process of photosynthesis separately, quite independently of the others. This scenario strains the imagination, because it is impossible for even a single organism to acquire, by coincidence such a complex system as photosynthesis, which cannot be replicated with today's advanced technology and level of scientific knowledge. Even though this impossibility is obvious for all to see, evolutionists still maintain that it took place again and again. But as you shall see in due course, the chlorophyll that is such an important component and of the working systems of photosynthesis has such an extraordinary design and structure that it cannot possibly have evolved by coincidence.

The Factors Influencing Photosynthesis

As the following sections will show, photosynthesis is a very complex and delicate process, and every part of the plant has special structures for the task. However, the elements necessary for photosynthesis are not limited to the plant's structure. As you have already seen, the wavelengths of the light that penetrate the atmosphere have been created to be in complete harmony with photosynthesis. However, other factors also have impact on the process.

1. Light Intensity and Duration

Photosynthesis varies depending on the intensity and duration of the light, and whether the light arrives directly or in a diffuse form. There are significant differences between direct sunlight and that filtered or reflected by clouds, fog and other bodies. Direct rays constitute 35% of total light, and scattered light, between 50 and -60%. Since scattered light has a greater physiological effect, plants' needs for light are actually met in full.

Plants are divided into sun-loving and shade-loving species, according to their needs for these two types of light. Sun-lovers have been created to obtain maximum efficiency by receiving sunlight directly, while shade-lovers achieve maximum photosynthesis with light arriving more indirectly, as in forests or in cold and cloudy climates.

Trees such as beech, lime, elm, and ash trees have been created to be capable of living in both types of environment.

2. Level or Density of Light

The further north or south from the equator one goes, the longer the variation between periods of night and day—and the photosynthesis linked to this illumination. The duration of daylight causes increased photosynthesis with a result in faster rapid, short-term growth, flowering and leaf production. Flowers time their blooming according to length of day. For example, the chrysanthemum, a short-daylight plant, opens its flowers in the early autumn, when the days are growing shorter, and grows its shoots and buds in summer when days are longest. However, no matter how much light may reach the plant, photosynthesis still continues, at a greater or lesser degree.[75]

3. Heat

Plants need warmth to carry out photosynthesis and survive. Plants open their flowers, sprout leaves, and germinate their seeds and all at specific temperatures—vital activities that come to an end when temperatures drops below a critical level. For example, forest trees begin their growth stage when the general temperature rises above 10 degrees Celsius. This figure is 5 degrees Celsius for agricultural crops. Chemical processes increase by two or three times as temperature rises. But excessively low or high temperatures may stress plants, inhibit growth so as to create a spindly appearance, or cause foliage to wither or fall prematurely.[76]

When the stages of photosynthesis and the special conditions the process requires are examined as a whole, important evidences of creation can be seen. This system, which brings together so many sensitive and delicate measures, is a blessing placed at the service of mankind by All-Mighty Allah, the creator of all things.

4. Nighttime

Many requirements need to be met for photosynthesis to take place, and in the absence of any one of these, photosynthesis will not occur. The growth activities of plants are closely linked to the temperature differences between day and night. Some plants need warm days with low temperatures at night to form new growth. Others do not require such a temperature differential.

As the Sun rises, perspiration and in relation to that photosynthesis in the leaf increases. In the afternoon, photosynthesis slows down. As heat levels decline at night, however, perspiration slows down and the plant goes to rest. If there were no night over the course of just one day then most plants would die. In the same way that it is for the animals, night is a period of rest and renewal for plants.[77]

In the Qur’an Allah has revealed that He has placed day and night, Sun and Moon and all plants, at the disposal of human beings:

He has made night and day subservient to you, and the sun and moon and stars, all subject to His command. There are certainly Signs in that for people who use their intellect.

And also the things of varying colors He has created for you in the Earth. There is certainly a Sign in that for people who pay heed. (Surat an-Nahl: 12-13)

In other verses, we are told that Allah has created night, and that no other entity than He has the power to do this:

Say: "What do you think? If Allah made it permanent day for you till the Day of Resurrection, what Allah is there other than Allah to bring you night to rest in? Do you not then see?"

But part of His mercy is that He has made both night and day for you so that you can have your rest and seek His bounty, and so that hopefully you will be thankful. (Surat al-Qasas:72-73)

5. Carbon Conversion

Plants may be thought of as factories that transform the carbon dioxide in the atmosphere and the oceans to produce organic compounds, and as purification units that cleans up the environment. They do produce low levels of carbon dioxide by way of respiration—especially at night—but during the day, use ambient CO_2 for photosynthesis. The balance between the consumption of CO_2 by plants and single-celled organisms and its exhalation by human beings and animals is established with the production of carbonates in the oceans. During this process, large quantities of carbon dioxide in the air and water are transformed.

Human activities raise the level of CO_2 in the air to a considerable extent, leading to global warming and the resulting greenhouse effect. The emission of carbon dioxide and other harmful byproducts of combustion and factories also leads to acid rain. The most powerful antidote to all these harmful factors is living things that perform photosynthesis. Had such equilibrium not been established, organisms would soon die out from a lack of oxygen and from carbon dioxide poisoning. As yet, however, we never have faced such a problem, because there are no flaws or deficiencies in the creations of our Lord Who has infinite knowledge and wisdom, and has created all things with due measure:

He to Whom the kingdom of the heavens and the Earth belongs. He does not have a son and He has no partner in the Kingdom. He created everything and determined it most exactly. (Surat al-Furqan: 2)

CHLOROPHYLL:
THE GREEN MIRACLE

Consider an area of 1 square millimeter—about the size of the tip of a lead pencil. Now, into that space, squeeze 500,000 special devices, each containing a very special design and function. Also, let's protect each one with a very special packaging system.

This might seem quite impossible for you, but Allah's creation is flawless and magnificent. The feat described above is regularly performed in real life. There are 500,000 chloroplasts in 1 square millimeter of a plant's leaf.[78] Chloroplast molecules, squeezed into

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[6] *Bitkiler* ("Plants"), Gorsel Kitaplar ("Visual Guide Series"), Dorling Kindersley, 1996, p. 37.
[7] Steven Vogel, *Op. cit.* pp. 94-95.
[8] *Ibid.*
[9] *Ibid.*
[10] "Desert Plant Adaptations", http://www.desertusa.com/du%5Fplantsurv.html.
[11] "Living stones and shredded leaves," http://botany.about.com/science/botany/library/weekly/aa022900b.htm.
[12] "Survivors in a Hot, Dry Land", *Botany*, 02.04.1998, http://www.botany.hawaii.edu/faculty/webb/BOT311/Leaves/LeafShape-1.htm.
[13] Kingsley R. Stern, *Introductory Plant Biology*, California, William C. Brown Publishers, 1991, p. 110.
[14] Capparis spinosa, Mediterranean climate gardening throughout the world, http://www.support.net/Medit-Plants/plants/Capparis.spinosa.html;

[15] "Desert USA," http://www.desertusa.com/du%5Fplantsurv.html, http://www.desertusa.com/nov96/du_ocotillo.htm.
[16] "School Botany Projects: Water & Salt," http://botany.about.com/science/botany/library/weekly/aa103100a.htm, http://botany.about.com/science/botany/library/weekly/aa052799.htm.
[17] Kingsley R. Stern, *Op cit.*, p. 52.
[18] "Tendril," http://www.botgard.ucla.edu/html/botanytextbooks/generalbotany/typesofshoots/tendril/.
[19] "Bitkilerin Duyulari, ("Sense of Plants")," *Bilim ve Teknik*, ("Journal of Science and Technologys"), June 2000, p, 70.
[20] "The carnivorous plant FAQ," http://www.sarracenia.com/faq/faq5965.html.
[21] "Carnivorous Plants", http://waynesword.palomar.edu/carnivor.htm.
[22] "Brassica oleracea", http://perso.wanadoo.fr/steven.piel/en_chouv.html, "*Brassica oleracea*, Acephala Group." http://www.leafforlife.com/PAGES/BRASSICA.HTM,
[23] "Goosefoot Family", http://waynesword.palomar.edu/ecoph31.htm#spinach.
[24] Lesley Bremness, *Herb*s, Eyewitness Handbooks, Singapore: Dorling Kundersley, Singapore, 1997, p.132.
[25] Audrey Stallsmith, "Sage: Savory and Saviour," http://www.i5ive.com./article.cfm/historical_plants/49588.

that very small area and have an exceedingly complex design, perform a function vital for human life—as briefly mentioned in an earlier section.

Imagine that you must design a special piece of apparatus whose job will be to break down water molecules—which as you know, consist of two atoms of hydrogen and one of oxygen. The device you design must separate the oxygen from the hydrogen.

The separation of oxygen and hydrogen atoms requires either a large explosion, or for the water molecules to be heated by thousands of degrees. Bear in mind that water boils at

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[27] Dr. Sara Akdik, *Botanik,* ("Botany") İstanbul: Şirketi Mürettibiye Publishing, , 1961, p. 106.
[28] Guy Murchie, *The Seven Mysteries Of Life*, 1978, Abd, Boston: Houghton Mifflin Company, p. 57.
[29] Guy Murchie, *Ibid.*, 58-59.
[30] Guy Murchie, *Ibid.*, p. 58.
[31] Dr. Sara Akdik, *Botanik*,(Botanic) Şirketi Mürettibiye Publishing, İstanbul, 1961, pp. 105-106
[36] Kingsley R. Stern, *Op. cit.*, p. 55.
[37] Sylvia S. Mader, *Inquiry into Life*, Willam C. Brown Publishers, 1991, pp. 158-159.
[38] "Plant Vacuole", http://microscopy.fsu.edu/cells/plants/vacuole.html.
[39] "Testing the Telome Theory," http://www.rrz.uni-hamburg.de/biologie/b_online/ibc99/ibc/abstracts/listen/abstracts/4069.html "Botany, an introduction to plant biology," http://biology.jbpub.com/Botany/interactive_glossary_showterm.cfm?term=telome%20theory.
[40] "Lycophyta: More on Morphology,, http://www.ucmp.berkeley.edu/plants/lycophyta/lycomm.html.
[41] "Bitkilerin Duyulari, ("Sense of Plants"), *Bilim ve Teknik*, ("Journal of Science and Technology"), June 2000, p. 71.
[42] Paul Simons, *Op. cit.*, p. 29; http://www.rrz.uni-hamburg.de/biologie/b_online/e30/30b.htm.
[43] "Root development and function: the perception and transduction nutrients," http://www.biology.leeds.ac.uk/centres/LIBA/cps/zhang.htm.
[44] http://www.sbs.utexas.edu/roux/research.htm.
[45] "Seismonasty," http://www.biologie.uni-hamburg.de/b-online/e32/32d.htm.
[46] "The Rapid-response mechanisms of plants," http://www3.telus.net/Chad/pulvinus.htm.
[47] "Sensitive Flower," *New Scientist*, 26 September 1998, p. 24.
[48] Dr. Sara Akdik, *Botanik* ("Botany") Istanbul :Sirketi Mürettibiye Publishing, , 1961, p. 13.
[49]"Plants that make you loco," http://waynesword.palomar.edu/ww0703.htm.
[50] "Pests leave lasting impression on plant." *New Scientist*, 4 March 1995, p. 13.
[51] *Ibid*.
[52]"Bitkilerin Duyulari, *Op cit.*, pp. 74-75.
[53] Malcolm Wilkins, *Plant Watching*, London, Facts on File Publications, 1988, pp. 75-77.
[54] Kingsley R. Stern, *Introductory Plant Biology*, Wm. C. Brown Publishers, USA, 1991, pp. 189-190

only 100 degrees Celsius, so the level of energy needed is apparent. Yet the only source of heat energy you are allowed to use is the Sun. And the device you are to design has another difficult task to perform; to combine the free CO_2 in the air with the H_2 molecules it obtains.

If you manage to design such a device, your name will go down in history, because despite all the extraordinary progress made in technology, science has still been unable to invent a device of the sort described above. Indeed, biologists are still trying to understand just how plants do this. The chlorophyll molecule is the only device on Earth capable of performing this process. When chlorophyll's design is examined, you can better appreciate how Allah has created all things with delicate calculation and infinite intelligence.

The chlorophyll molecule consists of 55 atoms of carbon, 72 of hydrogen, 5 of oxygen, 4 of nitrogen and 1 of magnesium, combined in a particular order and with a very

[55] "Plant hormones-nutrition", http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookPLANTHORM.html
[56] "Plant tropisms," http://www.geocities.com/CapeCanaveral/Hall/1244/colaborationstropism.htm
[57] Kingsley R. Stern, *Op. cit.*, pp. 189-190.
[58] "Geotropism, Gravitropism," http://www.biologie.uni-hamburg.de/b-online/e32/32c.htm.
[59] "Carnivorous plants," http://waynesword.palomar.edu/carnivor.htm; Wallace, Sanders, Ferl, *Biology The Science of Life*, New York: HarperCollins, 1996, pp. 640-641, 660.
[60] "Carnivorous plants," http://waynesword.palomar.edu/carnivor.htm.
[61] "Auxin, http://www.ultranet.com/~jkimball/BiologyPages/A/Auxin.html.
[62] "Plant Hormones, nutrition, and transport," http://www.emc.maricopa.edu/faculty/farabee/biobk/BioBookPLANTHORM.html; Malcolm Wilkins, "Plant-Watching," Facts on File Publications, 1988, pp. 167-169,
[63] Malcolm Wilkins, *Op cit.* , pp. 172-173.
[65] Devens Gust, "Why Study Photosynthesis?", http://photoscience.la.asu.edu/photosyn/study.html.
[68] Kingsley R. Stern, *Op cit.*, p. 38.
[69] *Ibid*.
[70] Solomon-Berg- Martin-Villee, *Biology*, New York: Harcourt Brace, 1993, p. 190.
[71] "From Photons to Chlorophyll: Some Observations Regarding Color in the Plant World," C.J. Horn, *Botany* column-November, 1997, http://photoscience.la.asu.edu/photosyn/education/photointro.html
[72] "The Photosynthetic Process," http://www.life.uiuc.edu/govindjee/paper/gov.html#52.
[73] Kingsley R. Stern, *Op. cit.*, pp. 167-168
[74] "From Photons to Chlorophyll: Some Observations Regarding Color in the Plant World, C.J. Horn, *Botany* column-November, 1997, http://photoscience.la.asu.edu/photosyn/education/photointro.html.
[75] Malcolm Wilkins, *Op. cit.*, p. 154.
[76] Kingsley R. Stern, *Op. cit.*, p. 174, http://aggie-horticulture.tamu.edu/greenhouse/nursery/guides/ornamentals/light.html.
[77] http://aggie-horticulture.tamu.edu/greenhouse/nursery/guides/ornamentals/light.html.

special design.[79] Every atom must be correctly placed for the molecule to do its job.

These atoms constituting chlorophyll know just what duties they have to do, and fulfill them and in an unbelievably short space of time beyond all human comprehension—one 10-millionth of a second.[80] The difference between 1/1000th of a second and 2/1000ths of a second is too short for us to grasp. One 10 millionth of a second is therefore totally unimaginable.

The Extraordinary Events That Take Place in Chlorophyll

Photons striking the water in leaves is loaded into the chlorophyll device. The impact of light activates the atomic sub-particles in the chlorophyll and changes their orbits. This process, takes place in as little as one 10 millionth of a second, and the hydrogen is separated from the oxygen in the water molecule. This process occurs so quickly that scientists still do not know just how the oxygen and hydrogen atoms separate.

The free hydrogen that has separated off is trapped by larger, spiral-shaped protein molecules known as enzymes or catalysts, whose shapes are specially designed to trap hydrogen. They chemically combine this hydrogen with the CO_2 absorbed in such a way that the two molecules intermingle by rotating at enormous speeds. This is another stage that scientist do not yet understand, since they lack the means to isolate and examine the system. They merely interpret what probably happens by analyzing the results that emerge.[81]

A single chlorophyll molecule contains a flawless system that 21st-century technology, with all the means at its disposal, cannot comprehend. Extraordinary phenomena take place within every single part of this system. For example, the enzymes seem to expect the hydrogen in water to be released with the light that arrives. When the hydrogen atoms separate, they immediately recognize and catch them, not letting them recombine with the oxygen that's been released. They then know they must transport the hydrogen and combine it with CO_2. Thanks to this highly conscious behavior, here summarized in the very briefest terms, life on Earth is able to survive.

In addition, all this happens in just one 10-millionth of a second. Despite all our technology, we cannot do under laboratory conditions what the enzymes and atoms in the chlorophyll molecule do. No doubt that the design and tasks accomplished by chlorophyll are proofs of the matchless and incomparable creation of Allah.

The Initial Stages

When we examine the processes by which photosynthesis takes place, the might of Allah and the glory in His creation can be seen more clearly.

The time required for this is quite unbelievable: just "1 billionth of a second!"[82]

During this space of time, energy transfers and the distribution of the energy stored in the reaction center must take place. These rapid energy transfers, a complex process, have to be achieved in an even shorter period of time, one which we cannot even imagine: **one 300 billionth of a second**.

This is one second divided by 300 billion—way beyond all human comprehension.

Danger under Control

The processes taking place during photosynthesis could give rise to very dangerous consequences if the necessary precautions were not taken. During these processes, a water molecule is split, following which one of its components is combined with another molecule. A very dangerous method is employed in doing this, using the movements of sub-atomic particles.

The movements of atomic sub-particles could give rise to unbelievable dangers. Unless all the processes are brought under complete control, the consequences could even lead to the total breakdown of the plant's cell. However, security measures have been created for every phase of the photosynthesis process.

This situation can be compared to the design of nuclear reactors in atomic power stations. The energy obtained from the splitting of atoms is used to produce electrical energy. In addition to energy, very dangerous radioactive isotopes are produced. The reactor is designed to convert the heat energy from the splitting of atoms into a useable state, but also to neutralize the harmful particles. Special systems that absorb these particles are installed in the reactor.

Of course the working systems and production in photosynthesis differ, but they share one point in common with those in nuclear reactors: The photosynthesis mechanisms also possess security systems to eliminate any harmful elements that might emerge during the process. But the plant's mechanisms possess a far more advanced technology and a design far superior to those in nuclear reactors. Moreover, reactors cover hundreds of square meters, while photosynthesis takes place in a cell too tiny to be seen with the naked eye. All dangers that might arise during photosynthesis have been foreseen. For example, the distance between the sub-systems that carry out electron transfer have been arranged according to a very careful plan. The distance in question is so minute as to be invisible even under the most advanced microscopes.

During photosynthesis, protein-pigment compounds literally work like robots. Which of these will be involved in which stage and which threat it will eliminate has also been set out carefully beforehand.

The examination of a few technical details will better reveal the perfection of the design involved:

When light is intense, the chlorophyll assumes a chemical state known as *triplet*, which could cause the plant severe damage, because the orbits of two electrons in the outer ring of chlorophyll are in the same direction in this state, rather than working in opposite directions.

This triplet chlorophyll might lead to the formation of a single free oxygen atom, and by immediately entering into a reaction with oxygen, could damage the proteins. What prevents any such damage is the carotene pigments installed immediately next to the chlorophyll. Carotene prevents the formation of single oxygen atom combining to calm the triplet status of the chlorophyll. In other words, by sharing the excess energy loaded in the chlorophyll, it prevents the chlorophyll assuming a harmful state.[83]

Leaving aside the hundreds of planned stages and systems built into photosynthesis and reflecting on just this last technical detail clearly shows the flawlessness in Allah's creation. The moment the chlorophyll molecule reaches a dangerous state, the carotene molecule eliminates the excess energy in the chlorophyll and prevents it from doing any harm in exactly the right place, at exactly the right moment. In addition, the carotene has exactly the right design for that purpose. This shows that this system was created by a superior mind—in other words by Allah. No coincidence can produce such a detailed, complex and flawless system, together with all its security measures. No right-thinking person can possibly imagine that blind chance brought such a system into being.

The Mysterious World of Photosynthesis

Energy-production systems trying to imitate photosynthesis have faced enormous difficulties. The most important of these has been the need to use new energy to initiate a reaction each time, rather than being able to set up a constantly self-sustaining process. Since no system to transfer the absorbed energy according to requirements or to convert it into another form of energy that can be stored has yet been built, a large part of sunlight is wasted by being scattered or reflected away. All mechanisms trying to make use of solar energy face this problem. Yet green leaves never encounter such a difficulty, thanks to the superior system they have possessed ever since they were first created.

The Stages of Photosynthesis

Scientists describe the photosynthesis that takes place inside chloroplasts as a long chemical chain reaction. But as was made clear in the preceding pages, since this reaction takes place unbelievably quickly, some stages have proven impossible to study. What is known is that photosynthesis takes place in two phases, known as the *light phase* and the *dark phase*.

In the light phase, which takes place only in the presence of light, pigments absorb sunlight and use the hydrogen in water to convert it into chemical energy. The left over oxygen is returned to the atmosphere. In the dark phase, which does not require light, the chemical energy obtained is used for the production of other organic substances such as sucrose.

The Light Phase

In the first stage of photosynthesis, NADPH and ATP products to be used as fuel are obtained.

The antenna groups that serve during the first stage of photosynthesis and are responsible for trapping the light are of the greatest importance. As you have seen, these chloroplasts consist of pigments such as chlorophyll, protein and fat and contain what are called *photosystems*. Photosystem II is stimulated at light wavelengths of 680 nanometers and less, and Photosystem I is stimulated at 700 nanometers and above. The chlorophyll molecules that trap specific wavelengths in the photosystems are known as P680 and P700.

The reactions initiated under the effect of light take place inside these photosystems. Although each photosystem performs a different process with the light energy that it traps, the two systems constitute a single chain reaction and are mutually complementary. The energy caught by Photosystem II enables hydrogen and oxygen to be released by breaking down the water molecule. Photosystem I permits NADP to be reduced with hydrogen.

In this three-stage process, the electrons in water are first carried to Photosystem II, then from Photosystem II to Photosystem I, and finally to the NADP. The first stage is exceedingly important, which takes place when a single photon strikes the plant's leaf.

The moment a photon strikes the plant, it initiates a chemical reaction, reaching that chlorophyll pigment in the Photosystem II reaction center and stimulating one of that molecule's electrons, raising it to a higher energy level. Electrons are exceedingly small particles that revolve in specific orbits around the atomic nucleus and bear a very low negative electrical charge. The light energy pushes the electrons in chlorophyll and other light-trapping pigments out of their orbits—an initial reaction that sets up the remaining stages of photosynthesis. At this point the electrons release an energy in as little as 1 millionth of a second. This energy flows from one pigment molecule to another, which are arranged in a sequence. (See diagram on Page 178.)

At this stage, the chlorophyll that has lost one electron assumes a positive electrical charge, and the receptor molecule that accepts the electron bears a negative charge. The electrons pass into what's known as the electron transfer chain, made up of carrier molecules, moving down from one carrier molecule to another. Each carrier molecule has a lower energy level than the one before it, as a result of which the electrons release their energy as they move down the chain.

To better understand this phenomenon, compare it to a hydroelectric station. The falling water in this station powers an electricity generator. The greater the height from which the water falls, the more energy will be obtained. However, two pumps are used to keep the water flowing from a high level, worked by panels that collect solar energy, which are located in two strategic positions to set the entire system in motion. Of course this is a

much simplified analogy. Even if we managed to construct this system, we would still encounter a major problem in converting the energy from the solar panels into electrical energy to run the pumps. Yet in performing photosynthesis, plants do so with an expert design and in a perfect manner.

In order for this photosynthesis system to function, the water must be broken down in the internal area of the thylakoids, which are sacs in which photosynthesis take place. Thus the electrons will pass along the membrane to the stroma where it will be reduced to NADP+ (*nicotinamide adenine dinucleotide phosphate*, a molecule with a high-energy charge receiving an electron for Photosystem I during photosynthesis). However, since water is not easily broken down, there is a need for precise organization and co-operation in this region. Energy needed for this process is obtained from the solar energy that enters the equation at two points. At this point, the water electrons are exposed to a "propulsive" force from both photosystems. In the wake of each propulsion movement they pass through the electron transfer system and lose part of their energy. This lost energy is used to power photosynthesis.

The Formation of Photosystem I and NADPH

A photon striking Photosystem I raises a P700 chlorophyll electron to a higher energy level. This electron is received by the NADPH line of the electron-transfer system. Part of this energy is used to reduce the NADP+ in the stroma to NADPH. In this process, NADP+ receives two electrons and receives one hydrogen atom from the stroma. (See the diagrams on pages 178 and 179.)

Photosystem II – Photosystem I

The electron leaving its orbit and reaching the electron receptor and many other subsequent processes provide the energy necessary for photosynthesis. Yet it is not enough for this process to occur only once. For photosynthesis to continue, it must be repeated again and again. But this suggests a major problem. When the first electron leaves its orbit, its place remains empty. A new electron must be installed there, a subsequent photon has to strike that electron, and the electron hurled out has to be caught by the electron receptor. There is a need for an electron to respond to the incoming photons on every single occasion.

At this stage, a new electron to replace the one lost by the P700 is installed: The hydrogen ion (H+) in the stroma is carried inside the thylakoid. In Photosystem II, a photon raises energy level by striking a P680 electron. This electron passes into the other electron transfer system, replacing the lost electron by moving to the P700 in Photosystem I. As the electron moves along this chain, the energy it receives from the photon is used for carrying the hydrogen ion from the stroma to the thylakoid.

This hydrogen will later be used in the production of ATP, which all living things use as a fuel to survive. It's obtained with the addition of a phosphorus atom to ADP (adenosine diphosphate, a chemical found in all living things). In conclusion, the carrier molecules take

the molecules of the Photosystem II to Photosystem I, and thus meet the P700's electron requirement. The system continues functioning in this impeccable manner.

Of course, the fact that an electron storage system has been designed to meet the electron expenditure, and has been installed in the appropriate location, is another proof that all the details of this system have been created.

Water – Photosystem II

This complex picture does not end here. The P680 that gave its electrons to P700 is now without an electron. However, another system has been established to meet this deficiency. The P680 electrons are obtained by the water carried up from the roots to the leaves being broken down into hydrogen and oxygen ions and free electrons. The electrons from the H_2O supply the missing P680 electrons by flowing to Photosystem II. Some of the hydrogen ions are used to produce NADPH at the end of the electron transport chain, and the freed O_2 molecules are released back into the atmosphere.

This chain of events, which is expressed in even its simplest terms, is very difficult to understand but which ensures the progressive release of energy is a sign of a superior design and infinite intelligence. Thanks to this complex and superior design, the chloroplasts and cell membranes are protected against any harmful rise in temperature. And in addition sufficient time is gained for the plant to manufacture such basic products as NADPH and ATP.

Another miracle that emerges in the design of photosynthesis is especially striking. As mentioned, the Photosystem I and II antenna are divided into two: P700 and P680. The 20-nanometer difference in the light wavelengths caught by the two receptors plays a key role in the functioning of the entire system. In fact, these two receptors possess the same structure and form. Yet the existence of separate molecules, known as *Kla* that serve as traps for light reveals the difference between them. A Creator possessed of infinite knowledge designed the special systems to obtain a distance of 20 nanometers (1 nanometer is 1 billionth of a meter—so small that it's hard even to imagine,) in a system built on such minute numbers and proportions.

The first stage in photosynthesis is actually a preparatory phase, despite such superior systems being in operation. The substances used as fuel and produced in this stage will be employed in the dark phase when the fundamental processes are carried out—and this system, a marvel of design, will thus be completed.

The Dark Phase

The energy-charged NADPH and ATP molecules that emerged during the light phase, in the dark phase convert the carbon dioxide into foodstuffs such as sugar and starch.

The dark phase is a circular reaction, which begins with a molecule that needs to be recreated at the end of the reaction in order for the process to continue. In the start of this

reaction, also known as the Calvin phase, electrons and hydrogen ions joined to the NADPH, and phosphorus joined to the ATP, are used to produce glucose. These processes take place in the liquid regions of the chloroplast known as *stroma*, and each phase is controlled by a different enzyme. The dark-phase reaction needs the carbon dioxide, which enter the leaves through the pores and disperse in the stroma. When these carbon dioxide molecules bind to the sugar molecules known as 5-RuBP in the stroma, they form an unbalanced 6-carbon molecule, and thus the dark phase is initiated. (See diagram on Page 185: 1st phase.)

This 6-carbon molecule immediately divides, and two 3-phosphoglycerate (3PG) molecules emerge. Phosphate is added to both molecules by ATP; this process is referred to as phosphorylation. (See diagram on Page 185, 2nd phase.) As a result of phosphorylation, two bisphosphoglycerate (BPG) molecules form. These in turn are broken down by NADPH, giving rise to two glyceral-3-phosphate (G3P) molecules. (See diagram on Page 185, 3rd and 4th stages.) This final product is now at the junction point and part of it abandons the chloroplast in order to participate in glucose production by entering the cytoplasm. (See diagram on Page 185, 5th phase.) The other part continues with the Calvin phase, is again subjected to phosphorylation, and is thus transformed into the 5-RuBP molecule at the beginning of the phase. (See diagram on Page 185, 7th and 8th phases.) This phase has to be repeated six times for the production of the G3P molecule needed to form one glucose molecule.

As in all the other stages of photosynthesis, the enzymes undertake important tasks. To cite one example of their vital importance, the enzyme carboxydismutase (ribulose 1.5 diphosphate carboxylase)— which plays a particularly important role in this stage of photosynthesis—breaks down acids, despite its being only 0.00000001 mm (one hundred-millionth of a millimeter) in size, and catalyzes oxidation processes.

What purpose does this serve? If the carbohydrates (triose-hexose molecules) are not stored in a specific quantity and a specific form inside the cell, then internal cell pressure rises and finally leads to cellular breakdown. This storage, therefore, takes place in starch molecules that do not affect internal fluid pressure. This is one of the ordinary tasks undertaken by enzymes 24 hours a day.

As already stated, the remaining 5 RuBP molecule establishes a non-stop chain reaction by providing the material necessary to begin the process anew. So long as carbon dioxide, ATP and NADPH are present, this reaction in the chloroplasts is constantly renewed. The thousands of glucose molecules produced during this reaction are used by the plant for respiration and as a structural material, or are else stored away.[84]

Even the broad outlines of this chain reaction, briefly summarized here, took scientists hundreds of years to understand. Carbohydrates cannot be formed in any other way on Earth, which have been produced by plants thanks to this exceedingly complex

system for millions of years. These substances thus produced are the main food source for all living things.

The plants, bacteria and single-celled organisms are entities with no brain, eyes or ears, and are unaware of what they do. Yet they have been carrying out photosynthesis for millions of years, even though it is still not fully understood by human beings. To maintain that these entities spontaneously acquired this photosynthetic system is as illogical as claiming that they decided to use the Sun, water and air to obtain energy and that they possessed the knowledge to implement that decision. Even if all the world's researchers and scientists joined forces and try to produce a substance that performs photosynthesis by using organic substances, alone they could never succeed, because before constructing such a system they would need to discover how it works. Yet present-day technology is unable to resolve anything more than the broad outlines of this exceedingly complex system.

Even if this secret is one day unraveled, producing a chlorophyll molecule similar to the 500,000 squeezed into a space the size of a pencil point will still lie far beyond the present level of human ability. Therefore, it is totally irrational to claim that the blind chance in unconscious plants performed something that human intelligence cannot.

PHOTOSYNTHESIS: THE PROCESS THAT INVALIDATES EVOLUTIONIST IDEAS OF COINCIDENCE

The theory of evolution, as you know, claims that living things and the complex structures and systems within them came into being spontaneously, under natural conditions. Yet as we have clearly shown up to now, the photosynthetic systems inside even a single plant leaf possess an exceedingly complex design. It is therefore impossible for coincidences to bring these into being, as evolutionists would have us believe.

To show this system could not have come about by chance, let us ask some questions of those who insist on defending the theory of evolution. Who designed this incomparable mechanism established in a microscopically small area? Can we assume that unconscious plant cells, in other words plants, planned such a system themselves? We cannot, of course, hypothesize any such thing, because there is no question of plant cells reasoning or designing anything. It is not the cell itself that makes the flawless system we see when we examine it under a microscope. Then is this system the product of human intelligence, of the only entity capable of rational thought? No human being has constructed the world's most complex facilities in a space one thousandth of a cubic millimeter. Human beings cannot even observe what goes on inside these microscopic facilities.

The theory of evolution maintains that all living things developed in progressive stages, from the simple to the complex. To consider whether that claim is true, assume that we can impose a specific number on the components in the photosynthesis process. Assume that the number of components necessary for photosynthesis to take place is 100 (though the actual number is very much larger). Also, assume that one or two of these components did arise spontaneously, in the way that evolutionists claim, ignoring that such an event is quite impossible. There will be a necessary wait of several billions of years for the remaining components to emerge. Yet even if the components that finally emerge remain together, they can still serve no purpose in the absence of all the other parts. It is impossible for this system to emerge in stages, since its components will serve no purpose if any one is absent. Like the systems belonging to all living things, therefore, the idea that a complex system like photosynthesis came into being over time, with the gradual addition of its component parts, is incompatible with reason and logic.

To see how hopeless this claim is, recall just some of the stages that take place in order for photosynthesis to occur. All the existing enzymes and systems have to be present in the plant cell at the same time. The duration of each process and the quantity of enzymes have to be regulated in the correct manner from the beginning. That is because if the slightest error takes place—for example, the duration of the reaction, or the slightest alteration in the amount of light or raw material entering the reaction—products resulting

from that reaction will be damaged and rendered useless. In the absence of any one of these elements, the system will cease to function.

That being the case, how did these functionless components survived until the emergence of the system as a whole came into being? Moreover, the smaller the dimensions involved, the greater the quality of the intelligence and engineering that system requires. As with laptops and cell phones, the shrinking of a mechanism's dimensions shows the sophistication of the technology used to create that structure. Comparing the bulky cameras used in the 19th century with today's cameras only enhances the importance of the immaculate structure in leaves. How is it that, human beings cannot perform photosynthesis in large factories, but plants have been carrying it out in microscopic ones for millions of years?

Evolutionists can give no coherent answers to these and similar questions, but come up with imaginary scenarios instead. They resort to the common tactic of drowning their scenarios in baffling technical descriptions. Using the most opaque terminology possible, they seek to evade the *Fact of Creation*, which is plain to see in all living things. Instead of responding to such questions as "How?" and "Why?" they hide behind detailed information and technical concepts and then hastily add that all this is a result of evolution.

However, even many of the determined proponents of evolution cannot conceal their amazement in the face of the miraculous systems in plants. By emphasizing the miraculous processes in photosynthesis, the Turkish evolutionist professor Ali Demirsoy makes the following admission:

> Photosynthesis is a quite complex mechanism, and it seems impossible to occur in an organelle in the cell. Because the formation of all the phases altogether is impossible, and it is meaningless for them to emerge one by one. [85]

Flawless mechanisms in the photosynthesis process have existed in all the plant cells there have ever existed. Even the most ordinary pond scum makes photosynthesis. The same proportions of carbon dioxide and water always enters the reaction and the products emerging are also always the same. Also, the sequence and speed of the reaction never vary. This applies, without exception, to all plants that employ photosynthesis.

It is of course illogical to seek to ascribe reason and decision-making to plants. It is equally illogical to say that this system, which exists in all green plants and works so flawlessly, came into being as the result of a chain of coincidences.

We are therefore faced with a manifest truth: The extraordinarily complex mechanics of photosynthesis have existed since plants first appeared. These immaculate systems inside such a tiny space show the knowledge and might of Almighty Allah, Who created them.

CONCLUSION:
WHO GOVERNS THE PLANT?

The creatures' complexity does not end here. In addition to complex chlorophyll pigments that enable photosynthesis, these organisms also possess the pigment xanthophyll, which imparts a yellowish color. These single-celled creatures, from which fish derive their greatest source of Vitamin D, have complex structures designed for a specific purpose.86 They are part of a specially created system that could not have come into existence by coincidence.

Throughout this book, we have examined two of the most important features of plants, photosynthesis and the extraordinary properties of leaves. The aim behind providing this information is to show that these living things and the features they possess could not have emerged as the result of coincidences.

Plants are organisms without any traces of consciousness and reason such as decision-making or free will. But as you can see from the information provided this far, the processes carried out by plants do require considerable consciousness and reason. Indeed, plants succeed in performing activities that human beings cannot replicate with their conscious knowledge and advanced technology, and in spaces of time as brief as a millionth of a second. So to whom does this intelligence—which human beings come nowhere near approaching—belong?

Since the day they were first created, plants have been behaving in the manner inspired in them by Allah, with His infinite knowledge and intelligence. Every one of the plant's cells, and even every atom, is told how to behave at every moment. This is revealed in a verse from the Qur'an:

It is Allah Who created the seven heavens and of the Earth the same number, the Command descending down through all of them, so that you might know that Allah has power over all things and that Allah encompasses all things in His knowledge. (Surat at-Talaq:12)

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[78] "From Photons to Chlorophyll: Some Observations Regarding Color in the Plant World, C.J. Horn, *Botany c*olumn-November, 1997.
[80] *Ibid.*
[81] *Ibid.*
[82] "Photosynthesis Problem Set 1," www.biology.arizona.edu/biochemistry/problem_sets/photosynthesis_1/09t.html.
[83] http://botany.hawaii.edu/faculty/webb/BOTT311/PSyn/Psyn11.htm
[84] Kingsley R. Stern, *Op. cit.*, pp. 169-170.
[85] Ali Demirsoy, *Kalitim ve Evrim*, ("Inheritance and Evolution"), Ankara, Meteksan Publishing, 1995**,** p. 80.
[86] *Ibid.*

All these miracles we encounter in plants show us that with their design, the actions they perform and the systems they possess, all plants have been created for a specific purpose by Almighty Allah. Infinite knowledge and enormous artistry have been employed in His creation. These belong to Allah, the creator of the worlds. Another verse states:

In the creation of the heavens and Earth, and the alternation of the night and day, and the ships which sail the seas to people's benefit, and the water which Allah sends down from the sky–by which He brings the earth to life when it was dead and scatters about in it creatures of every kind—and the varying direction of the winds, and the clouds subservient between heaven and Earth, there are Signs for people who use their intellect. (Surat al-Baqara:164)

[79] Guy Murchie, *The Seven Mysteries Of Life*, p. 52.