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Agrohomoeopathy: Soil Course

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≠ Soil

Soil Types

True science means that the subject under investigation is studied in its totality. All attempts at isolation and reduction of the related parts renders the scientific endeavour a meaningless mumbo-jumbo of unrelated events. The homoeopathic approach to the problems met with in growing plants, whether grown for food or as an exercise in recreation is scientific in the true sense of the word. It studies pests and diseases as well as soil problems as symptoms of a totality within the environment. The totality includes the medium in which the plant grows, the climate and weather patterns, the availability of water, nutrients and the occurrence of other organisms in that whole environment, which is the local habitat in the ecosystem. Since everything happens underground as much as it happens above and since this is the medium in which the plants find their life, we must begin with this medium, if we are to fully understand how to help our crops grow healthy and whole.

Soils are as different as people. They possess different compositions, such as mineral soils, clay, sand, organic soils, and their moisture content and nutritional capacity. They also behave in a different manner and attract various amounts of rain. Soils are extremely diverse in their acidity and composition. The minerals and particles of their construction, organic matter content and other components are particular to each type of soil and hence their behaviour differs as much.

Moreover, soils differ in their flora and fauna, microbes, fungi, roots, rhizomes and tubers or bulbs. If we understand everything that lives in the soil we can understand the needs of the plants that grow in and above the soil. This makes a piece of soil an individual piece that is different from all other pieces of soil.

Roughly, we divide soil into acidic, alkaline and neutral pH. We shall briefly explain how the soil acidity determines the available nutrients and how certain practices can change the pH of the soil. Further down, we shall dive a little deeper into the reasons for acidity and find out if the acid layer may be just on top or also has sub-soil components. This can be determined from the “weeds” that grow up above soil.

The soil pH is important for all the plants that grow in it. It expresses the acidity or alkalinity of a soil. Acid soils have a pH<7 and alkaline soils have a pH>7. The pH of a mineral soil lies between 3.5 to 8.5. Organic soils may have a lower pH. It is evident that each requires a particular set of nutrients in a particular consistency. Certain nutrients are less available while others are more abundant. When the pH drops below 6, aluminium can occupy a significant portion of the cation exchange phase of soils while exchangeable bases, such as Ca^{2+} Mg^{2+} K^{+} Na^{+} are more dominant at higher soil pH. This is because the base saturation rate is greater. Soils with a pH between 8 and 8.5 typically contain calcite. Higher pH levels, such as >9 can occur in arid areas, where one finds high levels of salts of the sodium group. These soils are being extended throughout the Australian outback, where short-sighted people have cut down the large swathes of forest for gaining new agricultural lands, because the ones they had cut down already gave only harvests for a few years.

There is a general trend of decreasing base saturation and increasing saturation with acidic ions such as Al^{3+} and H^{+} as the pH decreases. The sources of protons that contribute to the decline in soil pH and increasing soil acidity include atmospheric deposition of acids such as H_2SO_4 and NHO_3 generated from atmospheric reactions between water and gaseous NO_X and SO_X from fossil fuel emissions, H_2CO_3 produced from aqueous dissolution of atmospheric CO_2 or biologically produced CO_2 and biological activity, such as respiration, production of organic acids, nitrification of mineralised N or ammonium fertilisers and imbalances in cation and anion uptake by plants. The rate of soil acidification is related to the rates of acid inputs versus the soil buffering capacity. Soil pH is mainly buffered by the dissolution of calcite and other carbonates at a pH >7, cation exchange of bases by H+ and Al3+ or their hydrolysis species at a pH 7 to 5, dissolution of Al-bearing minerals at a pH<4. Phytotoxicity of simple organic acids is most evident in acidic conditions when organic acids are protonated, meaning neutral in charge and this toxicity is lost when organic acids are partially dissociated under neutral and basic conditions or negatively charged.

Soil Structure

They also contain living organisms such as microbes and fauna, plant organisms such as roots, rhizomes tubers and bulbs. If we therefore want to understand a given process within any type of soil, for example allelopathic interaction, leading to differences in nutrient uptake or plant development, then that entire process must be viewed in its totality within the constraints of that soil. Therefore, each soil is different from any other soil and none are alike. In one paddock we may encounter two different soils, because local constraints have made it so in the past. No matter what else we try to do, the basic structure of the soil can only be changed by organic matter. It is organic matter which makes a soil a viable medium to grow crops in and any other soil will have to be helped by large doses of chemical fertiliser.

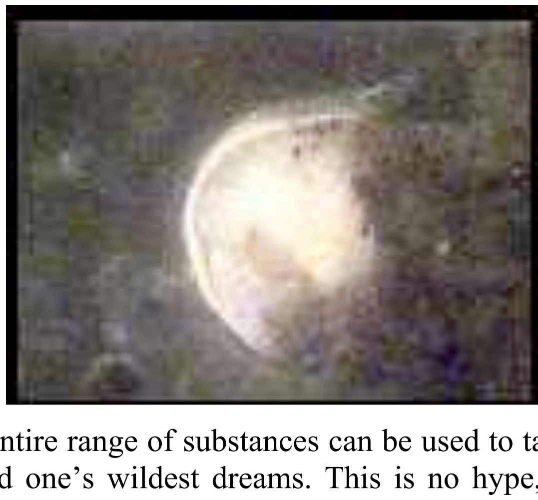
But what if we can change all this, by using these compounds and acids, these auxins and phenols, gibberellins and other pheromones that the plant world has at its disposal to create a natural environment, without poisoning the earth?

The first question must always be the dose, since it depends on the dose whether we poison or cure, as Paracelsus already knew in the 15th Century. Homoeopathy offers the advantage of complete control over the dose of any given substance to be used as a means to simply draw away the forces that otherwise eat our crops before they even come to the table. By applying to the soil the remedies found in that soil we can imitate a natural setting in which the plant is the focus of attention, because the soil of which we speak can only hold a limited amount of species within the constraints of pH and available nutrients and our crop must be one of them.

To generalise on a larger scale than we do at present, we accept the scientific view that similar soils will generate similar circumstances in regards to nutrient availability, allelochemicals present, fungi and bacteria and/or viruses present, and the components of the soil we already listed above. The only difference come from the climate in which they exist. Withon the climatic zone, we see crossovers from the next zones at the edges and a rather uniform distribution of plants that require these circumstances. Hence there have been scientific studies on how allelochemicals act in different types of clay. While such a reductionist approach as above may be useful, it does not tell us about interactions of the soil components and is thus limited in its view.

We may from this fact deduct several general principles.

1. Similar soils have similar pH.
2. Similar soils have similar nutrient availability.
3. Similar soils attract similar plants in similar climates.
4. Similar plants emit similar allelochemicals.
5. Similar substances will act in a similar manner on plants grown in similar soils.



Here we have the quintessential points of these paragraphs which show that the situation above-ground is a reflection of the situation in the soil and the remedies made from the plants above the ground will have medicinal relationships between them, at least for plants. All components from the habitat can be used to alleviate any problem the crop is suffering from. An entire range of substances can be used to target a specific pest or disease and the results are completely beyond one's wildest dreams. This is no hype, but discovered from practical application over a long period of time. But let us return to the studies and learn how to extract remedies for this almost Utopian type of gardening and see if it can be turned into a reality. Reductionist it may be, but we shall see how the limited view is possibly only in the eye of the beholder. Seen from a higher perspective, even titbits of information may hold the key to the development of suitable remedies.

In the integrated view, all possible parameters are always included. We have to bring the diverse fragmentary observations in a compete view of the whole, to understand those functions within the proper framework. Thus we discover that even a fragmentary detail can give us clues to the problems we face with a soil. A simple fact as acidity determines the available nutrients and the presence of sometimes toxic elements both for plants and humans.

The alchemical capacity of plants to trans-substantiate the elements has been known since ancient times and they can turn oil into healthy and edible clover. The humble wolf's claw takes up aluminium from the soil and has been used in medicine for hudreds of years. Its spores were used to make pills or at least their coating. In homoeopathy Lycopodium will nullify the uptake of aluminium in your crop and remover the symptoms in the plants caused by it.

In this way, nature shows us the answers to the questions on how to remove or neutralise the effects of heavy metals, oil, chemical spills and other man-made disasters. Similarly, the vegetation provides us often with answers because these answers are how nature changes a soil from extremely acidic to reasonably neutral and does the same with alkaline soils. If we have sorrel as a weed, we know we have an acid soil and sorrel is a pioneer plant on acid soil. She gradually alkalinises the soil and when it reaches a certain level, she and other acid soil weeds, will have turned the soil more alkaline and more alkaline loving plants will appear, which do best in a soil that is slightly acidic and thus make it more alkaline.

Soils have structural and biological properties that make for differences with what we call rocks, although these have been the parent material. Most soils originate from sediments and thus they are as different as the mountains from which they once came. Some have amassed sediments from different rock over which they have passed on their way to the sea, while others have side arms that come from different sources in different types of mountains. Hence the soils in the plains are as different as the sediments brought with the rivers. Nonetheless, we call sedimentary soils from rivers river-clay and ascribe certain properties to it, such as very fertile, not too heavy like sea-clay and easier to work, but not very porous – often lacking in organic matter – leading sometimes to damping off, even at more advanced ages of plants.

Soils are dynamic systems, providing plants with support, nutrients, air and water, housing distinctive populations of flora and fauna, microorganisms and fungi, involved in recycling organic matter produced by other living entities. All spatial and temporal scales on which the major influences defining that environment depend, which includes the soil, are dependent on the physical, chemical and surface properties of their components, such as minerals, organic matter, water, gases and living organisms. It is a complete system in which all components cooperate in maintaining that soil in its state, while their additions to that soil change it in a gradual process. An acidic soil attracts sorrels, which gradually make the acidic soil more alkaline. Each soil has what are called pioneer plants, which enter first and alter the pH of the soil, so making it suitable for other plants to live.

Ultimately the origins of our soils can be traced back to the weathering of igneous rock, such as diorite and granite, sedimentary rock, such as limestone and sand stone, or metamorphic rock, such as marble and slate. This weathering process produces coarse to fine particles, such as gravels, sand, clays and silts, which are often composed of only minerals. These minerals are always or nearly so, crystalline compound substances, which consist of oxygen, silicon and aluminium, sometimes with appreciable amounts of other minerals, such as iron, calcium, sodium, potassium or magnesium. These eight elements comprise 98% of igneous rocks, while the minor elements, such as phosphorus, titanium or manganese are generally less than 1%. Silicon oxide is the most abundant mineral in all igneous rocks, while the other six elements vary with the mineral composition of their originating rocks. For instance the dominant minerals found in limestone are of course calcite $CaCO_3$, quartz, SiO_2, clays and calcium.

Soil texture is dependent on particle size, which we note when we investigate some soils like clay, clay loam or sandy clay loam; the particle density, weight of the solid particles divided by the total volume of the particles [which does not include pore space]; bulk density, weight of the soil divided by the total volume [including pore space]. This bulk density runs from 1 to 1.8 g/cm fro mineral soils; because organic matter is highly porous and has a particle density of 1.2 to 1.5 g/cm, the incorporation of organic matter into mineral soil will generally decrease both particle and bulk density. A typical mineral soil has 45% minerals, 5% organic matter and 50% pore space.

It takes a long time to build up what now are our soils on which we grow food – from a few 10.000s to hefty millions of years, depending on the makeup of our soils. Rivers break down stones in very fine particles over a relatively short period, since water is both very powerful and moving. On the other hand, soils built up over coastal areas may take a relatively longer period to build up truly, because the sediment is thin and storms may wash away what has been built up over a long period. Where river sediments are accumulated faster, they are courser than sediments from the sea. Particle density is greater in sea clay than in river clay.

Much of this material has been brought where it is by gravity, water, wind and other means to accumulate and be deposited as soils with sufficient depth to accommodate for the development of horizons. Horizons form because they have accumulations of organic matter on the topsoil, which are decomposed and incorporated in the rest of the soil, causing transformation of soil minerals from physical and chemical weathering, undergone as part of the cycle of life that lives in our soils. The capillary and/or gravitational movement of water soluble and water suspended substances from the top soil layers to those below and the transformation of these substances by fungi, bacteria and microbes for the benefit of plant life incorporates other substances in the lower layers of soil. There are five major recognisable horizons but we shall restrict us to the top three, because they are important for plant life.

Topsoil

Looking at a vertical section of soil, the first thing that demands the attention is the variation of colour and a certain amount of dead organic matter, a host of living entities, structure and porosity as well as the extent of weathering and erosion. These elements form distinct layers, which are known as horizons. Three of these are usually taken into account.

This is the upper region. Here the greatest biological, physical and chemical activity takes place. The major portion of living entities, organic matter and chemical reaction are found here. A host of insects, earthworms, protists, nematodes and decomposer organisms all contribute to the decomposition of leaves, twigs, bark and wood. Their products are acids, phenols, nutrients in the form of compounds, allelochemicals released from plant matter while it is broken down by leaching and other means. The acids seem to have an important role to play, as we shall see.

They have gathered sufficient data to understand the behaviour of the different soil components and can give us a tentative overview. These effects of behaviour have been in respect of the reactions of components with simple phenolic acids, to first determine the value of such a reductionist approach. When they then also draw conclusions, the evidence must be plenty and we shall see that it is – again to a limited degree, because they always use the same plants for the same assays, because they respond well. When designing a scientific study, it is imperative to not only study in vitro, but foremost in vivo, where the circumstances can still be manipulated, such as in a greenhouse setting or even in the open field, where the circumstances are most like real-life.

The role of organic acids in the interactions of life within the soil is the subject of study and we shall see how the findings have important remedies to furnish for agrohomoeopathic cultivation of food crops. There is some uncertainty about the role of organic acids in the soil in some circles, because they do not understand how to look at the whole. The test substances are phenolic acids and others in the role as allelopathic agents in the soil. These acids are the ones we have to keep an eye on to discover new remedies.

In these paragraphs we describe soil system characteristics of interest, such as the nature of the mineral soils with emphasis on organic matter, soil organisms, soil processes and root anatomy, morphology, growth and development. We shall discuss how water-soluble allelochemicals, particularly organic acids, are influenced by these soil system characteristics.

There is plenty of phenolic acid literature, as can be seen from the Bibliography and this is the type we have studied to come to our conclusions. The underlined we already use as remedies, those in *italics* we propose to use for plants. The behaviour of phenolic acid in the soil is a good indicator how other potential allelochemicals would behave, such as coumaric acid, acetic acid, *butyric acid*, citric acid, *formic acid*, *fumaric acid*, lactic acid, *malonic acid*, *proprionic acid*, tannic acid and tartaric acid. Some of them we have already tried out in a past, such as acetic, lactic and citric acids and if their action is anything to go by, we might have here a range of remedies for weeds and chlorosis problems, respiration problems and photosynthesis impairment. We may expect action on fungi and bacterial rots and possibly an aid in fruit setting. This we deduct from the fact that acids and fungi not always like each other and that the acids so far used all were excellent for the problems mentioned. Formic acid has been used as Formica rufa, to keep away ants and to lure them to traps, but never as a remedy on any plants. There is some information on Antimonium tartaricum used on plants. Let us discover what the other party found in their research on these acids.

Soil colloids, which consist of organic matter and clay minerals and oxides, such as Fe, Al, and Mn-oxides, have a mixture of positively and negatively charged sites on their surface to which are attracted a range of ions, both organic and inorganic. In most soils the negative charges predominate to give a net negative charge to the soil.

A net positive charge may occur in certain soils, particularly at low pH. These charges are of considerable importance to plant nutrition, since they determine cation and anion exchange capacity of the soil. Organic matter in mineral soils provides between 20% and 80% of the cation exchange capacity. Pure organic soil has a cation exchange capacity (CEC) of 240 centimole (+)/kg and an anion exchange capacity (AEC) of 1 centimole(-)/kg

For instance, smectite and kaolinite, two clays, have a CEC of 118 and 7 and an AEC of 1 and 4 respectively. Because soils are composed of various mixtures of clays, sands, silts and organic matter, the CEC and AEC values vary considerably

Second horizon

Undecomposed and partially decomposed organic layer that forms just on top of the soil. This is the layer where nutrients and small particles of organic matter are deposited. This process uses percolation, or moving down through the soil. It is self-evident that when much less organic matter is available erosion is maximised while when organic matter is plenty available erosion is reduced to a minimum. Here insects and fungi decompose the organic substances, such as leaves, twigs, ashes, dead insect and animal bodies and straw, old blossoms and other organic material. Here life is a feast and all partake in that horizon. Worms from below come up and roll up leaves, which they drag into the ground and consume to their heart's content. Insects chew on twigs to extract the last bits of sap and fungi overcome leaves, corpses and other material to reduce it to its basic components, after which it is further worked into the ground.

There are millions of different living entities per cm^3 and they all have their function in reducing organic matter to its basic components suitable for plant life in a production/reduction cycle we call life. We see also a great variety among them, because there are so many different functions to fulfil in the subterranean world. Plants need nutrients in small sizable bites – not much larger and in similar suspension in colloids as homoeopathic remedies. Bacteria release the nutrients from the organic substrate in a reduction cycle, which the plant then consumes through a reaction cycle – the exact opposite from the bacteria. Viruses are the police force of the plant world, much as they function in humans. It is of course illogical to assign causal qualities to an entity, which is abundant at the final stage of disease and is therefore as much a result as all other symptoms. We have learned in primary school that cause and result are always two *different things*.

Fungi are of course the prime decomposers. We shall later return to these fascinating entities. For now we mention them because of the problems faced by crops – fungal attack. On a bare soil, the fungi have nothing to eat and since survival is the name of the game, they will attack the living plants, because there is nothing else to eat. Hence it is forced by agricultural practice to attack the crop, while making sure there is enough organic matter will keep the fungi in check, since they have other things to eat.

All these soil components can be turned into remedies and be useful in the treatment of our crops. Some fungi have already been exploited by the Agribusiness giants and bacilli have also found employ. While their product suffers from resistance build-up, the homoeopathic potency does not suffer such drawbacks, since it is the dose that confers resistance, rather than any one single substance on its own. Thus *Bacilus thuringiensis* in potency will never develop resistance problems, while its chemically altered counterpart from Agribusiness will do nothing but, simply because it has not been used other than in the crude.

Verticillium lecanii is a soil fungus that is parasitic on insects and is now available as a homoeopathic potency to deter pests. As it is used in potency only, the insects will never develop resistance, since the dose is too small to be detected by the immune-response of the insect. Because in nature there are different levels of scale – from the whale to the bacillus – the use of substances to enhance the life of one species at the cost of another must necessarily be of miniature magnitude to be accepted and hence be effective. Resistance means nothing else than too large a dose, against which the species must develop resistance. Newton already said that when enough pressure is excerted on a moving body, it will change direction. Similarly, when the pressure from the pesticide is large enough, the insect will move in the direction of resistance. If the pressure is exerted gradually and imperceptibly, resistance will not build up because the pressure is not noticed. Hence we use an opposite approach to regular agriculture in the smallness of the dose, while still being effective and without resistance build-up. Next to seeing the plant as a centre of investigation rather than chasing the pest or disease, we have an approach that has

1. proper focus on the plant
2. no chasing of the problem
3. remedy from direct environment
4. unique smallness of dose
5. no resistance build-up

Even homeopathy can do little against deliberate faulty practise and not implementing the recommendations is to *really* believe in a truly Utopian farm – where one does not have to abandon faulty practice but hopes to redress everything with homoeopathic remedies. However, "He must be capable of removing the causes, such as bad habits, undernourishment and exposure to mental and emotional aggravating circumstances and if he is able to remove them he is a true practitioner of the healing arts." (Hahnemann)

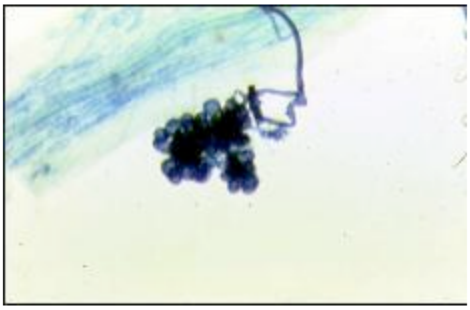
Hence we must redress the situation not just by giving homoeopathic remedies, but remove faulty practices and bad habits, replacing them with sound practices and disciplined plant husbandry. Where we now are faced with the ultimate famine, we can undo the damage still and pretty fast too. We have to be on the ball though and implement proper practice wherever we have the opportunity. It is not too late yet, but if we wait too long it certainly will be harder to change.

Elimination

The lowest horizon is where excess elements are leached out. It consists of larger particles of rock of any one kind; sand, lime or basalt, to name but a few, gravel and other debris. For the purpose of this book only the two top layers are of significance.

Dependent on the amount of organic matter, a soil is either a sponge or it is not. From an ecological point of view, bare soil cultivation, with little or no organic content, adds to global warming, because of its low water retention properties. A soil that acts as a sponge, cools down the air directly above it, thus helping plants to cope better with heat, reducing evaporation, both of the soil and the plant. Reflection is reduced to the minimum possible, if sufficient organic matter is suspended in the soil, while the lack of it increases reflection of heat. Also dependent on the content of organic matter is the dtermination about the quality of the soil - whether it is active or passive. Modern agricultural practises have produced vast tracts of passive soils, because nutrients have been given priority in the growth of plants. Soil is however much more than a medium in which to suspend nutrients.

Dead soils - the ultimate in passivity - have no organic content, little, if any, microbial life, which, for want of its proper foodsource, will attack living plants, creating a host of plant diseases, while the insects are more or less forced into a similar pattern of maintaining themselves. This reverse position requires a drastic turn of events, if the agricultural endeavour is to produce healthy crops and turn it into a viable enterprise, both economically and ecologically.



Soil is very dependent on light and air, however strange this may appear. Air and light are usually associated with above ground phenomena. Yet without light and air, even in the soil, essential elements to life are left out, which plants require for their immune systems. Science knows much more about the part of plants, which grows above ground than about the roots, although this picture is changing fast. The processes in the roots are fairly well known, but little is known about the interaction of soil and root. The emphasis is placed on the nutrients, while the pH - determining the acidity or alkalinity of the soil - is studied only in the context of the nutrient levels. Structure, biological activity and organic content are studied only in relation to these same levels, while the knowledge thus gathered is used only to 'improve' the manufacture, synthetic or otherwise, of the nutrients.

The homoeopathic approach is systemic - it does not compart-mentalize the soil into plants and nutrients, nor does it limit itself to organic content and biomass. Although they are essential building blocks forming a healthy soil, other non-visible elements, perceivable only by their results, are included as well. We have bacteria and viruses, allelochemicals pheromones and pollinators, predators and pests, companion plants and elemental substances that all form part of that systemic approach. From the totality of symptoms we derive as much information as we can. We know when a plant releases certain chemicals to achieve a phase of its development or to defend itself against pest and disease attack. We also know that certain diseases only come with certain weather types and that pests follow fertilizer gifts, especially Kali and Phosphorus. Because we have this knowledge at our fingertips, we are capable of determining which plant or other remedy to use in a particular situation. In the case of a developmental problem, we seek out a remedy made from a plant or an element that would be released around that time and so influence that development in a positive manner. In the case of tomatoes, one gives a dose of Phosphorus, because it is bloom time. Promptly, the poor plant is infested with aphids and Coccinella is the remedy. In the same tomatoes when it goes from flowers to fruits, we need Ocymum to do the trick, because basil releases a chemical in the soil when the tomato sets fruit. It is through viewing such relations that we can understand and deal with problems arising in the growing of our crops. We imitate nature and provide an environment that resembles the natural one as close as possible. This is the secret of growing crops in the best possible manner – employ the relations of elemental nutrients, plants and insects to recreate a virtual diverse environment in which the circumstances are as close to natural reality as possible.

Soil pH

An important property of the soil is its degree of acidity, also called pH. Acid soils have a pH < 7 and alkaline soils have a pH that is > 7. The pH of mineral soils lies between about 3.5 to about 8.5. organic soils may have a lower pH. When the Ph drops below 6, aluminium can occupy a significant portion of the cation exchange phase. Exchangeable bases such as Ca^{2+}, Mg^{2+}, K^+ and Na^+ are more dominant at higher soil pH, meaning the base saturation is greater.

Soils with a pH of 8 to 8.5 typically consist for a large part of calcite. Higher pH levels, > 9, can occur in desert biomes, with higher levels of soluble salts, such as sodium. From these facts we can deduct the following: there is a general trend of decreasing base saturation and increasing saturation with acidic ions such as Al^{3+} and H^+, as the pH decreases.

The sources of protons that contribute to declining soil pH and increasing soil acidity, which are the protons and exchangeable Al present, include also atmospheric deposition of acids, such as H_2SO_4 and NHO_3 generated from atmospheric reactions between water and gaseous NO_X and SO_X from fossil-fuel emissions, H_2CO_3 derived from aqueous dissolution of atmospheric CO_2 or biologically produced soil CO_2 and biological activity, such as respiration, production of organic acids, nitrification of mineralised N or ammonium fertilisers and imbalances of anion and cation uptake by plants. The rate of soil acidification is related to the rates of acid inputs versus soil buffering capacity. The soil pH is mainly buffered by dissolution of calcite and other carbonates at a pH >7, cation exchange of bases by H+ and Al+ or its hydrolysis species at a pH of 7 to 5, dissolution of Al-bearing minerals at a pH < 5, and dissolution of Fe-bearing minerals at a pH < 4.

Phytotoxicity of simple organic acids is most evident under acidic conditions when organic acids are protonated or neutral in charge and this toxicity is lost when organic acids are partially dissociated under neutral and basic conditions or negatively charged.

Influence of pH on Nutrient Availability

Plant nutrient availability varies quite dramatically with soil pH.

In very acid soils all the major plant nutrients (nitrogen (N), phosphorous (P), potassium (K), sulphur (S), calcium (Ca) and manganese (Mn)) and also trace element molybdenum (Mo), may be unavailable to plants, or only available in limited quantities. The other trace elements may be available in such soils in quantities sufficient to have a toxic effect. Some non-essential elements, notably aluminium, may also be available in toxic amounts in acid soils. In Australia there are several areas of such high aluminium content that the soil itself is harvested for its production. There are also areas where the content is too low for aluminium production, but high enough to be toxic to many plants. Several club mosses, among which Lycopodium, take up aluminium from the soil and can be used to detoxify it. Lycopodium is a moss and likes acidic conditions. To this moss aluminium may be an essential element needed for its growth and as a pioneer plant it occupies extreme acidic conditions, where aluminium is toxic for other plants. By removing it and by changing the acidity of the soil it becomes fit for other vegetation.

The picture is reversed in alkaline soils where the trace elements iron, manganese, copper, zinc and boron, so readily available in acid soils, may be unavailable to plants, even through they are present in the soil in adequate amounts and molybdenum is readily available. Therefore our crops have an affinity for some soils and not so much for others, but because we are able to manipulate the soil acidity to a certain degree we can grow crops in soils where they normally would not. For instance liming makes the soil more alkaline but too much may give calcium shock to the plants. Hence regular liming is better than applying large amounts at a time. If the soil is too acidic, the compost must contain lime to neutralise it. If the lime is composted first, the benefit to the plants is much greater, because the soil tends to become more neutral and thus all nutrients are available

Acid Soils

These soils have a high pH, 7.5 or higher. The acidity is expressed as a scale that runs fro 4.5 to 9, whereby 6.5-7 is considered neutral and the lower alkaline, while the higher depict acidic soils. They attract oxalate plants and those that like acidic soils, many of which are weeds. However, many of our crops also like a rather acidic soil, which is often made more so by the use of swine and chicken manure. This has an influence on the nutrients, of which the alkaline may have deficiencies. The nutrients that are alkaline in nature are harder to obtain than those that work through acids, such as Nitrogen. Potassium and Calcium salts may also be in short supply, while the phosphates are all plenty available. Manganese may be hard to get too, since the acidity hinders its uptake. Liming is a good method to make acidic soils more neutral in pH. This soil demands horse manure, for its alkaline qualities. This already tells us much about the above-ground plants – their shapes, their functions and their habitat within the plant community.

The acids are all decomposers and destroyers, which does not mean they are necessarily bad. Many processes cannot take place without the use of acids, the most important of which is perhaps respiration, which runs on the Citric acid cycle and has 7 acids in that cycle to enable uptake of necessary nutrients and processing of carbohydrates to sugars and proteins.

Symptoms of Topsoil Acidity

• Nodulation failure of legumes - reddening of stems and petioles on pasture legumes, or yellowing and death of oldest leaves on grain legumes indicate nitrogen deficiency.
• Deficiency symptoms of sulphur, phosphorus, molybdenum, calcium or magnesium.
• Root growth poor, with stubby roots and few fine roots.
• Crop yields/pasture growth are poor even in good seasons.

The pH scale is logarithmic, so a soil pH of 4.5 has 10 times the concentration of H+ ions than a soil of pH 5.5.

Symptoms of Subsoil Acidity

• Poor root growth (stubby and few fine roots) below 10 cm. Roots are often restricted to the topsoil area for no physical reason (e.g. no hardpan layers or tight clays that may normally stop root growth) since roots will not grow into a soil layer of high acidity.

• Crops drought easily since they have no deep roots.
• Crop yields are poor if spring is dry.

Molybdenum defeciency in kai lan and pak choi: leaf blade narrows and distorts, sometimes thickens; leaf stalks may be twisted.

The soils suitable for pulse crops (field pea, albus lupin, chickpea, faba bean and lentil) are loam and clay soils that occur in about 25% of the 18 million hectares used for agriculture in southwestern Australia. They are amongst the most fertile soils used for agriculture in WA. In addition, field pea is also successfully grown on marginally acidic sandy duplex soils (sand over loam or clay) in the region, and is by far the most widely grown pulse crop in WA.

The soils usually contain more than adequate potassium, sulphur, copper, and molybdenum for crops and pastures, with phosphorus and zinc being the only nutrient element deficiency problems when the soils were newly cleared.

Loam and clay soils, other than those mentioned in some zones, do not generally require copper, zinc or molybdenum, although isolated deficiencies of zinc have been reported.

60 g of molybdenum is contained in 150 g of sodium molybdate, or in 112 g of molybdenum trioxide.

Nutrients have different mobility in the soil and as seasonal moisture conditions vary, so too does the distribution of nutrients derived from applied fertilisers.

Soils differ in their nutrient holding capacity, both generally and for specific plant nutrients.

Neutral pH

A soil with a neutral pH will attract other plants and be better for different crops as the acidic or alkaline soils. They support plants that are in need of balanced diets of nutrients and whereby the excess of one or the other is mostly due to human failure. These excesses help in the build-up of pest populations. Excess Kali and Phosphorus always result in aphid population explosions. What we do to one part, we do to all parts is no more obvious than in this instance. Everything therefore depends on everything else and each part must be taken into account.

Neutral Ph soils have all nutrients available, but not always at the right time. This can be manipulated by using the remedies from the nutrient class or some of the companion plants, which have great influence over nutrient availability, such as Chamomilla. Crops may have requirements at other times that can be manipulated to advantage. Neutral pH is often considered the best soil for growing crops, but this is also dependent on the considerations of necessity for plants to have more acidic or alkaline soils to grow in. in general though the notion stands with many crops.

Alkaline Soils

Alkaline soils have opposite characteristics to the acidic types. Here the trouble is not found in the uptake of Phosphorus Calcium Carbon and Kali. More, the acidic nutrients are difficult to get at and they must be supplied with swine and chicken manure. Horse manure will here be contraindicated, since it is an alkaline manure. Plants that like Carbon, Calcium and Kali thrive on these soils and their predators and pests will be of a different nature. Humidity may be a problem and so may excessive salts.

Excessive salts are only formed in extremely alkaline soils, such as a desert biome. A desert biome can however easily be created by faulty farming practices. Denuding a soil of trees may seem to be a smart move, but by not adding any organic matter to the soil it will soon be depleted. A soil is always more than a medium to grow plants in and suspend nutrients in. A mineral soil has advantages over an acidic one in the availability of nutrients, but this can also be a disadvantage, attracting pests for instance.

Acidic nutrients such as nitric acid and decomposition of ammonium salts to nitrogen may sometimes be problematic. Too little acidity may cause other problems too and the defence against fungi is not well established. On the other hand, fungi will be less of a problem in non-acidic soils. Alkaline environments have morte problems with the sodium salts and here the remedies from the Natrium series can do much to alleviate problems. Phosphorus and magnesium are other elements that help antidote excessive salination. The problems associated with salination may be more difficult to remove than those of acidity.

Carbonates are among the best remedies for alkaline soils. Natrum carbonicum, Calcarea carbonicum, Kali carbonicum and so on all are important remedies for the alkaline soils. They form part of the carbon group of remedies, which are all connected with growth and structure building and through their acids in reduction cycles with Co and CO_2. Carbondioxide is an important greenhouse gas that is said to be responsible for climate change. In the introduction we shall further elucidate on this phenomenon, which we think is due to other causes and has different solutions, one of which is

the abandonment of fossil fuels as *the* energy source to drive this planet.

Organic matter.

This consists of plant debris, as we have seen, dead animals, insects, and other biological entities. This biomass forms the food of a host of other insects, such as ants, slaters, snails and slugs, many fungi, as moulds and mildews, bacteria and viruses. These organisms are called collectively decomposers - they break down organic matter into smaller particles and compounds, which in turn are processed into the various nutrients. The processes are all organic and many bacteria and bacilli are busy decomposing organic matter into ever smaller particles, so that nutrients can be utilised, carbon, calcium and silica are processed back into the soil so that the next generation of plants can live of the debris of their predecessors.

The organic decomposers consist of billions of entities, from the rather large such as snails and slugs, to the minuscule such as the bacterium or the virus. Each one has its own niche within the web of life and all work harmoniously to process organic matter into bite-size pieces for the next scale of living entities.

They are always in relation to and in connection with the organisms that produce them. These organisms release these nutrients in a steady stream to feed the plants. Fine particles of organic matter cling to the roots also and any plant is a decomposer in its own right. The roots, through the process of growth, bring light and air into the soil, together with the rest of the biomass. Microorganisms are of two types; aerobic and anaerobic, the former needs air to function properly, while the latter needs carbon dioxide for the same purpose.

For soil organic matter, 75% of the negative charges are pH dependent. Organic matter determines the anion and cation exchange rates, all dependent on the pH of the soil. We shall see that the pH has a great influence on the availability of nutrients and hence on the type of plants attracted to a particular type of soil.

Some vegetables and grains like a neutral pH, while others thrive on an alkaline or alternatively on an acidic soil. Each of these circumstances determines also what type of soil bacteria, fungi and other entities below-ground are in abundance or abeyance. These in turn are determined by the type of organic debris provided for by the plants that prefer that type of soil, with that type of pH. Naturally it also determines what type of insects are present in the biome, because they are dependent on the plants that grow there. The interconnectedness of all components in the biome depend therefore first of all on the Climate Zone and the Soil pH, because these determine the Habitat, which is the conglomerate of all living species in that biome. It consists of subsoil entities as much as of the flora and fauna above-ground and all play an equally crucial role and are interdependent as in a symbiosis – one cannot exist without the other. Organic matter is thus not only the decaying flora and fauna, but also and foremost the species that do the decomposing.

⓪ Microorganisms

Microorganisms such as bacteria, bacilli and viruses are also present in the soil, some in very large numbers. It has been shown that in $1cm^3$ of soil as many as a billion bacteria may live, although numbers may vary from 10.000 to a million as common occurrences. Depending on where the soil has been collected – the rhizosphere being more densely populated than the soil without any roots – these numbers increase with the amount of biological activity.

Thus in soils that have little or no plant growth, these numbers are very low and in a mixed biosphere of plants the numbers are consequently high. We shall return to these entities when discussing the plant's physiology.

The microorganisms are involved in reaction/reduction cycles, making nutrients available or unavailable to plants. Such is dependent for a large part on the soil pH. Acidic soils have fewer elements available to plants with increasing acidity. Alkaline soils may also be entirely inactive in the release of nutrients, depending on the microorganisms present. It has been shown by many researchers that the activity of microorganisms is highly dependent on soil pH because the level of pH determines which organisms are active or even present in the soil and hence how reaction/reduction cycles take place.

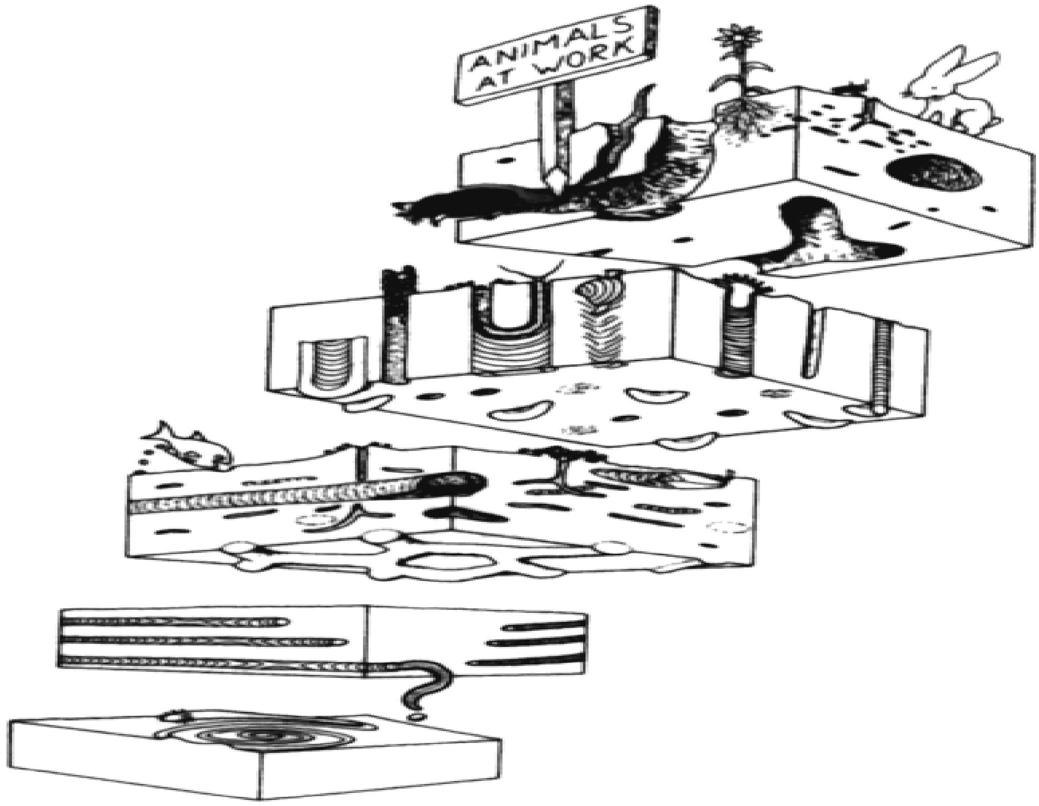
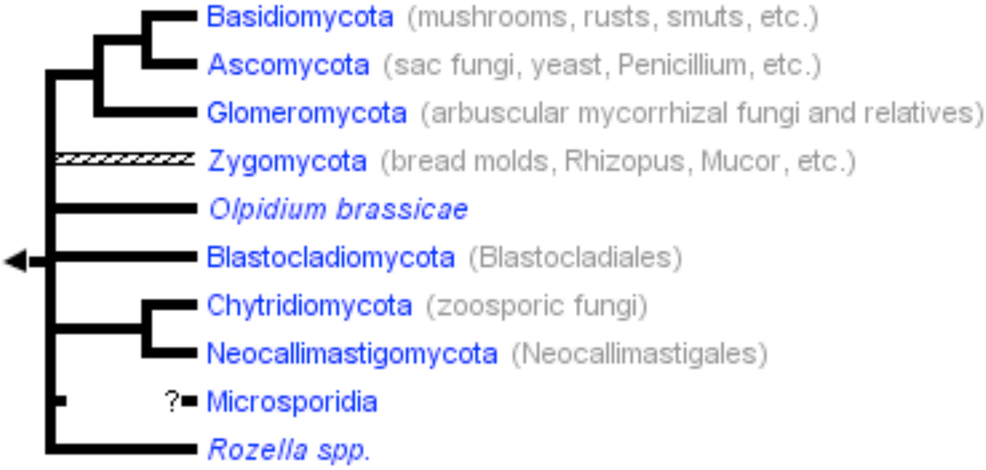


Figure 6. This figure captures a proportionate sense of the sub-aerial-subaqueous, soil-biomantle continuum on planet Earth. The upper block represents the biomantle of subaerial soils, which constitutes 29 percent of the present planetary surface. The four lower blocks represent the biomantle of subaqueous soils, which constitutes 71 percent of the global soil integument. The blocks are meant to convey the coastal-marsh-intertidal zone and continental shelf (second block), the continental slope (third block), and the deep abyss (lower two blocks). (Drawn by R. G. Bromley; from Ekdale et al. 1984.)



❄ Fungi

Introduction

The organisms of the fungal lineage include mushrooms, rusts, smuts, puffballs, truffles, morels, moulds, and yeasts, as well as many less well-known organisms (Alexopoulos et al., 1996). More than 70,000 species of fungi have been described; however, some estimates of total numbers suggest that 1.5 million species may exist (Hawksworth, 1991; Hawksworth et al., 1995).

Phylogeny modified from James et al., 2006a, 2006b; Liu et al., 2006; Seif et al., 2005; Steenkamp et al., 2006.

Containing group: *Eukaryotes*

The tree diagram on the previous page shows the relationships between several groups of fungal organisms

As the sister group of animals and part of the eukaryotic crown group that radiated about a billion years ago, the fungi constitute an independent group equal in rank to that of plants and animals. They share with animals the ability to export hydrolytic enzymes that break down biopolymers, which can be absorbed for nutrition. Rather than requiring a stomach to accomplish digestion, fungi live in their own food supply and simply grow into new food as the local environment becomes nutrient depleted.

The root of the current tree connects the organisms featured in this tree to their containing group and the rest of the Tree of Life. The basal branching point in the tree represents the ancestor of the other groups in the tree. This.ancestor diversified over time into several descendent subgroups, which are represented as internal nodes and terminal taxa to the right.

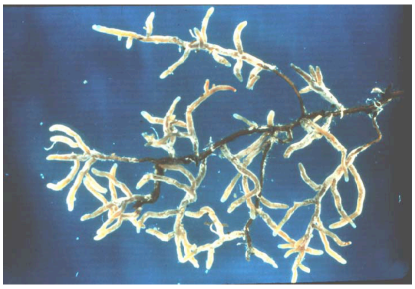
Most biologists have seen dense filamentous fungal colonies growing on rich nutrient agar plates, but in nature the filaments can be much longer and the colonies less dense. When one of the filaments contacts a food supply, the entire colony mobilizes and reallocates resources to exploit the new food. Should all food become depleted, sporulation is triggered. Although the fungal filaments and spores are microscopic, the colony can be very large with individuals of some species rivalling the mass of the largest animals or plants.

Prior to mating in sexual reproduction, individual fungi communicate with other individuals chemically via pheromones. In every phylum at least one pheromone has been characterized and they range from sesquiterpines and derivatives of the carotenoid pathway in *chytridiomycetes* and *zygomycetes* to oligopeptides in *ascomycetes* and *basidiomycetes*.

A Primary Decomposer

Within their varied natural habitats fungi usually are the primary decomposer organisms present. Many species are free-living saprobes (users of carbon fixed by other organisms) in woody substrates, soils, leaf litter, dead animals and animal exudates. The large cavities eaten out of living trees by wood-decaying fungi provide nest holes for a variety of animals and extinction of the ivory billed woodpecker was due in large part to loss, through human activity, of nesting trees in bottom land hardwoods. In some low nitrogen environments several independent groups of fungi have adaptations such as nooses and sticky knobs with which to trap and degrade nematodes and other small animals. A number of references on fungal ecology are available (Carroll and Wicklow, 1992; Cooke and Whipps, 1993; Dix and Webster, 1995).

However, many other fungi are biotrophs and in this role a number of successful groups form symbiotic associations with plants (including algae), animals (especially arthropods), and prokaryotes. Examples are lichens, *mycorrhizae* and leaf and stem *endophytes*. Although lichens may seem infrequent in polluted cities, they can form the dominant vegetation in Nordic environments and there is a better than 80% chance that any plant you find is mycorrhizal. Leaf and stem *endophytes* are a more recent discovery, and some of these fungi can protect the plants they inhabit from herbivory and even influence flowering and other aspects of plant reproductive biology. Fungi are our most important plant pathogens, and include rusts, smuts, and many *ascomycetes* such as the agents of Dutch elm disease and chestnut blight. Among the other well-known associations are fungal parasites of animals. Humans, for example, may succumb to diseases caused by



Pneumocystis (a type of pneumonia that affects individuals with suppressed immune systems), *Coccidioides* (valley fever), *Ajellomyces* (blastomycosis and histoplasmosis), and *Cryptococcus* (*cryptococcosis*) (Kwon-Chung and Bennett, 1992).

Fungal spores may be actively or passively released for dispersal by several effective methods. The air we breathe is filled with spores of species that are air dispersed. These usually are species that produce large numbers of spores, and examples include many species pathogenic on agricultural crops and trees. Other species are adapted for dispersal within or on the surfaces of animals (particularly arthropods). Some fungi are rain splash or flowing water dispersed. In a few cases the forcible release of spores is sufficient to serve as the dispersal method as well. The function of some spores is not primarily for dispersal, but to allow the organisms to survive as resistant cells during periods when the conditions of the environment are not conducive to growth.

Fungi are vital for their ecosystem functions, some of which we have reviewed in the previous paragraphs. In addition a number of fungi are used in the processing and flavouring of foods (baker's and brewer's yeasts, *Penicillia* in cheese-making) and in production of antibiotics and organic acids. Other fungi produce secondary metabolites such as aflatoxins that may be potent toxins and carcinogens in food of birds, fish, humans, and other mammals.

A few species are studied as model organisms that can be used to gain knowledge of basic processes such as genetics, physiology, biochemistry, and molecular biology with results that are applicable to many organisms (Taylor et al., 1993). Some of the fungi that have been intensively studied in this way include *Saccharomyces cereviseae, Neurospora crassa*, and *Ustilago maydis*.

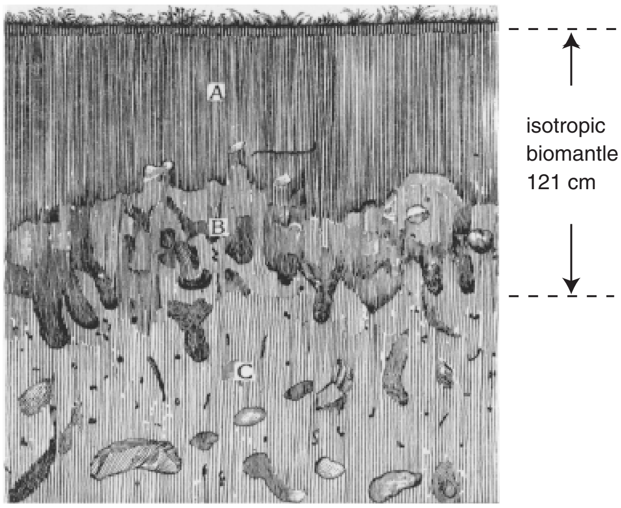
Most phyla appear to be terrestrial in origin, although all major groups have invaded marine and freshwater habitats. An exception to this generality is the flagellum-bearing phyla *Chytridiomycota, Blastocladiomycota*, and *Neocallima-stigomycota* (collectively referred to as chytrids), which probably had an aquatic origin. Extant chytrid species also occur in terrestrial environments as plant pathogenic fungi, soil fungi, and even as anaerobic inhabitants of the guts of herbivores such as cows (all *Neocallimastigomycota*).

Characteristics

Fungi are characterized by non-motile bodies (*thalli*) constructed of apically elongating walled filaments (*hyphae*), a life cycle with sexual and asexual reproduction, usually from a common *thallus*, haploid *thalli* resulting from zygotic meiosis, and heterotrophic nutrition. Spindle pole bodies, not centrioles, usually are associated with the nuclear envelope during cell division. The characteristic wall components are chitin (beta-1,4-linked homopolymers of N-acetylglucosamine in microcrystalline state) and glucans primarily alpha-glucans (alpha-1,3- and alpha-1,6- linkages) (Griffin, 1994).

Exceptions to this characterization of fungi are well known, and include the following: Most species of chytrids have cells with a single, smooth, posteriorly inserted flagellum at some stage in the life cycle and centrioles are associated with nuclear division. The life cycles of most chytrids are poorly studied, but some (*Blastocladiomycota*) are known to have zygotic meiosis (therefore, alternation between haploid and diploid generations). Certain members of *Mucoromycotina, Ascomycota*, and *Basidiomycota* may lack hyphal growth during part or all of their life cycles, and, instead, ***produce budding yeast cells***. Most fungal species with yeast growth forms contain only minute amounts of chitin in the walls of the yeast cells. A few species of *Ascomycota (Ophiostomataceae*) have cellulose in their walls, and certain members of *Blastocladiomycota* and *Entomophthoromycotina* lack walls during part of their life cycle (Alexopoulos et al., 1996).

So far the nature of fungi and some of their different classes, of which the *Ascomycota, Chitridomycota and Microsporidia* but also the *Zygomycota* with its subclass *Mucoromycotina* are of interest to us. This is because the first class is used for antibiotics and the next two classes are known for their ability to cause disease. However, before we proceed further with the antibiotics, we first like to impress upon the reader the dangers of fungi that may infest our grains*, which are related to antibiotics* and for which orthodoxy has no treatment or cure.



We have seen from the above that there are several phylae in the Class of fungi that each has large amounts of different families of fungi, with countless individual species. Many of these live in the soil, and another portion spends its life on decomposing plant and animal debris, while another class of fungi attacks living plants, such as rusts, smuts, phytophtera, and other fungal diseases of plants.

We continue with the history of these fungal diseases on grains, with which the first 'cure' with antibiotics spontaneously took place. For these belong in the class of *Ascomycota*, like all penicillins and most other antibiotics. From the above tree, these fungi are the ones that have our interest here. The *basidiomycota* are their close brothers, and some of these fungi also have found employ as medicines, of which the two under discussion in this book.

In the past as well as the present, most grains were and are prone to fungal diseases of which 'mother corn' or *secale cereale*, also known as *claviceps purpurea*, is the most famous, since it is surmised that it was also the precursor to LSD. While superficially similar in chemical structure, the effects of these two substances could not be further removed from each other as they are. In accordance with its common name, *secale cereale* lives on grains mainly.

Before we give it, we must mention another fungal disease of corn or maize, which is called smut. This is possibly worse than ergot poisoning, as eating anything made with the grains has severe repercussions, as we shall see.

Darnel is another grain implicated in fungal diseases. It was often eaten when the other grain harvests had been eaten by pests and a famine threatened. It also had serious consequences..

Remedies

Carbolic acid and many of the phenols and resins from plants and trees are powerful homoeopathic remedies in agriculture. They are all carbon based and all partake of construction and maintenance in the living systems. Carboneum and Carbon itself are also important remedies for these type of soils. We shall enumerate the different substances that can be used as remedies and which are derived from Elemental Carbon. Those we already use have been provided with an asterix *.

* Acetic acid.
Acetylsalysilicum acidum.
* Ammonium aceticum.
* Azadirachta indica.
Benzenum.
Benzinum
Benzinum dinitricum
Benzinum nitricum
Benzinum petroleum
Calcarea acetica

* Calcarea carbonica
Calcarea lactica
Calcarea oxalica
* Camphora.
* Carbo vegetabilis
Carbolicum acidum.
Carboneum.
Carboneum oxygenisatum
Carboneum sulphuratum.
* Citricum acidum
Cosmolinum.
Croton chloralum.
Cuprum aceticum.
* Eucalyptus
* Formicum acidum.
* Gallicum acidum.
Gaultheria.
Keroselinum.
Ketoglutaricum acidum
* Kreosotum.
Kresolum.
* Lacticum acidum.
* Magnesia acetica.
* Manganum aceticum
* Mentha piperita
Mentholum.
Naphta.
Naphtalinum.
Natrium pyruvicum.
* Natrum salicylicum.
Oleum Santali.
* Oxalicum acidum
Paraffinum.
Petroleum.
Propylaminum.
Salicinum.
* Salicylicum acidum.

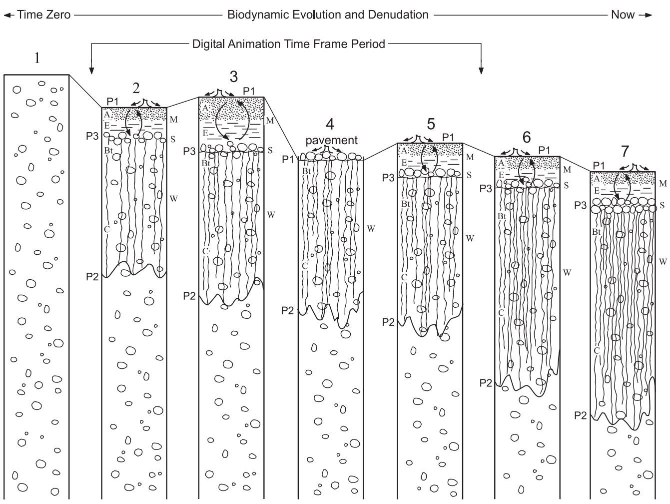


Figure 5. Hypothetical evolution of a glacial drift soil (now a Mollisol) similar to that of Figure 4a, from time zero (1) in the middle Pleistocene (≅ 600,000 years ago) to the present (7) in a midlatitude temperate environment. The location is the Iowan surface of northeastern Iowa and southeastern Minnesota of North America, a landscape underlain by glacial drift, with a prairie soil (presently) whose presettlement biomantle was profusely mixed by animals, especially the dominant bioturbator of this landscape, the Plains pocket gopher, *Geomys bursarius*. An E horizon is weakly expressed just above, and also partly coincident with, the stonelayer. (Pedons 2–5 span the digital animation that accompanies Johnson et al. forthcoming; see also http://www.staff.uiuc.edu/ ~ jdomier/temp/biomantle.html. (Modified from Figure 4 of Johnson and Balek 1991.)

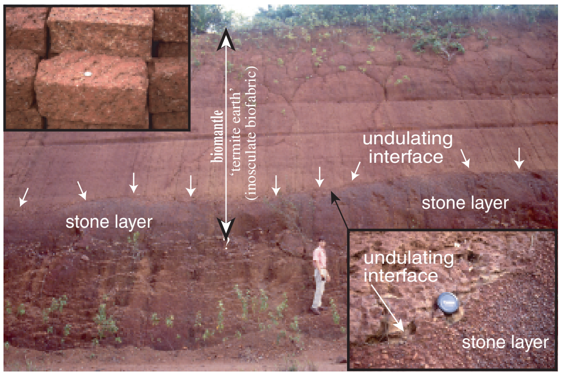
Tannicum acidum.
* Tartaricum acidum.
Terebinthina.
Terebinthina chios.
Terebinthina laricina
Thymol.
* Urea pura.
Uricum acidum.

From this list we can immediately derive 35 new remedies that are useful in the treatment of plants, without even considering their intrinsic qualities and characteristics, because these remedies all are carbon-based and as such important parts of the structure of the living universe. They are already in use for humans and therefore their symptoms must be similar in plants.

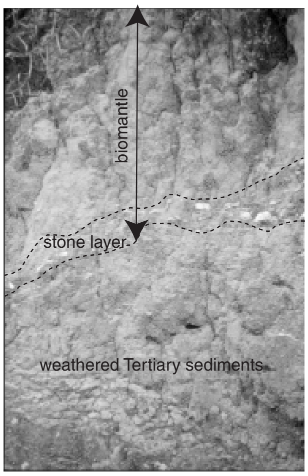
if a plant has reproductive problems, a remedy that helps humans with such problems will also be effective in plants and on the same symptomatology. The external manifestations are almost identical and show such close similarity that this might be called the most anthropomorphic part of all plant diseases and pests.

Many of these substances have such influences, besides being useful in other diseases such as fungal and/or bacterial conditions, provide protection against weeds and pests, attract pollinators and predators and be useful at different stages of development. Juvenile plants behave different from their grown-up elders and attract different insects, showing they emit different pheromones and are in a different stage of development. Young trees have no nests for birds in them, until they have reached a certain height. Some trees never have bird's nests, while others collect them like old brooms.

The different relations between the components in a natural habitat can be read by having a close look and by not moving too much and if one moves, do not move like a human, with rhythmic steps, but like a browsing animal – then a step here, next a step or two there, then a few steps more, a single step, always with a pause in between. Those are the normal sounds of the forest. Also wear clothes you only wear in the forest and be a nonsmoker, use no aftershave, perfumes or other scents, unless derived from the forest itself. The more you smell like the forest, the more you will see. The more you smell like a city-slicker, the least you will see, because even if you make all the right moves, your smell has chased everything away already. There you find the relatiuons between remedies and plants, elements, fungi, bacteria and so on, including allelochemicals, by observing what grows in the forest and where does it grow in relation to others, what insects and animals visit it and if they do, what for. Everything in nature happens for a reason and these reasons are what homoeopathy is after and specifically for agriculture these are significant, because they show solutions to what often seems a problem at first.



They can help us solve the problems associated with growing crops, although some could be fossil-fuel based. Even if we leave those out, do we still have sufficient remedies to choose from. If we consider that these form but a fifth at most of the compounds listed in the homoeopathic literature, we understand we have many more remedies to chose from. Although at present little or nothing is known about them for plants, from the family relationship we can make some predictions, especially if the individual parts of the compound have been known to homoeopathy before and also been used on plants in the past. From the use of Carbo veg we have learnt a lot and we expect that the other carbon compounds have similarities with Carbo veg while also having sufficient differences to be of use for similar but different problems. While anthropomorphising helps at times, it is not an important part of the entire picture. We rely more on the alchemical viewpoint of signature, which is a valid means to arrive at conclusions, because these conclusions have invariably been confirmed and verified in practise.



Soil Improvers

Soil improvers are known in agriculture as manure, compost and slush, which were traditionally produced at the farm and spread over the land. It was left to the worms to work it into the soil and the soil remained healthy.

With the beginning of the so-called Green Agricultural Revolution, chemical fertilisers were introduced, which seemed to do away with both the smell and the flies associated with manure and compost. It also appeared that the crops fared well by the regular feeds of fertiliser, seemingly adapted to the lifecycle of the plants.

Potassium and nitrogen during the growing phase produced larger and stronger plants. Increasing the phosphor content during flowering and fruitsetting seemed also to produce a bigger and better looking crop. However, this increase occurred with a simultaneous loss of taste. The food produced ceased to be healthy. Like in human society people became overweight from fast-food, the plants were similarly simply obese.

When subsequently the pests and diseases increased, requiring ever larger doses of poison, the food produced became factually dangerous to eat. Besides too large amounts of nitrogen, which is carcinogenic, also large amounts of poisons like DDT and the organochlorides were consumed. This notwithstanding withholding periods and the advise to wash fruit and vegetables thoroughly before consumption.

Rudolph Steiner was the first to see that bare soil cultivation with chemical fertilisers was the wrong way to go about. He developed several preparatios from cow manure – B500 – and pure silicea – B501 – to improve the soil without the stink and the flies. His preparations restore soil microbial life, add the necessary nutrients in for plants digestible form and improve its structure.

We like to present some of his findings here and offer the general public the possibility to do away with chemicals in the garden altogether.

If we prepare an elemental or vegetable substance according to either the homoeopathic method or the Steiner method, we discover a liberation of this consciousness, available in that element or vegetable matter. By adding these preparations to the soil, it becomes a harmonious living organism, which conveys this harmony to the plants that grow in it. The fruits we may harvest from such plants will add to our own harmony as well.

Healthy living is not just buying and eating good food. It is a complete and total concept, which includes the way we live and use the land. Whether for living, growing food or letting it wild, harmonious use of the land is of prime importance to our own survival. With these preparations we can create optimum conditions for growing food and living harmonious healthy lives. This enables us the time to realise for what purpose we were put on earth and put it in practise.

In the first volume of this work, we have also alluded to a constitution of plants, which we understand to be anchored in the Natural Order and Family in which a plant belongs. We have explained that the pests and diseases that visit one Order are often different from those of another Order. Cabbages have different diseases from grains, as every farmer can confirm.

This leads to the conclusion that different crops must require different bio-dynamic preparations, since their constitutions differ according to Natural Order, which governs their growth and their fruits. Steiner and Hugo Erbe seem to have concluded that each preparation is equally suited to all plants that grow on the soil so prepared. He also recommends the preparations to be used on all bio-dynamic farms, taking no account of the differences in soil that must exist between them.

However, we feel we have to differentiate their preparations according to differences in soil types – peat or sand need different preparations from loam or loess. Hence we will recommend such preparations based on the considerations of soil type and Natural Order of the crop.

From the background we come from, we also do not retail or recommend certain preparations, since we feel that killing a cow to obtain the four stomachs and their content as well as its blood, is going too far just to prepare a liquid compost builder. Steiner's idea was to bring more harmony. Killing cows to obtain something harmonious is in our vision incompatible with harmony – it is an oxymoron. The argument it is a sacrifice is but a false excuse, since nothing is done for the soul of the cow. Moreover, in natural death, the entire cow will disappear into the ground, except its bones.

Of course one may argue that using insect predators is little different. However, we never claimed the remedies to be harmonious. On the contrary, the remedies are mirror-images of the diseases and pests they treat and will cause the pest or disease to appear when given too often. One must fight fire with fire and not with oil. Killing cows – which are the most positive of animals – will for that reason not produce a harmonious result, regardless the claim. How will such needless killing affect our own harmony?

Using a few predators as negative forces to neutralise a negative pest, results in a positive result. What purpose serves the death of the cow other than producing compost, which its natural death also would provide? None whatsoever. The natural death of the predator serves nobody, while its homoeopathic preparation serves millions of plants and thousands of people.

Homoeopathic Remedies As Fertilisers

A select range of homoeopathy medicines is proving to be excellent bio-fertilizers with pest repellent properties for a range of plants and crops during field studies conducted by a volunteer team at the Government Homoeopathic Medical College here.

The results of these "clinical trials" on plants and crops have been much more than encouraging, with application of liquid form of the drugs in adjusted dosage returning bumper harvests and augmenting self-protective mechanisms to ward off disease and repel pests and insect attacks.

"Farmers, who tried it out on their crops as diverse as coconuts and bitter gourds, paddy and banana, have been ecstatic about the boost in yield," Dr. M. Abdul Lethif, Principal of the Government Homoeopathic Medical College in Thiruvananthapuram, project conceiver, told The Hindu.

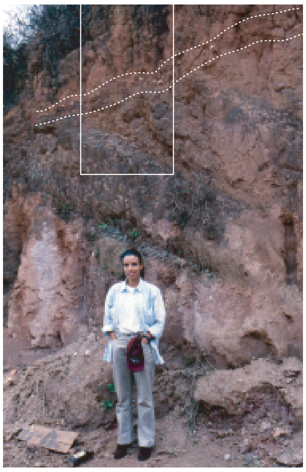
"Most importantly, the medicine-equipped plants/crops were enabled to ward off disease and pest attacks," says Dr. Lethif, who is also controlling officer, Department of Homoeopathic Medical Education, Kerala.

Dr. Lethif has been working on a baseline of around 10 homoeopathic formulations, classified as the "Agrocare" range of residue-free and organic vitalisers for the past eight years. The identity of the ingredients, supplied in the form of globules, is being kept a closely guarded secret as the innovator has applied (on October 20, 1999) for a patent at the office of the Controller for Patents in Chennai.

The phenomenon has already attracted the attention of the Union Agriculture Ministry, which has sought a demonstration before a panel of experts of the Indian Council for Agricultural Research.

However, in spite of the promising potential of the homoeopathic bio-fertilizers, there is yet to be a State-supported and systematic initiative to validate the innovation for largescale application in a State where the farming sector is in disarray.

The vitalisers have been tested at the Government seed farms at Chirayinkeezhu and Ulloor a couple of years ago but no systematic evaluation has ensured the trial. The most sincere attempt as yet has been initiated on 1.75 ha of banana plantations and 3 ha of paddy in Kunnatthukal grama panchayat in the district.



Field observations led by the agriculture officer, Mr. Gireesh Kumar, have already indicated that initial results from the application of homoeopathic medicines were encouraging. The technique was cost-effective, eco-friendly and provided improved yield and better control over pest and diseases of crop. However, prior to largescale use of this technique there had to be detailed research to explore the full possibilities of organic farming, according to the agricultural officer.

Meanwhile, the acceptance has been spontaneous among farmers who have volunteered to experiment with the medicines. Not only had the field trials with the homoeopathic medicines gained much from higher yields but also the plants and crops on the medicine- soaked soil base had not been attacked by pest, insects or any disease.

Wherever homoeopathic experiment had been attempted, the results were enthusing. Farmers have tested the bio-fertilizers on arecanut in 1999 at Maikavu and on five varieties of vegetables at Chelannur in Kozhikode and on orchids and anthuriums at Anayara in Thiruvananthapuram.

It is pointed out that plants do need some insects and need to ward off others. A group of plants follows a system of communication with chemicals, through a process known as allelopathy.

According to Dr. Lethif, it could be seen from the trials that application of homoeopathy solvents had lend additional protection to the plants by producing certain chemicals that are repellent to harmful insects or by increasing the natural immunity of the plants and trees.

"This inference leads to the potentiality of preparing separate formulations for the disease/pests for various crops such as coconut, pepper, plantains, tubers, or even flowering plants", says Dr. Lethif.

The innovation was presented as part of a compendium of background papers on the focal theme of the 12th Kerala Science Congress in January last year. The event organised by the State Committee on Science, Technology and Environment, had focussed on "Health for weaker sections and disabled".

The hope held out by this organic vitaliser will also figure in a paper presentation at the one-day workshop organised by the Kerala Agricultural University in Thrissur on November 22.

Insects

Many of the 'pests', identified as such because of their habit to feed on our food crops, are actually supposed to feed on organic debris, just as that is the function of fungi, bacteria and viruses. In the absence of dead organic matter these organisms are forced to feed on living plants, in order to restore the imbalance, created by huge monocropping practice and bare soil cultivation. In nature, the sum total of events is designed to maintain balance. Balance means even spacing, because it will prevent the crowding of one particular species. Monocultures are designed to outdo natural arrangements. Spa-ce in nature tends to be occupied by as great a variety as the natural habitat allows. Through this mechanism nature limits disease and the consequent elimination of any one species of plant, insect or animal. Too many plants or animals of the same species occupying too small or large a space triggers the mechanism that prevents breeding and makes up for excess through more rapid death, by means of pests and diseases.

All stable natural systems have those switches, but not all populations do. In Australia we see this in the rapid explosion of the rabbit and cane toad populations. In agriculture, species like the locust, the aphid or the Colorado beetle, rodents like rats and mice display the phenomenon that when provided with sufficient food, will rapidly produce enormously more young than the available food supply. Humans are by this definition the greatest pest of all. A farmer sowing a crop of their favourite food supply creates a situation where there is a massive reduction in the infant mortality rate of the pest.

Fluctuation implies relationship, because there is a flow between the living beings in an ecosystem. As man exploits nature he disturbs the flow, when his dealings are disharmonious. Thus man is at war with nature, while he could do much better if he sees her as a lover. Harvesting from nature can be seen as another form of natural death within an ecosystem, provided the spacing between plants is kept as natural as possible. In this way nature can be fooled into believing that harvesting is an absolutely natural occurrence, similar to grazing and foraging animals. To this end it is imperative that the immediate surroundings of food crops are as natural as possible and where such is impossible because of monocropping, that we imitate the natural setting as close as possible, to enable the growing of enough food to feed every human on the planet and have surplus to boot. By making nature believe that all is normal through imitation of the natural habitat we have achieved the possibility to monocrop without massive losses. In the absence of the natural habitat we cannot ever gain control of pests and diseases when these moreover are seen as the problem, while being but a symptom of an overall malaise of faulty husbandry. Thus the solution is to always imitate nature and trick her in believeing everything is perfectly arranged as a complete plant community.

osition

In the soil above this horizon the nutrients and allelochemicals are deposited. In general ten of the elements are believed to be nutrients. These ten elements, carbon hydrogen, nitrogen, oxygen, potassium, calcium, magnesium, phosphorus, sulphur and iron, were about a hundred years ago designated as essential elements for plant growth. In the early 1900s manganese was added. The importance of silica has only recently, around 1985, received the full attention it deserves. At present we know that copper, boron and molybdenum play an important role as well, while for some plants cobalt and aluminum are necessary. In speaking of inorganic nutrients, it follows that there must be organic forms as well. Little is said about them in the textbooks, maybe due to the fact that inorganic chemistry is not interested in the investigation of the organic content of the elements.

Although chemical analysis is useful to determine the relative amounts of nutrients in certain stages of growth of the healthy plant in natural surroundings, it is by no means an exclusive yardstick, as different plants have different requirements in different ecosystems.

Deficiencies will create havoc in equal manner as excesses. The homoeopathic approach requires that which is natural to a particular ecosystem. In some the soil may be dead, as in the desert, or rich, as in the rainforest. Soils are as individual as the plants that prefer a particular type. Thus the soil type is the first point of investigation, together with its structure and the amount of biomass. In the case of dead soils, much can be done to revive it, by the selection of the appropriate remedy.

It is difficult to compare pH readings in water to pH readings in calcium chloride. A rough guide to convert from pHw to pHCa is to subtract 0.8 from the pH in water measurement (although the real difference in pH at extreme may be from 0.6 to 1.2).

A 1:5 mix of soil: $CaCl_2$ solution (0.01M strength calcium chloride) strength is used to estimate the concentration of hydrogen ions in the soil solution.

Soil conservation

Soil conservation consists of a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by overuse, salinization, acidification, or other chemical soil contamination. The principal approaches these strategies take are:

- choice of vegetative cover
- erosion prevention
- salinity management
- acidity control
- encouraging health of beneficial soil organisms
- prevention and remediation of soil contamination
- mineralization
- other ways are
- no till farming
- contour plowing
- wind rows
- crop rotation
- the use of natural and man-made fertilizer
- resting the land

Many scientific disciplines are involved in these pursuits, including agronomy, hydrology, soil science, meteorology, microbiology, and environmental chemistry.

Decisions regarding appropriate crop rotation, cover crops, and planted windbreaks are central to the ability of surface soils to retain their integrity, both with respect to erosive forces and chemical change from nutrient depletion. Crop rotation is simply the conventional alternation of crops on a given field, so that nutrient depletion is avoided from repetitive chemical uptake/deposition of single crop growth.

Cover crops serve the function of protecting the soil from erosion, weed establishment or excess evapotranspiration; however, they may also serve vital soil chemistry functions. For example, legumes can be ploughed under to augment soil nitrates, and other plants have the ability to metabolize soil contaminants or alter adverse pH. The cover crop Mucuna pruriens (velvet bean) has been used in Nigeria to increase phosphorus availability after application of rock phosphate. Some of these same precepts are applicable to urban landscaping, especially with respect to ground-cover selection for erosion control and weed suppression.

Windbreaks are created by planting sufficiently dense rows or stands of trees at the windward exposure of an agricultural field subject to wind erosion. Evergreen species are preferred to achieve year-round protection; however, as long as foliage is present in the seasons of bare soil surfaces, the effect of deciduous trees may also be adequate. Trees, shrubs and groundcovers are also effective perimeter treatment for soil erosion prevention, by insuring any surface flows are impeded. A special form of this perimeter or inter-row treatment is the use of a "grassway" that both channels and dissipates runoff through surface friction, impeding surface runoff, and encouraging infiltration of the slowed surface water.

Erosion prevention

When surface planting is not feasible, there are a variety of mechanical management tactics to protect surface soils from water and wind erosion. Need for these tools arises on construction sites and other situations of transition, where bare soils are exposed. The primary tactics applied are mulching of soil surfaces and use of surface runoff barriers. From 1990 to 2005 considerable innovation has occurred in manufacture of plastic confined hay-bale products, so that a variety of shapes and sizes of runoff barriers can be delivered to the construction site.

There are also conventional practices that farmers have invoked for centuries. These fall into two main categories: contour farming and terracing, standard methods recommended by the U.S. Natural Resources Conservation Service , whose Code 330 is the common standard. Contour farming was practiced by the ancient Phoenicians, and is known to be effective for slopes between two and ten percent. Contour plowing can increase crop yields from 10 to 50 percent, partially as a result from greater soil retention.

There are many erosion control methods that can be used such as conservation tillage systems and crop rotation.

Keyline design is an enhancement of contour farming, where the total watershed properties are taken into account in forming the contour lines. Terracing is the practice of creating benches or nearly level layers on a hillside setting. Terraced farming is more common on small farms and in underdeveloped countries, since mechanized equipment is difficult to deploy in this setting.

Human overpopulation is leading to destruction of tropical forests due to widening practices of slash-and-burn and other methods of subsistence farming necessitated by famines in lesser developed countries. This is a plain lie because it is not overpopulation but McDonald that causes destruction of rainforests. Greed is stronger than overpopulation and the latter is used as an excuse to defend the indefensible. A sequel to the deforestation is typically large-scale erosion, loss of soil nutrients and sometimes total desertification.

Salinity management

The ions responsible for salination are: Na+, K+, Ca_2+, Mg_2+ and Cl-. Salinity is estimated to affect about one third of all the earth's arable land.

Soil salinity adversely affects the metabolism of most crops, and erosion effects usually follow vegetation failure. Salinity occurs on drylands from overirrigation and in areas with shallow saline water tables. In the case of over-irrigation, salts are deposited in upper soil layers as a byproduct of most soil infiltration; excessive irrigation merely increases the rate of salt deposition. The best-known case of shallow saline water table capillary action occurred in Egypt after the 1970 construction of the Aswan Dam. The change in the groundwater level due to dam construction led to high concentration of salts in the water table. After the construction, the continuous high level of the water table led to soil salination of previously arable land.

Another case of soil salination is Australia where arable land is in short supply and nutrients no longer present in the soil that is there. Cutting the trees has led to a rise in the water table and a consequent salination level with K+ Ca_2+ Mg_2+ and Cl-. This process continues to this day with a some exceptions, where farmers plant trees on land no longer useful for agriculture and achieve some lowering of the watertable.

Use of humic acids may prevent excess salination, especially in locales where excessive irrigation was practiced. The mechanism involved is that humic acids can fix both anions and cations and eliminate them from root zones. In some cases it may be valuable to find plants that can tolerate saline conditions to use as surface cover until salinity can be reduced; there are a number of such saline-tolerant plants, such as saltbush, a plant found in much of North America and in the Mediterranean regions of Europe.

Soil pH

Soil pH levels adverse to crop growth can occur naturally in some regions; it can also be induced by acid rain or soil contamination from acids or bases. The role of soil pH is to control nutrient availability to vegetation. The principal macronutrients (calcium, phosphorus, nitrogen, potassium, magnesium, sulfur) prefer neutral to slightly alkaline soils. Calcium, magnesium and potassium are usually made available to plants via cation exchange surfaces of organic material and clay soil surface particles. While acidification increases the initial availability of these cations, the residual soil moisture concentrations of nutrient cations can fall to alarmingly low levels after initial nutrient uptake. Moreover, there is no simple relationship of pH to nutrient availability because of the complex combination of soil types, soil moisture regimes and meteorological factors.

The important observation is that pH is the regulatory mechanism to plant nutrient uptake, and that the theoretical concentration of soil nutrients is meaningless until pH levels are in the optimum range for uptake. Soil pH can be raised by amendment by agricultural lime and liming (soil); The pH of an alkaline soil is lowered by adding sulfur, iron sulfate or aluminium sulfate, although these tend to provide costly short term benefits. Urea, urea phosphate, ammonium nitrate, ammonium phosphates, ammonium sulfate and monopotassium phosphate also reduce soil pH.

Soil organisms

Promoting the viability of beneficial soil organisms is an element of soil conservation; moreover this includes macroscopic species, notably the earthworm, as well as microorganisms. Positive effects of the earthworm are known well, as to aeration and promotion of macronutrient availability. When worms excrete egesta in the form of casts, a balanced selection of minerals and plant nutrients is made into a form accessible for root uptake. US research shows that earthworm casts are five times richer in available nitrogen, seven times richer in available phosphates and eleven times richer in available potash than the surrounding upper150 mm of soil. The weight of casts produced may be greater than 4.5 kg per worm per year. By burrowing, the earthworm is of value in creating soil porosity, creating channels enhancing the processes of aeration and drainage.

Soil microorganisms play a vital role in macronutrient wildlife. For example, nitrogen fixation is carried out by free-living or symbiotic bacteria. These bacteria have the nitrogenase enzyme that combines gaseous nitrogen with hydrogen to produce ammonia, which is then further converted by the bacteria to make other organic compounds. Some nitrogen fixing bacteria such as rhizobia live in the root nodules of legumes. Here they form a mutualistic relationship with the plant, producing ammonia in exchange for carbohydrates. In the case of the carbon cycle, carbon is transferred within the biosphere as heterotrophs feed on other organisms. This process includes the uptake of dead organic material (detritus) by fungi and bacteria in the form of fermentation or decay phenomena.

Mycorrhizae are symbiotic associations between soil-dwelling fungi and the roots of vascular plants. The mycorrhizal fungi increase the availability of minerals, water, and organic nutrients to the plant, while extracting sugars and amino acids from the plant. There are two main types, endomycorrhizae (which penetrate the roots) and ectomycorrhizae (which resemble 'socks', forming a sheath around the roots). They were discovered when scientists observed that certain seedlings failed to grow or prosper without soil from their native environment.

Some soil microorganisms known as extremophiles have remarkable properties of adaptation to extreme environmental conditions including temperature, pH and water deprivation.

The viability of soil organisms can be compromised when insecticides and herbicides are applied to planting regimes. Often there are unforeseen and unintended consequences of such chemical use in the form of death of impaired functioning of soil organisms. Thus any use of pesticides should only be undertaken after thorough understanding of residual toxicities upon soil organisms as well as terrestrial ecological components.

Killing soil microorganisms is a deleterious impact of slash and burn agricultural methods. With the surface temperatures generated, virtual annihilation of soil and vegetative cover organisms is achieved, and in many environments these effects can be virtually irreversible (at least for generations of mankind). Shifting cultivation is also a farming system that often employs slash and burn as one of its elements.

Mineralization

To allow plants full realization of their phytonutrient potential, active mineralization of the soil is sometimes undertaken. This can be in the natural form of adding crushed rock or can take the form of chemical soil supplement. In either case the purpose is to combat mineral depletion of the soil. There are a broad range of minerals that can be added including common substances such as phosphorus and more exotic substances such as zinc and selenium. There is extensive research on the phase transitions of minerals in soil with aqueous contact.

The process of flooding can bring significant bedload sediment to an alluvial plain. While this effect may not be desirable if floods endanger life or if the eroded sediment originates from productive land, this process of addition to a floodplain is a natural process that can rejuvenate soil chemistry through mineralization and macronutrient addition.

Soil contamination

There are thousands of roces]] chemicals that enter soil systems, most of which have an adverse effect upon soil quality and plant metabolism. While the role of pH has been discussed above, heavy metals, solvents, petroleum hydrocarbons, herbicides and pesticides also contribute soil residues that are of potential concern. Some of these chemicals are totally extraneous to the agricultural landscape, but others (notably herbicides and pesticides) are intentionally introduced to serve a short-term function. Many of these added chemicals have long half-lives in soil, and others degrade to produce derivative chemicals that may be either persistent or pernicious.

Typically the expense of soil contamination remediation cannot be justified in an agricultural economic analysis, since cleanup costs are generally quite high; often remediation is mandated by state and county environmental health agencies based upon human health risk issues.

Soil contamination is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage tanks, application of pesticides, percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensity of chemical usage.

The concern over soil contamination stems primarily from health risks, both of direct contact and from secondary contamination of water supplies. Mapping of contaminated soil sites and the resulting cleanup are time consuming and expensive tasks, requiring extensive amounts of geology, hydrology, chemistry and computer modeling skills.

It is in North America and Western Europe that the extent of contaminated land is most well known, with many of countries in these areas having a legal framework to identify and deal with this environmental problem; this however may well be just the tip of the iceberg with developing countries very likely to be the next generation of new soil contamination cases.

The immense and sustained growth of the People's Republic of China since the 1970s has exacted a price from the land in increased soil pollution. The State Environmental Protection Administration believes it to be a threat to the environment, to food safety and to sustainable agriculture. According to a scientific sampling, 150 million mi (100,000 square kilometres) of China's cultivated land have been polluted, with contaminated water being used to irrigate a further 32.5 million mi (21,670 square kilometres) and another 2 million mi (1,300 square kilometres) covered or destroyed by solid waste. In total, the area accounts for one-tenth of China's cultivatable land, and is mostly in economically developed areas. An estimated 12 million tonnes of grain are contaminated by heavy metals every year, causing direct losses of 20 billion yuan (US$2.57 billion).

The United States, while having some of the most widespread soil contamination, has actually been a leader in defining and implementing standards for cleanup[3]. Other industrialized countries have a large number of contaminated sites, but lag the U.S. in executing remediation. Developing countries may be leading in the next generation of new soil contamination cases.

Each year in the U.S., thousands of sites complete soil contamination cleanup, some by using microbes that "eat up" toxic chemicals in soil[4], many others by simple excavation and others by more expensive high-tech soil vapor extraction or air stripping. At the same time, efforts proceed worldwide in creating and identifying new sites of soil contamination, particularly in industrial countries other than the U.S., and in developing countries which lack the money and the technology to adequately protect soil resources.

Health effects

The major concern is that there are many sensitive land uses where people are in direct contact with soils such as residences, parks, schools and playgrounds. Other contact mechanisms include contamination of drinking water or inhalation of soil contaminants which have vaporized.

There is a very large set of health consequences from exposure to soil contamination depending on pollutant type, pathway of attack and vulnerability of the exposed population[citation needed]. Chromium and obsolete pesticide formulations are carcinogenic to populations[citation needed]. Lead is especially hazardous to young children, in which group there is a high risk of developmental damage to the brain, while to all populations kidney damage is a risk.

Chronic exposure to at sufficient concentrations is known to be associated with higher incidence of leukemia .Obsolete pesticides such as mercury and cyclodienes are known to induce higher incidences of kidney damage, some irreversible; cyclodienes are linked to liver toxicity. Organophosphates and carbamates can induce a chain of responses leading to neuromuscular blockage.

Many chlorinated solvents induce liver changes, kidney changes and depression of the central nervous system. There is an entire spectrum of further health effects such as headache, nausea, physical fatigue, eye irritation and skin rash for the above cited and other chemicals.

Ecosystem effects

Not unexpectedly, soil contaminants can have significant deleterious consequences for ecosystems. There are radical soil chemistry changes which can arise from the presence of many hazardous chemicals even at low concentration of the contaminant species. These changes can manifest in the alteration of metabolism of endemic microorganisms and arthropods resident in a given soil environment. The result can be virtual eradication of some of the primary food chain, which in turn have major consequences for predator or consumer species. Even if the chemical effect on lower life forms is small, the lower pyramid levels of the food chain may ingest alien chemicals, which normally become more concentrated for each consuming rung of the food chain. Many of these effects are now well known, such as the concentration of persistent DDT materials for avian consumers, leading to weakening of egg shells, increased chick mortality and potentially species extinction.

Effects occur to agricultural lands which have certain types of soil contamination. Contaminants typically alter plant metabolism, most commonly to reduce crop yields. This has a secondary effect upon soil conservation, since the languishing crops cannot shield the earth's soil mantle from erosion phenomena. Some of these chemical contaminants have long half-lives and in other cases derivative chemicals are formed from decay of primary soil contaminants.

Regulatory framework

United States of America

Until about 1970 there was little widespread awareness of the worldwide scope of soil contamination or its health risks. In fact, areas of concern were often viewed as unusual or isolated incidents. Since then, the U.S. has established guidelines for handling hazardous waste and the cleanup of soil pollution. In 1980 the U.S.Superfund/CERCLA established strict rules on legal liability for soil contamination. Not only did CERCLA stimulate identification and cleanup of thousands of sites, but it raised awareness of property buyers and sellers to make soil pollution a focal issue of land use and management practices.

While estimates of remaining soil cleanup in the U.S. may exceed 200,000 sites, in other industrialized countries there is a lag of identification and cleanup functions. Even though their use of chemicals is lower than industrialized countries, often their controls and regulatory framework is quite weak. For example, some persistent pesticides that have been banned in the U.S. are in widespread uncontrolled use in developing countries. It is worth noting that the cost of cleaning up a soil contaminated site can range from as little as about $10,000 for a small spill, which can be simply excavated, to millions of dollars for a widespread event, especially for a chemical that is very mobile such as perchloroethylene.

China

China, an economy that regularly records double digit annual economic growth, has little or no legislation to protect the environment. Currently, given the amount of land in question (up to one-tenth of China's cultivatable land may be polluted), the degree of the pollution in specific locations is unclear, making both prevention and remedy difficult. There are no laws or environmental standards regarding soil. Funding is limited, too, so there is little advanced scientific study of China’s soil taking place. The severity of the pollution is not known by the public or business population, and the situation is most likely worsening as a result.

United Kingdom

Generic guidance commonly used in the UK are the Soil Guideline Values published by DEFRA and the Environment Agency. These are screening values that demonstrate the minimal acceptable level of a substance. Above this there can be no assurances in terms of significant risk of harm to human health. These have been derived using the Contaminated Land Exposure Asseeement Model (CLEA UK). Certain input parameters such as Health Criteria Values, age and land use are fed into CLEA UK to obtain a probablistic output[citation needed].

Guidance by the Inter Departmental Committee for the Redevelopment of Contaminated Land (ICRCL) has been formally withdrawn by the Department for Environment, Food and Rural Affairs (DEFRA), for use as a prescriptive document to determine the potential need for remediation or further assessment. Therefore, no further reference is made to these former guideline values.

Other generic guidance that exists (to put the concentration of a particular contaminant in context), includes the United States EPA Region 9 Preliminary Remediation Goals (US PRGs), the US EPA Region 3 Risk Based Concentrations (US EPA RBCs) and National Environment Protection Council of Australia Guideline on Investigation Levels in Soil and Groundwater.

However international guidance should only be used in the UK with clear justification. This is because foreign standards are usually particular to that country due to drivers such as political policy, geology, flood regime and epidemiology. It is generally accepted by UK regulators that only robust scientific methods that relate to the UK should be used.

The CLEA model published by DEFRA and the Environment Agency (EA) in March 2002 sets a framework for the appropriate assessment of risks to human health from contaminated land, as required by Part IIA of the Environmental Protection Act 1990. As part of this framework, generic Soil Guideline Values (SGVs) have currently been derived for ten contaminants to be used as "intervention values"[citation needed]. These values should not be considered as remedial targets but values above which further detailed assessment should be considered.

Three sets of CLEA SGVs have been produced for three different land uses, namely

residential (with and without plant uptake)

allotments

commercial/industrial

It is intended that the SGVs replace the former ICRCL values. It should be noted that the CLEA SGVs relate to assessing chronic (long term) risks to human health and do not apply to the protection of ground workers during construction, or other potential receptors such as groundwater, buildings, plants or other ecosystems. The CLEA SGVs are not directly applicable to a site completely covered in hardstanding, as there is no direct exposure route to contaminated soils.

To date, the first ten of fifty-five contaminant SGVs have been published, for the following: arsenic, cadmium, chromium, lead, inorganic mercury, nickel, selenium ethyl benzene, phenol and toluene. Draft SGVs for benzene, naphthalene and xylene have been produced but their publication is on hold. Toxicological data (Tox) has been published for each of these contaminants as well as for benzo[a]pyrene, benzene, dioxins, furans and dioxin-like PCBs, naphthalene, vinyl chloride, 1,1,2,2 tetrachloroethane and 1,1,1,2 tetrachloroethane, 1,1,1 trichloroethane, tetrachloroethene, carbon tetrachloride, 1,2-dichloroethane, trichloroethene and xylene. The SGVs for ethyl benzene, phenol and toluene are dependent on the soil organic matter (SOM) content (which can be calculated from the total organic carbon (TOC) content). As an initial screen the SGVs for 1% SOM are considered to be appropriate.

Cleanup options

Cleanup or remediation is analyzed by environmental scientists who utilize field measurement of soil chemicals and also apply computer models for analyzing transport[6] and fate of soil chemicals. Thousands of soil contamination cases are currently in active cleanup across the U.S. as of 2006. There are several principal strategies for remediation:

Excavate soil and remove it to a disposal site away from ready pathways for human or sensitive ecosystem contact. This technique also applies to dredging of bay muds containing toxins.

Aeration of soils at the contaminated site (with attendant risk of creating air pollution)

Thermal remediation by introduction of heat to raise subsurface temperatures sufficiently high to volatize chemical contaminants out of the soil for vapour extraction. Technologies include ISTD, electrical resistance heating (ERH), and ET-DSPtm.

Bioremediation, involving microbial digestion of certain organic chemicals. Techniques used in bioremediation include landfarming, biostimulation and bioaugmentation soil biota with commercially available microflora.

Extraction of groundwater or soil vapor with an active electromechanical system, with subsequent stripping of the contaminants from the extract.

Containment of the soil contaminants (such as by capping or paving over in place).

△ ▽ Nutrient Imbalance

Nourishing Nutrients

All remedies from this section can be used as they have been made for human use. Nonetheless, we have seen fit to produce the remedy in a different manner, so that more qualities come to the fore because the remedy is to be used on many individuals over a large surface. Therefore, we produce the remedies for plants in a different manner as for humans, although humans can also use the remedies as they have been made for plants. The process is somewhat more involved and requires more time and effort. The most essential is that the final

product, regardless whether obtained in the pharmacy or from us, must receive 50 succussions before applying it to the water with which it is mixed before application on the plants. The 50 succussions are necessary to confer enough power to the remedy to penetrate everywhere, before UV has destroyed it in such minute dilutions. Within 24 to 48 hours after the application of the remedy all traces have been absorbed or been destroyed by UV. In the case of weed remedies we generally recommend 48 hours waiting time before sowing the crop, but with some remedies, we recommend sowing the crop and then applying the remedy, to kill two birds with one stone – suppress weeds and simulate the crop. Examples are Juglone for corn and Avena sativa before cabbage or other Brassicacea.

Most nutrients are essential for certain functions of plant life; be it photosynthesis, growth or metabolism. Some plants are characterised by unusual higher or lower concentrations of (a) particular nutrient(s).I t is therefore self evident that plants have different requirements amongst each other, even if grown in the same medium. Because of the complexity of the biomass it may appear that for instance alfalfa benefits from a nitrogen boost, as it is a nitrogen fixing plant. However, alfalfa can only take up the nitrogen provided by soil-bacteria, which would suffer a redundancy with a nitrogen boost, leaving the plant nitrogen deficient. Other plants, called C_4 plants, require sodium instead of potassium, or at least to a greater extent. Atriplex, also known as saltbush, is one of several halophytes, which requires salt to properly grow. Salt is pumped from the leaf tissue through the stalk into large expanding bladder cells. Soybeans, when deprived of nickel, will develop toxic levels of urea, resulting in necrosis in the leaf tips, and reduce growth.

Inorganic ions affect osmosis and thus help water balance (see Nat.m., and others like Sul. and the Kali preps.) Because several inorganic ions can serve this purpose, independent from each other, in many different plants, it is understood to be non-specific. On the other hand, an inorganic element may function as part of an essential biological molecule and as such its necessity is highly specific. As an example, magnesium presence in the chlorophyll molecule is highly essential to and in photosynthesis. Magnesium is strongly attracted to light and helps oxidation in the form of the oxide, thus enhancing oxygen production and release.

Some elements are essential to the structure of cell-membranes, while others control the function of these membranes, such as permeability. The enzyme systems in plants require specific elements to be present, while others again provide the ionic tension, required for certain biological reactions. Deficiencies affect a wide variety of structures and functions, as do excesses. This is because they fill such basic needs and processes essential to healthy growth and strong immune systems in the plant body.

One of the key roles elements play, is in the participation as catalysts in enzymatic processes. They can be an essential part in the enzyme structure. They can also function as activators and regulators of enzymes. Potassium is thought for instance to be involved in some 50 to 60 enzymes and is believed to regulate the production of some proteins. As biologists look at the single elements, the interactions between different elements, such as the compounds, like nitrate of potassium or the phosphate of sodium are little understood. In the homoeopathic scenario, these differences in action between for instance the Kali salts enable us to fine tune the treatment to a greater degree of accuracy. Thus not only can the change in shape of the enzyme expose or obstruct the reaction site, it will do so and be the cause of some forms of disease.

Many of the biochemical activities of cells, such as starch and protein production, photosynthesis and respiration fall within the class of oxidation/reduction processes. Some elements serve as structural components such as calcium and silica. Calcium combines with pectic acid, to form the lamella in the plant cell wall. Silica gives the skeletal strength to a plant, as is found in the haulm the cambium and the skin of seeds. Phosphorus is found in the sugar phosphate chains of both DNA and RNA, but its function is by no means limited to providing the backbone of the genetic material. Backbone function is also found in the hardest parts of the plant, such as bark and cambium. Too much or too little phosphorus causes degeneration, a generative function as the word implies. Nitrogen is an essential component of amino acids, chlorophyll and nucleotides. Sulphur is also found in amino acids, thus forming a component of proteins.

Plants use elements – mostly in compounds – from the Periodic Table of Elements, just as humans and animals do. However, they use not every element of the Periodic Table, but for their food are restricted to the first four Periods, as the table below shows. In those Periods, they also do not use every element, but are further restricted to only some.

Group**

Period	1 IA 1A																	18 VIIIA 8A
1	1 H 1.008	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 -------	9 VIII ------- 8 -------	10 -------	11 IB 1B	12 IIB 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.47	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80

From the first Period, only Hydrogen has any significance, whereas Helium is not found in plants. From the second Period, Boron is significant, Carbon is a main constituent, Nitrogen a major nutrient and Oxygen a major elemental substance they exhale during the day, while at night it is inhaled. Oxygen is an important element in all living entities for it enables respiration and helps in oxidation/reduction cycles. Fluoride has some importance too, in the development of certain plant constituents that deal with reproduction.

From the third Period, Natrium has importance in the water regulation of the tissues; Molybdenum is quite important, Magnesium and Silica and Phosphor, as well as Sulphur are important plant constituents. Aluminium is sometimes toxic to plants, especially in acid soils.

In the fourth Period, we see as the first element Kalium, next Manganese, Ferrum, Copper, Nickel and Zinc are the elements with significance. All other elements have not been discovered to play a role in plant life. While some take up considerable amounts of elemental substances that belong in the other periods of the Table, these are to us only of significance in their ability to take up heavy metals, to decontaminate the soil. For the rest, plants derive their essential nutrients from the first four Periods of the Periodic Table of Elements after Mendeliev.

It is as an aside interesting to note that the elements of the Periodic table have qualities that return every octave, both vertical and horizontal, as was discovered by Newlands, 3 years before Mendeliev presented his version. Newlands was laughed at, to connect such a frivolic subject as music to such serious matters as discussions on the Periodic Table of Elements. That he was right has been reluctantly admitted by some physicists, when they discover similarities in principles and reactive capacity in every element that lies under the one preceding it, because it is an octave or two after the previous.

For homoeopathy this is also significant and no homoeopaths have to date seen and published these facts from study of the materia medica. We shall point out such similarities where we find them, because they are found back in the relationships between the remedies. One of them is found in Carbon and Silicea, which both are elements of construction – one the brick, the other the cement. Another is Boron and Aluminium, which antidote each other – at least in plants. Natrium and Kalium have also similarities, just as Magnesium and Calcium, Nitrogen and Phosphorus, Oxygen and Sulphur. Since they are similar they are often each other's antidote or at least fulfil a function of complementary action, previous action and other surprises.

Naturally, the compounds, consisting of salts and acids have an important role to play in plant life, since few elements are taken up in their pure forms. Plants, like all life forms, do not assimilate elements in their pure form, since the oxidation/reduction cycles by their very nature do not work with pure elements. In the following chapter we shall introduce these elements in their pure form however, to show their importance in plant life as part of the different compounds that have significance.

Some elements cannot exist in their pure forms, because they are too reactive and immediately oxidise or undergo other reactions with surrounding elemental substances in compounds. Hence they are useless as remedies, because they cannot be processed into one. Of these elements we only list compounds. Kalium is one example that is so reactive, it cannot even be made pure, unless under strict vacuum conditions. A substance like Kali cannot be potentised, because it would immediately react with lactose, water or alcohol and form a compound. Hence of the Kalium group of remedies we list many of its compounds.

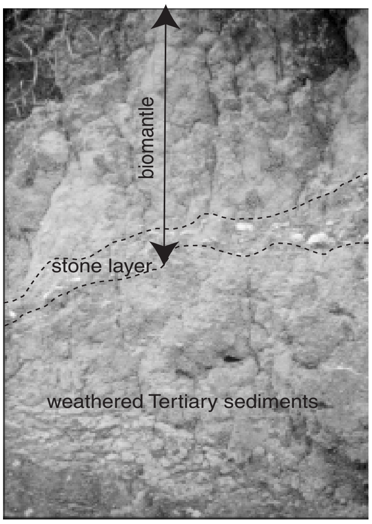


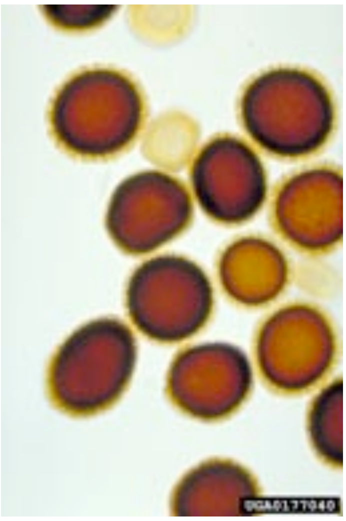
Figure 2. A very thick biomantle with a very thick residual stonelayer exposed in a north-facing roadcut along the east-west inland "coastal" road some 100 km west of Abidjan, Ivory Coast. (Horizontal marks are artificial scratches caused by road equipment.) The environment is perhumid tropical, with broadleaf rainforest prior to deforestation and agriculture. The dominant bioturbators are mainly species of termites (unidentified) and ants that produce surface mounds. This biomantle is indicative of the efficacy of conveyor belt species of bioturbators (Table 1), mainly termites and ants, that operate in perhumid and thickly forested landscapes where the biodynamic processes were probably, before clearing for cultivation, more or less in balance with removal processes. The white arrows define the top of the stonelayer; black arrow points to the recent burrow of an unidentified small mammal. The lower right inset shows a close-up of the interface between the stonelayer and upper, inosculate-dominated, termite-produced biofabric in this biomantle. The upper left inset shows laterite bricks (quarter for scale) composed of inosculate biofabric, now hardened and identical to that in the lower inset, that is so common in biomantles throughout the moist tropics.

Of the compounds there are many more than of the pure elements, but we shall not be repetitive in always enumerating their constituents. All elements to the right of the Period's peak element, which is always a noble metal, react with oxygen to form and acid, while those to the left of the peak produce a salt. Salts and acids are the constituents of the oxidation/reduction cycles and make these cycles possible. The Krebs cycle for instance works with only acids as its main constituents, many of which are however not found in the periodic table, while some are found to contain elements important to it.

Some plants contain a particular element in large amounts, which may not be found in others, such as clubmoss, which contains 28% of aluminium, and like extremely acidic soils, where such aluminium is available, or horsetail, which consists for 80% of Silica and likes mineral soils. Saltbush is one of the few plants that can live in an extremely salty environment where other plants would immediately perish. Hence the significance of the different elements differ from plant to plant, although most plants require similar amounts of nutrients. Some live on acid soils, while others prefer alkaline soils.

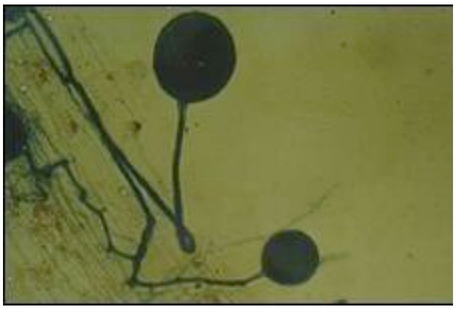
Such plants form the exception to the rule that plants need only the elements of the first four Periods of the Table for nutritional purposes.

Although some plants take up several other elements from the rest of the Table, it must be noted that these are not counted as nutrients. Nutrients are only those elements that are found in sufficient amounts in *all* plants. Therefore, we do not consider these elemental fractions as nutrients, but as special capacities and characteristics of only some plants, notwithstanding their sometimes considerable amounts.



Jan Scholten, a Dutch homoeopath, has done extensive investigations on the presence of such elements in plants, which he collected in two slim volumes. What struck us as at least strange was the absence of the element silica in many of his examples. We considered this strange, because all plants contain silica in significant amounts, since this element forms part of many plant structures, such as the cell walls, the cambium and the external covering of the roots. While interesting as a field of research, we do not consider his findings as very significant in the treatment of plant diseases and pests, because they are highly variable and differ greatly from plant to plant. He did his research more from the viewpoint of homoe-opathic remedies, where such findings may have significance in the treatment of people. We on the other hand use these tables to find plants and remedies for our section on pollution of the soil, the air and the water. From our point of view, we must alleviate the problems for the farmers, because good farm produce means healthier people who work more and harder and moreover, a rich farming community means also a strong economy.

The modern-day farmer is faced with ever-larger problems to produce a crop and still make sufficient money. Most need heavy subsidies to just play even. Since the beginning of the promising chemical revolution in agriculture, the problems have only increased. While first producing bigger crops, farmers have seen their lands produce ever-smaller crops, with ever-greater losses to pests and diseases. While the traditional farmer lost 5 – 10% of his crop, the modern equivalent is happy if his losses stay below the 30% mark.



The soil has become poorer and the amounts of fertiliser added have become larger almost every year. Thus the ground water is made saltier and no longer fit to drink or use on crops even. The added problems of pests and diseases have further added to the farmer's bills, since chemical pest-, disease- and weed-control measures must be repeatedly applied, to still have a minimal effect. Even the Agricultural Departments are agreed upon that commercial fertilisers are not ideal, to say the least.

'Nutrients in the form of commercial fertilisers have several drawbacks associated with their use. We shall name them first, before we deal with the other problems associated with excesses and deficiencies of these chemically made elementary substances. There are volatilisation, leaching, time of application and the evenness of spreading to consider.'

Nutrients as fertiliser, now where did that concept of enhancing fertility come from? Mind you, not to fertilise the soil, but solely for the plant's ability to produce offspring. While on first consideration this seemed a smart move, it overlooked some of the essential components of the nutrient cycle, by pretending it did not exist in the first place. The soil is not a medium in which you can suspend soluble nutrients at will and expect them to remain there for your convenience.

Next, fertility is the plant's goal and reason of being, so we must assist her in achieving that objective. Therefore the use of fertilisers seems to be again a smart move, but since the dose is outside the control of the farmer and the plant, it may suffer from too little when there is insufficient rain or too much when the rain does not stop for some time. Moreover, the dose is uncontrollable because of the crude size. Nutrients are therefore only available when it rains and in times of long dry spells, one must water the fields anyway to help the plants survive and this releases the fertiliser, which in turn leads to growth. However the plant knows the difference between water from rain and from irrigation by light, smell and taste. Water that arrives without a darkening of the sky is not rain water and smells and tastes very different from a good shower of rain. Even we know that difference.

Therefore the boost from the fertiliser is used in gaining height to maintain itself if the dry spell holds. If you give it water often, it becomes dependent and all that green needs a lot of water. Therefore, the result will be watery.

Now when you use the remedies, you imitate a relaxed community of plants living around your crop, which grows on and in organic matter because it feels better that way. If that is not possible, use at least a dose of

B500 every now and then. Your plants will have nutrients in balance and there is no leaching, because the organic matter holds the nutrients, being part of the cycle. The microbes feed off the decomposed and decomposing organic matter and process the nutrients by passing them on to the fungi that live in symbiosis with the plant roots and thus enter the plant completely attenuated and transformed from the once living bodies of its forebears. Plant debris must be composted or left on the land to function as fertiliser for the next crop and often to keep down the weeds. Since many farmers do not work that way their following crop has lots of weeds and he spends a fortune keeping it down. He needs to go about in a different way, but can redress only at the next crop

Volatilisation

'Urea forms an alkaline zone around each granule as it breaks down. At this higher pH, the urea changes into ammonia gas (which contains nitrogen). If the urea is covered by soil, most of this ammonia will be absorbed by the soil. However, if the urea is on the soil surface, much of the nitrogen supplied by the urea can be lost to the atmosphere as ammonia. This process is known as volatilisation.

'Volatilisation will occur only with urea on light soils, because these light soils are acidic. However, losses can occur with the other ammonium sources if they are top dressed on to alkaline soils such as sands. Losses by volatilisation will vary according to conditions at the time.

'Losses can be avoided if the urea is covered by soil soon after application or washed into the soil by a good rain following application. Maximum loss will occur when the urea is top dressed on moist, light soil and application is followed by an extended warm dry period.

'Volatilisation losses from urea in the field will generally range from 0 to 20 per cent of the nitrogen applied. Where early application is advisable, avoid most of the loss by topdressing the urea before sowing and covering it during the seeding operation. Deep banding of urea will also avoid this loss.'

(Farmnote 27/96)

Our answer is that sensible applications of manure and compost, together with bio-dynamic soil preparations (see paragraphs on weed control: 'Weed and Soil Remedies'.) will remove the risk of volatilisation, since urea, ammonia and nitrogen form part of the manure and compost in the exact balanced amounts the plant needs. As cow manure it is neutral, as chicken or pig manure it is acidic and as horse manure it is alkaline. Thus acid soils receive horse manure and alkaline soils are fed chicken and/or pig manure, while the neutral ones receive cow manure, all to come to the neutral pH balance, best fro growing crops.

ACHING

'Except on very poor sandy soils, little ammonium nitrogen is leached. However, nitrate nitrogen is very susceptible to leaching and urea can be leached while it remains as urea. On most soils, the urea will be completely converted to ammonium nitrogen within a week, with 90 per cent being converted in two to three days.

'Ammonium nitrogen is converted by special bacteria to nitrate nitrogen by a process called nitrification. The rate of this conversion depends on several factors, including soil moisture and soil pH. The process is slow on low pH soils and rapid on alkaline soils. The more organic content, the faster the conversion.

‘Because of the greater acidifying effect of fertilisers such as ammonium sulphate, the ammonium nitrogen in these sources is less rapidly nitrified to nitrate than with less acidifying sources such as urea.’

(Farmnote 27/96)

The longer the nitrogen stays in the ammonium form, the less susceptible it is to leaching. However, any loss from leaching depends on the amount of nitrate present during leaching rains.

On the other hand, if the topsoil dries, the ammonium nitrogen that remains in this zone will not be available to the plant until the topsoil is rewetted, while nitrate nitrogen may be available because it has moved downward into a moist soil zone.

Drying out of soils can easily be avoided when compost is added in sufficient quantities. The application of compost and green manure also reduces the occurrence of bacterial, viral and fungal diseases. These will be kept busy decomposing plant debris and compost. Moreover, leaching is reduced to almost nil if manure and compost are added, while the need for extra gifts of chemical fertilisers is also removed.

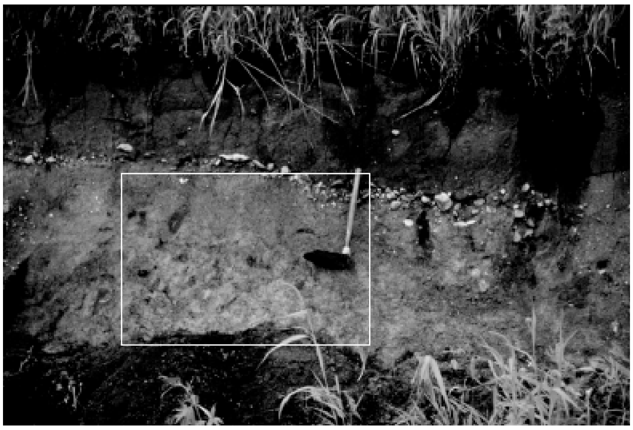


Figure 4a. Photo shows a thin biomantle with a barely discernible eluvial layer that occurs slightly above (though largely coinciding with) a basal stonelayer in a prairie soil 5 km west of Elma on State Road B-17, Howard County, Iowa. The location is the Iowan surface of northeastern Iowa and southeastern Minnesota, underlain by glacial drift. (The handle of the trench shovel is 51 cm (20 in.) long, and its head is 20 cm (8 in.) wide. The presettlement biomantle was profusely biomixed by pocket gophers and other small vertebrates, and their predators, and by crayfish, worms, ants, and such. Before cultivation, pest control, and land drainage, the two dominant bioturbators of this landscape segment were the Plains pocket gopher (*Geomys bursarius*), a typical mixmaster species, and crayfish, typical conveyor belt organisms (cf. Table 1, Figures 4b and 5).

Time of application

‘Nitrogen-phosphorus fertilisers are usually applied at sowing, drilled with the seed, because phosphorus is needed in a band close to the seed at establishment.

‘Urea and other nitrogen-only sources should be applied within four weeks after sowing. In higher rainfall areas, where leaching is more likely, do not apply them before four weeks, unless a machine is unlikely to get on the land later. In that case, apply the nitrogen earlier.

‘Nitrogen is needed early in the life of the crop because the main response is through increased tillering, which is determined early. If application is delayed beyond four weeks after sowing, there is less chance of getting a profitable response.

Figure 4b. Close-up of subsoil of Figure 4a, showing vertically arrayed krotovina of crayfish to left of shovel, plus other krotovina of much smaller invertebrates (worms, ants), which are, collectively, conveyor belt bioturbators (cf. Table 1; dimensions of shovel as in Figure 4a).

‘The time of application is less critical where there is a reasonable supply of soil nitrogen than where fertility is very low. This is because the soil nitrogen supply may be enough to produce the tillers and set up the yield potential, while the nitrogen fertiliser is only needed to help realise that potential by ensuring survival of ear-bearing tillers.’

Naturally, it is better to use biodynamic sprays than chemical fertilisers, since soil microbial life is important in the processing of nutrients, before they are digestible to plants. To engage this microbial life in their normal occupation – digestion of organic matter – we need to add compost and manure, rather than try to adjust the fertiliser lemands by adding chemicals in unbalanced proportions.

Evenness of spreading

‘If any nitrogen fertilisers are topdressed, it is important to get an even spread. Spinner type spreaders often result in uneven distribution of fertiliser with more than the recommended rate in some places and less, or none, in other places. The overall response will be less than with even spreading, because the increased yield in the strips receiving high fertiliser rates will be less than the decreased yield in the strips getting lower rates of fertiliser.

'It is important to get even distribution of fertiliser, even if it means using a combine to topdress.'

All these problems disappear when the farmer switches from commercial fertiliser to the one produced by his livestock for free and ages it properly. Old manure does not smell bad, attracts no flies and can be easily spread on the fields. When processed into B-500, cow manure can be used as a 'top-dressing' if such is desired or necessary. Its liquid form does not result in volatilisation, while a properly structured soil does not allow leaching.

Also consider

''When you are choosing between nitrogen-phosphorus fertiliser sources, also consider: the ease of handling and storage; the rate of fertiliser that can be drilled in contact with the seed without a harmful effect on plant numbers and grain yield. Do not drill urea in contact with cereal seed, either alone or in mixtures, at rates greater than 30 kg/ha. No urea should be placed with canola seed. Canola germination is very susceptible to the soluble nitrogen fertilisers and especially to urea.

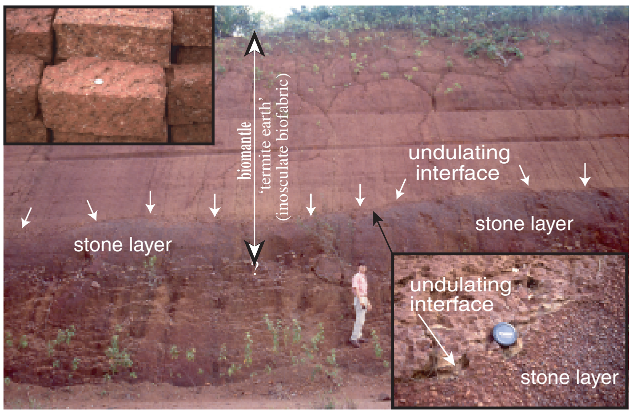
'If there is doubt about the need for other nutrients such as sulphur and zinc and if you cannot check this easily, use sources containing these nutrients as an insurance, particularly if there is little difference in the cost of nitrogen and phosphorus supplied by the chosen fertilisers.''

(Farmnote 27/96)

Many times, the amount of water coming into the production system cannot be controlled. In these situations there are some simple techniques to conduct water away from plant crowns and roots to prevent the kind of environment that favors *Phytophthora*. Methods include planting on raised beds or mounds, planting in permeable, well-drained soils, using highly porous potting mixes, tiling poorly drained fields and sloped container beds. In each case, excess water drains away from plant crowns and roots before *Phytophthora* can become a problem. In any situation, planting raspberries on raised beds was as effective as chemical control of Phytophthora root rot.

''Soil layers such as hardpans impede drainage and often allow free water to accumulate above the hardpan. This sets up a favorable environment for *Phytophthora* infection. Preventing excess soil compaction – stopping using the tractor – or ripping or subsoiling these areas can help increase water drainage.''

(Farmnote 27/96)



Of course subsoiling and ripping are nullified by the tractor riding in the furrows. They are as such only a measure to be executed with draught animals; the better suited will be the bull. For such a large plow, a sixspan of bulls is necessary. Impractical and timeconsuming, ripping is really not the option. Such soils will be best improved by raising the organic content, since this will greatly improve drainage and break up the hardpan, if not too deep below the topsoil. Worms are better than plows in breaking up the soil and therefore it is only logical to increase their presence by adding humus, compost and old manure.

Considering the ease a farmer has when using the homoeopathic approach, combined with the right bio-dynamic preparations, it remains to those convinced of the correctness of this appraoch to convince the farmers. Generally it is the farmers' wives, who convince their husbands. We may have to rely on them to convince their husbands of this way.

The only other convincing argument is that it saves the farmer a lot of money. However, as the Dutch remark; ‘the farmer will never eat what he does not know.’ Having been led to believe that alternatives to the modern chemical way means returning to his grandfather’s days he dismisses anything that to him reeks of ‘hippies, greens and other long-haired work-shy folk’.

Little do they realise that this is Future Farming, doing away with outdated ideas. This is science-fiction to most, but science-fact to the users and those involved in its development. Space-age in concepts and means, this goes beyond the concepts of those that think in mechanistic, rather than dynamic terms.

While mechanistic terms are inadequate to explain the dyna-mic processes at work, they have a practical function in that they provide the visible signs and symptoms, which due to similarities are sometimes diffi-cult to distinguish from one another. Deficiencies demand their own terminology, explain-ing the visible signs and des-cribing what has happened and is happening. Let us have a look at this terminology and see whether we can discover the differences and similarities.

Terminology of nutrient deficiencies

Chlorosis

General yellowing of the leaf tissue. A very common deficiency symptom, since many nutrients affect the photosynthesis process directly or indirectly.

Coloration abnormalities

Some deficiencies lower the amount of photosynthesis and chlorophyll which is produced by the plant. Other colored compounds can then become dominant. When normal nutrient sinks are not available, the plants can store up excess sugars within other compounds which have distinct colors of red, purple, or sometimes brown. The absence of chlorophyll altogether causes the plant to turn white.

Firing

Yellowing, followed by rapid death of lower leaves, moving up the plant and giving the same appearance as if someone touched the bottom of the plants with a flamethrower.

Interveinal Chlorosis

Yellowing in between leaf veins, but with the veins themselves remaining green. In grasses, this is called striping.

Necrosis

Severe deficiencies result in death of the entire plant or parts of the plant first affected by the deficiency. The plant tissue browns and dies. This is called necrosis. The tissue which has already died on a still living plant is called necrotic tissue.

Stunting

Many deficiencies result in decreased growth. This can result in shorter height of the affected plants. It will also show up as deformed leaves as in curly top.

Functions of the 17 soil elements

Plant nutrition is the study of the chemical elements that are necessary for plant growth. There are several principles that apply to plant nutrition.

Some elements are essential, meaning that the absence of a given mineral element will cause the plant to fail to complete its life cycle; that the element cannot be replaced by the presence of another element; and that the element is directly involved in plant metabolism (Arnon and Stout, 1939).

However, this principle does not leave any room for the so-called beneficial elements, whose presence, while not required, has clear positive effects on plant growth.

Plants require specific elements for growth and, in some cases, for reproduction.

Major nutrients include:

1. C = Carbon 450,000 ppm
2. H = Hydrogen 60,000 ppm
   - = Oxygen 450,000 ppm
3. P = Phosphorus 2,000 ppm
4. K = Potassium 10,000 ppm
5. N = Nitrogen 15,000 ppm
6. S = Sulfur 1,000 ppm
7. Ca = Calcium 5,000 ppm
8. Mg = Magnesium 2000 ppm

Minor Nutrients:

1. Fe = Iron 100 ppm
2. Mo = Molybdenum 0.1 ppm
3. B = Boron 20 ppm
4. Cu = Copper 6 ppm
5. Mn = Manganese 50 ppm
6. Zn = Zinc 20 ppm
7. Cl = Chlorine 100 ppm

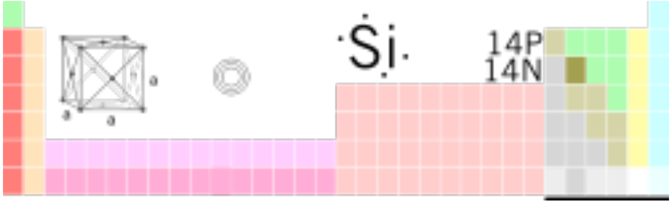
These nutrients are further divided into the mobile and immobile nutrients. A plant will always supply more nutrients to its younger leaves than its older ones, so when nutrients are mobile, the lack of nutrients is first visible on older leaves. When a nutrient is less mobile, the younger leaves suffer because the nutrient does not move up to them but stays lower in the older leaves. Nitrogen, phosphorus, and potassium are mobile nutrients, while the others have varying degrees of mobility. Concentration of ppm (parts per million) represents the dry weight of a representative plant. Hence when a plant suffers from a nutrient deficiency, it is necessary to note on which leaves it starts and this is also the case with diseases, which are often due to nutrient imbalances.

Processes

Plants uptake essential elements from the soil through their roots and from the air through their leaves. Nutrient uptake in the soil is achieved by cation exchange, wherein root hairs pump hydrogen ions (H+) into the soil through proton pumps. These hydrogen ions displace cations attached to negatively charged soil particles so that the cations are available for uptake by the root. In the leaves, stomata open to take in carbon dioxide and expel oxygen. The carbon dioxide molecules are used as the carbon source in photosynthesis.

Though nitrogen is plentiful in the earth's atmosphere, relatively few plants engage in nitrogen fixation (conversion of atmospheric nitrogen to a biologically useful form). Most plants thus require nitrogen compounds to be present in the soil in which they grow.

General soil science considers not all the nutrients mentioned in this list. They do not consider many of the micronutrients, believing them to be insigni-ficant to the maintenance of plant-life. There are elemen-tary substances not mention-ed at all among their list here reproduced and extended that are of equal if not more importance to plant life than those listed by the orthodox. We mention before everything Silicea, which is a formative nutrient of the first order. We consider it the key element in agriculture. Also there is seldom any mention of chlorine, fluor or carbon, while sodium is sometimes mentioned as a problem



△ Silicea

Silicea is an elemental substance not even considered in conventional agriculture. It is a formative substance. With formative we mean here the development of the plant, which is entirely regulated by the moon. In this connection it is important to remember that Silica has its aggravations at the new- and full-moon phases generally, while in some it may have an influence during the first and last quarters also.

Without Silicea no plant stays upright and it is of equal importance for germination and maintenance of the plant during its entire lifecycle. The flaws and shortcomings of the orthodox approach also do not consider the dynamics of plant life in general, nor do they look at anything specific, except that which confirms their prejudices. Nonetheless, we give here the orthodox notions regarding the micro- and macronutrients. As usual, they begin with the macronutrients. We take the opposite approach and begin with the trace elements.

Silica protects against fungi, bacteria and viruses, gives strength to the plant and makes it flexible. Together with calcium and carbon it forms the backbone of the entire construct. Cell walls, cambium, hardwood in trees and pulp are all dependent on Silicea as their connector and outer sheet. Sillicea is the cement in the building of the plant whereas carbon and calcium are the building blocks. Without Silicea the combination of Carbon and Calcium is of course possible – Calcium carbonate is a well-known compound – this cannot function as it does in plants without the aid of Silicea. In this manner Silicea gives shape to plants and is therefore a formative element.

Plants do not develop, but their growth of cells are sorted out just as in every other living entity according to function and position and both may be multifunctional or overlap.

Cambium is therefore not only outer protective skin but also the channel for sap and sugar transports just as leaves are respiratory, digestive, but also eliminative organs, depending on the function of the stomata and the chlorophyll content of the cells. What is called development is really the genetic material at work, which provides one type of cell with an enzyme and another with an acid, so that their structures and functions are sorted, rather than develop out of the template.

Structure and function are often identical in the sense that from the structure the function is obvious and cannot be otherwise, while the function determines the structure. Hence roots show from their position and arrangement in the soil and the arrangement and position of stomata and hair-roots what function each fulfils. The stomata are for exudation and the hair-roots for feeding. The food is nutrients, but also traces of allelochemicals, which are released by the roots of surrounding vegetation and may act inhibitive or stimulating. Similarly the plant is capable of releasing allelochemicals to warn others in his community against pests, repel the same and attract predators, because the allelochemicals released also pheromones from the plant that attract them. The interrelations between the presence of one component of the habitat and the others is but slowly beginiing to be understood somewhat, mainly due to the relations we know from the materia medica.

Since we do not know allelochemicals in homoeopathy other than the resins and alkaloids, we cannot say anything with certainty about their use in plants, but considering the things known from other studies than the homoeopathic we can make predictions that often pan out to be exactly what happens. Scientific work is on the matter somewhat one-sided, because everyone uses the same models for their tests and thus reveal little new, while also each test is done with the same species of plants and the same or very similar allelochemicals in an attempt to study every little detail of them. After studying it to death, they believe to have some useful product to distil from that, for which they will charge exorbitant prices to the consumer and call it environmentally friendly, although still using massive amounts and quickly building resistance.

We on the other hand study it in its action on the plants we want to use it on, to get realistic results about the events we will certainly meet in the field. We are not interested so much in how the remedy works, but that it works and each time in the same predictable manner. Thus the use of remedies by others is a repetition of a scientific experiment that always leads to the same predictable results.

Those that break their heads over the how of homoeopathic drug action we refer to Volume 1. the Introduction to this concept, where some attempt is made at giving an acceptable and logical explanation. Here we are concerned with that it does what we predict it will do, each and every time. We must not waste our time trying to understand a mechanistic effect and take that to be the mechanism, because remedies act in a dynamic manner, just as the life of plants is dynamic.

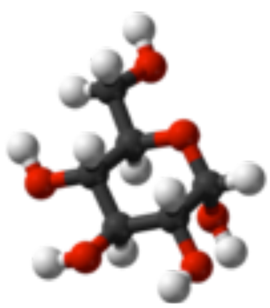
The scientific approach wants to see it as a static system, in which all parameters can be manipulated, but this is unrealistic, because any living system is by its nature not static. If we are to have any influence over a living system, we must approach it from its own viewpoint and lower our vision to the level of the earth and below it and see the relationships between all the components in the plant's habitat.

Silicea is in that sense certainly the broadest polychrest in all of agriculture, with Phosphorus coming a close second. Silicea covers so many aspects of plant life in such a deep manner that it is inconceivable it has been overlooked completely, except by Rudolph Steiner. A lack of Silicea is much more serious in its repercussions than is a lack of Phosphorus, first because orthodoxy would not know how to apply it. Moreover, a lack of Silicea may be masked by other poisons they apply, but shows up in repeated fungal attacks and weak straggly plants with little vigour. A lack of Phosphorus can be redressed very quickly by a dose of fertiliser and the effects of the lack are soon healed. Silicea can of course be applied as Steiner recommends, but I do not see the Agribusinesses stir up the Silicea on a full moon night, 200 times left and 200 times right. It would also be too embarrassing to buy massive quantities of B501 and so it is not given any attention. In its absence, they rather develop 'new' fungicides.

Instead they have stared themselves blind on Phosphorus, first because it is a macronutrient and used in considerable amounts by plants and second because it also covers so many aspects of plant life and is essential to flowering and fruit-setting, the goal for which the plant is grown. While Phosphorus is certainly the most important of the macronutrients, we see the emphasis as misguided and leading to many Phosphorus problems from excess.

△ Boron

Boron is important in sugar transport within the plant. It has a role in cell division, and is required for the production of certain amino acids, although it is not a part of any amino acid. Fructose (also levulose or laevulose) is a simple reducing sugar (monosaccharide) found in many foods and is one of the three important dietary monosaccharides along with glucose and galactose. Honey, tree fruits, berries, melons, and some root



es, such as beets, sweet potatoes, parsnips, and onions, contain fructose, usually in ation with glucose in the form of sucrose. Fructose is also derived from the digestion of lated table sugar (sucrose), a disaccharide consisting of glucose and fructose, and high-uctose corn syrup (HFCS).

Crystalline fructose and high-fructose corn syrup are often mistakenly confused as the same product. The former is produced from a fructose-enriched corn syrup which results ı a finished product of at least 98% fructose. The latter is usually supplied as a mixture of nearly equal amounts of fructose and glucose.

Glucose (Glc), a monosaccharide (or simple sugar) also known as grape sugar, blood sugar, or corn sugar, is an important carbohydrate in biology. The living cell uses it as a source of energy and metabolic intermediate. Glucose is one of the main products of photosynthesis and starts cellular respiration in both prokaryotes and eukaryotes. The name comes from the Greek word glykys (γλυκύς), meaning "sweet", plus the suffix "-ose" which denotes a sugar.

△ Sodium

Sodium is a disturbing element, but nonetheless important for several plant functions.

Water, introduced to the plant through the roots, salty or not, enters through the epithelial cells by means of salt contained in these cells, for salt has the property of attracting water. Water is needed to moisten all tissues and cells. Every cell contains soda. The nascent chlorine which is split off the salt in the intracellular fluid combines with the soda. The sodium chloride arising from this combination attracts water. By this means the cell is enlarged and divides itself. Only in this way is growth through cell division possible. If there is no salt in the cells, then water remains in the intracellular fluid, and hydraemia results. The plant dries out, though it looks watery and bloated.

Common salt does not heal this problem, since common cells can only receive salt in attenuated solutions. The salt is then redundant in the intracellular fluid and produces epidermis problems such as scald, halo blight and stripe blight where the tissue is waterlogged. Disturbances in the distribution of salt in cells produces residues that become transparent like water on the leaves.

Some plants, like the saltbush have bladders in their leaves that absorb the salt and store it. These plants are used for phytoremediation of saltpans, caused by excessive fertiliser, which has leached into the ground water.

△ Molybdenum

Molybdenum is needed for the reduction of absorbed nitrates into ammonia prior to incorporation into an amino acid. It performs this function as a part of the enzyme nitrate reductase. In addition to direct plant functions, molybdenum is also essential for nitrogen fixation by nitrogen-fixing bacteria in legumes. Responses of legumes to Molybdenum application are mainly due to the need by these symbiotic bacteria.

Enzymes are biomolecules that catalyze (i.e., increase the rates of) chemical reactions. Almost all enzymes are proteins. In enzymatic reactions, the molecules at the beginning of the process are called substrates, and the enzyme converts them into different molecules, the products. Almost all processes in a biological cell need enzymes to occur at significant rates. Since enzymes are selective for their substrates and speed up only a few reactions from among many possibilities, the set of enzymes made in a cell determines which metabolic pathways occur in that cell.

Like all catalysts, enzymes work by lowering the activation energy (Ea or $\Delta G^{\ddagger}$) for a reaction, thus dramatically increasing the rate of the reaction. Most enzyme reaction rates are millions of times faster than those of comparable un-catalyzed reactions. As with all catalysts, enzymes are not consumed by the reactions they catalyze, nor do they alter the equilibrium of these reactions. However, enzymes do differ from most other catalysts by being much more specific. Enzymes are known to catalyze about 4,000 biochemical reactions. A few RNA molecules called ribozymes catalyze reactions, with an important example being some parts of the ribosome. Synthetic molecules called artificial enzymes also display enzyme-like catalysis.

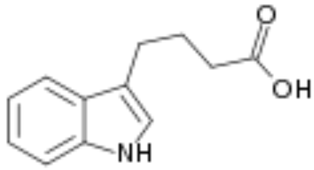
Enzyme activity can be affected by other molecules. Inhibitors are molecules that decrease enzyme activity; activators are molecules that increase activity. Many drugs and poisons are enzyme inhibitors. Activity is also affected by temperature, chemical environment (e.g., pH), and the concentration of substrate. Some enzymes are used commercially, for example, in the synthesis of antibiotics. In addition, some household products use enzymes to speed up biochemical reactions (e.g., enzymes in biological washing powders break down protein or fat stains on clothes).

△ Zinc

Zinc is a component of many enzymes. It is essential for plant hormone balance, especially auxin activity. Auxins are a class of plant growth substance (often called phytohormone or plant hormone). Auxins play an essential role in coordination of many growth and behavioral processes in the plant life cycle, they and the behavior they played in plant growth was first revealed by a Dutch scientist named Fritz Went (1903-1990)

Auxins derive their name from the Greek word αυξανω ("auxano" -- "I grow"). They were the first of the major plant hormones to be discovered and are a major coordinating signal in plant development. Their pattern of active transport through the plant is complex. They typically act in concert with (or opposition to) other plant hormones. For example, the ratio of auxin to cytokinin in certain plant tissues determines initiation of root versus shoot buds. Thus a plant can (as a whole) react on external conditions and adjust to them, without requiring a nervous system. On a molecular level, auxins have an aromatic ring and a carboxylic acid group (Taiz and Zeiger, 1998).

The most important member of the auxin family is indole-3-acetic acid (IAA). It generates the majority of auxin effects in intact plants, and is the most potent native auxin. However, molecules are chemically labile in aqueous solution, so IAA is not used commercially as a plant growth regulator.



Naturally-occurring auxins include 4-chloro-indoleacetic acid, phenylacetic acid and indole-3-butyric acid (IBA).

Synthetic auxin analogs include 1-naphthaleneacetic acid (NAA), 2,4-dichlorophenoxyacetic acid (2,4-D), and others.

Auxins are often used to promote initiation of adventitious roots and are the active ingredient of the commercial preparations used in horticulture to root stem cuttings. They can also be used to promote uniform flowering, to promote fruit set, and to prevent premature fruit drop.

Used in high doses, auxin stimulates the production of ethylene. Excess ethylene can inhibit elongation growth, cause leaves to fall (leaf abscission), and even kill the plant. Some synthetic auxins such as 2,4-D and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) have been used as herbicides. Broad-leaf plants (dicots) such as dandelions are much more susceptible to auxins than narrow-leaf plants (monocots) like grass and cereal crops. These synthetic auxins were the active agents in Agent Orange, a defoliant used extensively by American forces in the Vietnam War.

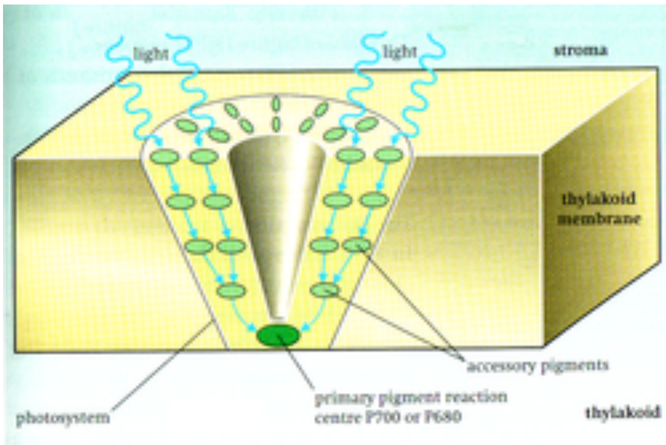
Copper

Copper is a component of enzymes involved with photosynthesis. Photosynthesis is a metabolic pathway that converts light energy into chemical energy. Its initial substrates are carbon dioxide and water; the energy source is light; and the end-products are oxygen and (energy-containing) carbohydrates, such as sucrose, glucose or starch. This process is one of the most important biochemical pathways, since nearly all life on Earth either directly or indirectly depends on it as a source of energy. It is a complex process occurring in plants, algae, as well as bacteria such as cyanobacteria. Photosynthetic organisms are also referred to as photoautotrophs.

The word comes from the Greek φώτο- (photo-), "light," and σύνθεσις (synthesis), "placing with."

Photosynthesis splits water to liberate O_2 and fixes CO_2 into sugar

Photosynthesis uses light energy and carbon dioxide to make triose phosphates (G3P). G3P is generally considered the first end-product of photosynthesis.



It can be used as a source of metabolic energy, or combined and rearranged to form monosaccharide or disaccharide sugars, such as glucose or sucrose, respectively, which can be transported to other cells, stored as insoluble polysaccharides such as starch, or converted to structural carbohydrates, such as cellulose or glucans. Sugar however is not the only organic substance that can be produced by photosynthesis. The triose phosphate formed with the incoporation of carbon dioxide to ribulose may in some cases be converted into amino acids, fatty acids or various other plant acids. Also, the triose phosphate may be converted to glycerol which can react with fatty acids to form fats.

A commonly used slightly simplified equation for photosynthesis is:

$6\ CO_2(g) + 12\ H_2O(l)$ + photons → C6H12O6(aq) + $6\ O_2(g) + 6\ H_2O(l)$

carbon dioxide + water + light energy → glucose + oxygen + water

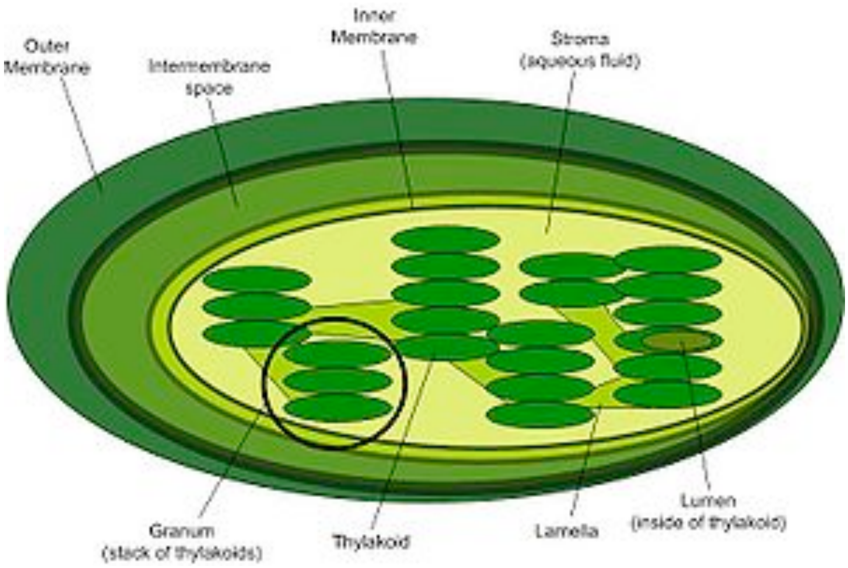
The equation is often presented in introductory chemistry texts in an even more simplified form as:

$6\ CO_2(g) + 6\ H_2O(l)$ + photons → $C_6H_{12}O_6(aq) + 6\ O_2(g)$

Photosynthesis may simply be defined as the conversion of light energy into chemical energy by living organisms. It is affected by its surroundings, and the rate of photosynthesis is affected by the concentration of carbon dioxide in the air, the light intensity, and the temperature.

△ Chlorine

Plants use chlorine as chloride ion. Chloride is useful as a charge-balancing ion and for turgor regulation, keeping plant cells more free of infection by disease organisms. It is essential for photosynthesis and chlorophyll production. Water, introduced to the plant through the roots, salty or not, enters through the epithelial cells by means of salt contained in these cells, for salt has the property of attracting water. Water is needed to moisten all tissues and cells. Every cell contains soda. The nascent chlorine which is split off the salt in the intracellular fluid combines with the soda. The sodium chloride arising from this combination attracts water. By this means the cell is enlarged and divides itself. Only in this way is growth through cell division possible. If there is no salt in the cells, then water remains in the intracellular fluid, and hydraemia results. The plant dries out, though it looks watery and bloated.



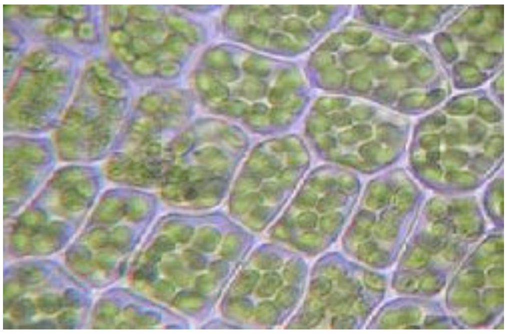
Common salt does not heal this problem since common cells can only receive salt in attenuated solutions. The salt is then redundant in the intracellular fluid, and produces epidermical problems such as scald, halo blight and stripe blight where the tissue is waterlogged. Disturbances in the distribution of salt in cells produces residues that become transparent like water on the leaves.

Photosynthesis is the energy transfer system of the plant and its most important digestive function.

Chlorogenic acid is a family of esters formed between certain trans cinnamic acids and (-)-quinic acid[1] and is a major phenolic compound in coffee, found widespread in plants, and can be isolated from the leaves and fruit.[2] This compound, long known as an antioxidant, also slows the release of glucose into the bloodstream after a meal.

Chemical properties

Structurally, chlorogenic acid (CGA) is the ester formed between caffeic acid and (L)-quinic acid (1L-1(OH),3,4/5-tetrahydroxycyclohexanecarboxylic acid).[4] Isomerisation of chlorogenic acid have been reported with 3 isomerisations of the quinic acid in position 3, (3-CQA), 4 (4-CGA) and 5 (5-CQA). Isomerisation at position 1 and 6 has not yet been reported.



Biological importance

This acid is an important factor in plant metabolism. It is also an antioxidant and an inhibitor of the tumor promoting activity of phorbol esters.

Chlorogenic acid and caffeic acid are antioxidants in vitro and might therefore contribute to the prevention of Type 2 Diabetes Mellitus and cardiovascular disease.

This substance is claimed to have antiviral, antibacterial and antifungal effects with relatively low toxicity and side effects, alongside properties that do not lead antimicrobial resistance. Potential uses are suggested in pharmaceuticals, foodstuffs, feed additives, and cosmetics

Chlorogenic acid is marketed under the tradename Svetol in Norway and the United Kingdom as a food active ingredient used in coffee, chewing gum, and mints to promote weight reduction.

Chlorogenic acid has been proven in animal studies in vitro to inhibit the hydrolysis of the enzyme glucose-6-phosphatase in an irreversible fashion. This mechanism allows chlorogenic acid to reduce hepatic glycogenolysis (transformation of glycogen into glucose) and to reduce the absorption of new glucose. In addition, in vivo studies on animal subjects have demonstrated that the administration of chlorogenic acid lessens the hyperglycemic peak resulting from the glycogenolysis brought about by the administering of glucagon, a hyperglycemiant hormone. The studies also confirmed a reduction in blood glucose levels and an increase in the intrahepatic concentrations of glucose-6-phosphate and of glycogen.

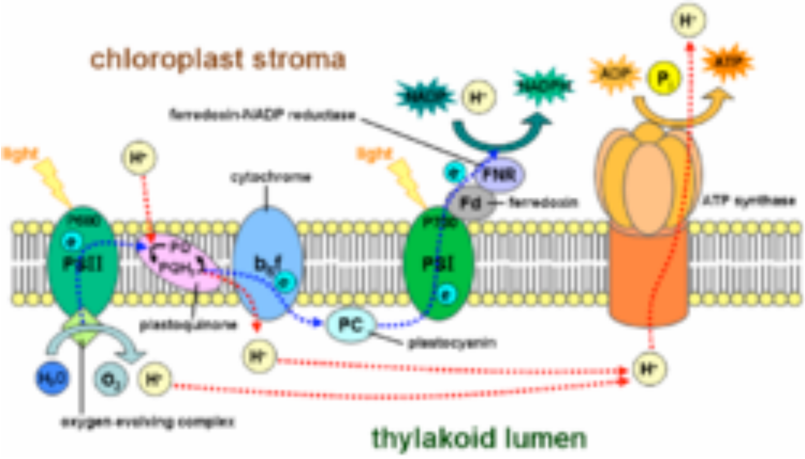
△ Fluor

It is found at the surfaces of bones, the enamel in teeth, in elastic fibers and the cells of the epidermis. These latter have significance in plant use. Induration, threatening suppuration. Spot blotch, stem rot and stem nematode. The skin or bark is dry and harsh.

△ Manganese

Manganese is a cofactor in many plant reactions. It is essential for chloroplast production. The chloroplasts are closely associated with chlorophyll and therefore of prime importance for plant respiration.

Chloroplasts are organelles found in plant cells and eukaryotic algae that conduct photosynthesis. Chloroplasts absorb light and use it in conjunction with water and carbon dioxide to produce sugars, the raw material for energy and biomass production in all green plants and the animals that depend on them, directly or indirectly, for food. Chloroplasts capture light energy to conserve free energy in the form of ATP and reduce NADP to NADPH through a complex set of processes called photosynthesis. The word chloroplast is derived from the Greek words chloros which means green and plast which means form or entity. Chloroplasts are members of a class of organelles known as plastids.

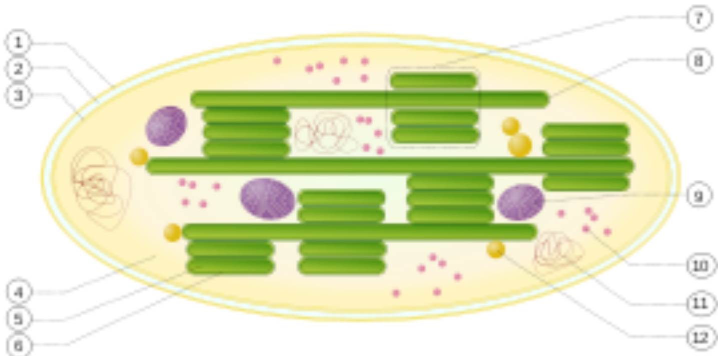


Chloroplasts are one of the many different types of organelles in the cell. They are generally considered to have originated as endosymbiotic cyanobacteria (i.e. blue-green algae).

This was first suggested by Mereschkowsky in 1905 after an observation by Schimper in 1883 that chloroplasts closely resemble cyanobacteria. All chloroplasts are thought to derive directly or indirectly from a single endosymbiotic event (in the Archaeplastida), except for Paulinella chromatophora, which has recently acquired a photosynthetic cyanobacterial endosymbiont which is not closely related to chloroplasts of other eukaryotes. In that they derive from an endosymbiotic event, chloroplasts are similar to mitochondria but chloroplasts are found only in plants and protista. The chloroplast is surrounded by a double-layered composite membrane with an intermembrane space; further, it has reticulations, or many infoldings, filling the inner spaces. The chloroplast has its own DNA which codes for redox proteins involved in electron transport in photosynthesis.

Chloroplast ultrastructure:

1. outer membrane
2. intermembrane space
3. inner membrane (1+2+3: envelope)
4. stroma (aqueous fluid)
5. thylakoid lumen (inside of thylakoid)
6. thylakoid membrane
7. granum (stack of thylakoids)
8. thylakoid (lamella)
9. starch
10. ribosome
11. plastidial DNA
12. plastoglobule (drop of lipids)



△ ▽ Magnesium

Magnesium is a micronutrient of which plants need macro-doses, because they need it as if it were a macronutrient. Magnesium is therefore on the border between macro and micronutrients and has characteristics of both.

Magnesium is the central element within the chlorophyll molecule. It is an important cofactor the production of ATP, the compound which is the energy transfer tool for the plant.

In order to understand the role of *Pyruvic acid*, we must first explain how it is formed and its use in agricultural homoeopathic remedies. *Pyruvic acid* does not exist as a free acid in nature, but is always found in the processes of respiration in plants.

Glucose
ATP→↓↑→ADP
Glucose 6-phosphate
↓↑
Fructose 6-phosphate
ATP→↓↑→ADP
Fructose 1,6-phosphate
↓↑
Dihydroxyacetone phosphate
↓↑
2 (Glyceraldehyde 3-phosphate)

↓ ↑→4H
2 (1,3-Diphosphoglyceric acid)
2ADP →↓ ↑→ +2ATP
2 (3-Phosphoglyceric acid)
↓ ↑
2 (2-Phosphoglyceric acid)
↓ ↑
2 (2-Phosphoenolpyruvic acid)
2ADP →↓ ↑→ 2ATP
2 (Pyruvic acid)

By far the most important means by which energy is released from the glucose molecule is by the process of glycolysis and the oxidation of the end-products of glycolysis.

Glycolysis means the splitting of the glucose molecule to form two molecules of pyruvic acid. This occurs by a process of 10 successive steps of chemical reactions as shown above. Each step is catalysed by at least one specific protein enzyme.

Note that glucose is first converted into fructose and subsequently split in 2 three-carbon atom molecules, each of which is then converted through 5 successive steps to *pyruvic acid*.

The formation of Adenosine Triphosphate (ATP) during glycolysis is dependent on the least loss of energy (following the principle of *minimus maxima* as explained in the Introduction Volume). Despite many chemical reactions in the glycolitic series, little energy is released. Most of the released energy is turned into heat and is lost to the metabolic system of the cells. This is the same in all living entities and this is crucial in the practical application on weeds.

To return to the energy production, it must be noted that between the 1,3-Diphosphoglyceric acid and the 3-Phosphoglyceric acid stages and again between the Phosphoenolpyruvic acid and *Pyruvic acid* stages, the packets of energy released are greater than 8000 calories per mol. This is the amount required to form ATP and the reactions are coupled in such a way that ATP is formed. Thus, a total of 4 mols of ATP are formed for each mol of fructose 1,6-phosphate that is split to pyruvic acid.

The citric acid cycle is the third stage in the degradation of the glucose molecule. It is also known as the tricarboxylic acid cycle or Krebs cycle. This is a sequence of chemical reactions in which the acetyl portion of acetyl Co-A is degraded to carbon dioxide and hydrogen atoms. Then the hydrogen atoms are subsequently oxidised, releasing still more energy to form ATP. Below we give the chemical reactions in the citric acid cycle.

CH_3-CO-Co-A+O=C-COOH
(Acetyl Co-A)
|
H_2C-COOH
(Oxaloacetic acid)
H2O→↓ →Co-A
H_2C-COOH
|
HOC-COOH
|
H_2C-COOH
(Citric acid)
↓→H_2O
H_2C-COOH

|
C-COOH
||
HC-COOH
(*cis*-Aconitic acid)
H_2O→↓
H_2C-COOH
|
HC-COOH
|
HOC-COOH
|
H
(Isocitric acid)
↓→2H
H_2C-COOH
|
HC-COOH
|
O=C-COOH
(oxalosuccinic acid)
↓→CO_2
H_2C-COOH
|
H2C
|
O=C-COOH
H_2O ADP→↓→$CO_2$2H ATP
H_2C-COOH
|
H_2C-COOH
↓→2H
HC-COOH
||
HOOC-CH
(fumaric acid)
H_2O→↓
H
|
HO-C-COOH
|
H_2C-COOH
(mallic acid)
↓→2H
O=C-COOH
|
H_2C-COOH
(oxaloacetic acid)

Any disturbance or distortion of the citric acid cycle will severely influence plant life, since it breaks into the citric acid cycle and profoundly upset the glucose transformation and so impair the plant’s energy. If repeated twice in two days, the death of the plant is certain and swift.

▽ Ammonium (NH_3)

Ammonia (NH_3) is the most important commercial compound of nitrogen. It is produced by the Haber Process. Natural gas (methane, CH_4) is reacted with steam to produce carbon dioxide and hydrogen gas (H_2) in a two step process. Hydrogen gas and nitrogen gas reacted via the Haber Process to produce ammonia. This colourless gas with a pungent odour is easily liquefied (in fact, the liquid is used as a nitrogen fertilizer). Ammonia is also used in the production of urea, NH_2CONH_2, which is used as a fertilizer, used in the plastic industry, and used in the livestock industry as a feed supplement. Ammonia is often the starting compound for many other nitrogen compounds.

Ammonification

When a plant or animal dies, or an animal excretes, the initial form of nitrogen is organic. Bacteria, or in some cases, fungi, convert the organic nitrogen within the remains back into ammonia, a process called ammonification or mineralization. Enzymes Involved: 1.) GS: Gln Synthetase (Cytosolic & Plastid) 2.) GOGAT: Glu 2-oxoglutarate aminotransferase (Ferredoxin & NADH dependent) 3.) GDH: Glu Dehydrogenase:

-Minor Role in ammonium assimilation.

-Important in amino acid catabolism.

Anaerobic ammonium oxidation

In this biological process, nitrite and ammonium are converted directly into dinitrogen gas. This process makes up a major proportion of dinitrogen conversion in the oceans.

Ammonia (NH_3) in the atmosphere has tripled as the result of human activities. It is a reactant in the atmosphere, where it acts as an aerosol, decreasing air quality and clinging on to water droplets, eventually resulting in acid rain.

▽ Nitrogen N

An essential component of amino acids, and therefore all proteins. An essential component of nucleic acids, and therefore needed for all cell division and reproduction. Enzymes are specialized proteins, and serve to lower energy requirements to perform many tasks inside plants. Nitrogen is contained in all enzymes essential for all plant functions.

Sodium nitrate ($NaNO_3$) and potassium nitrate (KNO_3) are formed by the decomposition of organic matter with compounds of these metals present. In certain dry areas of the world these saltpeters are found in quantity and are used as fertilizers. Other inorganic nitrogen compounds are nitric acid (HNO_3), ammonia (NH_3), the oxides (NO, NO_2, N_2O_4, N_2O), cyanides (CN-), etc.

The nitrogen cycle is one of the most important processes in nature for living organisms. Although nitrogen gas is relatively inert, bacteria in the soil are capable of "fixing" the nitrogen into a usable form (as a fertilizer) for plants. In other words, Nature has provided a method to produce nitrogen for plants to grow. Animals eat the plant material where the nitrogen has been incorporated into their system, primarily as protein. The cycle is completed when other bacteria convert the waste nitrogen compounds back to nitrogen gas. Nitrogen is crucial to life, as it is a component of all proteins.

Amino acids are critical to life, and have a variety of roles in metabolism. One particularly important function is as the building blocks of proteins, which are linear chains of amino acids. Amino acids are also important in many other biological molecules, such as forming parts of coenzymes, as in S-adenosylmethionine, or as precursors for the biosynthesis of molecules such as heme. Due to this central role in biochemistry, amino acids are very important in nutrition.

In chemistry, an amino acid is a molecule containing both amine and carboxyl functional groups. These molecules are particularly important in biochemistry, where this term refers to alpha-amino acids with the general formula $H_2NCHRCOOH$, where R is an organic substituent. In the alpha amino acids, the amino and carboxylate groups are attached to the same carbon, which is called the α–carbon. The various alpha amino acids differ in which side chain (R group) is attached to their alpha carbon. They can vary in size from just a hydrogen atom in glycine through a methyl group in alanine to a large heterocyclic group in tryptophan.

The nitrogen cycle is the biogeochemical cycle that describes the transformations of nitrogen and nitrogen-containing compounds in nature. It is a cycle which includes gaseous components.

Earth's atmosphere is about 78% nitrogen, making it the largest pool of nitrogen. Nitrogen is essential for many biological processes; and is crucial for any life here on Earth. It is in all amino acids, is incorporated into proteins, and is present in the bases that make up nucleic acids, such as DNA and RNA. In plants, much of the nitrogen is used in chlorophyll molecules which are essential for photosynthesis and further growth.

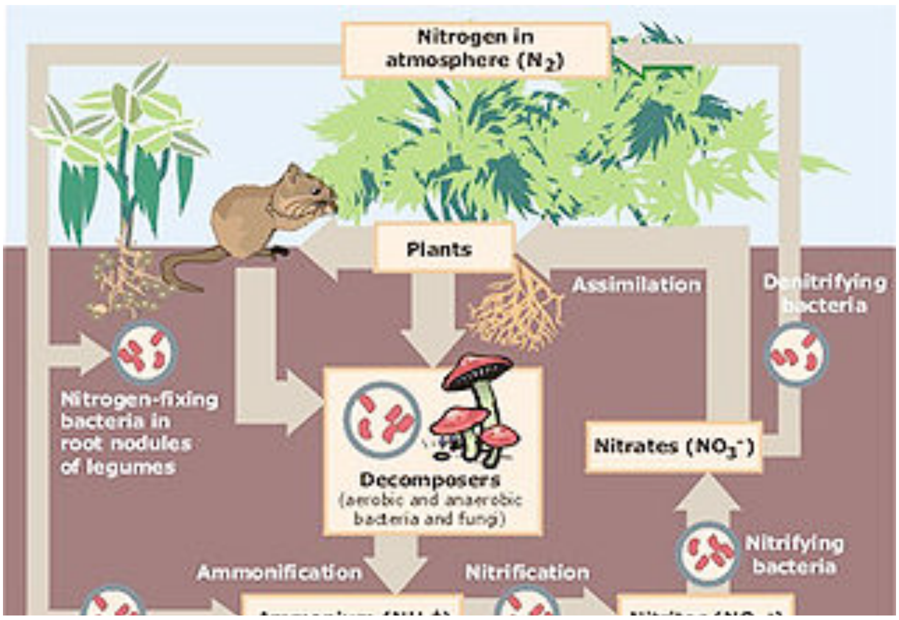
Processing, or fixation, is necessary to convert gaseous nitrogen into forms usable by living organisms. Some fixation occurs in lightning strikes, but most fixation is done by free-living or symbiotic bacteria. These bacteria have the nitrogenase enzyme that combines gaseous nitrogen with hydrogen to produce ammonia, which is then further converted by the bacteria to make its own organic compounds. Some nitrogen fixing bacteria, such as Rhizobium, live in the root nodules of legumes (such as peas or beans). Here they form a mutualistic relationship with the plant, producing ammonia in exchange for carbohydrates. Nutrient-poor soils can be planted with legumes to enrich them with nitrogen. A few other plants can form such symbioses. Nowadays, a very considerable portion of nitrogen is fixated in ammonia chemical plants.

Other plants get nitrogen from the soil, and by absorption of their roots in the form of either nitrate ions or ammonium ions. All nitrogen obtained by animals can be traced back to the eating of plants at some stage of the food chain.

Due to their very high solubility, nitrates can enter groundwater. Elevated nitrate in groundwater is a concern for drinking water use because nitrate can interfere with blood-oxygen levels in infants and cause methemoglobinemia or blue-baby syndrome.[2] Where groundwater recharges stream flow, nitrate-enriched groundwater can contribute to eutrophication, a process leading to high algal, especially blue-green algal populations and the death of aquatic life due to excessive demand for oxygen. While not directly toxic to fish life like ammonia, nitrate can have indirect effects on fish if it contributes to this eutrophication. Nitrogen has contributed to severe eutrophication problems in some water bodies. As of 2006, the application of nitrogen fertilizer is being increasingly controlled in Britain and the United States. This is occurring along the same lines as control of phosphorus fertilizer, restriction of which is normally considered essential to the recovery of eutrophied waterbodies.

Ammonia is highly toxic to fish and the water discharge level of ammonia from wastewater treatment plants must often be closely monitored. To prevent loss of fish, nitrification prior to discharge is often desirable. Land application can be an attractive alternative to the mechanical aeration needed for nitrification.

During anaerobic (low oxygen) conditions, denitrification by bacteria occurs. This results in nitrates being converted to nitrogen gases (NO, N2O, N2) and returned to the atmosphere. Nitrate can also be reduced to nitrite and subsequently combine with ammonium in the anammox process, which also results in the production of dinitrogen gas.



The Processes of the nitrogen cycle

Nitrogen fixation

Conversion of N_2

The conversion of nitrogen (N_2) from the atmosphere into a form readily available to plants and hence to animals and humans is an important step in the nitrogen cycle, that determines the supply of this essential nutrient. There are four ways to convert N_2 (atmospheric nitrogen gas) into more chemically reactive forms:

Biological fixation: some

symbiotic bacteria (most often associated with leguminous plants) and some free-living bacteria are able to fix nitrogen as organic nitrogen. An example of mutualistic nitrogen fixing bacteria are the Rhizobium bacteria, which live in legume root nodules. These species are diazotrophs. An example of the free-living bacteria is Azotobacter.

Industrial N-fixation : Under great pressure, at a temperature of 600 C, and with the use of a catalyst, atomospheric nitrogen and hydrogen (usually derived from natural gas or petroleum) can be combined to form ammonia (NH_3). In the Haber-Bosch process, N2 is converted together with hydrogen gas (H_2) into ammonia (NH_3) which is used to make fertilizer and explosives.

Combustion of fossil fuels : automobile engines and thermal power plants, which release various nitrogen oxides (NO_x).

Other processes : Additionally, the formation of NO from N2 and O2 due to photons and especially lightning, are important for atmospheric chemistry, but not for terrestrial or aquatic nitrogen turnover.

Assimilation

Plants can absorb nitrate or ammonium ions from the soil via their root hairs. If nitrate is absorbed, it is first reduced to nitrite ions and then ammonium ions for incorporation into amino acids, intense nucleic acids, and chlorophyll. In plants which have a mutualistic relationship with rhizobia, some nitrogen is assimilated in the form of ammonium ions directly from the nodules. Animals, fungi, and other heterotrophic organisms absorb nitrogen as amino acids, nucleotides and other small organic molecules.

Ammonification

When a plant or animal dies, or an animal excretes, the initial form of nitrogen is organic. Bacteria, or in some cases, fungi, convert the organic nitrogen within the remains back into ammonia, a process called ammonification or mineralization. Enzymes Involved: 1.) GS: Gln Synthetase (Cytosolic & Plastid) 2.) GOGAT: Glu 2-oxoglutarate aminotransferase (Ferredoxin & NADH dependent) 3.) GDH: Glu Dehydrogenase:

-Minor Role in ammonium assimilation.

-Important in amino acid catabolism.

Nitrification

The conversion of ammonia to nitrates is performed primarily by soil-living bacteria and other nitrifying bacteria. The primary stage of nitrification, the oxidation of ammonia (NH_3) is performed by bacteria such as the Nitrosomonas species, which converts ammonia to nitrites (NO_{2-}). Other bacterial species, such as the Nitrobacter, are responsible for the oxidation of the nitrites into nitrates (NO_{3-}). It is important for the nitrites to be converted to nitrates because accumulated nitrites are toxic to plant life.

Denitrification

Denitrification is the reduction of nitrites back into the largely inert nitrogen gas (N_2), completing the nitrogen cycle. This process is performed by bacterial species such as Pseudomonas and Clostridium in anaerobic conditions. They use the nitrate as an electron acceptor in the place of oxygen during respiration. These facultatively anaerobic bacteria can also live in aerobic conditions.

Anaerobic ammonium oxidation

In this biological process, nitrite and ammonium are converted directly into dinitrogen gas. This process makes up a major proportion of dinitrogen conversion in the oceans.

Human influences on the nitrogen cycle

As a result of extensive cultivation of legumes (particularly soy, alfalfa, and clover), growing use of the Haber-Bosch process in the creation of chemical fertilizers, and pollution emitted by vehicles and industrial plants, human beings have more than doubled the annual transfer of nitrogen into biologically available forms.[2] In addition, humans have significantly contributed to the transfer of nitrogen trace gases from Earth to the atmosphere, and from the land to aquatic systems.

N_2O has risen in the atmosphere as a result of agricultural fertilization, biomass burning, cattle and feedlots, and other industrial sources. N_2O has deleterious effects in the stratosphere, where it breaks down and acts as a catalyst in the destruction of atmospheric ozone. Ammonia (NH_3) in the atmosphere has tripled as the result of human activities. It is a reactant in the atmosphere, where it acts as an aerosol, decreasing air quality and clinging on to water droplets, eventually resulting in acid rain. Fossil fuel combustion has contributed to a 6 or 7 fold increase in NO_X flux to the atmosphere. NO_X actively alters atmospheric chemistry, and is a precursor of tropospheric (lower atmosphere) ozone production, which contributes to smog, acid rain, and increases nitrogen inputs to ecosystems. Ecosystem processes can increase with nitrogen fertilization, but anthropogenic input can also result in nitrogen saturation, which weakens productivity and can kill plants. Decreases in biodiversity can also result if higher nitrogen availability increases nitrogen-demanding grasses, causing a degradation of nitrogen-poor, species diverse heathlands.

Wastewater

Onsite sewage facilities such as septic tanks and holding tanks release large amounts of nitrogen into the environment by discharging through a drainfield into the ground. Microbial activity consumes the nitrogen and other contaminants in the wastewater. However, in certain areas the soil is unsuitable to handle some or all of the wastewater, and as a result, the wastewater with the contaminants enters the aquifers. These contaminants accumulate and eventually end up in drinking water. One of the contaminants concerned about the most is nitrogen in the form of nitrates. A nitrate concentration of 10 ppm or 10 milligrams per liter is the current EPA limit for drinking water and typical household wastewater can produce a range of 20-85 ppm (milligrams per liter).

The health risk associated with drinking >10 ppm nitrogen water is the development of methemoglobinemia and has been found to cause blue baby syndrome. Several states have now started programs to introduce advanced wastewater treatment systems to the typical onsite sewage facilities. The result of these systems is an overall reduction of nitrogen, as well as other contaminants in the wastewater.

Phosphorus

A component of the compound within plants which supply the energy to grow and maintain the plant. Part of cell membranes, the structures which selectively keep out unneeded compounds and allow in those compounds which are needed for the plant cells to function correctly. A part of DNA and its relatives. Needed for cell division and for reproduction.

Among all living organisms, flowers, which are the reproductive structures of angiosperms, are the most varied physically and show the greatest diversity in methods of reproduction of all biological systems. Carolus Linnaeus (1735 and 1753) proposed a system of classification of flowering plants based on plant structures, since plants employ many different morphological adaptations involving sexual reproduction, flowers played an important role in that classification system. Later on Christian Konrad Sprengel (1793) studied plant sexuality and called it the "revealed secret of nature" and for the first time it was understood that the pollination process involved both biotic and abiotic interactions (Charles Darwin's theories of natural selection utilized this work to promote his idea of evolution). Plants that are not flowering plants (green alga, mosses, liverworts, hornworts, ferns and gymnosperms) also have complex interplays between morphological adaptation and environmental factors in their sexual reproduction. The breeding system, or how the sperm from one plant fertilizes the ovals of another, is the single most important determinant of the mating structure of nonclonal plant populations. The mating structure or morphology of the flower parts and their arrangement on the plant in turn controls the amount and distribution of genetic variation, a central element in the evolutionary process.

Pollen grains, the male gametophyte, developed for protection of the sperm during the process of transfer from male to female parts. It is believed that insects feed on the pollen and plants evolved to use insects to actively carry pollen from one plant to the next. Seed producing plants, which include the angiosperms and the gymnosperms, have hetromorphic alternation of generations with large sporophytes containing much-reduced gameto-phytes. Angiosperms have distinctive reproductive organs called flowers with carpels and the gametophyte is greatly reduced to a female embryo sac with as few as eight cells and the male gametophyte develop from the pollen grains. The sperm of seed plants are non motile except for two older groups of plants the Cycadophyta and the Ginkgophyta which have flagellated sperm.

Many plants have complete flowers that have both male and female parts, others only have male or female parts and still other plants have flowers on the same plant that are a mix of male and female flowers. Some plants even have mixes that include all three types of flowers, where some flowers are only male, some are only female and some are both male and female. A distinction needs to be made between arrangements of sexual parts and the expression of sexuality in single plants verses the species. Some plants also undergo what is called Sex-switching, like Arisaema triphyllum which express sexual differences at different stages of growth. In some arums smaller plants produce all or mostly male flowers and as plants grow larger over the years the male flowers are replaced by more female flowers on the same plant. Arisaema triphyllum thus covers a multitude of sexual conditions in its life time; from nonsexual juvenile plants to young plants that are all male, as plants grow larger they have a mix of both male and female flowers, to large plants that have mostly female flowers. Other species have plants that produce more male flowers early in the year and as plants bloom later in the growing season they produce more female flowers. In plants like Thalictrum dioicum all the plants in the species are ether male or female.

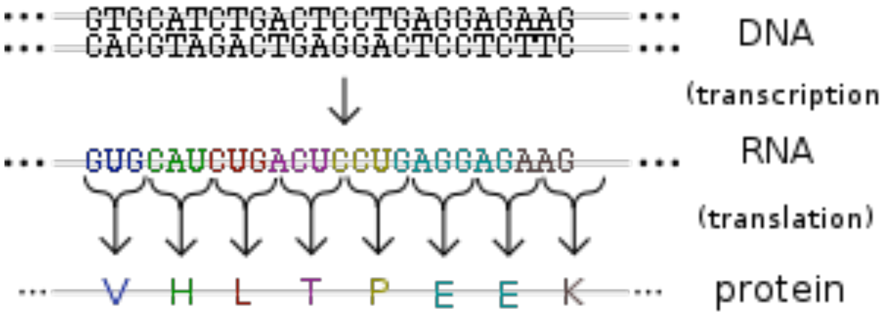
Phosphorus has a great influence on all these processes in each and ever species of plant.

Potassium

Potash is widely distributed and is formed in the feldspar and silicates and chlorides of the earth' s crust. By the process of oxidation and hydration it becomes one of the most important ingredients of the soil for the sustenance and growth of plant life. When soils become deficient in potash, plant life languishes and becomes infected with destructive fungi, which end its existence. This is especially true in the growth and production of corn. And from observations made, it has been found that the sap channels of the stalk were clogged with iron deposits as a result of a lack of potash. When these potash-exhausted soils were supplied with potassium sulphate in sufficient quantities healthy corn would grow, flourish and mature free of fungi and disease.

But potash is equally essential to animal life and when it is deficient either from lack of supply or from faulty potassium metabolism the animal weakens and takes on many forms of disease, which end in death. Even as the corn stalk sap channels become clogged and useless to distribute the life giving juices to the plant organism, so does the lymphatic system of the animal become impaired and blocked leaving the tissues wasting and non-resisitant to infective organisms, because the nourishing lymph is checked in its journey of repair if the normal potassium content is not present.

Clarke says that the potassium salts have more specific relations to the solid tissues than the fluids of the body; to the blood corpuscles rather than to the blood plasma. The fibrous tissues such as the ligaments and joints of the back and the ligaments of the uterus are all particularly affected. He also cites Kali-c. and Caust. as the two preparations that are most typical and profound in action and expression symptomatically of the potash group.



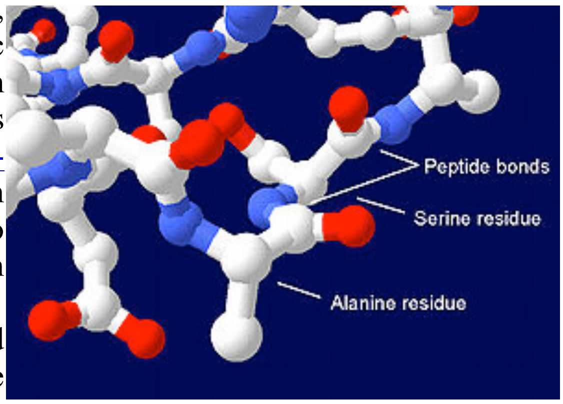
The potassium ... tient is anemic and weak, always tired ... d lacking stamina. The plant's cambium is weak and strained easily. Potassium is found more abundantly in the ascending sap than the descending sap and its presence is necessary for the balance between these flows of sap; if the potassium is deficient there, the rising sap breaks down and its iron content is released and oxidized and deposited in cambium channels and nodes with impairment of function in these tissues. Without potassium the life of the plant would fail. Small amounts stimulate, but large amounts weaken and inhibit. Potassium and the other alkaline minerals act in the maintenance of the alkali-acid balance of the organism. Also potassium is essential in the mechanism controlling the sap-flow pressure and, still more important, it is one of the essential factors in oxidation; that basic function of life where the interchange of gases take place in the organism to produce and use all the multitudinous energies needed in the physiologic activities of repair and growth.

Potassium activates certain enzymes. It regulates stomate opening, which in turn regulates air-flow into the leaf and transpiration of water out of the leaf. It acts to balance charge between negatively and positively charged ions within plant cells. It regulates turgor pressure, which helps protect plant cells from disease invasion. In certain plants, potassium can be replaced by sodium.

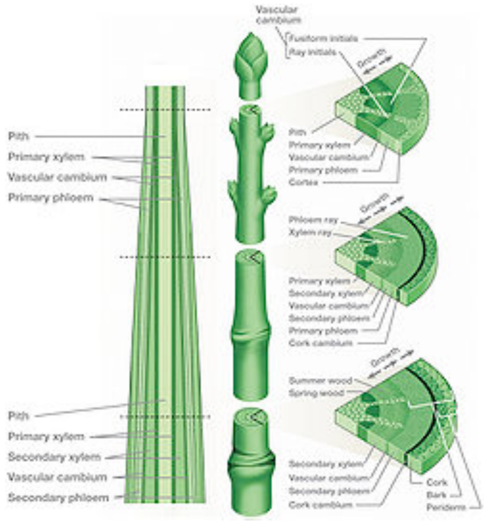
▽ Sulphur

Sulphur is a part of certain amino acids and all proteins. It acts as an enzyme activator and coenzyme (compound which is not part of all enzyme, but is needed in close coordination with the enzyme for certain specialized functions to operate correctly). It is a part of the flavour compounds in mustard and onion family plants.

Proteins are organic compounds made of amino acids arranged in a linear chain and joined together by peptide bonds between the carboxyl and amino groups of adjacent amino acid residues. The sequence of amino acids in a protein is defined by the sequence of a gene, which is encoded in the genetic code. In general, the genetic code specifies 20 standard amino acids, however in certain organisms the genetic code can include selenocysteine - and in certain archaea - pyrrolysine. The residues in a protein are often observed to be chemically modified by post-translational modification, which can happen either before the protein is used in the cell, or as part of control mechanisms. Proteins can also work together to achieve a particular function, and they often associate to form stable complexes.



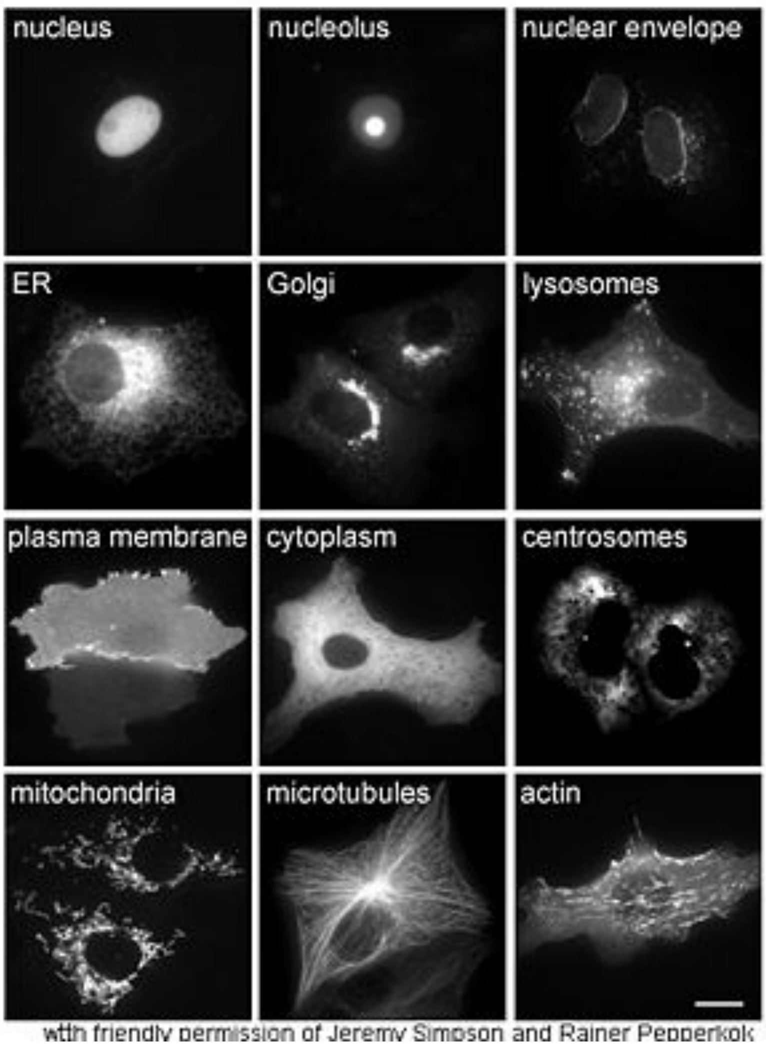
Like other biological macromolecules such as polysaccharides and nucleic acids, proteins are essential parts of organisms and participate in every process within cells. Many proteins are enzymes that catalyze biochemical reactions and are vital to metabolism. Proteins also have structural or mechanical functions, such as actin and myosin in muscle and the proteins in the cytoskeleton, which form a system of scaffolding that maintains cell shape. Other proteins are important in cell signaling, immune responses, cell adhesion, and the cell cycle. Proteins are also necessary in animals' diets, since animals cannot synthesize all the amino acids they need and must obtain essential amino acids from food. Through the process of digestion, animals break down ingested protein into free amino acids that are then used in metabolism.



The word protein comes from the Greek word πρώτειος (proteios) "primary". Proteins were first described and named by the Swedish chemist Jöns Jakob Berzelius in 1838. However, the central role of proteins in living organisms was not fully appreciated until 1926, when James B. Sumner showed that the enzyme urease was a protein.

The first protein to be sequenced was insulin, by Frederick Sanger, who won the Nobel Prize for this achievement in 1958. The first protein structures to be solved included hemoglobin and myoglobin, by Max Perutz and Sir John Cowdery Kendrew, respectively, in 1958.[3][4] The three-dimensional structures of both proteins were first determined by x-ray diffraction analysis; Perutz and Kendrew shared the 1962 Nobel Prize in Chemistry for these discoveries.

Proteins are linear polymers built from 20 different L-α-amino acids. All amino acids possess common structural features, including an α carbon to which an amino group, a carboxyl group, and a variable side chain are bonded. Only proline differs from this basic structure as it contains an unusual ring to the N-end amine group, which forces the CO–NH amide moiety into a fixed conformation. The side chains of the standard amino acids, detailed in the list of standard amino acids, have different chemical properties that produce three-dimensional protein structure and different reactivities, are therefore critical to protein function.



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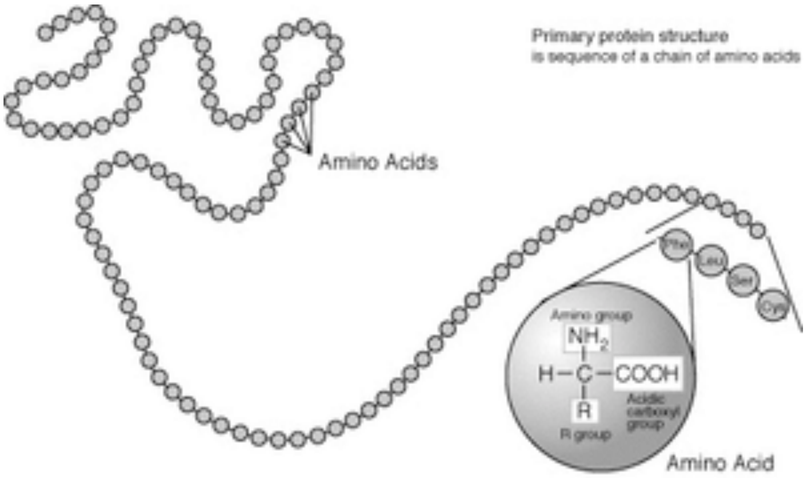
The amino acids in a polypeptide chain are linked by peptide bonds. Once linked in the protein chain, an individual amino acid is called a residue, and the linked series of carbon, nitrogen, and oxygen atoms are known as the main chain or protein backbone. The peptide bond has two resonance forms that contribute some double-bond character and inhibit rotation around its axis, so that the alpha carbons are roughly coplanar. The other two dihedral angles in the peptide bond determine the local shape assumed by the protein backbone.

Due to the chemical structure of the individual amino acids, the protein chain has directionality. The end of the protein with a free carboxyl group is known as the C-terminus or carboxy terminus, whereas the end with a free amino group is known as the N-terminus or amino terminus.

The words protein, polypeptide, and peptide are a little ambiguous and can overlap in meaning. Protein is generally used to refer to the complete biological molecule in a stable conformation, whereas peptide is generally reserved for short amino acid oligomers often lacking a stable three-dimensional structure. However, the boundary between the two is not well defined and usually lies near 20–30 residues. Polypeptide can refer to any single linear chain of amino acids, usually regardless of length, but often implies an absence of a defined conformation.

Calcium



Calcium regulates transport of other nutrients into the plant and is also involved in the activation of certain plant enzymes. Calcium deficiency results in stunting.

Calcium is a part of cell walls and regulates cell wall construction. Cell walls give plant cells their structural strength. Enhances uptake of negatively charged ions such as nitrate, sulphate, borate and molybdate. It balances charge from organic anions produced through metabolism by the plant. Some enzymes are regulated by Ca-calmodulin.

Metabolism is the set of chemical reactions that occur in living organisms in order to maintain life. These processes allow organisms to grow and reproduce, maintain their structures, and respond to their environments. Metabolism is usually divided into two categories. Catabolism breaks down organic matter, for example to harvest energy in cellular respiration. Anabolism, on the other hand, uses energy to construct components of cells such as proteins and nucleic acids.

The chemical reactions of metabolism are organized into metabolic pathways, in which one chemical is transformed into another by a sequence of enzymes. Enzymes are crucial to metabolism because they allow organisms to drive desirable but thermodynamically unfavorable reactions by coupling them to favorable ones, and because they act as catalysts to allow these reactions to proceed quickly and efficiently. Enzymes also allow the regulation of metabolic pathways in response to changes in the cell's environment or signals from other cells.

The metabolism of an organism determines which substances it will find nutritious and which it will find poisonous. For example, some prokaryotes use hydrogen sulfide as a nutrient, yet this gas is poisonous to animals. The speed of metabolism, the metabolic rate, also influences how much food an organism will require.

A striking feature of metabolism is the similarity of the basic metabolic pathways between even vastly different species. For example, the set of carboxylic acids that are best known as the intermediates in the citric acid cycle are present in all organisms, being found in species as diverse as the unicellular bacteria Escherichia coli and huge multicellular organisms like elephants. These striking similarities in metabolism are most likely the result of the high efficiency of these pathways, and of their early appearance in history.

Iron

Iron is a component of the many enzymes and light energy transferring compounds involved in photosynthesis.

In green vegetables especially, it requires careful monitoring, as this is another elementary remedy. Its secondary effects are opposite and give rise to its homoeopathic use.

Ferrum is needed for the process of photosynthesis. If there is an iron deficiency plants become chlorotic, with a lack of chlorophyll. Iron is not a constituent of chlorophyll, but is its catalyst. Ferr. inactivates Calc. in favor of magnesium, which is an important constituent of chlorophyll.

As Calcium represents Water, so Ferr. represents Fire, Phosphorous is Air and Silica and Potassium are Earth. Chlorosis in plants, sterility, no fruit, no flowers, sickly stunted growth, pale, no strength to stand up, as in Calc. carb., Calc. fluor and Calc. phos. with which it should be compared. Imperfect assimilation due to capillary problems, capillary collapse. Impaired photosynthesis due to absence of chlorophyll, consequently, low protein content as photosynthesis produces proteins. This in turn leads to further weakening of the plants with inevitable collapse.

Iron is known as a nutritive remedy in some plant disorders, having an organopathic relationship to the capillary system.

Photosynthesis is a metabolic pathway that converts light energy into chemical energy. Its initial substrates are carbon dioxide and water; the energy source is light; and the end-products are oxygen and (energy-containing) carbohydrates, such as sucrose, glucose or starch. This process is one of the most important biochemical pathways,[1] since nearly all life on Earth either directly or indirectly depends on it as a source of energy. It is a complex process occurring in plants, algae, as well as bacteria such as cyanobacteria. Photosynthetic organisms are also referred to as photoautotrophs.

The word comes from the Greek φώτο- (photo-), "light," and σύνθεσις (synthesis), "placing with."

Photosynthesis splits water to liberate O2 and fixes CO2 into sugar

Photosynthesis uses light energy and carbon dioxide to make triose phosphates (G3P). G3P is generally considered the first end-product of photosynthesis.

It can be used as a source of metabolic energy, or combined and rearranged to form monosaccharide or disaccharide sugars, such as glucose or sucrose, respectively, which can be transported to other cells, stored as insoluble polysaccharides such as starch, or converted to structural carbohydrates, such as cellulose or glucans. Sugar however is not the only organic substance that can be produced by photosynthesis. The triose phosphate formed with the incoporation of carbon dioxide to ribulose may in some cases be converted into amino acids, fatty acids or various other plant acids. Also, the triose phosphate may be converted to glycerol which can react with fatty acids to form fats.

A commonly used slightly simplified equation for photosynthesis is:

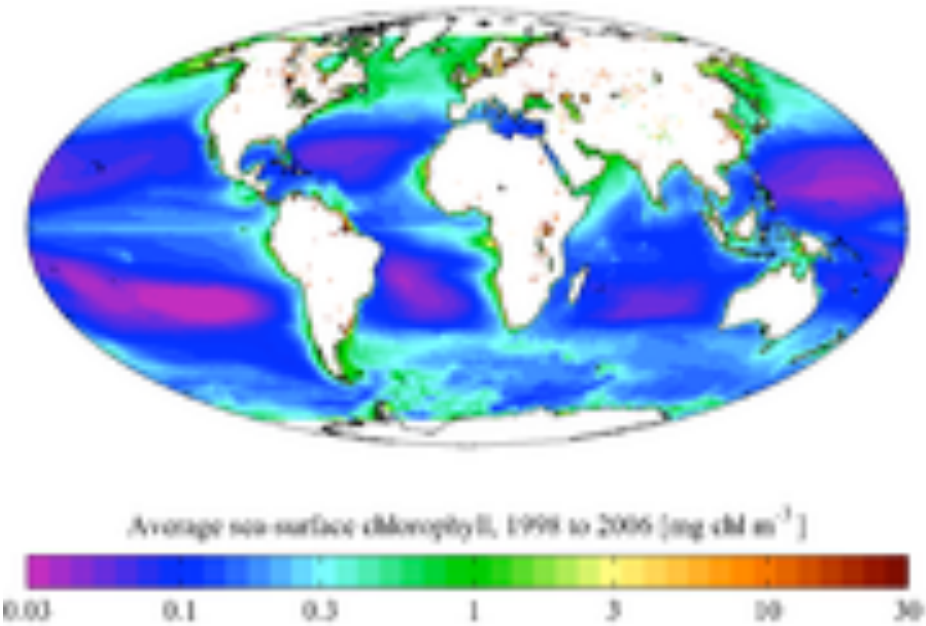
6 CO_2(g) + 12 H_2O(l) + photons → C6H12O6(aq) + 6 O_2(g) + 6 H_2O(l)

carbon dioxide + water + light energy → glucose + oxygen + water

The equation is often presented in introductory chemistry texts in an even more simplified form as:

6 CO_2(g) + 6 H_2O(l) + photons → $C_6H_{12}O_6$(aq) + 6 O_2(g)

Photosynthesis may simply be defined as the conversion of light energy into chemical energy by living organisms. It is affected by its surroundings, and the rate of photosynthesis is affected by the concentration of carbon dioxide in the air, the light intensity, and the temperature.

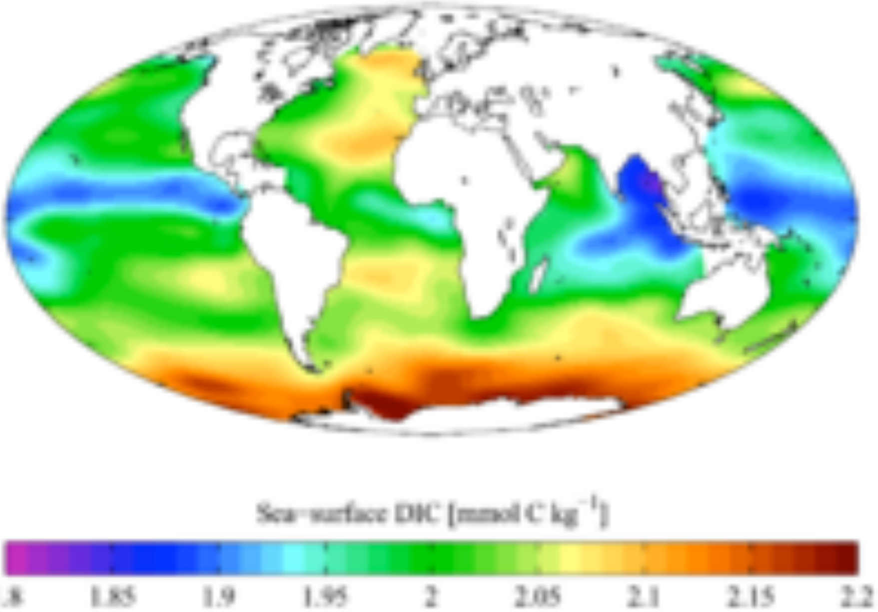


Most plants are photoautotrophs, which means that they are able to synthesize food directly from inorganic compounds using light energy - for example from the sun, instead of eating other organisms or relying on nutrients derived from them. This is distinct from chemoautotrophs that do not depend on light energy, but use energy from inorganic compounds. The energy for photosynthesis ultimately comes from absorbed photons and involves a reducing agent, which is water in the case of plants, releasing oxygen as product.

Algae come in multiple forms from multicellular organisms like kelp, to microscopic, single-cell organisms. Although they are not as complex as land plants, the biochemical process of photosynthesis is the same. All algae produce oxygen, and many are autotrophic. However, some are heterotrophic, relying on materials produced by other organisms. For example, in coral reefs, there is a mutualistic relationship between zooxanthellae and the coral polyps.

The other photosynthetic bacteria have a variety of different pigments, called bacteriochlorophylls, and use electron donors different from water and thus do not produce oxygen. Some bacteria, such as Chromatium, oxidize hydrogen sulfide instead of water for photosynthesis, producing sulfur as waste. Other photosynthetic bacteria oxidize ferrous iron to ferric iron, and still others use arsenites, producing arsenates. All photosynthesizing organisms must be in the photic (light-receiving) zone, except for those near hydrothermal vents which give faint light.

Human beings photosynthesize a class of lipid-soluble chemicals usually referred to as the vitamin Ds in their skin through the action of ultra-violet light.



Some sea slugs such as Elysia chlorotica acquire chloroplasts from their diet and store these in their bodies, where they continue to carry out photosynthesis. Some of the genes from the plant cell nucleus have even been transferred to the slugs, so that the chloroplasts can be supplied with proteins that they need to survive.

▽ Carbon

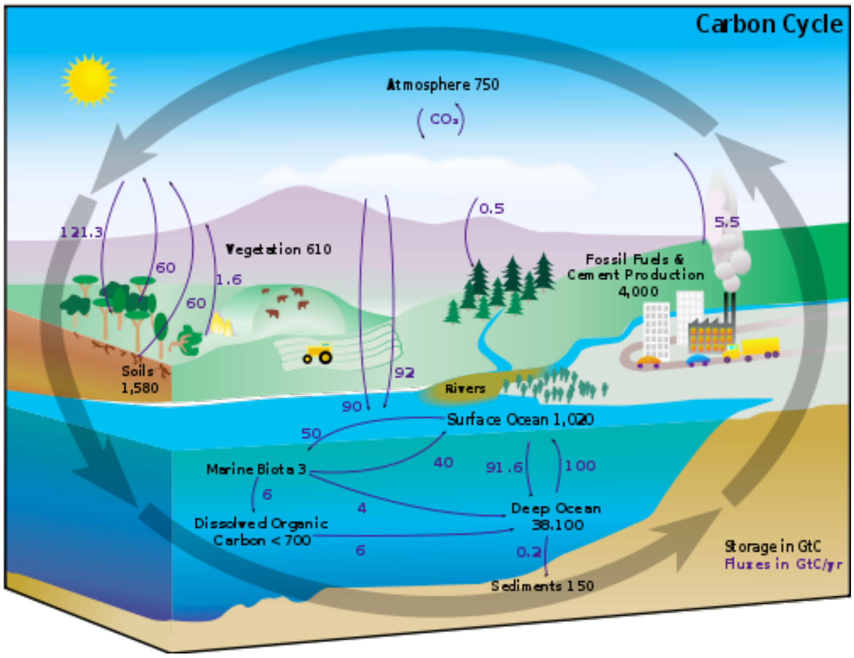
Carbon may be last but is certainly not least, because without it there are no plants, nor any other life. Carbon

Carbon forms the backbone of many plants biomolecules, including starches and cellulose. Carbon is fixed through photosynthesis from the carbon dioxide in the air and is a part of the carbohydrates that store energy in the plant.

It combines with almost everything and also with itself to form very stable compounds and is by far the most abundant of all life's molecules, certainly so in plants. Carbon is the fuel for plant life and also its product, thus making the Carbon-cycle complete.

The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes. The ocean contains the largest active pool of carbon near the surface of the Earth, but the deep ocean part of this pool does not rapidly exchange with the atmosphere.

The global carbon budget is the balance of the exchanges (incomes and losses) of carbon between the carbon reservoirs or between one specific loop (e.g., atmosphere ↔ biosphere) of the carbon cycle. An examination of the carbon budget of a pool or reservoir can provide information about whether the pool or reservoir is functioning as a source or sink for carbon dioxide.



In the atmosphere Carbon exists in the Earth's atmosphere primarily as the gas carbon dioxide (CO_2). Although it is a small percentage of the atmosphere (approximately 0.04% on a molar basis, and increasing), it plays an important role in supporting life. Other gases containing carbon in the atmosphere are methane andchlorofluorocarbons (the latter is entirely entirely caused by human interaction or anthropogenic). The overall atmospheric concentration of these greehouse gases has been increasing in recent decades, contributing to climate change.

Carbon is taken from the atmosphere in several ways:

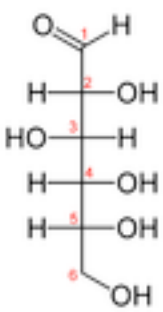
When the sun is shining, plants perform photosynthesis to convert carbon dioxide into carbohydrates, releasing oxygen in the process. This process is most prolific in relatively new forests where tree growth is still rapid. The effect is strongest in deciduous forests during spring leafing out. This is visible as an annual signal in the Keeling curve of measured CO_2 concentration. Northern hemisphere spring predominates, as there is far more land in temperate latitudes in that hemisphere than in the southern.

Forests store 86% of the planet's above-ground carbon and 73% of the planet's soil carbon.

At the surface of the oceans towards the poles, seawater becomes cooler and more carbonic acid is formed as CO2 becomes more soluble. This is coupled to the ocean's thermohaline circulation which transports dense surface water into the ocean's interior (see the entry on the solubility pump).

In upper ocean areas of high biological productivity, organisms convert reduced carbon to tissues, or carbonates to hard body parts such as shells and tests. These are, respectively, oxidized (soft-tissue pump) and redissolved (carbonate pump) at lower average levels of the ocean than those at which they formed, resulting in a downward flow of carbon (see entry on the biological pump).

The weathering of silicate rock. Carbonic acid reacts with weathered rock to produce bicarbonate ions. The bicarbonate ions produced are carried to the ocean, where they are used to make marine carbonates. Unlike dissolved CO_2 in equilibrium or tissues which decay, weathering does not move the carbon into a reservoir from which it can readily return to the atmosphere.



Carbon is released into the atmosphere in several ways:

Through the respiration performed by plants and animals. This is an exothermic reaction and it involves the breaking down of glucose (or other organic molecules) into carbon dioxide and water.

Through the decay of animal and plant matter. Fungi and bacteria break down the carbon compounds in dead animals and plants and convert the carbon to carbon dioxide if oxygen is present, or methane if not.

Through combustion of organic material which oxidizes the carbon it contains, producing carbon dioxide (and other things, like water vapor). Burning fossil fuels such as coal, petroleum products, and natural gas releases carbon that has been stored in the geosphere for millions of years. Burning agrofuels also releases carbon dioxide.

Production of cement. Carbon dioxide is released when limestone (calcium carbonate) is heated to produce lime (calcium oxide), a component of cement.

At the surface of the oceans where the water becomes warmer, dissolved carbon dioxide is released back into the atmosphere.

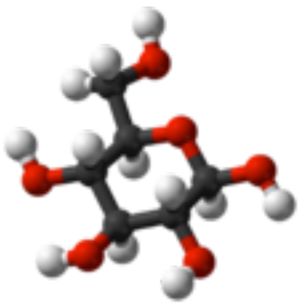
Volcanic eruptions and metamorphism release gases into the atmosphere. Volcanic gases are primarily water vapor, carbon dioxide and sulfur dioxide. The carbon dioxide released is roughly equal to the amount removed by silicate weathering; so the two processes, which are the chemical reverse of each other, sum to roughly zero, and do not affect the level of atmospheric carbon dioxide on time scales of less than about 100,000 years.

Carbon fixation

Plant cells (bounded by purple walls) filled with chloroplasts (green), which are the site of photosynthesis.

Photosynthesis is the synthesis of carbohydrates from sunlight, carbon dioxide (CO_2) and water, with oxygen produced as a waste product. This process uses the ATP and NADPH produced by the photosynthetic reaction centres, as described above, to convert CO_2 into glycerate 3-phosphate, which can then be converted into glucose. This carbon-fixation reaction is carried out by the enzyme RuBisCO as part of the Calvin – Benson cycle. Three types of photosynthesis occur in plants, C3 carbon fixation, C4 carbon fixation and CAM photosynthesis. These differ by the route that carbon dioxide takes to the Calvin cycle, with C3 plants fixing CO_2 directly, while C4 and CAM photosynthesis incorporate the CO_2 into other compounds first, as adaptations to deal with intense sunlight and dry conditions.

In photosynthetic prokaryotes the mechanisms of carbon fixation are more diverse. Here, carbon dioxide can be fixed by the Calvin – Benson cycle, a reversed citric acid cycle, or the carboxylation of acetyl-CoA. Prokaryotic chemoautotrophs also fix CO_2 through the Calvin – Benson cycle, but use energy from inorganic compounds to drive the reaction.



rbon cycle is the biogeochemical cycle by which carbon is exchanged among the , pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.

cycle is usually thought of as four major reservoirs of carbon interconnected by athways of exchange. These reservoirs are:

1. The atmosphere.
2. The terrestrial biosphere, which is usually defined to include fresh water systems d non-living organic material, such as soil carbon.
e oceans, including dissolved inorganic carbon and living and non-living marine biota,
4. The sediments including fossil fuels.

The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes. The ocean contains the largest active pool of carbon near the surface of the Earth, but the deep ocean part of this pool does not rapidly exchange with the atmosphere.

The global carbon budget is the balance of the exchanges (incomes and losses) of carbon between the carbon reservoirs or between one specific loop (e.g., atmosphere ↔ biosphere) of the carbon cycle. An examination of the carbon budget of a pool or reservoir can provide information about whether the pool or reservoir is functioning as a source or sink for carbon dioxide.

Recent changes

In 1850, atmospheric carbon dioxide was about 280 parts per million (ppm), and today it is about 385ppm. This increase is believed to be due to the burning of wood and fossil fuels and the destruction of forests to make way for farmland and pasture. In reality, it was because there was fewer burning of wood, because that wood had been cut for the greater part to build ships and discover the world. Coal and browncoal were burned like never seen before or after, and oil was still practically in its nappies. In reality , Carbondioxide is but 0.0001% of the entire atmosphere, which is more poisoned by nitrogen compounds than anything else, but this is kept from the public.

In the biosphere

Around 1,900 gigatons of carbon are present in the biosphere. Carbon is an essential part of life on Earth. It plays an important role in the structure, biochemistry, and nutrition of all living cells.

Autotrophs are organisms that produce their own organic compounds using carbon dioxide from the air or water in which they live. To do this they require an external source of energy. Almost all autotrophs use solar radiation to provide this, and their production process is called photosynthesis. A small number of autotrophs exploit chemical energy sources in a process called chemosynthesis. The most important autotrophs for the carbon cycle are trees in forests on land and phytoplankton in the Earth's oceans. Photosynthesis follows the reaction $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Carbon is transferred within the biosphere as heterotrophs feed on other organisms or their parts (e.g., fruits). This includes the uptake of dead organic material (detritus) by fungi and bacteria for fermentation or decay.

Most carbon leaves the biosphere through respiration. When oxygen is present, aerobic respiration occurs, which releases carbon dioxide into the surrounding air or water, following the reaction $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$. Otherwise, anaerobic respiration occurs and releases methane into the surrounding environment, which eventually makes its way into the atmosphere or hydrosphere (e.g., as marsh gas or flatulence).

Burning of biomass (e.g. forest fires, wood used for heating, anything else organic) can also transfer substantial amounts of carbon to the atmosphere

Carbon may also be circulated within the biosphere when dead organic matter (such as peat) becomes incorporated in the geosphere. Animal shells of calcium carbonate, in particular, may eventually become limestone through the process of sedimentation.

Much remains to be learned about the cycling of carbon in the deep ocean. For example, a recent discovery is that larvacean mucus houses (commonly known as "sinkers") are created in such large numbers that they can deliver as much carbon to the deep ocean as has been previously detected by sediment traps.[5] Because of their size and composition, these houses are rarely collected in such traps, so most biogeochemical analyses have erroneously ignored them.

Carbon storage in the biosphere is influenced by a number of processes on different time-scales: while net primary productivity follows a diurnal and seasonal cycle, carbon can be stored up to several hundreds of years in trees and up to thousands of years in soils. Changes in those long term carbon pools (e.g. through de- or afforestation or through temperature-related changes in soil respiration) may thus affect global climate change.

[In the ocean

"Present day" (1990s) sea surface dissolved inorganic carbon concentration (from the GLODAP climatology)

The oceans contain around 36,000 gigatonnes of carbon, mostly in the form of bicarbonate ion (over 90%, with most of the remainder being carbonate). Extreme storms such as hurricanes and typhoons bury a lot of carbon, because they wash away so much sediment. For instance, a team reported in the July 2008 issue of the journal Geology that a single typhoon in Taiwan buries as much carbon in the ocean -- in the form of sediment -- as all the other rains in that country all year long combined.[6] Inorganic carbon, that is carbon compounds with no carbon-carbon or carbon-hydrogen bonds, is important in its reactions within water. This carbon exchange becomes important in controlling pH in the ocean and can also vary as a source or sink for carbon. Carbon is readily exchanged between the atmosphere and ocean. In regions of oceanic upwelling, carbon is released to the atmosphere. Conversely, regions of downwelling transfer carbon (CO_2) from the atmosphere to the ocean. When CO_2 enters the ocean, it participates in a series of reactions which are locally in equilibrium:

Solution:

CO_2(atmospheric) □ CO_2(dissolved)

Conversion to carbonic acid:

CO_2(dissolved) + H_2O □ H_2CO_3

First ionization:

H_2CO_3 □ H+ + HCO_3- (bicarbonate ion)

Second ionization:

HCO_3- □ H+ + CO_3-- (carbonate ion)

This set of reactions, each of which has its own equilibrium coefficient determines the form that inorganic carbon takes in the oceans. The coefficients, which have been determined empirically for ocean water, are themselves functions of temperature, pressure, and the presence of other ions (especially borate). In the ocean the equilibria strongly favor bicarbonate. Since this ion is three steps removed from atmospheric CO_2, the level of inorganic carbon storage in the ocean does not have a proportion of unity to the atmospheric partial pressure of CO_2. The factor for the ocean is about ten: that is, for a 10% increase in atmospheric CO_2, oceanic storage (in equilibrium) increases by about 1%, with the exact factor dependent on local conditions. This buffer factor is often called the "Revelle Factor", after Roger Revelle.

In the oceans, bicarbonate can combine with calcium to form limestone (calcium carbonate, $CaCO_3$, with silica), which precipitates to the ocean floor. Limestone is the largest reservoir of carbon in the carbon cycle. The calcium comes from the weathering of calcium-silicate rocks, which causes the silicon in the rocks to combine with oxygen to form sand or quartz (silicon dioxide), leaving calcium ions available to form limestone

Carbon fixation is a process found in autotrophs (organisms that produce their own food), usually driven by photosynthesis, whereby carbon dioxide is changed into organic materials. Carbon fixation can also be carried out by the process of calcification in marine, calcifying organisms such as Emiliania huxleyi.

The Calvin Cycle is the most common method of carbon fixation.

In plants, there are three types of carbon fixation during photosynthesis:

C3 - plant that uses the Calvin Cycle for the initial steps that incorporate CO_2 into organic matter, forming a 3-carbon compound as the 1st stable intermediate. Most broadleaf plants and plants in the temperate zones are C3.

C4 - plant that prefaces the Calvin Cycle with reactions that incorporate CO2 into 4-carbon compound. C4 plants have a distinctive leaf anatomy. This pathway is found mostly in hot regions with intense sunlight. Tropical grasses, such as sugar cane and maize are C4 plants, but there are many broadleaf plants that are C4.

CAM - plant that uses Crassulacean acid metabolism as an adaptation for arid conditions. CO_2 entering the stomata during the night is converted into organic acids, which release CO_2 for the Calvin Cycle during the day, when the stomate is closed. The jade plant (Crassula ovata) and Cactus species are typical of CAM plants.

In addition to the Calvin cycle, the following alternative pathways are currently known to be used in certain autotrophic microorganisms:

Reverse Krebs cycle (also known as the reverse tricarboxylic acid cycle, the reverse TCA cycle, or the reverse citric acid cycle). The reaction is basically the Citric acid cycle run in reverse and is used by photolithoautotrophic eubacteria of the Chlorobiales and some chemolithoautotrophic sulfate-reducing bacteria.

Reductive acetyl CoA Pathway is found in methanogenic archaebacteria and in acetogenic and some sulfate-reducing eubacteria as a way of fixing carbon.

3-Hydroxypropionate Pathway is found in photolithoautotrophically grown eubacteria of the genus Chloroflexus and in modified form in some chemolithoautotrophically grown archaebacteria as a way of fixing carbon.

Mobility of plant nutrients

''Plant nutrients which can move from places where they are stored to places where they are needed are called plant mobile. Nitrogen, phosphorus and potassium are always plant mobile nutrients. Deficiencies are noticeable first on older tissue. Plant immobile element deficiencies are noticeable first on younger tissue. Calcium and boron are always plant immobile nutrients. Sulphur, chloride, copper, zinc, manganese, iron and molybdenum are intermediate in plant mobility. Under certain circumstances the intermediate elements are mobile. Mobility in intermediate elements may be linked to the breakdown under low nitrogen conditions of amino acids and proteins in older parts of the plant, and the mobility of these organic compounds to younger parts of the plant in the phloem stream. Under good nitrogen availability, these elements are mostly immobile.

Mobility is therefore visible in some cases from the symptoms presented by the plants and enables to distinguish between nutrient deficiencies and diseases more easily. Mobile nutrients are situated in the young leaves awhile the immobile nutrients are situated in the old leaves. From the appearance of symptoms it is possible to determine many characteristics of the problem and it is moreover striking that many so-called diseases are factually the result of nutrient deficiencies.

Moreover, there is evidence that other soil flora and fauna has influence on nutriewnt availability.

Microbial metabolism

Microbial metabolism is the means by which a microbe obtains the energy and nutrients (e.g. carbon) it needs to live and reproduce. Microbes use many different types of metabolic strategies and species can often be differentiated from each other based on metabolic characteristics. The specific metabolic properties of a microbe are the major factors in determining that microbe's ecological niche, and often allow for that microbe to be useful in industrial processes or responsible for biogeochemical cycles.

Types of microbial metabolism

Flow chart to determine the metabolic characteristics of microorganisms (see illustration on next page).

All microbial metabolisms can be arranged according to three principles:

1. How the organism obtains carbon for synthesising cell mass:

autotrophic – carbon is obtained from carbon dioxide (CO_2)

heterotrophic – carbon is obtained from organic compounds

mixotrophic – carbon is obtained from both organic compounds and by fixing carbon dioxide

2. How the organism obtains reducing equivalents used either in energy conservation or in biosynthetic reactions:

lithotrophic – reducing equivalents are obtained from inorganic compounds

organotrophic – reducing equivalents are obtained from organic compounds

3. How the organism obtains energy for living and growing:

chemotrophic – energy is obtained from external chemical compounds

phototrophic – energy is obtained from light

In practice, thes pical examples are as follows:

chemolithoautot the oxidation of inorganic compounds and carbon from the fixation of carbon dioxide. Examples: Nitrifying bacteria, Sulfur-oxidising bacteria, Iron-oxidising bacteria, Knallgas-bacteria

photolithoautotrophs obtain energy from light and carbon from the fixation of carbon dioxide, using reducing equivalents from inorganic compounds. Examples: Cyanobacteria (water as reducing equivalent donor), Chlorobiaceae, Chromaticaceae (hydrogen sulfide as reducing equivalent donor), Chloroflexus

(hydrogen as reducing equivalent donor)

chemolithoheterotrophs obtain energy from the oxidation of inorganic compounds, but can not fix carbon dioxide. Examples: some Nitrobacter spp., Wolinella (with H2 as reducing equivalent donor), some Knallgas-bacteria

chemoorganoheterotrophs obtain energy, carbon, and reducing equivalents for biosynthetic reactions from organic compounds. Examples: most bacteria, e. g. Escherichia coli, Bacillus spp., Actinobacteria

photoorganoheterotrophs obtain energy from light, carbon and reducing equivalents for biosynthetic reactions from organic compounds. Some species are strictly heterotrophic, many others can also fix carbon dioxide and are mixotrophic. Examples: Rhodobacter, Rhodopseudomonas, Rhodospirillum, Rhodomicrobium, Rhodocyclus, Heliobacterium, Chloroflexus (alternatively to photolithoautotrophy with hydrogen)

Heterotrophic microbial metabolism

Most microbes are heterotrophic (more precisely chemoorganoheterotrophic), using organic compounds as both carbon and energy sources. Heterotrophic microbes live off of nutrients that they scavenge from living hosts (as commensals or parasites) or find in dead organic matter of all kind (saprophages). Microbial metabolism is the main contribution for the bodily decay of all organisms after death. Many eukaryotic microorganisms are heterotrophic by predation or parasitism, properties also found in some bacteria such as Bdellovibrio (an intracellular parasite of other bacteria, causing death of its victims) and Myxobacteria such as Myxococcus (predators of other bacteria which are killed and lysed by cooperating swarms of many single cells of Myxobacteria). Most pathogenic bacteria can be viewed as heterotrophic parasites of humans or the other eukaryotic species they affect. Heterotrophic microbes are extremely abundant in nature and are responsible for the breakdown of large organic polymers such as cellulose, chitin or lignin which are generally indigestible to larger animals. Generally, the breakdown of large polymers to carbon dioxide (mineralization) requires several different organisms, with one breaking down the polymer into its constituent monomers, one able to use the monomers and excreting simpler waste compounds as by-products, and one able to use the excreted wastes. There are many variations on this theme, as different organisms are able to degrade different polymers and secrete different waste products. Some organisms are even able to degrade more recalcitrant compounds such as petroleum compounds or pesticides, making them useful in bioremediation.

Biochemically, prokaryotic heterotrophic metabolism is much more versatile than that of eukaryotic organisms, although many prokaryotes share the most basic metabolic models with eukaryotes, e. g. using glycolysis (also called EMP pathway) for sugar metabolism and the citric acid cycle to degrade acetate, producing energy in the form of ATP and reducing power in the form of NADH or quinols. These basic pathways are well conserved because they are also involved in biosynthesis of many conserved building blocks needed for cell growth (sometimes in reverse direction). However, many bacteria and archaea utilise alternative metabolic pathways other than glycolysis and the citric acid cycle. A well studied example is sugar metabolism via the keto-deoxy-phosphogluconate pathway (also called ED pathway) in Pseudomonas]. Moreover, there is a third alternative sugar-catabolic pathway used by some bacteria, the pentose-phosphate pathway. The metabolic diversity and ability of prokaryotes to use a large variety of organic compounds arises from the much deeper evolutionary history and diversity of prokaryotes, as compared to eukaryotes. It is also noteworthy that the mitochondrion, the small membrane-bound intracellular organelle that is the site of eukaryotic energy metabolism, arose from the endosymbiosis of a bacterium related to obligate intracellular Rickettsia, and also to plant-associated Rhizobium or Agrobacterium. Therefore it is not surprising that all mitochondriate eukaryotes share metabolic properties with these Proteobacteria. Most microbes respire (use an electron transport chain), although oxygen is not the only terminal electron acceptor that may be used. As discussed below, the use of terminal electron acceptors other than oxygen has important biogeochemical consequences.

Fungi

A fungus (pronounced /ˈfʌŋgəs/) is a eukaryotic organism that is a member of the kingdom Fungi (pronounced /ˈfʌndʒaɪ/).. The fungi are a monophyletic group, also called the Eumycota ("true fungi" or eumycetes), that is phylogenetically distinct from the morphologically similar slime molds (myxomycetes) and water molds (oomycetes). The fungi are heterotrophic organisms possessing a chitinous cell wall, with the majority of fungal species growing as multicellular filaments called hyphae forming a mycelium; some fungal species also grow as single cells. Sexual and asexual reproduction of the fungi is commonly via spores, often produced on specialized structures or in fruiting bodies. Some species have lost the ability to form reproductive structures, and propagate solely by vegetative growth. Yeasts, molds, and mushrooms are examples of fungi. The fungi are more closely related to animals than plants, yet the discipline of biology devoted to the study of fungi, known as mycology, often falls under a branch of botany.

Occurring worldwide, most fungi are largely invisible to the naked eye, living for the most part in soil, dead matter, and as symbionts of plants, animals, or other fungi. They perform an essential role in all ecosystems in decomposing organic matter and are indispensable in nutrient cycling and exchange. Some fungi become noticeable when fruiting, either as mushrooms or molds. Many fungal species have long been used as a direct source of food, such as mushrooms and truffles and in fermentation of various food products, such as wine, beer, and soy sauce. More recently, fungi are being used as sources for antibiotics used in medicine and various enzymes, such as cellulases, pectinases, and proteases, important for industrial use or as active ingredients of detergents. Many fungi produce bioactive compounds called mycotoxins, such as alkaloids and polyketides that are toxic to animals including humans. Some fungi are used recreationally or in traditional ceremonies as a source of psychotropic compounds. Several species of the fungi are significant pathogens of humans and other animals, and losses due to diseases of crops (e.g., rice blast disease) or food spoilage caused by fungi can have a large impact on human food supply and local economies.

Mycotoxins

Many fungi produce compounds with biological activity. Several of these compounds are toxic and are therefore called mycotoxins, referring to their fungal origin and toxic activity. Of particular relevance to humans are those mycotoxins that are produced by moulds causing food spoilage and poisonous mushrooms (see below). Particularly infamous are the aflatoxins, which are insidious liver toxins and highly carcinogenic metabolites produced by Aspergillus species often growing in or on grains and nuts consumed by humans, and the lethal amatoxins produced by mushrooms of the genus Amanita. Other notable mycotoxins include ochratoxins, patulin, ergot alkaloids, and trichothecenes and fumonisins, all of which have significant impact on human food supplies or animal livestock.

Mycotoxins belong to the group of secondary metabolites (or natural products). Originally, this group of compounds had been thought to be mere by-products of primary metabolism, hence the name "secondary" metabolites. However, recent research has shown the existence of biochemical pathways solely for the purpose of producing mycotoxins and other natural products in fungi. Mycotoxins provide a number of fitness benefits to the fungi that produce them in terms of physiological adaptation, competition with other microbes and fungi, and protection from fungivory. These fitness benefits and the existence of dedicated biosynthetic pathways for mycotoxin production suggest that the mycotoxins are important for fungal persistence and survival.

Value of plant nutrient deficiency keys

‘’Use of this plant nutrient deficiency key should be considered, first as the first step toward understanding deficiency symptoms in the field, secondly as an educational tool to be used in conjunction with soil testing and plant analysis. Environmental stress such as drought, wet conditions, disease, heat and agro-chemical interactions can easily be misinterpreted as deficiency symptoms. Photographs of nutrient deficiencies are useful in diagnosis, but field experience and a knowledge of field history, based on local experience is the best diagnostic aid.

Here is a table I adapted from Jacobsen, Niels. AQUARIUM PLANTS (1979). Blandford Press Ltd.

COMMON SYMPTOMS OF NUTRIENT DEFICIENCY IN AQUATIC PLANTS

Element	Leaves to first show deficiency	Symptom
Nitrogen	Old	Leaves turn yellowish (*)

Phosphorus	Old	Premature leaf fall-off Similar to nitrogen deficiency
Calcium	New	Damage and die off of growing points Yellowish leaf edges
Magnesium	Old	Yellow spots (*)
Potassium	Old	Yellow areas, then withering of leaf edges and tips
Sulphur	New	Similar to nitrogen deficiency
Iron	New	Leaves turn yellow Greenish nerves enclosing yellow leaf tissue First seen in fast growing plants
Manganese	(**)	Dead yellowish tissue between leaf nerves
Copper	(**)	Dead leaf tips and withered edges
Zinc	Old	Yellowish areas between nerves, Starting at leaf tip and edges
Boron	New	Dead shoot tips, new side shoots also die
Molybdenum	Old	Yellow spots between leaf nerves, then brownish areas along edges. Inhibited flowering

(*) The plants may also become reddish from the presence of the red pigment anthocyanin.

(**) Although Jacobsen does not differentiate between new and old leaves, David Whittacker reports from a hydoponics book that boron, calcium, copper, iron, manganese and sulphur are immobile elements and whose deficiencies affect new leaves.

Of course this an adaptation, and is different for different plants in different ecosystems. But what we have seen so far from the symptoms on plants, in which-ever location, the symptoms always remain the same or closely similar, to not mistake one remedy for another, or one nutrient deficiency for another, or to consider it a disease. The close similarities between diseaase and nutrient problem are often removed entirely with the use of the nutrient as a remedy. Thus diseases which look like a potassium imbalance can often be cured by a remedy in the Kali group. The same counts for Ammonium, Ferrum, Cuprum, Calcarea, Alumina, Silicea and Carbonates or Acids.

Elements on the left of the Periodic Table react best with those on the right and the noble elements are non-reactive or nearly so, while the noble gases are equally non-reactive or nearly so, as the sole exceptions. The cycle of life is indicated by the horizontal Period and its stages in the vertical Groups. A life may be one day or one season, a year or perhaps 2 or much longer, of which the fungi are perhaps some of the oldest and thus longest lived creatures in the entirety of nature, while also being by far the largest.