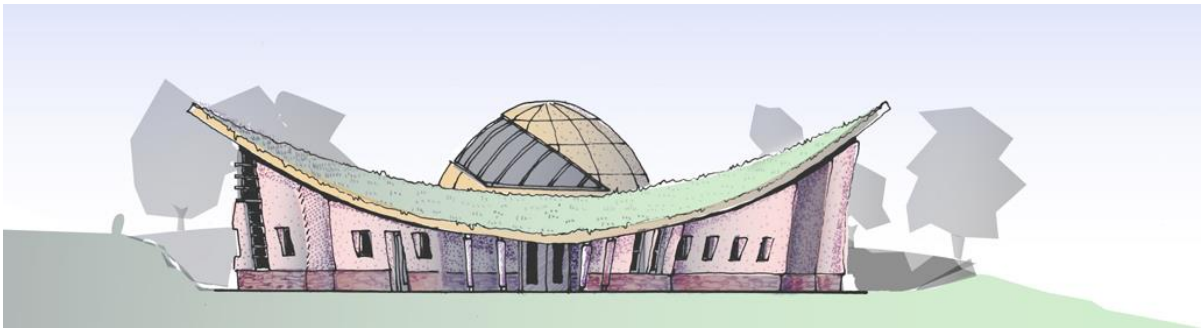
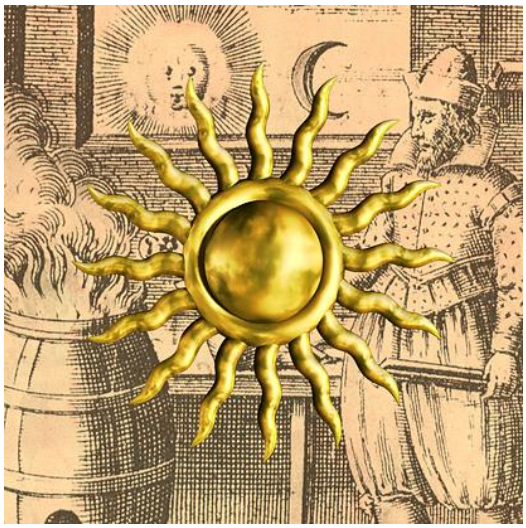


Gold Colloids in the Sun Chamber at the Field Centre

The chemical symbol for Gold is Au from the Latin name Aurum, and the roots of this name can be traced back to the word Ur, a basic word in all ancient languages: Urt in Egyptian and Aor in Ancient Hebrew. Its many different meanings all have to do in some way with the Being of Light.

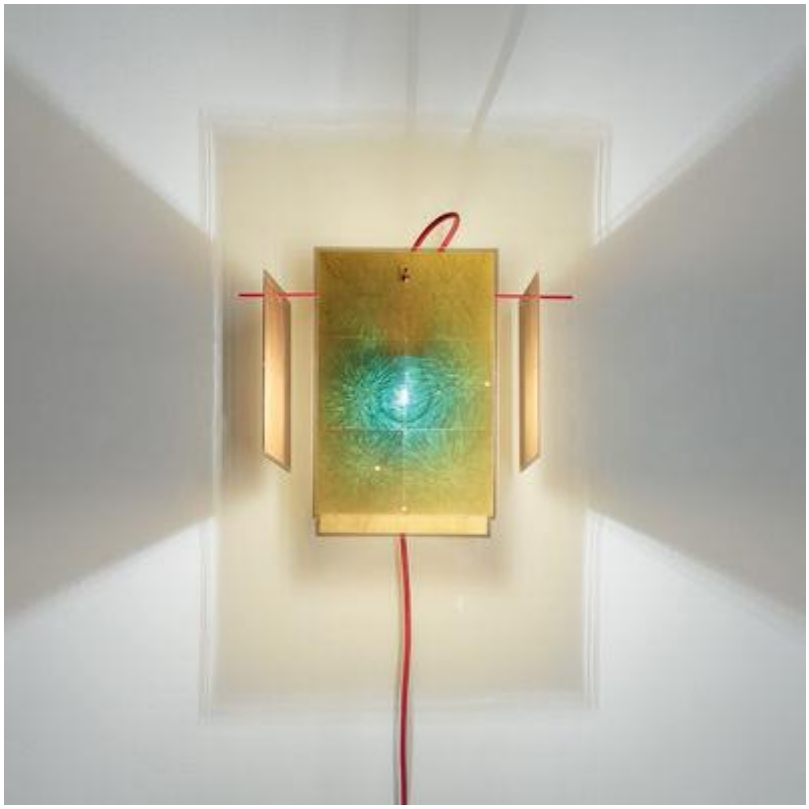
As we shall see Gold has unique characteristics in its relationship with light and this has inspired Artists, Craftspeople, Kings and Queens, Priests and Priestesses down through the ages. The majority of the chemical elements are metals but almost all have the passive reflectivity which gives them a silvery appearance. Only Gold and Copper, and the rarely known Caesium, give intimately warm yellow-reddish colouration to the reflected light. Understood nowadays with quantum mechanics this phenomena is due to something called Surface Plasmon Resonance: the surface of the metal catches the light and infuses its own tone into what is reflected.



When we call the sunlight "golden" it is also a recognition of this kinship of gold and light

Ancient wisdom saw gold as belonging to a time when earth and Sun were united. Perhaps our contemporary astrophysics has grasped part of the truth of this : we know that our present day Sun can synthesise elements only as far as Iron the 26th element. Elements heavier than Iron (Gold is the 79th of the 92 natural elements) can be made only in a much larger Sun which would have encompassed in its final phase our solar system as far out as Saturn. The richness of the chemical environment on Earth, the presence of Gold across all continents, dispersed in all the Oceans, is a testament to the processes in the Old Sun which existed before giving birth to our present Sun and planets.

Gold is the most malleable and most ductile metal. It can be drawn out into the finest wires used to form the connecting threads of the microscopic integrated circuits in our electronic technology. When thinned into gold leaf it becomes partially transparent and the transmitted light takes on a blue - green hue.



24 Carat Gold lampshade showing the colour of light that passes through Gold

The spectrum of Gold shows no lines in the green so it is especially permeable by this central part of the light spectrum, the colour of living plants:

The spectral lines of pure Gold showing the absence of emission and absorption lines in the green

There is a further condition of Gold which also reveals its unique interaction with light: the Gold Colloid. Gold Colloids were used artistically in the stained glass windows of the great cathedrals of the Middle Ages.

Detail of a European stained glass image of St. George from the early 15th century. Medieval artisans discovered through alchemical experimentation that adding gold chloride to molten glass resulted in a red tint, and adding silver nitrate turned the glass yellow. The technique reached its height during the 16th through 18th century and resulted in some of the world's most spectacular stained glass windows. Recently scientists analyzed stained glass from this era and discovered that the technique, possibly dating back to the 10th century, worked because of nanotechnology; analysis of the stained glass revealed that gold and silver nanoparticles, acting as quantum dots, tuned the gold red and yellow respectively.

Modern scientific evaluation of colloidal gold did not begin until Michael Faraday's work in the 1850s. In 1856, in a basement laboratory of Royal Institution , Faraday accidentally created a ruby red solution while mounting pieces of gold leaf onto microscope slides. Since he was already interested in the properties of light and matter, Faraday further investigated the optical properties of the colloidal gold. He prepared the first pure sample, which he called 'activated gold', in 1857. The colloidal gold Faraday made 150 years ago is still optically active. For a long time, the composition of the 'ruby' gold was unclear. Faraday recognized that the colour was actually due to the miniature size of the gold particles.

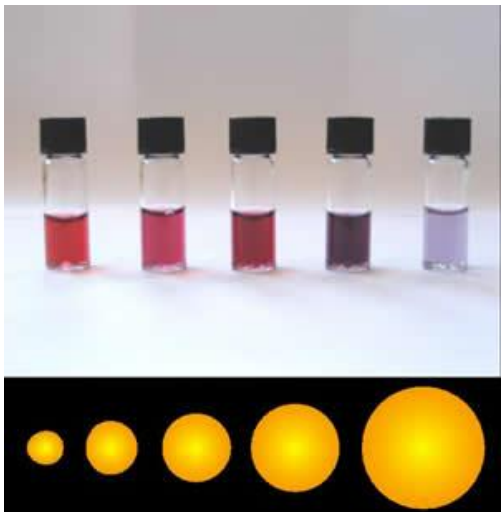
The effect is now called the Faraday-Tyndall effect, a scattering of the light that happens when matter is thinned down or made sub microscopic in size. The blue of the sky is a result of the scattering of the sun's light by the hundred miles of transparent air through which we look into the darkness of space. Through the finely illumined atmosphere the dark space is lightened to blue. As the sun penetrates more atmosphere when it nears the horizon its brightness is dimmed in the most subtle way by the air and the Sun turns golden and then red. Goethe called this archetypal phenomena of the blue sky and the yellow sun the first lightening of the dark and the first darkening of the light.

With the Gold Colloid the rose colour tells us of the appearance of solid particles within the highly diluted chemical solution. It is the first dawning of solid matter in the liquid

A gold colloid, as in the above photograph, is a highly dispersed suspension of very fine "nano-particles" of solid gold, which because of their size remain suspended in solution. They are freed from the force of weight not only by the normal fluid forces of buoyancy but also by the inner movement of the water and its matrix of electrical , chemical and biochemical fields . In this condition the colloidal gold interacts with light in a multifaceted way. Although transmission, absorption, and reflection are enhanced by the vastly increased surface area of the material particles, scattering is the predominant effect, coupled with gold's distinct surface resonance. Its most attractive colour is rose magenta , sometimes a ruby red, but this can vary to purple and violet depending both on concentrations and size of the gold particles. The colour arises in the subtle interweaving of light with matter which happens at this scale one thousand times below the microscopic!

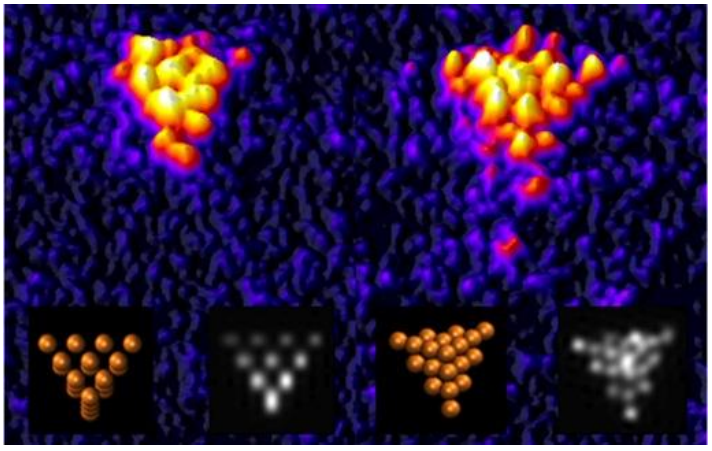
The colours are often strikingly beautiful, with depth and clarity, combining translucence, transparency and fluorescence together with the radiance of scattering

In the huge modern field of colloid and nanoparticle technology Gold has a special position. The red gold colloids are the result of the smallest nanoparticles in existence. The light is woven around and between the solid metal , touched but not trapped by the substance.



The Colour of Gold colloids depends on the size of the particles of Gold from a few nanometres up to 8 micrometers. They span the same scale as viruses and the dilutions used at the Field Centre to make them are approaching but not yet within the homeopathic realm

Modern techniques can create not only spheres of Gold, but beautifully geometric polygons and all kinds of crystal shapes. The forms cannot be seen in the true sense of seeing : the matter is visible in normal light only by its colour! But sophisticated techniques like atomic force and electron microscopy can reveal forms at the nano-scale, although it should be pointed out that the colloid has to be destroyed before the particles can be imaged. An example from the University of Birmingham is an image of the world's smallest gold pyramid!



Physicists have theorised for many years how atoms of gold and other elements would be arranged and ten years ago the structure of a 20-atom tetrahedral pyramid was proposed by scientists in the US. Birmingham physicists can now reveal this atomic arrangement for the first time by imaging the cluster with an electron microscope

The production of colloids is an important part of electronic, chemical, and medical technology and has grown tremendously in the last few years. Solid metal, with elements of form and a measurable scale, arise out of a fluid state. Such tiny specks of substance cannot be made by the subdivision of solid matter through grinding and pulverising.

The Gold colloids at the Field Centre are always made by "green chemistry" that is an environmentally friendly technique using a substance taken from life to provide the context in which the Gold can condense out of the solution. Most commonly tannic acid is used, derived originally from the bark of oak trees. There are many other possibilities from the plant realm as tannin-like substances are common and an important part of our food intake. Details of the chemistry involved are given in the addendum article.

It is interesting to note how the process of coagulation of Gold in the organic structure provided by the tannin is akin to the process that folds around the metal Magnesium in the chlorophyll molecule, the essential green substance for photosynthesis in plants, and around the metal Iron in blood haemoglobin.

In the formation of nano particle colloids there is a transition from an essentially invisible state in solution to a state of matter on the very edge of detectability as physical substance. The materialistic paradigm in science wants to believe in the material presence even where it cannot be seen, just as in optical physics because Newton colours are believed to exist where they are invisible. Hence we talk about gold atoms being in solution as chemical ions. This form of thinking misses the important transition that occurs, and fixes our thinking in a naive "particle" imagery. It applies "solidity" where it does not belong, and the pictures lead us away from the direct experiences we have in relationship with the world.

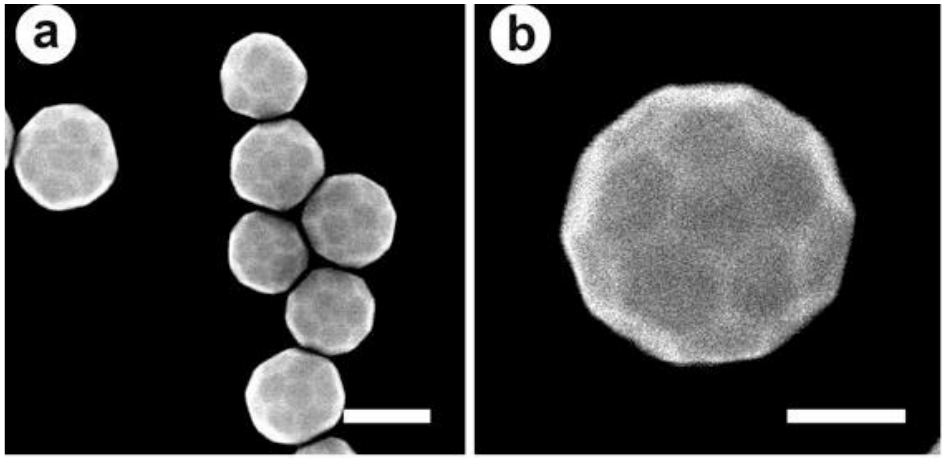
Gold in solution exists in the fluid matrix in a state quite different from anything we call material. Weight, form and colour, three attributes of material existence, are not there in the same way in the dissolved form, and begin to arise in the colloids only in a way that will be further changed as we approach the more usual scale of things. They are at the transition between bulk materials and atomic or molecular structures and they exhibit phenomena that are not observed at larger or smaller scales. They are between the quantum mechanical and the physical. They are between the world of visible forms, and the formless solutions which are the scene for chemical transformations.

So gold colloids are just at the point of becoming definite objects out of the quantum mechanical matrix of forces that science will admit is the state of "matter "in solution.

As evidence of this, so as to contribute to a new way of thinking about matter, I can point to the fact that only certain numbers of gold atoms can exist in the nanoparticle structures.

"For *each of these structural states of a nanoparticle, there is a certain set of numbers of the atoms involved in the particle that corresponds to optimum stable configurations. These numbers are usually called the magic numbers*."

The finest gold nano particles, in the true Ruby Red Colloids, have been shown both theoretically and by imaging processes , to consist of 12 atoms of gold. Anything less than this is unstable and hence reverts to the dispersed intangible form of gold in the solution.



Scanning Electron Microscope Images of Dodecahedral Nanoparticles of Gold. Gold displays a full range of geometrical forms : suboctahedral, spherical, octahedral, icosahedral ,multiple twined decahedral, multiple twined tetrahedral, irregular shaped ,nanotriangles, hexagonalplatelets, nanorods, and nanoprisms

This numerical "magic" is what underlies the wonderful geometric forms which gold particles can assume. At the same time it points to the mathematical and musical nature of the sub-material world. Vibrations in harmony are what allow the arising of material form, capable of interacting with light , and then later on possessing weight and colour.

Careful observation of the forming of gold colloids has repeatedly given a sensation of the change that happens when the materialization begins. It is both sudden and subtle, a barely visible darkening, several minutes before any scattering colour can be detected in the transparent solutions.

* * *

The above writing has been a description of gold phenomena from within the current scientific paradigm, although I have pointed to the limitations of a materialistic approach to chemistry. Work with gold colloids has accompanied the development of the Field Centre in all its areas of research.

We can now look at the significance and purpose of gold colloids within the Field Centre and the Ruskin Mill Trust.

The Field Centre enables research into

- A new methodology in Science and a new idea of scientific practice.
- A new approach to Education
- An aesthetic and therapeutic approach to practical work
- New approaches to Agriculture and Medicine
- An approach to Economics that supports social living, the crafts and the arts .

Agriculture and Medicine

Research in Biodynamic Agriculture is beginning into the use of gold nanoparticles as a way of enhancing the action of sunlight within the layer of topsoil so vital for the growth of

plants. We know that the vastly increased surface area of nanoparticles will increase the action of sunlight, and in addition they could provide centres of stability in the soil that could facilitate living processes at the sub-microscopic and microscopic scales, possibly supporting the micro biome needed for soil fertility.

Considering the dilution of the colloidal solutions, and the usual practice of further dilution in biodynamic agriculture, there is little likelihood of any toxicity from the use of our gold colloids in this research. The estimated concentrations will be around the level of gold in sea water and so it is likely that any addition of colloids will constitute a refinement and harmonisation with the natural background dispersion of the element.

The water has been exposed to direct sunlight everyday of the year, throughout all seasons. All the colours of gold: yellow, blue green and red have been continually interwoven into the fluid.

In ordinary medicine gold nanoparticles are used in organic synthesis and also as a way of carrying substance through the skin: "*Gold nano particles are able to interact with the skin barrier, enhancing delivery and improving the skin permeability of high-molecular-weight active agents. GNPs are considered as promising candidates for skin immunization and optimizing transdermal delivery systems.*"

Colloidal particles are also in between the measurable and the homeopathic levels of material reality and could be important in deepening our understanding of the therapeutic uses of substance. The current orthodox medical direction of research indicates perhaps a way forward also for gentler forms of medicine like herbalism, homeopathy, and Anthroposophical medicine.

Economics

The Field Centre has always represented a spiritual-scientific approach to the world, and this approach to Economics is most certainly needed today.

Gold has had a world-changing role in modern civilisation as the metal that for many centuries underpinned the economic life of mankind. The weight of gold is the measure of the promise written on English Bank notes for example. Although the economy is no longer regulated by the gold standard, still many banks store hundreds of tonnes of gold in their vaults. The value attached to the earth-bound weight compels human beings to dig up tonnes of rock, and extract gold from it, only to see it buried away again in the darkness. Through material possession the weight of gold has obscured the spiritual qualities of the financial system: the trust that underlies good commerce, and builds communities; and the liberation of creativity which is the real task of economic activity.

The colloids of gold at the Field Centre are of minimal economic value but they are undoubtedly aesthetic, they remind us of the relationship of gold to the light, as they scatter the rose magenta hues whenever the sun is above the horizon. Rudolf Steiner suggests that gold makes the spirit visible. Would it not be a positive step to increase the aesthetic use of gold in our homes, workplaces, and public spaces?

Education and Science

People who have been at the Field Centre for the festive moments when the colloids have been made have seen gold coming into existence, in an original moment of crystallisation which catches the light and the mind. If our thoughts about matter can be changed by seeing its first solid appearance in the dawning rosy hue then the new form of gold in its gentlest most dispersed form will have affected us with its sun nature, with its natural connection to light.

The way we think about matter is important because it can liberate or bind our imagination. Just as we see through the colloidal suspension, and through the scattered light, we need to learn to see through the pictures of reality which have become materialistic. The old materialism is still dominant in education even though it has theoretically been superseded. It underlies our medical science, neurophysiology, and psychology in so far as we think there

is a material world creating our sensations by the stimulation of our sense organs. An alternative and liberating view is that we grow into the world of phenomena, as beings with an ***inner*** dimension, through our sense organs and sensory experiences which together constitute the ***outer*** world.

As William Blake put it: "*We are led to believe a lie, when we see with, not through the eye*." A technological world need not lead us a way from trust in our human nature, in the human senses and in our spiritual inwardness.

Instead of an invisible material world behind the sense world working into us, we are soul-spiritual beings growing outwards on the basis of a will towards freedom, into an embodied reality. Developing this new scientific and educational paradigm is a task of the action research for which the Field Centre and the whole Ruskin Mill Trust was designed.

Handling gold for its aesthetic value means to handle it selflessly; it both recognises and reveals the special connection of this element not to weight but to light. Making Colloids of Gold is an artistic deed for the spreading of gold's sun influence in communities that love the earth, and that support human development, so the work of hands and hearts and minds can be strengthened in the direction of freedom in our time.

Alexander Murrell for the Field Centre. March 2022

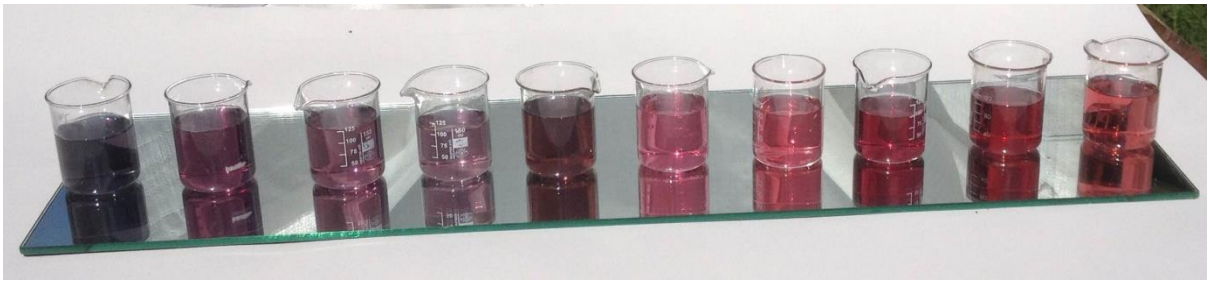
The Addendum Article contains more scientific detail on the colloidal chemistry .

Further Scientific Reflections on Colloids

To dissolve gold, that is to bring it into a dispersed ionised state in a fluid, you need a very concentrated acid called by the alchemists ***aqua regia*** or kingly water- a corrosive mixture of nitric and hydrochloric acids. Then you will have fully dispersed (ionised) the gold, and its metallic qualities only potentially exist within the solution. The Chloro-Auric Acid solution is yellow, and yellow crystals of gold chloride can be made by evaporation. All metallic properties like hardness, reflectiveness, conductivity, every quality we identify with gold, will have disappeared.

The solution is now diluted in pure water and a dilute solution of an organic material is then added to it. We used tannic acid: a close relative of many organic substances – called tannins – which are important nutritional compounds. Other natural organic compounds can be used, eg. Sodium citrate derived from vitamin C, or the juice from rose petals.

A few moments later the solution begins to take on a rose pink colour which can sometimes deepen into red or purple. What we know is that tiny particles of gold have formed in the centre an organic matrix provided by the tannin. They are protected from clumping together by the organic molecules and by an electric polarity engendered in connection with them. They become solid, but only in the finest particulate form, not as nuggets or flakes of gold as found on the beds of rivers, but as suspended independent pieces within the water. The particles are very pure gold, but never sink under earth's gravity through their own weight.



In the above picture there are 10 colloidal solutions, from deep purple on the left to a red on the right. Numbering from left to right, numbers 1-6 were made with rose petal extract, 7-9 with tannic acid and 10 with sodium citrate.

Deionised water was used throughout, and a dilute solution of Chloroauric acid commercially obtained (and diluted approximately 1:20 with deionised water). Gold Chloride is similar to this.

Rose petal extract was made from about 2g dried petals , heated with water at 80 ^{0}C and then filtered and cooled.

Tannic acid solution was made with 2g dissolved in 200 ml of water as the stock solution.

It is best to find your own dilutions by scaling up or down the approximate proportions of these ingredients with the deionised water. Typical starting quantities are given below. Greater dilutions can lead to better results – sometimes you then have to wait a few minutes.

0.5 ml of tannic acid solution in 100ml of water. Add to 0.5 ml of chloroauric acid solution in 100ml water. Experiment by increasing the amount of tannic acid in steps of 0.5 ml.

Dilute the rose petal extract until it is a similar tint to chloroauric acid solution made by dissolving 0.5 ml in 100ml of water. Add equal volumes of these together.

Sodium citrate : Dissolve 1g in 100ml of water.

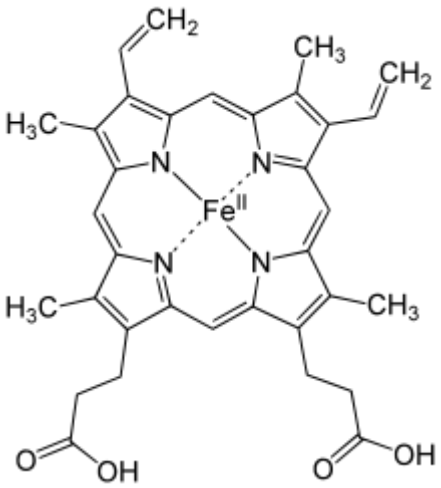
Heat 2ml gold solution in 100ml water, and then add to 4ml of the sodium citrate solution.

More accurate recipes using mM quantities can be easily found on the internet.

Each particle maintains its independence, and can grow within the context of the organic matrix that surrounds it. The limit to growth is achieved when all the gold in solution has in this way condensed. If there is too much gold the solution goes dark and the colloidal particles will coagulate and sink. In a true colloid there is a wonderfully clear transparency about the colours produced, especially when they are observed in sunlight.

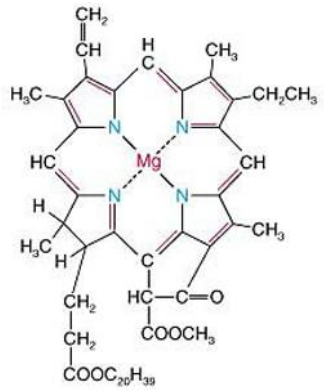
Some coagulation may happen over time leading to a small amount of precipitate. If the colloid is diluted by adding more pure water the colloid appears to become entirely stable and the clear rose colour will last for years. Embedded in glass we have examples of this colloid which have lasted for over a thousand five hundred years.

Iron in the blood exists in the form of haemoglobin which consists of an organic matrix surrounding an atom of Iron. The carbon atoms are indicated by the angular nodes, and are most often in the carbon ring form.



Haemoglobin – the chief ingredient of most animal and human blood. An iron atom (Fe) is held by coordinate bonding within the centre of the organic structure

This is called a chelation of iron and while not being the same as a colloid, it is similar in that a metal is embedded in an organic matrix. The crucial plant substance –chlorophyll- has a structure around the metal magnesium:

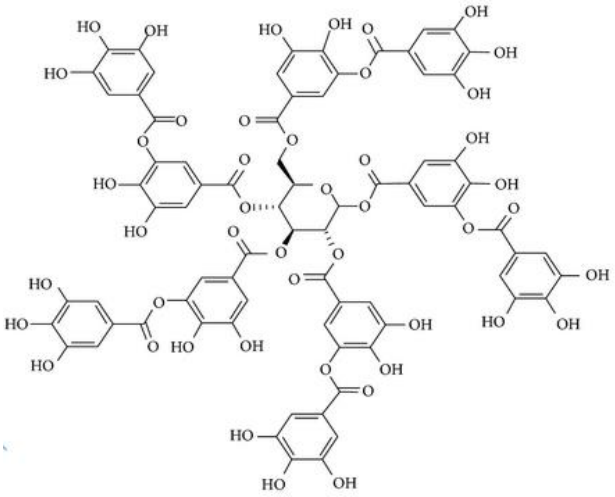


Chlorophyll - the essential green substance of the plant world

In both these important molecules the central metal atom is a reactive one and it is held back from its full chemical activity by the formative structure around it. The organic formative forces hold the metal so that its chemical - ie transformative - forces maintain photosynthesis or respiration. In a

way the carbon framework preserves the chemical nature of the metal so that it is used continually in the service of the life processes. It does not lose itself in them. This ability of the formative forces of organic molecules to surround the metals and so avail themselves of their chemical transformative forces is crucial for all of life. The same type of process underlies colloid formation as we shall see.

With the gold colloid the organic structure needed is larger, and there is an absence of nitrogen in its composition. Instead, oxygen seems to be the key element to attract the gold.



Tannic acid ($C_{76}H_{52}O_{46}$)

With such a diagram we are challenged to imagine a sub-microscopic reality, fundamentally invisible and only symbolically expressed. In a materialistic fashion we tend to think of the representations as atoms in some hazy kind of solid state. What is more certain is that the organic substances especially the carbon provide a framework of formative forces. Through this special arrangement of forces, solid gold is enabled to form in the centre of the tannin matrix, where you can see a cluster of oxygen atoms. Gold has little natural chemistry but in this way it comes to its natural uncombined state and forms a colloid.

The central parts of the tannin orientate themselves around a gold centre which then gathers more gold to itself. This is represented below, where the wavy blue lines represent the five strands of the tannin molecule , the purple balls are parts of the central oxygen-rich region and the orange ball is the metal gold particle.

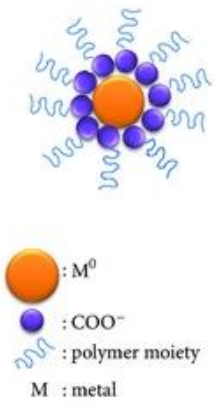


Diagram of a colloid formation in the centre of several tannic acid molecules

Scientists can use gold colloids to study organic molecules because the gold centre provides an anchor of stability to which different carbon structures can be attached. Formative forces can be carefully controlled and new forms of organic molecules and medicines are synthesised using gold colloids.

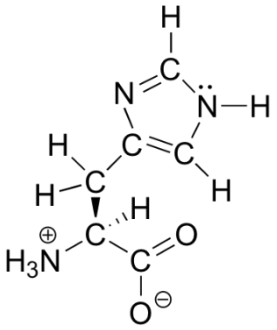
Looking at the structure and composition of the tannic acid – a highly important nutrient for us - helps us to imagine the many formative processes that must be continuing all of the time within the living cell. The life processes have to be directed partly to solid formation so as to build the organism structures; and secondly they have to hold back the chemical transformative processes so that the organism can maintain its living relationship with the environment. For example, the incoming light needs to be continually woven into chemical and formative potential through photosynthesis.

There is a clear similarity between gold colloids and the important organic chelations of haemoglobin and chlorophyll. The colloid is a larger structure and the metal grows in the centre rather than being completely bound within it. Form has arisen - as demonstrated by various imaging techniques - and with it comes a stability which is then used by chemical technologists. In chelations the metals are held in a more dynamic state of readiness for chemical transformative processes, yet are held back from losing themselves in the process.

Life depends on both relative permanence of form- some degree of solidity- and the ongoing fluid-chemical transformations which take place in the unified context of the organism. It is this dual nature of life processes that gives organic molecules possibilities of engendering colloids and chelations.

I have attempted to make an extremely fine gold colloid using histidine – an essential amino acid for human beings – as the organic surround. In this case the colloid is even closer to the chelation type of structure as the gold centre that forms is thought to contain only 10 atoms of gold. It forms a fine bluish or purple suspension .

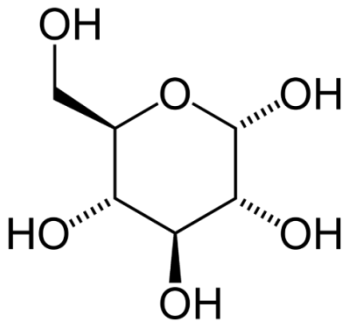
Gold colloids made using histidine as the organic material. These contain possibly smaller nano particles than the rose gold colloids.



Histidine

Histidine is an essential amino acid which needs to be part of our nutrition, as we cannot synthesise it using the formative forces of the other protein building molecules.

I have also made ***copper*** colloids using glucose, the first and simplest organic molecule synthesised by every plant from light, water and carbon dioxide.



Glucose molecule diagram

The solutions have to be quite concentrated and hot when added to weak copper sulphate solution. Then striking fluorescent colours arise from the finely dispersed metallic copper which forms in the organic matrix. Investigation shows that nano-spheres or rods of copper have been formed within the glucose complex.

A set of copper colloids formed in hot glucose solutions

After a few days the copper colloid disappears because the reactivity of copper makes it gradually oxidise and dissolve into the solution. Here again we can see how life mediates between form-giving and transformative chemistry. The copper's tendency to react is held back by the glucose when it comes into the realm of solid form, but only for a few days. Then the brilliant yellow solutions will become clear and almost transparent again.

Copper **Chelations** exist in many forms of life including human beings, where some atoms of copper are co-ordinately bonded in an organic protein which is an essential precursor in the synthesis of haemoglobin. So, although we need only a little copper in our diet, without it we would become anaemic.

Conclusions and Suggestions

Colloid particle formation seems to be an intermediate realm, between the world of visible forms, and solutions which are formless but are the scene for chemical transformations.

A study of colloids in relation with chelations leads to some understanding of life processes and formative forces which operate in living organisms. The role of Nitrogen in forming chelations may also be an important line of research.

Rudolf Steiner's description of evolution as a condensing of material (warmth to air to water to earth) and a concurrent ascent of what he called the ethers (warmth, light, chemical, life) could be well illustrated by some of the processes here described.

Colloidal particles are also in between the measurable and the homeopathic levels of material reality and could be important in deepening our understanding of the therapeutic uses of substance. The chemistry I have used is almost entirely non-toxic.

The special colour effects from colloids are of potential artistic use. Colloids can be evaporated onto glass surfaces and incorporated in windows for example. Colloids become reflectors and transmitters of light in very individual ways. The colours can then act as a guide in the preparation of colloids, and this may be useful also whenever very dispersed metals are required.

Alexander Murrell *9th July 2015*

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