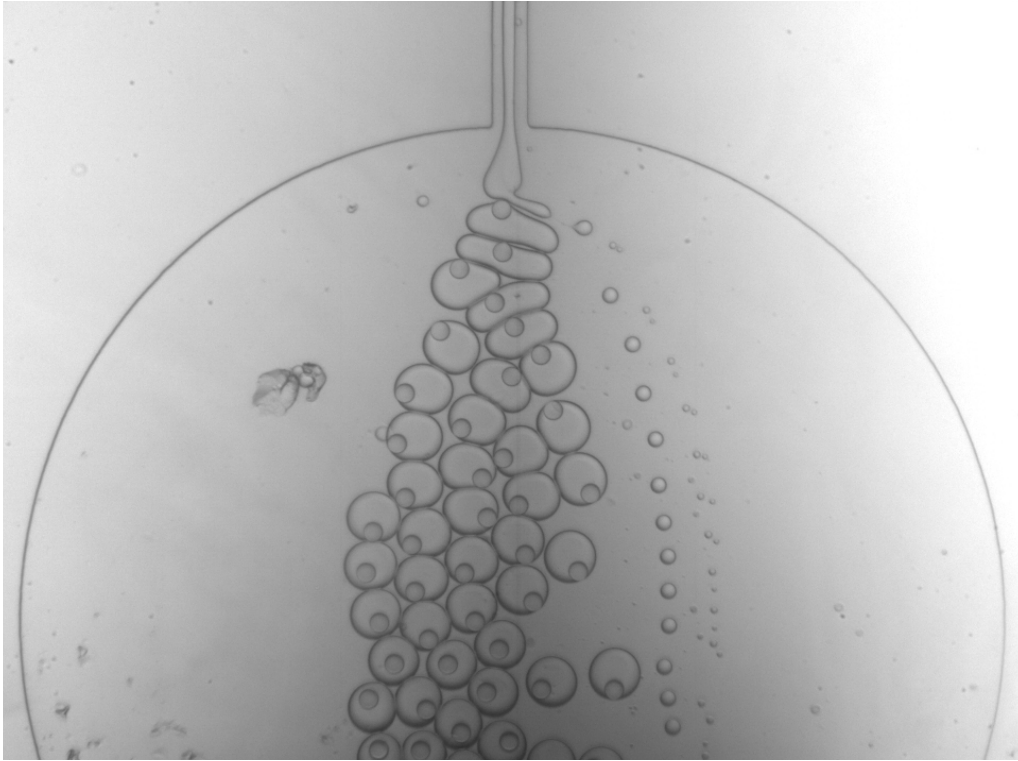


# The Definitive Word about Colloids



## **DEFINITIONS:**

In Scotland in 1861, Thomas Graham coined the term *colloid* to describe Selmi's "pseudosolutions". The term emphasizes their low rate of diffusion and lack of crystallinity. Graham deduced that the low rate of diffusion implied that the particles were fairly large - at least 1nm in diameter in modern terms. On the other hand, the failure of particle sedimentation implied an upper size limit of 1 micrometer. Graham's definition of the range of particle sizes that characterize the colloidal domain is still widely used today. [http://www.mpikg-golm.mpg.de/kc/what\\_is\\_a\\_colloid](http://www.mpikg-golm.mpg.de/kc/what_is_a_colloid)

The dull term *colloid* that reminds us of glue is, nevertheless, the accepted word. The Father of Physical Chemistry, Thomas Graham (1805-1869), employed *colloid* to distinguish those materials in aqueous solution that would not pass through a parchment membrane from those that would. Glue was indeed a material that would not, and the Greek for glue is *kolla*, from which we also get "protocol" and "collagen." Those that would pass through were things like salt, and other soluble crystalline substances, which Graham called *crystalloids*. <http://www.du.edu/~jcalvert/phys/colloid.htm>

*Grolier's Multimedia Encyclopedia* (version 8.01) states that: "The Colloidal State lies somewhere between a solution and a suspension." Colloidal minerals from humic shale are among the smallest crystalline particles known to exist, and are neither a suspension nor a solution. This gives these colloids some special properties that larger size colloids do not exhibit. Colloids larger than 0.005 microns have difficulty moving through plant and animal membranes. These colloids are hydrophobic in nature, meaning they have an inherent resistance to interaction with water. Examples in nature include: carbonates, sulfides, phosphates, framework silicates, aluminum, iron oxides, phyllosilicates, and some clays. <http://minerallogic.com/safe.htm>

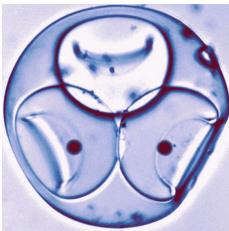
According to the Schlumberger company a colloid is a finely divided, solid material, which when dispersed in a liquid medium, scatters a light beam and does not settle by gravity. Such particles are usually less than 2 microns in diameter. Some drilling fluid materials become colloidal when used in a mud, such as bentonite clay, starch particles and many polymers. Oil muds contain colloidal emulsion droplets, organophilic clays and fatty-acid soap micelles. <http://www.glossary.oilfield.slb.com/Display.cfm?Term=colloid>

In Wikipedia we find:

In general, a colloid or colloidal dispersion is a substance with components of one or two phases, a type of mixture intermediate between a *homogeneous mixture* (also called a *solution*) and a *heterogeneous mixture* with properties also intermediate between the two. Typical membranes restrict the passage of dispersed colloidal particles more than they restrict the passage of dissolved ions or molecules; i.e. ions or molecules may diffuse through a membrane through which dispersed colloidal particles will not. The dispersed phase particles are largely affected by the *surface chemistry* existent in the colloid.

Many familiar substances, including butter, milk, cream, aerosols (fog, smog, smoke), asphalt, inks, paints, glues, and sea foam are colloids.

The size of dispersed phase particles in a colloid range from one nanometer to one micrometer. Dispersions where the particle size is in this range are referred to as **colloidal aerosols, colloidal emulsions, colloidal foams, or colloidal suspensions or dispersions**. Colloids may be colored or translucent because of the *Tyndall effect*, which is the scattering of light by particles in the colloid. <http://en.wikipedia.org/wiki/Colloids>



A colloid is simply a fluid filled with lots of very small solid particles; this includes black ink, blood (filled with blood cells), and paint (filled with particles which stick to surfaces when they dry). Typically, these particles are very small, between 1 nm and 1000 nm (one-millionth to one-thousandth of a millimeter).

<http://www.deas.harvard.edu/projects/weitzlab/research/animglass.html>

In actuality, "colloid" is a term commonly applied to any of a wide variety of substances besides glues and other sticky or gummy substances. Alas, all are deemed colloidal, i.e., somewhat similar in appearance and with general characteristics, and often exuded by or extracted from plants. In this classification, however, many substances that are not true gums are included, among them many *resins*, so-called gum resins, and such substances as frankincense, myrrh, labdanum, copal, amber, chicle ("gum" in Spanish), and rubber (gum elastic, India rubber).

True gums are complex organic substances mostly obtained from plants, some of which are soluble in water and others of which, although insoluble in water, swell up by absorbing large quantities of it. With water they form thick, gluey fluids. Their chemical nature is complex. In general, they contain in various proportions Carbon, Hydrogen, Oxygen, and such metals as Calcium, Magnesium, and Potassium in the form of salts of various organic acids. Gum arabic, or gum acacia, is a typical, water-soluble gum obtained from various plants of the genus *Acacia*, chiefly those found in Africa. A complex polysaccharide containing metal salts, gum arabic varies in color from white to red and is used extensively in making inks, adhesives, and confections; in the textile industry for filling fabrics; and in medicine as an emollient. Gum senegal is very similar. Among the gum resins (mixtures of gums and resins) are [ammoniac](#), asafetida, [bdellium](#), [gamboge](#), and myrrh. See also [tragacanth](#). <http://www.bartleby.com/65/gu/gum.html>

Clays are also well-known as colloids <http://clays.org/journal/archive/volume%201/1-1-54.pdf>

In that context, clay as member of the colloids, also fits the following description:

**Colloidal clay:** A **colloid** consists of **one substance** (or mixture of substances) **very finely dispersed in another substance** (or a mixture of substances) without a new true solution forming. So a colloid is a **mixture of a dispersed phase** and a **continuous phase** (disperse medium) **BUT the dispersed phase is NOT dissolved in the continuous phase.**

- A colloid is NOT a solution, although the **colloid particles are not usually seen under a microscope**, they are much bigger than molecules, and much bigger than the molecules of the continuous phase (disperse medium e.g. water).
- In a solution the solvent or solute particles are usually of comparable size and completely mixed at the 'individual particle level' i.e. completely homogeneous in the same phase.
- A colloid can be thought of as intermediate between a true solution and a mixture of e.g. a liquid and an insoluble solid. No filtration separation is possible with solutions and filtration is **easy and effective with an insoluble solid**. Similarly, **most colloid particles are too small to be filtered**, but separation from truly dissolved substances is possible with a membrane.
- The colloidal particles of the disperse phase are equivalent to the solute of a solution and the continuous phase is equivalent to the solvent. The mixture is sometimes referred to as the 'colloidal solution'. These descriptors can be somewhat 'blurred' by the intermediate nature of colloidal systems!

**The particles in a colloid are so small that they remain 'suspended'** in the disperse medium (e.g. colloidal clay particles in water) with little tendency to settle out. However the colloidal particles are big enough for their surface area properties to be significant. <http://www.wpbschoolhouse.btinternet.co.uk/page01/AqueousChem/AqueousChem.htm#Colloidal%20clay>

A related area and interesting one to the understanding of colloids is that of 'Soft condensed matter' which is a newly-emerged sub-discipline of physics concerned with the study of colloidal suspensions, polymers, and surfactants (soap-like molecules). (The term 'soft matter' was used by Pierre-Gilles de Gennes in his 1991 Nobel Physics Prize speech.) The behavior of these systems is dominated by one simple fact: they contain 'mesoscopic' structures with sizes between that of a typical small molecule such as water (~ 0.3 nm) and the beaker containing the liquid. These 'mesoscopic' structures (say, 10 nm to 1 micron) can be suspended solid particles or liquid drops, polymer coils formed by linking together tens of thousands of smaller molecular units, or 'micelles' ([www.montmorillonite.info](http://www.montmorillonite.info) pp. 10-11) spontaneously formed by soap molecules trying to 'hide' their hydrophobic (water-hating) 'tails'.

<http://www.ph.ed.ac.uk/cmatter/soft.html>

**Humic acids are colloids** and behave somewhat like clays [Senn, T. L. and Kingman, Alta R., 1973, *A review of Humus and Humic Acids*. Research Series No. 145 and 165, S. C. AGRICULTURAL EXPERIMENT STATION, Clemson, South Carolina.]

**Another colloidal substance is humus.** <http://foliarfert.com/pages/humus.htm> Its properties are generated in part by the workings of bacteria as they feed upon decomposing compost, generating humic acid and fulvic acid in the process. However, according to at least one source, "The term **colloids** is being mistakenly used to refer to Fulvic Acid complexes, which are readily absorbable and in the perfect electrolyte form to react with cells." Since Fulvic acid is soluble in water while humic acid is not, this may be the correct view. Nevertheless, whether a colloid or not, it is clear fulvic acid is found in conjunction with accepted colloidal substances and has some amazing properties of its own which no doubt contribute synergies to the metabolic process. [<http://www.msminerals.com/v200/include/FATMM.pdf>]

The general association of humus with clay and humic acid, all regarded as colloids, and as interdependent ingredients in soil texturizing, and mechanisms or structures that enhance bioavailability, and increase nutrition thereby, is a tantalizing one. In that context it seems strange that anyone would overlook **Montmorillonite** ([www.chelatedtraceminerals.com](http://www.chelatedtraceminerals.com)) as a composite substance, and the ideal ingredient for any gardening or farming purpose. It contains three distinct forms of colloids each of which brings nutrients to the equation, fulvic acid, chelated trace elements with catalytic properties, ions, other minerals, organic matter, water-retentive clay, and macro amounts of Silicon for plant structural strengthening. Its application enjoys countless testimonials praising its success in increasing yields while serving as a remineralizer and pH balancer for future harvests, as well as corrective substance to prevent and remove blight. Interestingly enough, these same complexes and substances within the Montmorillonite foster restorative health to foundered horses, as well as, accelerated growth and vitality to a wide variety of production livestock. [www.montmorillonite.org](http://www.montmorillonite.org)

The prevalence of colloids in Montmorillonite would seem to present a natural additive effect upon the nutritional process while remaining complementary to chelative transport and assimilation of ions in a balanced fashion. [www.montmorillonite.info](http://www.montmorillonite.info)

The most active clay group in terms of amount of ion exchange reactivity per unit weight of clay is the **Montmorillonite** family ([www.montmorillonite.info](http://www.montmorillonite.info), Dr. Aayesha Nasreen). The high degree of their base exchange capacity and the rapidity of their reactions have long been recognized as outstanding attributes of this class of clay minerals. Minerals of this group are plate shaped, three-layer lattice minerals with a very high degree of isomorphous substitution, distributed both in the octahedral positions in which chiefly magnesium substitutes for aluminum, and in the tetrahedral coordination in which predominantly aluminum substitutes for silicon [**Harry, 1950; Hendricks, 1945; Koss and Hendricks, 1945**]. Because of both the large base-exchange capacity and the widespread occurrence and economic importance of this group of minerals, a great deal of the experimental work has been done [**Hauser, 1951**]. <http://clays.org/journal/archive/volume%201/1-1-54.pdf>.

British physicist Martin Smalley in his book, Clay Swelling and Colloid Stability, summarizes the 21 experimental and 15 theoretical papers he has written on clays and colloids over the past couple of decades. The cornerstone of his account is his experimental investigations, mainly using neutron scattering, of the three-component clay-salt-water system composed of n-butylammonium vermiculite, n-butylammonium chloride, and water. For readers with a solid background in colloid physics and chemistry, he describes the process of experiment, interpretation, bewilderment, theory construction, and back to experiment that led to two paradigm shifts in colloid science. <http://www.encyclopedia.com/doc/1G1-151852801.html>

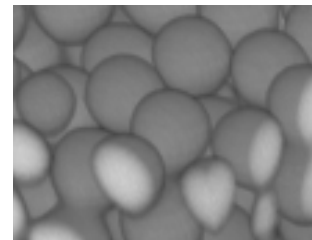
Colloidal minerals is a curious term that is used by some to mean those minerals that occur in nature in a colloidal state. That is, they are minute particles that either are, or can be, easily dispersed in a medium such as water. By this they are probably referring once again to “fulvic acid complexes.” In that these are made up of such small particles, there is a major increase in surface area giving them greater exposure to the liquid or solvent they are to be distributed in. This results in increased solubility, bioavailability, absorption, and usefulness to the body. What is usually intended by the foregoing is narrower interpretation meaning, plant-derived (colloidal) minerals. The notion is that plant derived colloids containing minerals may provide the best of all forms of minerals not only because of their increased solubility, but also because they are associated with natural plant tissue. Many claims have been made about their superior bioavailability to simple, chelated minerals, and particularly metallic minerals (meaning more precisely, elements in a metallic state.) <http://www.northupfamily.com/Farms/Colloids.htm>

Generally, we should think of “colloidal minerals” as the minerals trapped or transported by colloids whether derived from living plants or sediments forming largely by plant life. The statement "Colloidal minerals are not bio-available" is only true when discussing hydrophobic minerals such as calcium carbonate, zinc oxide, or magnesium phosphates. These “chemical” colloidal minerals are poorly utilized due to the lack of fulvic acid. They require a chemical reaction caused by the body's enzymes and hydrochloric acid before they can be of any value to the body's cells. Since fulvic minerals extracted from humic/fulvic shale are chelated by fulvic acids, the statement "*Colloids do not diffuse easily through plant or animal membranes*" is not accurate. Let's examine why.

We have already seen in the foregoing text that the size of colloids varies greatly and there is a distinction between colloids formed in an organic environment and those which are classically inorganic. The conclusion that colloids cannot pass through membranes of vegetable and animal matter is based solely on studies and experiments done with inorganic colloids. These chemical colloids are much larger in particle size than naturally-occurring mineral colloids. "Chemical" colloids were not chelated in nature by fulvic acids! <http://www.minerallogic.com/safe.htm>

Plants take minerals from the earth by their roots in ionic and colloidal form, and many are also capable of taking in minerals via their leaf membranes. Studies conducted using colloidal trace minerals in a foliar spray produced dramatic results in the health and growth rate of various plants. It should be stressed living plant cells are capable of containing minerals in the colloidal form generated by the action of fulvic acid in the humus around the roots. It has been amply demonstrated that minerals in colloidal form, lend themselves readily to uptake by roots and plant internal cellular absorption. Diatoms are a form of algae (plant family) that created the bulk of the sedimentary clays from which similar colloidal substances and chelated minerals can be obtained in a natural balance. The colloidal particle sizes from microscopic algae, are very small, indeed.

So-called "Fulvic colloids" recovered from sedimentary clays have particles with a diameter **as small as 0.001 microns** which pose no problem for absorption by modern plants' tissues. Thus, colloids containing numerous molecules per particle are often smaller than inorganic minerals that contain only one molecule (and nevertheless in their ionic form are also uptaken by roots). The problem is then one of tissue absorption and toxicity.



Particles **0.002 mm** in diameter

An alternative way of explaining colloidal chemistry is that it is the science that studies the conversion of certain elements into particles so minute that they can be utilized by living cells.

The effect of colloids is explainable in part by electric action. Sick and dead and broken-down cells are attracted to the colloids such as clays by electro-magnetic force, just as iron filings are attracted to a magnet. The colloids carry those decayed or poisonous substances into the blood stream, where they are further conducted to organs involved with elimination, and excreted. Meanwhile, the system selectively adapts individual elements it needs, obtained from the colloids.

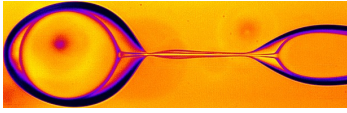
In colloidal form, Iodine, for example, is one of the trace elements essential to the well-being of human cells. Yet if you should drink as much as two or three grains of free Iodine, it would kill you. The story is told of a Dr. Macy, when explaining this, held up an eight ounce cup full of colloidal iodine. "There," he said, "This is the equivalent of 740 grains of free iodine -- enough to kill 300 men." And he drank it. In that form Iodine was not only harmless but beneficial. The same is true of Arsenic, Selenium and other deadly poisons. <http://www.northupfamily.com/Farms/Colloids.htm> Some of these in their transformed, or chelated and colloidal state as now referred to as the "essential poisons."

We thank Dr. W.P. Brown of the UK for these further examples of **colloids**, and additional explanations:

**i.e.**, the fine dispersion of one substance in another without a new solution forming:

- A **sol** is a solid dispersed in a liquid, e.g., tiny particles of clay in water.
- A **foam** is a gas dispersed in a liquid e.g. a well shaken soap solution or shaving cream foam.
- An **emulsion** is a liquid dispersed in another liquid e.g. (i) milk (aqueous solution + insoluble, but dispersed fats), (ii) French dressing in salads (based on vinegar + olive oil, but these do reform the two oil/aqueous layers quite easily which is why they are shaken before use) and (iii) margarines contain emulsifiers to stop the salty water from separating out.
- Colloidal particles may be electrically charged. (Note: So far the discussion has been confined to hydrophobic ('water hating') colloids which do NOT interact strongly with the continuous phase. In contrast 'gels' for example, are hydrophilic ('water liking') colloids, in which the colloid particles are very solvated (solvated means the particle is weakly attracted to layers of surrounding 'solvent' molecules of the dispersal medium e.g. water), and stabilised by the continuous phase).\*
- **Colloidal particles of a sol absorb ions**, but not in electrically balanced proportions. Depending on which ion(s) are preferentially absorbed from the water, the net charge on the colloid particle can be positive or negative. The situation is complicated further because the charged colloid particles attract a sheath of oppositely charged ions around them. This is called the **electrical double layer effect**. This means neighbouring colloid particles have the same 'outer charge' and so are repelled, rather than attracted together. The **sol itself is overall electrically neutral** like any other solution.
- Colloids are destroyed when the particles of the disperse phase join together and separate out from the continuous phase. This process is called coagulation. For sols, any disturbance of the double layer can cause coagulation to happen. It **can be caused by boiling the sol**, the increased random thermal collisions disturb the electrical balance and allows the colloid particles to collect together.
- **Sols are also very sensitive to the presence of ions**, so any electrolyte ions present can affect the electrical double layer (the theory is complex but just think of the ions charge as affecting the stability of the double layer). The **more highly charged the ion**, the greater the electrical field force effect, so **the greater its coagulating power**. The ions reduce the repulsion between the colloid particles and allow coagulation to occur.
- Examples of **coagulating power**:  $\text{Al}^{3+} > \text{Mg}^{2+} > \text{Na}^+$  or  $[\text{Fe}(\text{CN})_6]^{3-} > \text{SO}_4^{2-} > \text{Cl}^-$  and this explains why aluminium sulphate  $\text{Al}_2(\text{SO}_4)_3$  is used to precipitate (coagulate) colloidal clay in water treatment.

<http://www.wpbschoolhouse.btinternet.co.uk/page01/AqueousChem/AqueousChem.htm#Colloidal%20clay>



So, what is all the fuss about colloids? Why are the two camps, i.e, A) *pro colloids* -- Dr. Joel Wallach, et al., and B) *colloids' relevance in agriculture is a bunch of bunk* -- with many vigorous opponents, divided so heatedly in a debate?

Perhaps this is due to overzealousness on the part of those who have an axe to grind, one way or another. It is clear that those extracting nutrients, formulating fertilizers, quarrying soil amendments, synthesizing chemicals, and packaging and merchandising liquid minerals, vitamins, plant food, potting soils—you name it! -- are trying to hard sell what they have. They talk about the upsides of their particular deposit or formula, but sadly, throw dirt on other people's philosophies and livelihoods. Are most of these extremists, well-intentioned, simply ignorant partisans, or is one group always lying, and the other group the only one capable of telling the truth?

From the research regurgitated on this website it appears that a strong case can be made for colloids having some importance, perhaps even serious value, in horticulture, agriculture, hydroponics and the like. We all probably need to read more of the published research and think about things more studiously with an open mind. Soil science is a complex field. Another thing all of us should work on is getting the regulatory agencies in step with what is confirmed about chelation as an antidote to concerns about ppm of free heavy metals in supplements. The precise role that colloids such as clays and their counterparts, fulvic acid and humic acid, play in rendering toxic substances impotent, needs to be grasped quickly before we have the remaining good topsoil so hopelessly impregnated with anti-friendly bacterial chemicals that drastic measures have to be undertaken to restore a little humus.

Kevin Trudeau should get a hold of this one. He'd have a field day.

Many reports attest to the fact that our groceries have less nutritional value than they did a couple decades ago. Just buying so-called organic food is not any panacea, but understanding organics and nutrition is. We can make our organic food even more nutritious, and increase yields and productivity at the same time.

A number of links are provided throughout. We hope you will take advantage of reading each website to which they direct you and the further sites linked to them in turn. Go the library; check out a book; read some papers published in scientific journals. It is difficult to make intelligent decisions unless one is properly educated. Researching and writing this website and the others affiliated with it has been a great education for me. I'm not resting on my laurels. Heck, I'm just getting started! How about you?

See also: [www.montmorillonite.us](http://www.montmorillonite.us)