Contents

Introduction

Gold from Newton's Apple Tree is an exploration of the art of extracting colors from plants, and draws its inspiration from sources dating back to antiquity and continuing in the present day through my own work as a visual artist and researcher. The potential for plant material to be transformed into an array of colors is examined through the art of organic alchemy. This process harnesses the diverse pigments and dyes found in plants and develops them into a new and sometimes unpredictable palette of colors.

People often ask how I began using plants to create organic paint systems. My inspiration to make an herb garden developed from a wood engraving in Adam Lonicer's *The Herbal* (1545), which depicted a gardener working in an herb garden surrounded by raised beds and potted plants, pear trees, and grapevines. The first seed I planted was woad, primarily for the second year's seed crop. Most of my herbs were grown from seed, and within two years, I had established a potted grapevine, trees, and bushes, and thirty different herb plants for cooking, scent, brewing tea, and, of course, making colors. This became my herb garden, which was encouraged by a local elderly lady named Ivy, whose little cat sometimes hid in my laurel bushes.

In 2002, I found myself contemplating whether to pursue a fine art degree, so I decided to integrate plants into my academic journey, creating a paint palette using the herbs to produce a collection of artist's colors and installations. The first plant I processed was soldier's woundwort, more commonly known as yarrow (*Achillea millefolium*), which took more than four hours to grind into a fine pigment before gum tragacanth was mixed in as a binder to produce a golden-colored paint. I then continued to process other plants into dry pigments for further exploration.

Soon after, I traveled to Italy to meet a specialist dyer linked to the Spindigo Project (Sustainable Production of Plant-derived Indigo), carrying a silver-colored briefcase that contained eighteen jars of plant pigments segmented and cushioned in foam. The dyers were intrigued by my work, as were the airport security personnel when my pigment briefcase went through the X-ray scanners, prompting them to open and inspect the contents with puzzled expressions.

My research continued following graduation, focusing on plants mentioned in historical technical manuscripts. I discovered that some of the most significant medieval plant colors referenced in the manuscripts of painters, illuminators, and dyers included weld, madder, woad, brazilwood, and buckthorn. This research culminated in the *Artist's Garden* exhibition, which was displayed in Lisbon, Portugal, and organized by the Dyes in History and Archaeology (DHA) committee. DHA is an international annual conference that focuses on discussion of dyes and organic pigments used in the past. The exhibition showcased colors

A gardener in an herb garden. Wood engraving from Adam Lonicer's *The Herbal* (1545).

29

Von Bauung der Gärten / und Pflantzung der Bäume.

Es hat der Allmächtige Gott anfangs der Schöpffung der Welt / das Erdrich zum zierlichsten mit allerhand Edlen Gewächsen / von Kräutern / und Bäumen/in aller vollkommenheit/dem Menschen zum Wollust / und zu seiner Notdurfft zu gebrauchen / besetzet und geschmückt / auch den Menschen in den herrlichen Lustgarten deß Paradeiß / denselbigen zu besitzen/ und seinen Lust darinnen zu haben / eingesetzet/ und hat der Erdboden damals alles für sich selbst/ungebauet herfür gegeben. Solche Freude und Wollüste / herrliches Wesen/und müssige Leben/hat der leydige Satan dem Menschen mißgönnet / und alle seine Liste angestellet/ daß er ihn möchte zur übertrettung deß Göttlichen Gebotts reitzen/und also Gottes Zorn wider ihn erregen / daß er auß solchem Lustgarten verstossen würde / und mit Mühe und Arbeit sich ernehren müste. Da nun der böse Feind den Menschen also betrogen hat / da ist der Fluch über uns ergangen/und dem Erdreich seine Krafft auch genommen worden/ Wie dann Genes. am 3. Cap GOtt zum Menschen spricht: **Verflucht sey der Acker um deinet willen/mit Kummer solt du dich darvon nehrẽ dein Lebenlang/ Dorn und Disteln soll er dir tragẽ/und solt das Kraut auf dem Feld essen. In Schweiß deines Angesichts solt du dein Brodt essen/biß du wieder zur Erden werdest / davon du genommen bist.**

Also haben wir nichts dann Mühe und Arbeit / so lang wir auf dieser Welt leben / müssen wir mit Kummer / Angst / und grosser Mühe das Feld bauen und pflantzen/ und wann wir lang grosse Arbeit und Unkosten geführet/so kommt offtmals Reiffe/ Hagel/ Ungewitter und Ungeziefer/beschädiget und verderbet alles/was gepflantzet ist/ an Obs/ an Früchten und Wein / daß nichts dann Jammer und Elend zu sehen ist,

Dieweil dann nun unsere Leibs notdürfftige Underhaltung erheischet / die Gärten und das Feld stättigs mit säen und Pflantzen/daß sie Getreyde/Wein und Obs/jährlich uns ertragen/zu erbauen/so haben je und allweg unsere erste Eltern und deren Nachkömlinge mit allem Fleiß deß Feldbauens und Gartenpflantzens sich angenommen / und den grösten Reichthumb und Nahruug an den Feldgütern und Viehezucht gehabt/

C iij schone


a.
b.
Achillea Millefolium L.

derived from plants and featured a collection of images illustrating those recipes, influenced by historical technical manuals and techniques, and used by craftsmen and artisans throughout the centuries. I also created a hybrid ink for a conceptual art piece, which combined a 15th-century German poppy recipe and a 14th-century Venetian recipe, with additional ingredients such as the bladder of a sturgeon and white wine. The ink was kept in a Victorian inkwell, which was fixed to a military brass gun case dated 1916 to commemorate those affected by the First World War.

Another artwork drew on a 15th-century manuscript called *The Göttingen Model Book*, which illustrated how to draw acanthus leaves in illuminated manuscripts. I transformed the leaf shapes into large abstract sculptures with spheres that represented repetition, rotation, and circular motion. The spheres were painted green according to a French medieval recipe that used purple iris flower dye adhered to powdered chalk and mixed with tree gum. I continued my investigations by creating a collection of abstract paintings using egg tempera. These were painted using green stinging nettle pigment from the crushed dried leaves, black pigment from charred nettle stalks, and crushed eggshell to include a white pigment.

For a SciArt Residency at FrukLab at the University of Cambridge in 2024–25, I developed a permanent painting collection using a range of different plant pigments, such as weld (*Reseda luteola*), madder (*Rubia tinctorum*), and indigo (*Indigofera tinctoria)*, which focuses on color composition. Further colors were processed from the leaves of an on-site staghorn sumac tree (*Rhus typhina*) following a 14th-century recipe to produce a black colorant. Additional cancer treatment plants were used in the work, including the Madagascar periwinkle (*Catharanthus roseus*), which makes a green-black color, and a yellow color from leaves of the mayapple (*Podophyllum peltatum*), both collected from Cambridge University Botanic Garden glasshouse and woodland area. This collection also included 23.5-karat gold leaf and chalk collected from the Cambridge Cherry Hinton chalkpits.

The following pages will guide you through a color-by-color investigation of historical and technical texts, illuminated manuscripts, medical herbals and remedies, physicians and artists, the natural and horticultural worlds, and various cultures. Here, you'll find information on a selection of plants from around the world, including well-known species and those that may be less familiar. As well as long-forgotten stories, people, and recipes, also included are recipes that I developed to create colorants and as a way of engaging with nature. At the end of each chapter you will find a summary of the colors that can be created using the plants, from the medieval recipes to the featured contemporary recipes. Exploring plant dyes, inks, and paints for yourself will give the possibilities for making old and new colors.

Yarrow (*Achillea millefolium*) can be ground into a pigment to create a golden color. Handcolored lithograph from Johann Gottlieb Mann's *Deutschlands Wildwachsende Arzney-Pflanzen* (Germany's Wild Medicinal Plants; ca. 1828).

The physician and painter

There were two main guilds in medieval Europe and these represented the craftsmen and merchants, who fulfilled economic, educational, social, and religious functions. Florentine painters and illuminators belonged to the Arte dei Medici e degli Speziali

(Guild of Physicians and Pharmacists), which emerged during the mid-1300s. This was also a guild for physicians, apothecaries, and spice merchants, along with other overlapping trades, and supplied artist's pigments and a range of raw materials, from organic materials to mineral and earth pigments and other ingredients. Venice established the Arte dei Depentori (Guild of Painters) in 1271, whose members included figure painters, sign painters, furniture painters, mask makers, illuminators, gilders, leatherworkers, textile designers and embroiderers, and playing-card makers.

Each European city had its own guilds. Such guilds provided rules and regulations for skilled artisans, although these were not standardized or universal. Nor would the artisans necessarily share the same patron saint. For example, in the city of York, in England, the medieval painters, stainers, and gold-beaters—whose patron saint was Dunstan and sometimes St. Eligius—all belonged to one guild. The guilds were all distinctly different from each other, especially in London, where the guild for painters and stainers stipulated the use of specific materials; along with the illuminators in Bruges, for instance, stainers were only allowed to use watercolor paints and not oils, which were reserved for painters. Indeed, the Painter-Stainers' Company was established in 1502 in London due to previous disputes between the painters and the stainers. The organization still maintains traditional customs and remains under the guardianship of St. Luke, the patron saint of painters and doctors as well as other tradespeople such as tailors, cheesemakers, and gold-beaters.

Establishing guilds in this way separated the trades into sectors relating to specific skills and artistic purposes: for example, stainers were responsible for staining cloth, flag designs using stencils for pageants and funeral ceremonies, and imitation tapestries; painters undertook the painting of portraits, wooden panels, and barges or murals on walls; and saddlers painted saddles, shields, chariots, and banners for a different purpose. In Spain there were separate guilds for different painting applications—for example, painters of altarpieces, painters of interiors, and fabric painters—with similar trends in Paris and elsewhere in Europe.

Illuminators who used organic color materials were also associated with the monastic life of the scriptorium. They were not part of any craft guild outside their religious orders and demonstrated multiple skills. However, one renowned late 12th-century monk called Walter of Colchester was celebrated as a leading painter and sculptor at the English Benedictine Abbey of St. Albans; he was brought in as a skilled layman to paint the abbey, staying on to become an artistic monk-craftsman.

Organic paint colors, as well as mineral and earth pigments, were generally used by illuminators for book work in monasteries until the 11th–12th century and also outside them in workshops. Vitruvius states in his 1st-century *De Architectura Libri Decem* (Ten Books on Architecture) that some plant colors—for example, mountain pansies (*Viola lutea*; see page 136)—can be used by fresco painters, indicating that different craftsmen, other than dyers, could use plants for color, which is also seen in the 14th-century *Liber Diversarum Arcium* (Book of Various Arts), a collection of paint and dye recipes.

St. Luke, the patron saint of painters and doctors, was a doctor and painter who allegedly painted the Virgin Mary in person. Illuminated manuscript by the Bedford Master, showing St. Luke painting an image of the Virgin Mary (ca. 1440–50).


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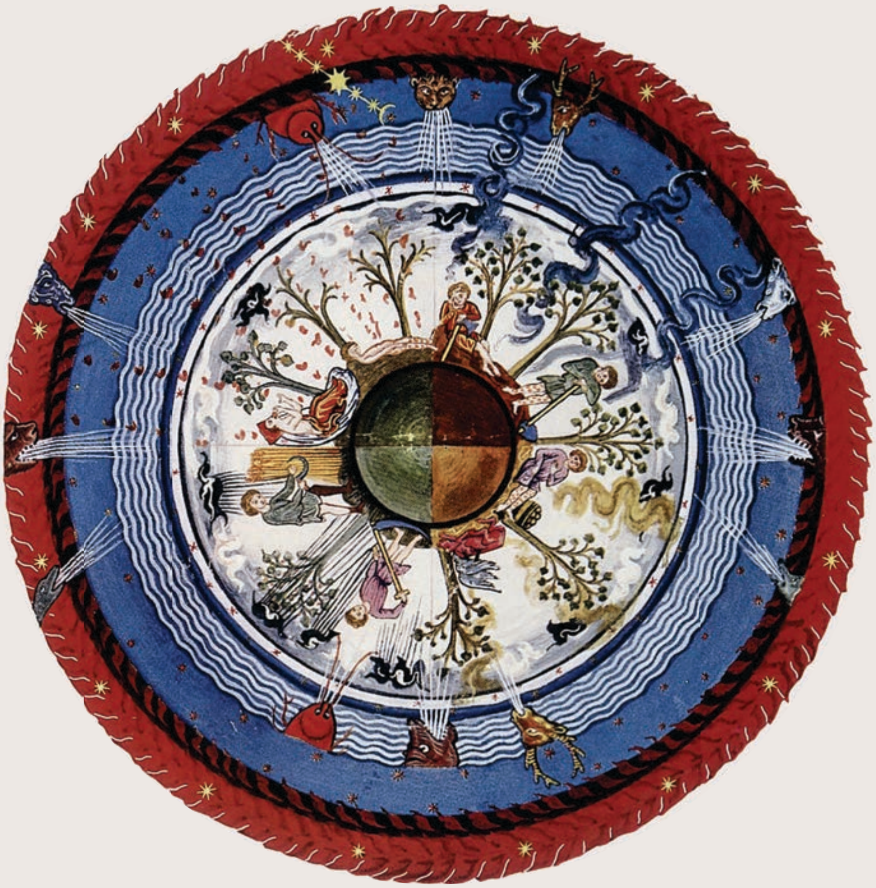


Natural dyes were highly prized by the spinners, weavers, and dyers of the wealthy Guild of Clothiers. They enjoyed a monopoly over the manufacture of the cloth depicted in medieval art by English royal court painters. Some of the guild's members were, indeed, skillful Benedictine monks from Westminster Abbey.

It is believed that St. Luke was a doctor and painter from the 1st century CE who created the only portrait in person of the Virgin Mary. The Guild of Saint Luke catered for both physicians and artists, primarily painters, who used many of the raw materials commonly employed in each field—for example, herbs; pigments; natural materials like cinnabar, sepiolite, and red ocher; and elements frequently found in apothecaries and dispensaries. Consequently, it is perhaps not surprising to find the recipes of painters, illuminators, dyers, and stainers alongside medical texts and manuscripts that mention plants, as the two were closely related.

Numerous technical recipes highlight the use of plants by both physicians and painters, with the recipes originally used by painters for panel paintings, as well as illuminators and dyers, and by textile craftsmen to dye cloth using "colored waters" for wall hangings. Technical manuscripts outlined detailed staining techniques, copied in many 15th-century Middle English manuscripts. One untitled manuscript (MS Ee.i.13, fol.131r–135v.), held in the Cambridge University Library, clearly highlights a collection of stainer's dye recipes, perhaps set out by the master of the workshop for the apprentice.

Ancient Mesopotamian clay tablets mention ingredients such as turmeric, saffron, hellebore, and alum mordants alongside a hair-dye recipe made from leeks and cassia extracts. The *Eber Papyrus*, an Egyptian herbal from around 1550 BCE, contains a wide array of plant remedies, including more than 800 medical plant recipes. These were further documented in early herbal medical texts and technical manuscripts used by medieval illuminators and painters.

Many of the materials were also well known to painters, dyers, and stain-makers. For instance, saffron (*Crocus sativus*) is referred to by the ancient Egyptians as "the Blood of Thoth," while other notable materials include aloe gum (*Aloe* species), gum tragacanth (*Astragalus verus* and *A. gummifer*), indigo (*Indigofera tinctoria*), woad (*Isatis tinctoria*), smoke tree (*Rhus* species), madder (*Rubia tinctorum*), dyer's broom (*Genista tinctoria*), and the weld plant (*Reseda luteola*).

Centuries later, the Worshipful Society of Apothecaries was established by a royal charter from James I in 1617 as the equivalent of the community pharmacy. In 1673 the society founded London's Chelsea Physic Garden, which continues to cultivate a variety of medical, edible, and dye plants known since antiquity.

Understanding the origins of colorants in relation to their historical context, especially organic colors and their ties with the medical field, is important, as this is how the medieval European guilds started to influence and standardize the quality and function of trade: by regulating industries through a range of rules. Ignoring these aspects diminishes the connection between other disciplines and our knowledge of the past, specifically regarding the use of plants. Furthermore,

This illustration shows the **cosmos, body, and soul** as having influences on mankind, animals, and plants through creation, fire, ether, water, the stars, and the winds. Color features strongly: the blue circle represents the water, the red the celestial fire, and the black and red circle represent judgment on Earth. Illustration from Hildegard of Bingen's *Liber Divinorum Operum* (Book of Divine Works; 13th century).

integrating this wisdom enhances the exploration of color and fosters a harmonious relationship with the natural world through creativity and a multidisciplinary perspective from past practice into the modern day.

Plants in technical manuscripts

The earliest surviving technical manuscripts date from around 1700 BCE and originated in Mesopotamia. The recipes highlight processes for making natural dyes, colored glazes, and imitation gems, which were recorded considerably later in the 3rd-century-CE *Leiden Papyrus X* and the *Papyrus Graecus Holmiensis* (often referred to as the *Stockholm Papyrus*) of around 300 CE.

Many centuries later in Europe, a collection of recipes from the early medieval period survives in the *Mappae Clavicula* manuscripts (written in Greek and Latin). The manuscripts include the *Lucca Manuscript* (Biblioteca Capitolare Feliniana, Codex 490); *Sélestat Lectionary* (Bibliothéque Humaniste, MS 17); and the *Phillipps-Corning Manuscript* (Rakow Research Library, Corning Museum of Glass, New York). They date from the 9th to the late 12th century CE, with some recipes from the classical period. They explain processes for using plants and organic matter, such as dragon's blood (see page 92) mixed with orpiment and juniper juice to make a golden sealing wax called *bero inbriome*. Other recipes cover using saffron with vermilion to produce an orange shade; the juice of a "lupine cluster" (probably of the plant's roots) combined with the sprouts of sea leek (*Allium ampeloprasum* var. *babingtonii*) and red natron salt to clean tarnished silver; and a recipe for "lulax," a shade of light blue made using the flowers of parsley (*Petroselinum crispum*), common flax (*Linum usitatissimum*), and violets (*Viola* species) along with blue lily and woad leaves. (In the past, the term *lily* might, in fact, have referred to iris.)

Recipes were often copied into later manuscripts, with a fine Latin example being the 14th-century *Liber Diversarum Arcium* (Book of Various Arts), preserved in manuscript MS H 277, an early-15th-century physical copy of the 14th-century collection held in the Bibliothèque Universitaire Historique de Médecine, Montpellier. It lists over thirty different plants for making paint and ink, as well as other craft skills. The manuscript also includes a handful of dyeing processes using various plants, including the roots of madder, brazilwood, weld, indigo, young fustic, sumac leaves, lichens, and ripe buckthorn berries. Another 14th-century Middle English manuscript called the *Five Medical Texts* (MS O.9.39), held at Trinity College, Cambridge, contains recipes for manufacturing pigments and dye, preparing skins and furs, imitating expensive imported leathers, counterfeiting semiprecious materials, adulterating verdigris, and making soaps and confectionery.

Later in the 16th century, Giovanventura Rosetti's *Plictho de Larte de Tentori* (Instructions in the Art of Dyers; 1548) reveals in-depth processes. The organics are oak galls (see page 204), pomegranate (*Punica granatum*; see page 208), peach stones, walnut husks, turnsole (also known as folium), and common rue (*Ruta graveolens*; see page 172), which causes skin irritation and blisters in sunlight.

Astragalus verus is a source of gum tragacanth, a common natural binder used in pigments. Illustration by J. H. Colen from Joseph Carson's Illustrations of Medical Botany (1847).

II. Pflanzenreich A.
Fig: 1.
Fig: 2.
Fig: 3.
Fig: 4.
Fig: 5.
A_E.
Befruchtungsorgane etc.
Fig: 1. Abgeschnittener Grashalm. a, Blatt des hohlen Grashalms, b. Blatthäutchen, c. Halmknoten.
Fig: 2. Ruchgras (Anthoxanthum) II. 2. Blüthenährchen, d. Staubbeutel, f. Staubfäden, e, Pistille mit den
behaarten Narben, g. der Saamen, h. Blüthenhülle od. untere Blumenspelze, i. Blüthenscheide od. obere
Kelchspelze, k, unfruchtbare, geschlechtslose Blüthen. Fig: 3. Gem. Weizen (Triticum vulg:) III. 2. Ein
Theil der Spindel desselben mit einem darauf sitzenden Weizenkorne. Fig: 4. Roggen (Secāle). III. 2.
Blüthe: l, innere befiederte Spelze, m, Staubbeutel, n, die gefiederten Narben, o, äußere, lang begrannte Spelze
s. Saftschuppen. Fig: 5. Aechte Camille (Matricaria chamomilla) XIX. 3. A. Blüthe (Strahlenblüther) B. Ein,
zelne Blüthe a. d. Strahlenrande, C. Röhrenblüthe a. d. Fruchtboden, D. Derselbe gespalten; p. innere Höhlung
q. durchschnittene Wand, r. vielblättr. Hülle, t. die auf dem Fruchtboden (E) sitzenden Röhrenblüthen (C).
Verlag v. C.C. Meinhold & Söhne, Dresden.
H. J. Ruprecht, Wand-Atlas 27.
III. Aufl.

Thousands of such recipes appear in technical manuscripts throughout the world's libraries and this book highlights only a small proportion of them. Some originate from much earlier cultures, including those of ancient Egypt, Greece, and Rome, and were then translated over the centuries. Inevitably, such recipes featured in palimpsests (manuscripts written over due to the scarcity of expensive papyrus), appeared in lost or destroyed texts, or were the result of inaccurate interpretations.

The Framework

Working from ancient texts and medieval manuscripts, and even their modern translations, throws up a wealth of artistic and scientific information that can be difficult to navigate, especially for a beginner new to the world of organic colors. I have found that using a structured system to create these colors can help beginners grasp the basic principles of developing a paint palette from plants in their own garden with confidence. I have named this process "The Framework" (see Box, page 19), which serves as a practical working system.

When we observe a plant, we might appreciate its flowers, leaves, foliage, color, the texture of its bark, or the fruits and berries it produces. Yet every part of a plant has the potential to yield a colorant. The Framework consists of six sections, each containing the ingredients you can use to make an organic dye, paint, or ink.

1. Parts of plants

The first section outlines the parts of plants that can be processed. This includes the leaves; roots; berries, fruits, and seeds; flowers, petals, and stamens; and bark. To create organic paint, it is necessary to first extract a dye from one or more of these parts.

2. Liquids

The second section lists suitable liquids for extracting the dye from a plant. These include white wine, spirits (such as vodka, rum, or brandy), clear vinegar, and water. When using water, it is advisable to add a preservative.

3. Preservatives

The third section focuses on preservatives to prevent bacterial or mold growth in water. Grapefruit seed extract is very effective, as are concentrated rosemary extract and cloves. You can also add 3% Preventol® (sodium-2-phenylphenolate), which should be handled with care. Preservatives are less essential when using clear vinegar, spirits, or wine.

4. Mordants/additives

The fourth section lists some mordants or additives. A mordant is a metal salt that can alter the color characteristics of a dye and help it adhere to fabric fibers, stabilizing the color. When creating a dye, which is the midway point when making a paint, I use four little dishes for side tests. Each dish contains a different mordant,

Dissected flowers of a grass, rye, wheat, vernal grass, and chamomile, which can be used to make dye colors. Chromolithograph by H. J. Ruprecht (1877).

allowing me to add a small amount of dye and observe any color changes. Mordants can modify the pH level of the dye from acidic (pH 1–4) to alkaline (pH 9–12), influencing the final color. Suitable mordants include:

Alum (aluminum potassium sulfate) – helps to brighten the dye (pH 2–3)
Tin (stannous chloride) – brightens color and is acidic (pH 2–3)
Copper (copper sulfate) – produces greener hues (pH 3–4)
Iron (iron II sulfate/ferrous sulfate) – darkens color, reacts with tannins (pH 2–3)
Baking soda (bicarbonate of soda) – makes dye more alkaline (pH 9)
Potash (potassium carbonate) – enriches color and is very alkaline (pH 12)
Chrome (potassium dichromate) – brightens color (pH 3–5)

Safety notes: Handle mordants with care, as they can be skin irritants and should not be ingested or inhaled. Wearing gloves and goggles or a mask is advisable. Chrome is highly toxic and should be disposed of appropriately at a waste facility.

5. Fillers
The fifth section covers fillers, those substances to which the dye adheres when creating a colored pigment. The following materials can be used:

- Chalk (calcium carbonate)
- Eggshells (calcium carbonate)
- Marble dust (calcium carbonate)
- Gesso (contains gypsum or calcium sulfate dihydrate)
- Cuttlefish bone (calcium aragonite)
- Sepiolite clay (magnesium silicate)
- Kaolin or China clay (aluminum silicate hydrate)

6. Natural binders
The sixth section focuses on natural binders or glues that are soluble in water and used to fix the pigment to the surface. Other natural materials can serve as a binder, including non-animal substitute products. For instance, onion or garlic juice can act as a mild adhesive, making them ideal for gilding, along with fig tree latex. Which binder you use is a matter of personal preference.

- Gum arabic – *Acacia senegal* (now *Senegalia senegal*) and *Acacia seyal* (now *Vachellia seyal*) trees
- Gum tragacanth – from the *Astragalus gummifer* and *A. verus* shrubs
- Rabbit skin glue – processed animal hide in granule form
- Egg white (glaire), yolk – chicken eggs, which are easily accessible
- Isinglass glue – glue made from the bladder of the sturgeon fish
- Parchment glue – glue made by boiling scraps of parchment (from animal hide)

The Framework is a system for creating organic colors according to established guidelines. By using this system, the processes involved become significantly simpler and more fluent, allowing you to achieve your objectives when collecting plants from your garden and turning them into colorful paints, pigments, dyes, stains, and inks, many of which may surprise you.

The Framework

Making Organic Paint

1. Parts of plants

Leaves
Roots
Berries / fruits / seeds
Flowers / petals / stamens
Bark

2. Liquids

Water
White wine
Alcohol
Clear vinegar

3. Preservatives

Needed when using water
Grapefruit seed extract
Rosemary extract
Vinegar
Cloves
Preventol®

4. Mordants/additives

Alum
Tin
Copper
Iron
Baking soda
Potash
Chrome

5. Fillers

Chalk
Eggshells
Marble dust
Gesso
Cuttlefish bone
Sepiolite clay
Kaolin (China clay)

6. Natural binders

Gum arabic
Gum tragacanth
Rabbit skin glue
Egg white (glaire), yolk
Isinglass glue
Parchment glue

A note on recipe quantities

It is important to note that the quantities of plants used can vary significantly. For instance, leaves typically contain more colorant material than berries, although this is not always the case. The amount of colorant can also change based on factors such as the seasonal crop and whether the leaves are harvested in early spring or late summer. A good starting point is to try a small amount, then through experience you will learn how much is needed for the result you are trying to achieve.

Therefore, the recipes featured in this book should be viewed as guidelines, in terms of both the quantities and methods used, and can be adjusted according to your own experience and working practice. Some of the featured recipes do not include specific measurements so as to encourage a more organic approach.

Cambridge University Botanic Garden

The botanic garden at Cambridge University, in the heart of Cambridge, was founded in 1762 to provide medical students with a knowledge of plants used for treatments. Around 1846, Professor John S. Henslow relocated the garden from its original site, near today's New Museums Site, to its current location. Professor Henslow, a botanist, geologist, and clergyman, created wall charts and diagrams as teaching tools for his students, emphasizing the importance of plant diversity. He enlisted hundreds of collaborators, one of whom was Charles Darwin. Henslow's son, George, owned a 14th-century manuscript (MS Egerton 2852), now held by the British Library, London, which includes twenty-eight recipes for dyeing with plants. He referenced these recipes in his 1899 publication *Medical Works of the Fourteenth Century*.

The Cambridge University Botanic Garden is highly significant for plant research and has been invaluable for organic artists like myself. The garden provided an ideal environment for developing organic paint systems and exploring a diverse range of plants from around the world that could potentially produce dye colors.

I arrived at the gates of the garden as artist-in-residence in 2023, and was given the opportunity to explore the vast world of the plant kingdom. My goal was to create a public index catalog of dyes showcasing colors produced through a specific processing framework, as outlined on pages 17–19. The garden offered thousands of color possibilities, all waiting to be discovered and transformed into shades derived from nature. And so began my alchemical journey into the world of organic colors.

First, I obtained a detailed map of the garden, highlighting specific areas such as the glasshouses, David Rogerson Mellor's circular fountain, Cory Lodge, and the custodian hut, which historically housed the on-site policeman. I converted this hut into a temporary art space for a night installation called *The Hut of Curiosity*. This installation featured large apothecary jars, bottles, and Victorian decanters, artificially lit from below and filled with natural dyes that glowed in the dark.

I spent a considerable amount of time exploring the dye plants growing in the systematic garden beds. This became my starting point for transforming familiar plants, such as the weld plant, madder root, and woad leaves, into dyes. I also ventured into creating a colorant using the endangered Wollemi pine (*Wollemi nobilis*), working with several of its leaves. By adding iron sulfate and employing a heat and reducing method, I was able to produce a black ink. Furthermore, by applying a tin and alum mordant, I created a yellow, as well as achieving an orange color by adding potash.

Map of the Cambridge University Botanic Garden, drawn by the garden's first curator, Andrew Murray, in 1845.


Plan of the New Botanic Garden, Cambridge.

Many sections of the garden introduced new plants for my research. I roamed through the woodland area to the rock gardens up the main walk, then onward through the old pinetum, the trees of which were planted when the garden was first established in the 19th century. As I went deeper into the garden, I found the location of Newton's apple tree, which had been uprooted after dying from disease.

Newton's apple tree

Woolsthorpe Manor, in Lincolnshire, was the birthplace of the famous scientist and alchemist Sir Isaac Newton. It is said that Newton was inspired by a falling apple while walking in his garden. Twenty-six years after graduating from Trinity College, Cambridge, this led him to develop his fundamental work on the theory of gravity, *Philosophiæ Naturalis Principia Mathematica* (The Mathematical Principles of Natural Philosophy), published in 1687, which focuses on the laws of motion, the universal law of gravity, and the concept of absolute time and space.

Scientists at Cambridge University Botanic Garden took a scion from the original tree and replanted the grafted tree in the garden in 1954. Unfortunately, the tree died of honey fungus, and was uprooted in 2022 by Storm Eunice. After sixty-eight years of producing pink and white blossoms and adequate apples, Newton's tree was logged and stored away from public view. The apple tree (*Malus pumila* 'Flower of Kent') was cloned and grafted by a horticulturist and is currently in the garden's nursery. Once mature, it will be planted again in the garden.

Back in 2016, before the tree died, I walked past it while collecting garden plants to process, and noticed many newly fallen apples on Brookside Lawn. I took one of them to my garden studio to clone artistically. To do this, I made a plaster mold of the apple, from which I produced a stone plaster replica, so I could make it into a singular piece of art. I covered the final shaped apple in thin copper tape and placed it inside a sealed container where it was exposed to the vapors of clear vinegar. Over time, this transformed the copper color of the apple into a vivid, turquoise–greenish blue hue.

This singular sculpture, entitled *Newton's Apple*, is permanently on display in Brookside House at Cambridge University Botanic Garden. The color concept and process were inspired by a technical recipe in the late-12th-century *Phillipps-Corning Manuscript* (in New York's Corning Museum of Glass) for making "Greek Green" or verdigris, which can be widely seen naturally forming on weathered bronze statues and copper pipes. Similar verdigris recipes are described in the 14th-century *Liber Diversarum Arcium* (Book of Various Arts). However, making verdigris dates back to antiquity, with color recipes appearing in the *Papyrus Graecus Holmiensis* (also known as the *Stockholm Papyrus*) and centuries earlier in Pedanius Dioscorides' 1st-century-CE *De Materia Medica* (On Medical Substances).

At Cambridge University Botanic Garden, my aim was to undertake organic color research using the garden's Living Collections and to produce site-specific artwork relating to nature. A few months into my residency, I revisited Newton's apple tree and chiseled off some bark from the logs. My aim was to process the bark into a colorant for an art installation called *The Tree That Once Was*. The bark was made into a golden-yellowish dye in a process inspired by a recipe for apple dye in an early 16th-century German manuscript, *Liber Illuministarum* (Book of the Illuminator), held in the Bavarian State Library in Munich, Germany (MS BSB Cgm. 821). I used the dye to paint sixty-eight duplicated stone plaster apples covered with thin cotton paper, dyed with yellow apple bark dye and then sealed with a beeswax binder.

The yellow replica apples were raised 4 inches (10 centimeters) off the ground and fixed to thin transparent rods, which gave the illusion that they were levitating above the grass, seemingly moving harmoniously together as you walked past them. The site where Newton's apple tree once stood on Brookside Lawn was covered with these yellow apples. They gave the appearance of falling fruit suspended by the absence of the laws of gravity, frozen in time and space, with one central apple placed exactly where the rooted trunk would have grown. This single apple was gilded according to a medieval process of fixing 24-karat gold leaf with fish glue over a ground of red bole (naturally forming red clay) mixed with rabbit skin glue.

The Tree That Once Was references Newton's alchemic work and its relation to the *Principia*, with gold representing alchemical purity and perfection, echoing the gold standard brought in when Newton became Master of the Royal Mint in 1699.

Woolsthorpe Manor, Lincolnshire, where Sir Isaac Newton was born and was inspired by a falling apple. Engraving (ca. 1810).

Chapter 1

Gold

Cornflower

Latin name: *Centaurea cyanus*
Other name: Bachelor's buttons
Family: *Asteraceae*
Genus: *Centaurea*
Native: Southeastern Europe, Western Asia
Type: Annual

The bluish-purple cornflower (*Centaurea cyanus*), a delicate flower with slender petals, often blooms with the vibrant red corn poppy (*Papaver rhoeas*; see page 88) and can be seen painted in ancient Egyptian tombs. Intriguingly, archaeologists in Egypt revealed dried cornflowers in the floral collars of Tutankhamun's embalming cache from the 18th Dynasty (ca. 1550–1295 BCE) and in artifacts in the Greco-Roman era (up to 395 CE). Some artistic representations of the flower, can be dated even earlier, to the 4th millennium BCE, showcasing the cornflower's long-standing cultural significance.

Historical evidence indicates that flowers of Iranian knapweed (*Centaurea depressa*)—which differs from the cornflower in both origin and the color of the flowers—were combined with the fragrant leaves of European olive (*Olea europea*), willow foliage (*Salix*), petals of blue water lily (*Nymphaea nouchali* var. *caerulea*), and wild celery leaves (*Apium graveolens*) for use in sacred rituals.

One of the earliest literary mentions of the cornflower appears in the *Garland*, an anthology of Greek poems woven together by Greek poet Meleager of Gadara in the 1st century BCE. This work includes a vivid image of the cornflower, juxtaposed with "young shoots of Alexander's olive." Pliny the Elder, writing in the 1st century CE, also refers fleetingly in his *Naturalis Historia* (Natural History) to the cornflower, noting its scarcity during the era of Alexander the Great—perhaps the small, blue flower was hidden in plain sight or forgotten in the centuries before. Yet it remains today, growing among the weeds and wildflowers to be enjoyed.

The beauty of the cornflower also inspired medieval and Renaissance artists. Along with other wildflowers, it was often depicted in the borders of illuminated manuscripts, in easel paintings, on altarpieces, and in woven tapestries. More recently, the flower was celebrated in floriography, the Victorian language of flowers, in which it embodied the poignant message of "Hope in Love." The cornflower remains a testament to human emotion, signifying the remembrance of fallen French soldiers in the First World War. It still inspires artists today, in expressive images and through the ancient practice of crushing the fresh flowers to extract the blue juice that is exposed to sulfur to create a coloration that imitates gold.

Cornflower (*Centaurea cyanus*). Illustration from Johannes Zorn's *Icones Plantarum Medicinalium* (Illustrations of Medicinal Plants; 1779–90).

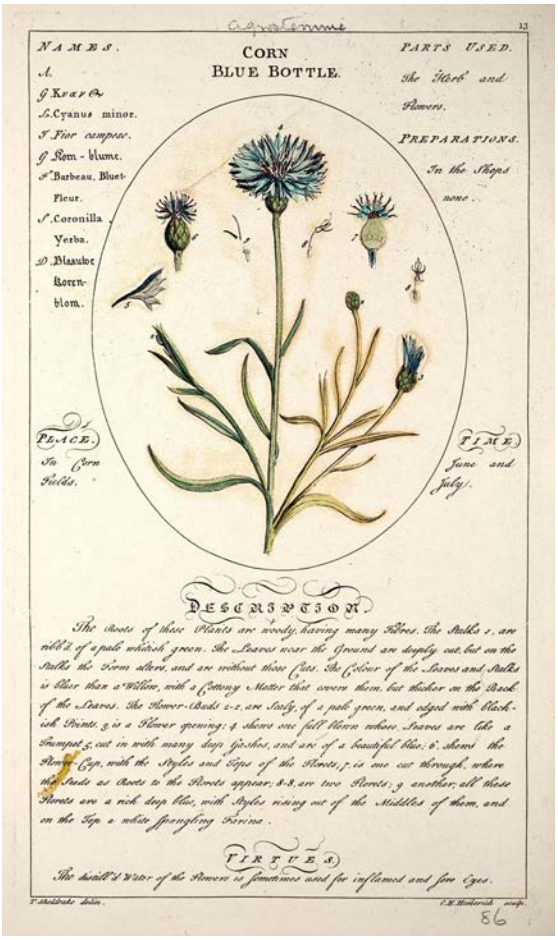
Recipes from Cornflower

The 12th-century *Mappae Clavicula* manuscript contains recipes for metallic gold made by adding juice from greater celandine (*Chelidonium majus*) to mercury and using saffron (*Crocus sativus*) as a glaze to transform tin leaf into imitation gold (see pages 34 and 30, respectively). Fig juice, from the *Ficus carica* leaf, was used to stick silver leaf to paper, and layers of yellow-orange celandine juice could be painted over the top, allowing the silver to shimmer in the light and resemble gold leaf.

Theoretically, therefore, blue cornflower juice may have been applied to silver leaf to create an imitation gold, as suggested in the 15th-century *Strasbourg Manuscript*, a medieval painters' handbook (see *Recipe 1*), and in a 16th-century German recipe for *Dunnckhel blaw* (a dark blue translucent color on silver). Although historical recipes do not imply that this was the intention, in my own experiments I created a golden color by placing a silver leaf sample that was glazed using concentrated cornflower juice in a sealed container. I then exposed the sample to hydrogen sulfide from an egg yolk inside the container. After several days, the transparent glaze changed from dullish blue to a golden color that shimmered in the daylight—all made possible through organic alchemy. Compared with other plants, the cornflower technique is perhaps the most convincing way to make silver, or lesser metals like tin, look like gold, although each organic colorant has its own qualities. Cornflower gold can be made through a unique process using only a handful of flowers and metal leaf stuck down with egg glaire or the sap from fig leaves.

Cornflower juice on its own can produce a blue, as outlined in Recipe 1.3.4A in the *Liber Diversarum Arcium* (Book of Various Arts) and in German recipes held in Heidelberg University Library (Cod.Pal.Germ.489, ff.23–4), but the raw juice can be light-fugitive, fading more quickly than dyer's indigo (*Indigofera tinctoria*) or woad (*Isatis tinctoria*). Several medieval recipes from the 15th century describe similar techniques to that of the *Liber Diversarum Arcium* recipe, briefly explaining how blue flowers can be crushed for the juice to write the blue initials at the beginning of illuminated texts (see *Recipe 2*).

Cornflower (*Centaurea cyanus*). Colored line engraving by C. H. Hemerich (ca. 1759).



Recipe 1: Making azure-blue or gold

"If you want to make good blue color, take the flowers of cornflower—you know well when—and dry softly and grind them with good wine, and let that dry. Take a little camphor [*Camphora officinarum*] and half as much sal ammoniac [ammonium chloride] and grind it also into it. So you have to apply onto silver or where you want good blue as fine azure. Temper [mix] it with gum or with medium of egg glaire."

—Recipe 108, *Strasbourg Manuscript*, 15th century

Recipe 2: Creating blue letters

"If blue flowers which are found in [corn-] fields are crushed, from them blue letters can be made."

—Recipe 1.3.4A, *Liber Diversarum Arcium*, 14th century

Detail of **cornflower** (*Centaurea cyanus*). Illustration from A. Mentz and C. H. Ostenfeld's *Billeder af Nordens Flora*, vol 1 (Pictures of the Flora of the North; 1917–27).

Saffron Crocus

Latin name:	*Crocus sativus*
Other name:	Autumn crocus
Family:	*Iridaceae*
Genus:	*Crocus*
Native:	Greece, Lebanon, Jordan
Type:	Perennial corm

Saffron, or *za'faran* in Arabic, is an aromatic spice derived from the delicate stigmas of *Crocus sativus* flowers. It has an illustrious history stretching back thousands of years. Saffron crocus flourishes in the sun-soaked landscapes of the Middle East. Ancient Minoan wall frescoes at Akrotiri on Crete, which survived a volcanic eruption in 1625 BCE, depict women gathering crocuses as an important medicinal and dye crop.

The fragrance of the flowers is strikingly potent and richly aromatic, captivating the senses with every breath. Historical accounts from Pliny the Elder emphasize that this intoxicating scent is best when the flowers are harvested under warm, clear skies. This is especially true in hot climates where the blooms flourish, infusing the air with a tantalizing bouquet that lingers long after they have been gathered.

Saffron's golden color and distinctive flavor have made it a prized possession for culinary and medicinal purposes, as well as for yellow dye and paint for illuminating the pages of books. In fact, saffron was so valuable that it was often referred to as "red gold" due to the high prices it fetched. The ancient Greek physician and botanist Pedanius Dioscorides described saffron in his monumental *De Materia Medica* (1st century CE), a pharmacopoeia of medicinal plants. He highlighted its many benefits and uses as a digestive aid, emollient, mild astringent, and diuretic.

In recent times, Norfolk Saffron, in East Anglia, UK, has excelled in cultivating premium saffron, achieving a quality on a par with the renowned Spanish producers. Interestingly, England has had historical ties with this treasured spice since the Middle Ages. The market town of Saffron Walden derives its name from the saffron that flourished there, serving as a significant cash crop in the 15th and 16th centuries. England had already established itself as a prominent saffron producer in the 14th century, with the spice grown in monasteres across the south and on the premises of such Cambridge colleges as Peterhouse, Pembroke, King's, and St. John's, and later at Clare, Trinity, and Jesus.

Saffron's rich history tells a captivating story through time, from being revered by ancient cultures to receiving modern recognition as a prized spice. Its legacy continues to shine brightly, showcasing how valuable saffron remains today.

Saffron crocus (*Crocus sativus*). Illustration by Dame Ann Hamilton from *162 Drawings of Plants* (1752–66).

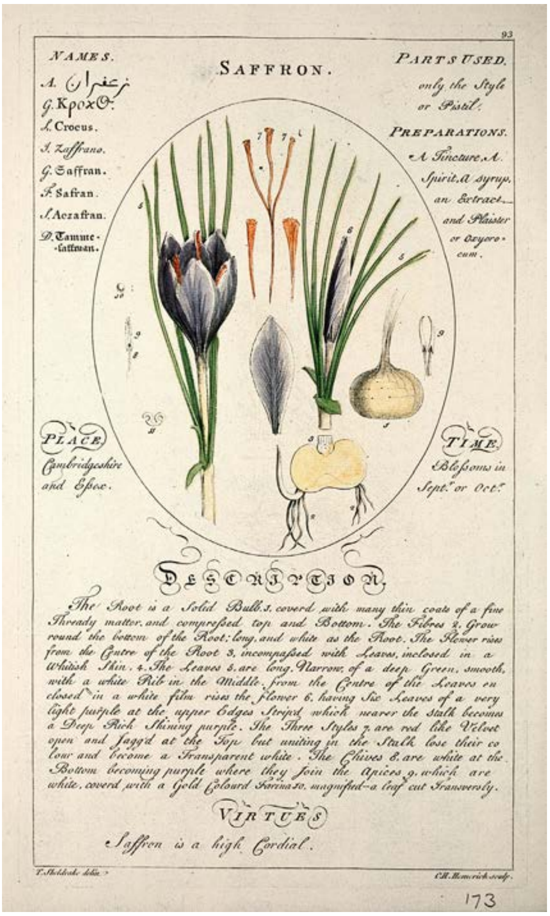
Recipes from Saffron Crocus

Saffron has been used for hundreds of years as a colorant to dye fabrics, produce ink, and make paint. Evidence for these uses can be found in color recipes in technical manuscripts that survived both the English Reformation in the 16th century—when many old recipes were destroyed—and the passage of time. However, learning the practical aspects of using saffron, from its cultivation to application, can be a lengthy process due to the unpredictability of seasonal conditions and variations in crop yields in different parts of the world. Generally, saffron is sourced from multiple countries to meet the high demand for this valuable product that can be used to provide instant color quite easily (see *Recipe 1*).

The Greco-Roman Egyptian *Leiden Papyrus V* (ca. 300 CE) documents the use of saffron to make arrows look golden, while the 3rd-century *Papyrus 121* (P.Lond. I 121), one of the Greek Magical Papyri, held in the British Library, London, explains: "To make an egg become like an apple: Boil the egg and smear it with a mixture of egg-yolk or saffron and [red] wine."

In medieval times, one of the purposes of the dye was to produce an imitation golden color. The 12th-century German Benedictine monk Theophilus Presbyter provided a recipe in his treatise *De Diversis Artibus* (On Diverse Arts) for creating saffron yellow from the dried stigmas, primarily for staining the surface of tin as a glaze to mimic the appearance of gold (see *Recipe 3*). This is a fairly simple process that can be done quickly. The stigmas were sometimes combined with other pigments to create different colors. For example, to make an orange-gold called "glaucus," Recipe 1.27.10 of the 14th-century *Liber Diversarum Arcium* (Book of Various Arts) suggests mixing orpiment (or king's yellow, a toxic color containing arsenic sulfide that is found in large natural deposits but can also be made artificially) with vermiculum (dried bodies of female *Coccus ilicis* insects that produce a red colorant), along with a small amount of saffron. Making a golden saffron glaze with egg glaire is useful when applying the saffron over an azure (any form of blue) color base that has been mixed with chalk to create a yellow-green.

Saffron crocus (*Crocus sativus*).
Colored line engraving by
C. H. Hemerich (ca. 1759).



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