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Glossary

Akhmim (Greek: *Panopolis*). A city in upper Egypt on the east bank of the Nile River. With a long history dating back to the pre-dynastic period, this site has important ties to the Graeco-Roman and Roman periods.

Alunite. A white mineral recently identified as a pigment used for painting mummy portraits. As a source of alum, it was also used as a mordant for fixing organic dyes on textiles and for producing lake pigments. Chemical formula: $KAl_3(SO_4)_2(OH)_6$

Animal glue. A collagen-based adhesive made by boiling animal skin, bones, or tendons in water. The proteinaceous glue is used as a binding medium that is mixed with pigments for painting; it can also be used for sizing or sealing wood, for applying gilding, and for joining or bonding. Glues can be made from many types of animals including cow, rabbit, horse, or fish and has been identified on thirty-six percent of painted panels (at the time of publication).

Antinoöpolis. An ancient Roman city south of Cairo and the Fayum basin, on the east bank of the Nile. The mummy portraits believed to have been discovered at this site exhibit a characteristic austere style and the wooden panels a unique stepped shape. The city was founded in 130 BCE when the emperor Hadrian named it in honor of Antinous, his lover who drowned in the Nile.

Antonine period (138–192 CE). The era that encompasses the reigns of the emperors Antoninus Pius (138–161 CE), Marcus Aurelius (168–180 CE), and Commodus (180–192 CE). Provincial elite populations flourished in the Antonine period, and the distinctive, Hellenized hairstyles of members of the imperial court were seen on coins and in widely disseminated portraits, largely of stone and bronze. For women, a bun of braids coiled at the crown of the head and gradually draped to the nape of the neck; men adopted a bearded appearance with long, tousled hair. Closely imitated, these specific hairstyles help scholars propose a rough chronology of Roman portraiture and art.

Balteus. A sword strap, typically depicted on painted portraits as a diagonal red band, sometimes with gold or silver studs, worn over the tunic. Its presence suggests that the deceased was in the military.

Beeswax. A natural wax produced by honeybees (*Apis* sp.) that is primarily composed of hydrocarbons, fatty acids, esters, and long-chain alcohols. Egyptians used beeswax for the mummification process, in cosmetics, to retain the permanency of wig curls, and to create painted portraits (encaustic). The material has been identified on sixty-two percent of painted panels (at the time of publication).

Binding media. Organic materials that hold pigments together, enabling them to be applied as a cohesive film. Ancient binding media are based on natural materials, including wax, plant gums, and proteins such as animal glues. The physical properties of the medium strongly influence the handling and visual characteristics of the paint.

Bitumen. A naturally occurring petroleum-based black resinous material used throughout antiquity as an adhesive, waterproof sealant, and for decorative effect. It was commonly used for its ritual and preservative properties in the production of mummies.

Bulla (pl. bullae). A type of amulet, similar to a locket, worn around the neck of a boy. An indication of free birth, a bulla was used for protection as well as an official status symbol.

Calcium carbonate (chalk, lime, calcite). A chemical compound used to create a stable white pigment with limited hiding power (opacity); this pigment is used to make grounds (preparation layers) for painting. Chemical formula: $CaCO_3$

Carbon black. A pigment made by charring wood or other organic materials in a reducing environment (restricted air supply). It is also known as vine black (charred, desiccated grape vines and stems) or lamp black (soot collected from oil lamps). Due to the pigment's tendency to absorb infrared radiation, infrared imaging can be used to reveal artists' sketches and underdrawings made in carbon black that may not otherwise be visible beneath the painted layer.

Cauterium (cautarium). Similar to a spatula or a palette knife, a metal tool that, after being heated, was used to blend the wax colors in encaustic painting.

Cestrum. A pointed graver, possibly metal, used for adding incised details in encaustic. The cestrum would have been heated and used to draw into wax.

Chiton (tunic). A simple garment that covered the upper body, starting at the shoulders and ending at a length somewhere between the hips and the ankles. The English word *chiton* originates from the Latin *chiton*, which means "mollusk"; that, in turn, is derived from the Greek word *khitōn*, meaning "tunic." The tunic was a basic garment worn by both men and women during the Roman empire. Citizens and noncitizens alike wore chitons (usually white for men and red for women). Citizens might wear the garment under the toga, especially on formal occasions. Its length and the presence or lack of stripes (clavi), as well as width and ornamentation, indicated the wearer's status in Roman society.

Cinnabar. An orange-red pigment with excellent hiding power (opacity) and good permanence. It has been used from antiquity to the present. Chemical formula: Mercuric sulfide, HgS

Clavus (pl. clavi). A vertical stripe or ribbonlike ornament, placed in pairs, that adorned the shoulders of a tunic. In Rome some clavi of specific width and/or color distinguished members of a particular rank or status, but the significance of the clavus in an Egyptian context remains undetermined.

Computerized tomography or computerized axial tomography (CT, CAT). An imaging technique combining computer technology with X-rays to create cross-sectional images enabling detailed and layered viewing through an object.

Conifer resin. A sticky and aromatic exudate that is produced by coniferous trees such as cedar and pine. This resin was used in antiquity as a medical unguent, perfume, and for religious and ritual applications.

Consolidate. To strengthen or stabilize a material by adding another impregnating material, such as an adhesive (consolidant). For example: *The paint on the surface was consolidated using gelatin.*

Copper greens. Green pigments based on the element copper. They can include, but are not limited to, synthesized pigments such as verdigris ($Cu(CH_3COO)_2$), copper resinate (copper salts of resin acids), copper (II) oleate (copper and fatty acid), Egyptian green ($CaOCuO(SiO_2)_4$), and naturally occurring mineral pigments such as malachite ($Cu_2CO_3(OH)_2$).

Dura-Europos. An ancient city, in what is now Syria, that borders the Euphrates River. A strategic site that served as a crossroads for different cultures, language, and religions. With a long and complex history, the site is best known from the excavations sponsored by Yale University and the French Academy in the 1920s and 1930s.

Earth pigments. Naturally occurring minerals colored by metal oxides, principally of iron and manganese, mixed with clays and silicates. Earth pigments have been used since prehistoric times and their primary forms are ochres (iron oxide–based) and umbers (iron and manganese-based).

Egyptian blue (Roman: caeruleum, mineral: cuprorivaite). A pigment manufactured and used by Egyptians possibly as early as 3100 BCE. Considered to be the first synthetic pigment, Egyptian blue was traditionally made by mixing copper with a calcium compound (typically lime) together with silica/quartz and a flux. The mixture was heated to a very high temperature (900°C) and the resulting glassy product was then ground to a powder. Chemical formula: Calcium copper silicate, $CaCuSi_4O_{10}$ or $CaOCuO(SiO_2)_4$

el-Hibeh (el-Hiba). An archaeological site on the east bank of the Nile, south of Cairo. Remains at the site date from the late Pharaonic, Graeco-Roman, Coptic, and early Islamic periods—approximately 1100 BCE to roughly 700 CE.

ELISA (enzyme-linked immunosorbent assay). An analytical technique that employs antibodies to identify proteins in binding media such as animal glue, egg, and milk, as well as polysaccharides in plant gums. ELISA can also often characterize the biological source of the protein (e.g., rabbit-skin vs. fish glue).

Encaustic. A wax-based painting technique. From the Greek word *enkaustikos* ("burned in"), the term in its most literal sense refers to the use of molten beeswax combined with pigments; once solidified, the paint can be further manipulated using heated tools. The term is also often used, however, to describe any painting technique in which wax is the major component of the medium.

er-Rubayat (er-Rubayyat, er-Rubiyat, er-Rubayet, el-Rubaiyat). An archaeological site on the west bank of the Nile within the Fayum basin, also known as the cemetery near ancient Philadelphia. This location is where many portraits acquired by the Viennese art dealer Theodor Graf were found.

Excitation-emission matrix (EEM) fluorescence spectroscopy. A non-destructive analytical technique in which emission spectra are collected across a range of excitation wavelengths and plotted together, creating a 3D contour plot (the excitation-emission matrix) from which the wider fluorescence behavior of the material under investigation can be measured. EEM has a high sensitivity and is most often used to detect trace materials present in foodstuffs, water, and biological samples. The excitation-emission matrix can often serve as a unique indicator of the material present.

Fag el-Gamous. A large ancient Graeco-Roman cemetery located within the Fayum, Egypt, approximately 90 km south of Cairo. It was first excavated by Bernard Grenfell and Arthur Hunt in 1901–1902; more recent excavations by Brigham Young University have discovered nearly 2,000 burials.

False-color infrared (FCIR) / infrared-reflected false color (IRRFC). Images created through digital post-processing by combining visible and near-infrared images. The false colors produced can help in characterizing materials or in distinguishing between visually similar substances.

False-color ultraviolet (FCUV) / ultraviolet-reflected false color (UVRFC). Images created through digital post-processing by combining visible and ultraviolet reflectance (UVR) images. The false colors produced can help in characterizing materials or in distinguishing between visually similar substances.

Fatty acid metal soaps (lead soaps). Products created by the saponification of an oil (such as a drying oil, which hardens due to oxidation) promoted by a lead-based pigment, such as lead oxide. The soaps formed by interaction between fatty acids in the oil and lead ions from the pigment can manifest as insoluble white aggregates within the paint layer or as a white haze (efflorescence) on the surface. Soaps can also form in wax-based paints. Beeswax is composed of wax esters that contain palmitic acid (fatty acid) and a long-chain alcohol. Hydrolysis of the wax ester produces free palmitic acids and alcohols, and if lead pigment (or another metallic ion) is present, a fatty acid soap (such as lead palmitate) can form.

Fayum (Faiyum, El Faiyûm, Al-Fayoum, Fayyum, Fayoum). A fertile desert basin immediately to the west of the Nile River, south of Cairo. Roman mummies were discovered there in several ancient cemeteries and archaeological sites, including Hawara and er-Rubayat. The Fayum was a very prosperous region and a vibrant cultural center during the Ptolemaic and Roman periods.

Fiber optics reflectance spectroscopy (FORS), also visible near-infrared fiber optics reflectance spectroscopy (VIS-NIR-FORS). A non-invasive analytical technique in which reflectance spectra are collected using two fiber optics: one to illuminate the area of interest and one to collect the spectrum. The illumination source is typically white light with reflectance spectra collected across the visible and into the near-infrared regions of the electromagnetic spectrum. FORS is most often used in the identification of pigments and dyestuffs.

Fibula. A decorative pin or brooch, usually made of metal such as bronze, silver, or gold, used to gather and secure the folds of a garment.

Flavian period (69–96 CE). The era that encompasses the reigns of Vespasian (69–79 CE) and his sons Titus (79–81 CE) and Domitian (81–96 CE). Although Vespasian encouraged a return to traditional Roman values of austere modesty, the rule of Domitian saw new levels of extravagance, especially in the dress and coiffure of imperial women. As imperial fashions became known through the dissemination of coins and sculptured busts and statues, the elaborate hairstyles were imitated, with tiers of curls requiring hairpieces to achieve the required height and mitered shape above the brow; men copied the look of balding emperors Vespasian and Titus.

Fluorescence / luminescence / photoluminescence. The response of certain materials when exposed to a high-energy radiation source. When these materials absorb high energy, they become unstable and, as they return to a more stable state, release energy (i.e., fluorescence / photoluminescence / luminescence). This response is captured with a sensor (such as a camera or an analytical instrument) and it allows for the identification of the

response as a unique signature of that material. *See also* UVF/UVL, VIL, and XRF.

Fourier transform infrared spectroscopy (FTIR). An analytical method used for characterization and identification based on the absorption of discrete wavelengths of infrared radiation to excite molecular vibrational modes. Analysis can be performed in Reflectance or Attenuated Total Reflectance (ATR) mode. This is a primary technique for the characterization of organic and some inorganic materials.

Galena. A natural mineral form of lead sulfide used as a gray/black pigment and as a cosmetic in antiquity. Chemical formula: PbS

Gammadion (pl. gammadia). A symbol composed of four Greek capital letters gamma (Γ) placed at right angles to form a decorative cross figure. Originally an ancient cosmic or religious symbol thought to bring good luck, this symbol has been found in many ancient contexts associated with Byzantium, Rome, and Graeco-Roman cultures.

Garland. A floral necklace used in religious rituals and for festive occasions. The Egyptians placed garlands on their mummified bodies as a sign of celebration in entering the afterlife; this practice developed at the beginning of the New Kingdom and continued into the Roman period. The rose was specifically associated with the goddess Isis.

Gas chromatography/mass spectrometry (GC/MS). An analytical technique used for the precise identification of organic binding materials such as proteins, oils, waxes, resins, and gums. The gas chromatograph separates complex mixtures of organic compounds using a capillary column housed in a temperature-controlled oven and, in combination with the mass spectrometer, can facilitate identification and quantification of the individual components.

Gilding. A term that describes the various decorative techniques for applying a very thin layer of gold leaf or gold powder to a solid surface such as wood, stone, or metal to give the appearance of being made of solid gold. Gold leaf, typically between 18 and 22 karats, is hammered into extremely thin sheets (leaves) or ground into a powder, and then applied with an adhesive.

Graeco-Roman Egypt / Greco-Roman Egypt (332 BCE to 395 CE). A period in ancient Egypt that lasted over 700 years. During this time, Egypt was ruled by the Greeks (332–30 BCE), also known as the Ptolemaic period, and the Romans (30 BCE–395 CE), when it became a far-reaching and wealthy province of the Roman Empire.

Green earth (terre verte). A naturally occurring Fe, Mg, Al, K hydrosilicate mineral pigment colored by glauconite or celadonite, with other associated minerals.

Ground (preparation layer). A primary layer applied to a substrate to form a smooth surface on which to paint. Typically, ground layers were composed of a white material such as gypsum, although they can range in color and composition.

Gum. A water-soluble, polysaccharide exudate obtained from woody plants or other natural sources and used as a binder for pigments. Acacia gum was the most commonly used plant binder in antiquity.

Gypsum (calcium sulfate dihydrate). A soft sulfate-based mineral found in nature. Often mixed with water to form plaster, it is used in the preparation of substrates, such as wood panels for painting. Also used as a white pigment, gypsum was identified in Tutankhamen's paint box. Chemical formula: $CaSO_4 \cdot 2H_2O$

Hadrianic period (117–138 CE). The era that encompasses the reign of Hadrian, who was known for his interest in Greek culture. The visual legacy in the portraiture of this period is exemplified in the Hellenization of male features (a short Greek beard reminiscent of that of the Athenian general and politician Pericles, and a full head of curly hair) and the classicization of female features (modest clothing and coiffures made of braids wrapped around the head).

Hawara. A Roman site in Egypt located in the Fayum basin. The necropolis at this site is well known for the systematic and well-documented excavations by British Egyptologist Sir Flinders Petrie.

Himation (pallium in Latin). A mantle worn by both men and women in the Greek world. It consisted of a square piece of cloth worn over the shoulder (typically the left), with the excess cloth draped over to the opposite shoulder. (*See* pallium.)

Horus lock. A distinctive Egyptian hairstyle depicted on the gods Horus/Harpocrates, worn by children (typically male) and sometimes by adult males. It appears as a single lock of hair (a sign of youth) on the right side of the head, above the ear.

Huntite. A white carbonate-based mineral used as a pigment throughout the ancient Mediterranean. Chemical formula: $Mg_3Ca(CO_3)_4$

Hyperspectral imaging (HSI). A spectral imaging technique in which images of the same spatial area are recorded at a series of different wavelengths across the

electromagnetic spectrum. HSI systems typically utilize a dispersion element to enable the collection of hundreds of images over a set of wavelengths. Depending on the instrument, this range typically includes the visible through the near infrared (400–1000 nm) but is sometimes extended further into the infrared (up to 2500 nm). The stack of images collected at each wavelength is called a hyperspectral data cube, where each pixel contains spectral information that can help detect or characterize the materials present.

Indigo. A natural blue dye derived from the plant *Indigofera tinctoria* and related species growing in the Mediterranean, India, and Asia, among other locations. It is believed that originally the dye woad (*Isatis tinctoria*), rather than indigo, was used in antiquity. Indigo has better lightfast properties than woad. Chemical formula: $C_{16}H_{10}N_2O_2$

Infrared reflectography (IRR). An imaging technique in which an object is irradiated with short-wave infrared radiation (SWIR; 1000–3000 nm). A specialized infrared-sensitive camera detects and captures the contrast between materials that reflect the infrared, such as lead white, and those that absorb it, such as carbon-containing pigments. Because infrared radiation has longer wavelengths than visible light, it can penetrate low-absorbing materials, revealing hidden underdrawings, artist's modifications and methodology, or modern interventions.

Iron oxide pigments (hematite, ochres, sienna, umber). Also referred to as earth pigments and made from minerals containing oxides and hydroxides of iron. Iron oxide pigments can occur in many different colors, most commonly yellow, orange, red, brown, and black. Approximately sixteen known iron oxides and oxyhydroxides were widely sourced and processed (calcined) for use as pigments.

Jarosite (natrojarosite). A yellow-to-brown mineral within the alunite group used as a pigment in Egypt. It is composed of basic hydrous sulfate of potassium and ferric iron (Fe-III). Natrojarosite is the sodium analog of jarosite. Chemical formula: $KFe_3(SO_4)_2(OH)_6$ / $NaFe_3(SO_4)_2(OH)_6$

Julio-Claudian period (27 BCE–68 CE). The era that saw the establishment of imperial rule at Rome by five successive members of a single family: Augustus (27 BCE–14 CE); Tiberius (14–38 CE); Gaius, often known as Caligula (38–41CE); Claudius (41–54 CE); and Nero (54–68 CE). Augustus developed a clean-shaven look of somewhat short, neatly cut hair with a fringe of locks above the brow. Later Julio-Claudian court hairstyles were longer and more elaborate, with coiled corkscrew ringlets in front of the ears and tightly wound curls around the face. Wealthy provincial men and women imitated Roman imperial court style, which was rigorously disseminated across the empire, notably on coins and in portraits in many media.

Kermes. An insect-derived ancient red dye/colorant, source of the word *crimson*. Early Egyptians made this red dye from the dried bodies of a female wingless scale insect—either *Kermes ilices* or *K. vermilio,* both of which live on certain species of Mediterranean oaks and produce a powerful, permanent scarlet dye and organic colorant. Chemical formula: kermesic and flavokermesic acid, $C_{16}H_{10}O_8$

Lake. A pigment manufactured by precipitating a dye onto an inorganic substrate/mordant (such as the metallic ions aluminum or calcium).

Lead white. A white pigment, both found as a naturally occurring mineral known as hydrocerussite and produced synthetically by exposing metallic lead to an acid (e.g., vinegar). Lead white has been widely used since antiquity and in Egypt from around 400 BCE. Chemical formula: Basic lead (II) carbonate, $2PbCO_3{\cdot}Pb(OH)_2$

Linen (flax). A textile derived from the flax fiber, commonly used in but not originally native to Egypt, dating back to the Neolithic period (about 4000 BCE). Two types of flax were cultivated in predynastic Egypt: *Linum bienne* (synonym *Linum angustifolium*) and *Linum usitatissimum*. To produce linen thread, flax was dried, retted (soaked), beaten to separate the bast fibers from the stems, spliced, and spun. Although rarely done, linen thread could then be dyed (using ochre or organic colorants) before being woven into cloth. Women, men, and children were involved in linen production, but weaving is most closely associated with women. Linen cloth was very valuable and sometimes used as currency. Egyptian mummies were wrapped in linen because it symbolized wealth, light, and purity.

Liquid chromatography with diode array detection and mass spectrometry (LC/DAD/MS). An analytical technique typically employed for the study of natural dyes, which consist of multiple chemical compounds. The sample is placed in a liquid solution and the individual components are separated by passing through a chromatography column, then detected using the DAD and MS detectors.

Litharge and Massicot (from Greek *lithargyros*, *lithos* "stone" +*argyros* "silver" λιθάργυρος). A red-colored pigment that is one of the natural mineral forms of lead

(II) oxide, having a tetragonal crystal structure, t-PbO. The orthorhombic form, o-PbO, is yellow in color and known as massicot.

Lomentum (Tritum). Ancient literary sources describe various shades and grades of the Roman pigment caeruleum (Egyptian blue) based on its production. According to Pliny, washing and grinding caeruleum was used to produce a refined, fine-particle sized, and thus paler, blue pigment called lomentum. While more expensive than caeruleum, tritum was an even paler and lower-quality (cheaper) version.

Macro-X-ray fluorescence spectroscopy (MA-XRF). A mode of X-ray fluorescence spectroscopy (see XRF) wherein spectra are collected over a wide area, producing images showing the distribution of individual elements over the area. The distribution, or combination, of elements not only can inform researchers about the identity of pigments or other materials present but can also help unravel the artistic process. XRF maps can reveal, for example, initial composition, artist changes, or even the order in which materials may have been applied, down to individual brushstrokes.

Madder. A dyestuff derived from the root of the madder plant (*Rubia tinctorum*), which is native to the eastern Mediterranean and Persia. Likely introduced to Egypt by the Greeks or Romans, madder was used throughout antiquity for coloring textiles and as a pigment. Chemical name: alizarin (1,2-dihydroxyanthraquinone), purpurin (1,2,4-trihydroxyanthraquinone)

Malachite. A naturally occurring green copper-based mineral. It can be ground to produce pigments of varying green hues, with finer grinds producing lighter green hues. Found on Egyptian tomb paintings, malachite is perhaps one of the oldest known green pigments. Chemical formula: Basic copper (II) carbonate, $Cu_2CO_3{\cdot}Cu(OH)_2$

Minium. *See* red lead.

Modified wax. Beeswax that has been modified by the addition of other materials—such as resin, glue, or oil—or treated with an alkali to make it water soluble and cold paintable. Some scholars have proposed that modified wax was used as a paint medium in ancient Egypt.

Morellian method. Developed by nineteenth-century art historian Giovanni Morelli, this technique explores and assists in identifying an artist's "hand" by analyzing a painting's details and minutiae through an iterative procedure.

Multiband imaging (MBI), also broadband imaging. A technical imaging protocol that uses a modified full-spectrum silicon sensor camera, filters, and lighting to capture images in broad spectral bands (such as those within the near-ultraviolet [UV] and near-infrared [IR] regions). The technique is used to enhance, compare, and reveal features that are beyond the visible region of the electromagnetic spectrum.

Multiband reflectance subtraction imaging (MBR). A digital post-processing technique that subtracts a near-infrared image from a visible light image, thus enabling the visible characterization of certain materials, specifically indigo.

Multispectral imaging (MSI). The creation of a series of images, each recording reflectance and luminescence within a different, limited, narrow-band range of wavelengths. This process involves using a series of band-pass camera filters or a set of narrow-band illumination sources; thus, it records variations in the absorption of materials at different wavelengths. Comparing or combining these images can help to characterize materials or to distinguish between materials that may appear similar.

Orchil. A violet/purple dye extracted from certain lichen (*Roccella*) through a fermentation process. Used in antiquity, orchil has been identified as a dye on textiles and in manuscript paintings. It is often used as a substitute for Tyrian purple, a rare and expensive dye obtained from a sea mollusk.

Orpiment. From the Latin *auripigmentum* (*aurum* "gold" + *pigmentum* "pigment"). A naturally occurring bright yellow arsenic sulfide mineral. When ground into a pigment, it has large, sharply faceted particles and a glittering quality. Sourced from the Red Sea and Asia Minor, and mentioned by Pliny and Vitruvius as well as in Egyptian works of the Pharaonic period, orpiment was widely traded by the Romans. Chemical formula: Arsenic trisulfide, As_2S_3

Pallium. A large, draped rectangular cloth, worn as a cloak or mantle with no undergarment, often associated with Greek intellectual activities. To the Romans, the pallium was a distinctly Greek form of dress, and so it was worn only in specific contexts. (*See* himation.)

Panel. Painting support made from various woods, including lime, sycomore fig, and cedar of Lebanon, among others. The shape of the upper portion of mummy portrait panels may indicate the region in which the mummy was buried: stepped panels are associated with

Antinoöpolis, round-topped panels with Hawara, and angled panels with er-Rubayat.

Pastiche. An artwork that incorporates several different styles or is composed of parts drawn from a variety of sources (e.g., a complete panel that is made of two or more components).

Penicillum. A paintbrush with bristles made from plant fibers or animal hair.

Peptide mass fingerprint (PMF). An analytical technique that involves the enzymatic digestion of proteins followed by Matrix Assisted Laser Desorption-Ionization Time of Flight mass spectrometric (MALDI) analysis of the resultant peptide mixture. PMF is currently applied extensively to collagen- and keratin-based materials, and can be used to determine the sources of, for example, leather, bone, parchment, animal and fish glues, ivory, horn, hoof, hair, baleen, and silk. In cultural heritage and art, materials such as egg and casein can similarly be identified to a specific source with PMF.

Pharaonic Egypt (3000–332 BCE). An era during ancient Egyptian history that lasted over 3,500 years and is known for important developments in art, architecture, and writing, and for contributions to science and technology. The Pharaonic period ended with Alexander the Great's conquest of Egypt in 332 BCE.

Philadelphia. An ancient cemetery near the archaeological site of er-Rubayat on the west bank of the Nile and within the Fayum basin, where many portraits acquired by the Viennese art dealer Theodor Graf were discovered. The site is often listed as the find spot for mummy portraits.

Photometric stereo imaging. A computational imaging technique that separates color from shape data to generate a high-resolution composite image that estimates surface topography.

Pigment. A colorant either derived from natural sources—mineral, plant, or insect—or produced synthetically. Typically, pigments are crushed into a fine powder and mixed with a binder, resulting in a suspension that becomes insoluble when dry; a dye produces a lake pigment when attached to an inorganic substrate or mordant.

Pistacia resin. An aromatic resin obtained from the mastic tree (*Pistacia lentiscus*).

Plant resin. A water-insoluble exudate obtained from plants, particularly coniferous trees such as pine, cedar, or fir. Composed of chemical compounds known as terpenes, plant resins are used to produce varnishes and adhesives and for mummification processes. Many resins have an aromatic quality that also acts as a preservative (biocide).

Polarized light microscopy (PLM). A form of optical microscopy in which a sample is observed under polarized light, often used to examine the crystalline properties of materials. Pigments may be characterized by their isotropic and anisotropic characteristics when viewed under polarized light, which can provide information about their crystallographic structure.

Polychrome. The application of multiple colors to an object to produce a decorative effect.

Polysaccharide gums. Complex long chains of carbohydrate molecules of natural origin, typically in the form of a plant gum. Gum acacia is a polysaccharide gum.

Polyvinyl acetate (PVA, PVAc). Developed in the 1950s, PVA is a synthetic resin and/or emulsion. It is widely available in artist-grade paints and is also used as an adhesive. Due to reversibility challenges with emulsion preparations and the potential for the release of volatile compounds, such as acetic acid, PVA adhesives are not typically used in conservation today, although they have been identified on historical treatments.

Provenance. The ownership history of an artifact.

Provenience. The geographic origin of an artifact and its context.

Ptolemaic period (323–30 BCE). The Ptolemies were an ancient Greek dynasty in Egyptian history that began with Alexander the Great's defeat of the Persians and were the longest and final rulers of ancient Egypt until its incorporation into the Roman Empire in 30 BCE.

Punic wax. Described by both Pliny and Dioscorides, the precise nature and composition of Punic wax have been much debated, with the source texts variously interpreted as describing the preparation of a purified or clarified beeswax, or one that has been partially or completely saponified by the addition of an alkali. In the latter case the product is presumed by some to be water miscible and amenable to application in a cold state.

Radiocarbon dating (carbon14, C-14, ^{14}C). A scientific method for dating organic materials or objects containing organic materials. All living things take up the radioactive carbon isotope carbon-14, and when the plant or animal dies, the amount of carbon-14 it contains begins to decay at a known rate. Measuring the amount of carbon-14

remaining in a sample can be used to estimate the time that has elapsed since the plant or animal died.

Raking light. Illumination by a light source positioned at an oblique angle or almost parallel to an object's surface. It is used to provide information about the surface topography.

Raman spectroscopy. An analytical technique that can be used to identify the molecular components of materials. Most frequently used for the analysis of pigments, Raman spectroscopy uses laser light (typically directed onto the sample through a microscope objective, allowing the interrogation of single particles) to generate a spectrum that is uniquely characteristic of the material under study (a "fingerprint" spectrum). Identification is often made by comparing spectra to reference spectral databases, although the examination of specific bands can also provide information about the functional groups present. Raman spectroscopy is a complementary spectroscopy to Fourier transform infrared spectroscopy (*see* FTIR).

Realgar. Closely related to orpiment, realgar is a naturally occurring red-orange arsenic sulfide pigment that was widely traded in the Roman Empire and used throughout ancient Egypt and Mesopotamia. When exposed to light, realgar alters to pararealgar, a more yellow-orange compound with the same elemental composition but different crystalline structure. Chemical formula: Arsenic sulfide, As_4S_4

Red lead (minium). A bright red-orange pigment that was one of the first to be synthetically produced. It is also referred to as *minium*, the naturally occurring form of the pigment named after the river Minius, located in northwest Spain. Chemical formula: Lead (II,IV) oxide, Pb_3O_4

Red ochre. A brownish red earth pigment colored by anhydrous iron oxide, or hematite (from the Greek *hema*, meaning "blood"), along with clays and silicates. Used since prehistory as pigments, ochres may vary widely in shades and transparency depending on the composition. *See also* earth pigments. Chemical formula: Anhydrous iron (III) oxide, Fe_2O_3

Reflectance transformation imaging (RTI). A computational imaging technique that reveals surface topography, details, and textures, thus enabling the study of tool and brush marks, etc. To perform RTI a light source is positioned at a constant radius from the subject and images are collected at different angles creating a hemisphere of image captures. The final processed file determines all possible light positions within the virtual hemisphere and generates a polynomial texture map, or pseudo three-dimensional image of an object or surface.

Reflected near-infrared (NIR) photography. An imaging technique that records radiation responses in the near-infrared region (700–1100 nm), thus capturing the contrast between materials that reflect the infrared and those that absorb it, such as carbon-containing pigments. Because infrared is of longer wavelength than visible light, some low-absorbing materials may also allow the infrared to be transmitted through them, revealing hidden underdrawings, artist's modifications and methodology, or modern interventions.

Romano-Egypt or Roman Egypt (30 BCE to ~305 CE). The era when Egypt was a province of the Roman Empire. This period followed the defeat of Marc Antony and Cleopatra in the battle at Actium by the later emperor Augustus.

Sagum. A long, dark-colored (red, blue, or purple) outer cloak worn by Roman soldiers. The sagum was fastened on the shoulder with a fibula (brooch).

Scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM-EDS / SEM-EDX). SEM is an analytical imaging technique in which a narrow beam of high-energy electrons is directed onto the surface of a sample in a raster pattern, and detectors are used to collect electrons either scattered (backscatter electrons [BSE], related to the average atomic number of the sample) or produced as a result of an ionization process (secondary electron [SE], sensitive to the surface topography). The addition of an energy-dispersive X-ray detector can collect fluorescence emission spectra that enable the identification of the elemental composition of the sample (*see* X-ray fluorescence).

Severan period (193–235 CE). An era characterized by, among other things, a fashion for short military beards and hair cropped close to the head for men and center-parted and pulled back for women. These distinctive styles help scholars to propose a rough chronology of Roman portraiture and art, as images with these coiffures appear on dated materials such as coins and busts.

Shroud. A cloth used to cover or protect another object. The term is most often used to refer to a cloth that covers or envelops a corpse. Many mummy shrouds were painted before being placed over the mummy's head or enveloping the entire body.

Specular light. Light that behaves as if it has been reflected by a mirror—that is, a ray of incoming light (incident ray) that strikes a surface and is reflected in a single outgoing direction.

Stucco. A fine plaster made of either gypsum or calcite that is used for coating surfaces or that is molded into decorative shapes. The mixture is applied wet and shaped/molded; it is typically painted after drying. Funerary masks made of stucco are found in Egypt from the First Dynasty to at least the third century CE.

Tebtunis or Tebtynis. A settlement in the lower Fayum region, known for its rich source of ancient literary, astronomical, magical, medical, and religious texts. An important regional center during the Ptolemaic period, the site was first excavated by British archaeologists Bernard Grenfell and Arthur Hunt in 1899/1900.

Tempera. In the context of ancient art, this term generally refers to a fast-drying, water-miscible painting medium such as animal glue or plant gum. The term *tempera* originates from the Latin *temperare* ("combining, blending").

Terpenoid resin. A major component of conifer (cone-bearing seed trees and bushes) oleoresin. This natural plant resin is used as a defense from insects and pathogens and was an ingredient used for ritual mummification in ancient Egypt, with a primary function as a biocide to help preserve the body from decay.

Thebes. Located on the east bank of the Nile, south of Cairo, Thebes was the ancient capital of Egypt during the Middle and New Kingdoms. Today occupied by the modern city of Luxor, the site of ancient Thebes was one of the richest and most important cities in ancient Egypt, functioning as the religious capital of the country with temples and palaces at Karnak and the necropolises of the Valley of the Kings and the Valley of the Queens.

Trajanic period (98–117 CE). The era that corresponds to the reign of Trajan. This period is exemplified by a distinctive women's hairstyle consisting of a "nest" of braids placed at the back of the head and rolls of curls arranged into a tall diadem (crown or headpiece) towering over the forehead. These distinguishing styles help scholars to propose a rough chronology of Roman portraiture and art, as images with these coiffures appear on dated materials such as coins and busts.

Tuna el-Gebel. Known as the "City of the Dead" in Egypt, this site mainly houses funerary monuments ranging in date from the New Kingdom up to and including the Graeco-Roman period. The majority of those buried at the necropolis during the Roman period were Egyptian, yet their burial style was Greek.

Tunic. *See* chiton. A simple garment that covered the upper body, starting at the shoulders and ending at a length somewhere between the hips and the ankles. The English word *chiton* originates from the Latin *chiton*, which means "mollusk"; that, in turn, is derived from the Greek word *khitōn*, meaning "tunic." The tunic was a basic garment worn by both men and women in ancient Rome. Citizens and noncitizens alike wore chitons (usually white for men and red for women). Citizens might wear a chiton under the toga, especially on formal occasions. The length of the garment and the presence or lack of stripes (*clavi*), as well as their width and ornamentation, indicated the wearer's status in Roman society.

Ultraviolet-induced visible fluorescence (UVF) / UV-visible fluorescence / Ultraviolet-induced visible luminescence (UVL) (historically UV/VisFL) / Ultraviolet-induced luminescence (UIL). An imaging technique and diagnostic examination method, based on characteristic responses of materials to ultraviolet (UV) radiation (~185–400 nm, commonly the narrow band at 365 nm) in the form of fluorescence, in which radiant energy in the UV region is absorbed to create an unstable high-energy state and then reemitted as lower-energy visible light to regain stability. The fluorescence revealed by the technique is used to assist in the general characterization or differentiation of materials—such as pigments, coatings, binders, and adhesives—and to diagnose the condition of an object (e.g., to detect areas of restoration). The term *luminescence* also encompasses the possibility of a phosphorescent response to UV radiation in which there is a delay in the reemission of the absorbed energy by some materials, so that emission might even continue for a period after the UV excitation source is turned off. While *luminescence* encompasses all the emission processes that may occur, the term *fluorescence* is by far the dominant phenomenon being observed and has historically been used in describing this technique in conservation (as well as in medicine, non-destructive testing, and forensics). *Luminescence* is an equally appropriate descriptor. (*See also* fluorescence / photoluminescence / luminescence.)

Ultraviolet reflectance or ultraviolet reflected (UVR) imaging / reflected ultraviolet (RUV) imaging. An imaging technique that records variations in reflection and absorption of ultraviolet (UV) radiation by the surface of a subject. This imaging technique primarily aids in the characterization or differentiation of materials. Also, because UV radiation exhibits very limited surface penetration, the technique can also help in characterizing surface sheen.

Umbers (raw and burnt umber). Natural earth pigments colored by iron and manganese oxides and hydroxides. Used throughout history as earth-tone pigments, umbers

range in color from cream to brown, depending on the amount of iron and manganese oxides present. Chemical formula: Iron (III) oxide, partly hydrated + manganese oxide, $Fe_2O_3(\cdot H_2O) + MnO_2\cdot(nH_2O)$

Visible-induced infrared luminescence / visible-induced luminescence (VIL). An imaging technique in which visible light is used to induce the emission of infrared radiation (primarily in the near-infrared [NIR] region [700–1100 nm]) by certain materials. It has been used to identify historical blue pigments (principally Egyptian blue, Han blue, and Han purple) as well as many cadmium pigments and some natural dyes. These materials may show a very strong IR emission when excited by visible light. The setup for VIL imaging is relatively simple, only requiring an excitation source emitting visible light with no IR component, a detector with sensitivity to NIR (such as an IR-modified digital camera), and a lens filter that absorbs all visible light and transmits NIR.

Visible-induced visible luminescence (VIVL). A method of recording a photo-induced emission of light in the visible region (500–700 nm) when the object is illuminated within a narrow band of visible light of higher energy (400–500 nm). The technique requires careful control of the illuminating source and imager lens filtration to ensure the range of wavelengths imaged do not include those in the excitation source.

Vitruvian proportions. Based on the work of the ancient architect Vitruvius (first century BCE), the ideal proportions, measurements, and scale of the human body as delineated in his *Ten Books on Architecture*. Leonardo da Vinci (1452–1519) was the first to successfully illustrate Vitruvius's description with his drawing, *Vitruvian Man*.

Woad (*Isatis tinctoria*). Known as "dyers woad" and used since the Neolithic period, this plant was grown as an important source of a blue dye that was extracted from the leaves. Although a different plant than *Indigofera tinctoria* (indigo), the chemical extracted from woad is the same dye extracted from "true indigo," but in a lower concentration and thus not as lightfast.

Wreath. An assortment of flowers, leaves, fruits, twigs, or other materials constructed to resemble a loop. Typically worn on the head in ceremonial events, wreaths have much history and symbolism associated with them. In the Graeco-Roman world, wreaths were used as adornments that could represent a person's occupation, rank, achievements, or status.

X-radiography. An imaging technique used to reveal the internal structure of an object by using X-rays to record variations in the densities of its constituent materials. X-rays are transmitted, absorbed, or scattered in varying degrees by the materials present; the radiation that passes through the object is then captured on photographic film or a digital receptor placed behind the subject, thereby creating the radiograph. Dense materials and/or those containing elements of high atomic number, such as metal and lead white paint, strongly absorb X-rays and will appear white or light in tone; less dense materials, such as wood or other organic matter, readily transmit X-rays and appear dark in the resulting image.

X-ray diffraction (XRD). An analytical method that can give information about the structure of crystalline materials, from which the identity of the materials may be inferred. This technique is most used to examine mineral pigments, stone, and corrosion products.

X-ray fluorescence (XRF) spectroscopy. A non-invasive technique that provides a means to identify the chemical elements present in a sample or area of study. The technique employs a focused beam of X-rays that excite the atoms in the irradiated area. As the atoms relax back to their initial state, they emit fluorescent X-rays at specific energies that are unique to the element. XRF spectrometers employed in conservation applications typically can detect the elements present in metals, mineral-based pigments, and other inorganic materials, but cannot detect light elements such as carbon, oxygen, or nitrogen, found in organic materials. The identification of the main elements may allow researchers to infer the identity of the materials present, but a molecularly specific technique, such as Raman spectroscopy or XRD, is necessary to provide a definitive identification.

Yellow ochre. A naturally occurring mineral consisting of silica and clay colored by the iron oxide mineral goethite. Found throughout the world, yellow ochre has many shades and hues. Chemical formula: Iron oxyhydroxide, FeO(OH)