Influences of Ancient Greek on Chemical Terminology

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The ancient Greek civilization flourished between roughly 700 BCE to about 100 CE *(1)* and is rightly called classical for its major contributions to human knowledge, especially in the fields of philosophy, astronomy, literature, mathematics, and science in general. For example, the words *marathon, euthanasia, democracy, xenophobia, encyclopedia, hippopotamus,* and many others of Greek derivation are part of our daily vocabulary. Medical terms abound with words of Greek descent: *oncology, allergy, asthma, arthritis, cholesterol, diabetes,* and *orthopedics* to name just a few.

Table 1. Greek-Derived Prefixes Commonly Used in Chemical Terminology

Greek Prefix	Meaning in English
Allo-	Other, different
Amphi-	On both sides, double
Auto-	Self
Baro-	Weight, pressure
Bio-	Life
Chiro-	Hand
Chroma-	Color
Dia-	Through
En-	In
Epi-	Above, on
Eu-	Well, easy
Hemi-	Half
Hetero-	Other
Homo-	Same
Hydro-	Water
Hyper-	Over
Hypo-	Under
Iso-	The same
Kilo-	Thousand
Macro-	Large
Micro-	Small
Mono-	Alone, single
Oligo-	Few
Photo-	Light
Poly-	Many
Pseudo-	False
Pyro-	Fire
Stereo-	Solid, three-dimensional
Tauto-	The same
Thermo-	Heat, hot

Actually the word *chemistry* itself comes from two possible sources: either from the word *khem,* referring to the land of Egypt and the mysterious arts practiced there, or from the Greek word *cheo,* meaning “I cast or pour”, referring to the metallurgical operations of the ancient Greeks *(2).*

In chemistry there are hundreds of terms used commonly that are derived from the ancient Greek language and, generally, academics make use of these terms without often realizing the exact meaning of the underlying words. This article looks at words used in teaching chemistry that are derived from the ancient Greek and describes the exact meaning of the Greek antecedents from which additional knowledge can often be gained.

So many Greek-derived terms exist in chemistry and science broadly because the early discoverers in the Western world who named them during the 18th and 19th centuries generally had a thorough grounding in classical languages. In those times in the West one could only be called “educated” if one had a good grounding in Greek and Latin.

Understanding the Meaning of Greek-Derived Words

In order to understand the meaning of Greek-derived words it is first necessary to look at word prefixes and suffixes from the Greek language. Familiarity with these word components (morphemes) allows easy formation and understanding of these words. Table 1 shows an alphabetical list of Greek prefixes commonly found in chemical terminology and Table 2 lists Greek suffixes routinely used *(3–5).* Applying the information from these tables leads to a ready and richer understanding of the meaning of Greek-derived words such as barometer, biology, allotropic, hydrometer, hydrogen, polymorphism, and photometer.

Greek-Derived Names for Chemical Elements

Several papers addressing the naming of the elements have appeared in this *Journal* over the years *(6–15).* Two articles *(13,*

Table 2. Greek-Derived Suffixes Commonly Used in Chemical Terminology

Greek Suffix	Meaning in English
-gen	Born, produced
-gon	Angle
-hedron	Side
-graphy	Writing, drawing
-logy	Words about, study
-meter	To measure
-morphism	Form
-scope	To look at
-trope	Form
-urgy	Work

15), in particular, explore the origin of these elemental names and many are shown to be derived from either Latin or Greek. In the periodic table there are no fewer than 36 elements whose name derives from the Greek language or come from Greek mythology. Table 3 lists these elements in order of increasing atomic number, giving the Greek word from which the name is derived,

Table 3. Etymologies of Chemical Elements with Greek-Derived Names

Element Information			Greek-Language Root or Roots	Etymological Meaning (Translation in English and Rationale for Selection)
No.	Symbol	Name		
1	H	Hydrogen	*Hydro + Gen*	"Water former": when H_2 burns, water is formed
2	He	Helium	*Helios*	"Sun": first discovered in the spectrum of the sun
3	Li	Lithium	*Lithos*	"Stone": discovered in compounds from the mineral world
4	Be	Beryllium	*Beryllos*	The gem "beryl": a precious stone containing the element
7	N	Nitrogen	*Niter + Gen*	"Saltpeter producer"
8	O	Oxygen	*Oksys + Gen*	"Acid producer": all acids were considered to have oxygen
10	Ne	Neon	*Neos*	"New": refers to its unexpected discovery in air residues in 1898
15	P	Phosphorus	*Phos + Phero*	"Light bearer": white phosphorus emits light in the dark
17	Cl	Chlorine	*Khloros*	"Greenish yellow": named after the color of the gas
18	Ar	Argon	*A + Ergon*	"No work": inactive: refers to its inertness
22	Ti	Titanium	*Titans*	Named for the sons of Uranos (in Greek mythology) by Klaproth, who had already discovered uranium
24	Cr	Chromium	*Khroma*	"Color": different Cr compounds have different colors
33	As	Arsenic	*Arsenikos*	"Male, brave": Cu goods made harder with arsenic
34	Se	Selenium	*Selene*	"Moon": found in association with tellurium (earth in Latin)
35	Br	Bromine	*Bromos*	"Stench": named after the smell of the element
36	Kr	Krypton	*Kryptos*	"Hidden": finally discovered in liquefied air by Ramsay
41	Nb	Niobium	*Niobe*	Named for the daughter of Tantalus in Greek mythology because it was discovered in the same ore where Ta was found
42	Mo	Molybdenum	*Molybdos*	"Lead": after the principal ore from which it is extracted
43	Tc	Technetium	*Technetos*	"Artificial": the first artificially produced element
45	Rh	Rhodium	*Rhodon*	"Rose": named after the red solutions of rhodium salts
48	Cd	Cadmium	*Kadmeia*	Calamine, a mineral mined in Kadmeia, in Greece
51	Sb	Antimony	*Anti + Monos*	"Not alone; not one": usually found with other elements
53	I	Iodine	*Iodes*	"Violet colored": named after the color of its vapor
54	Xe	Xenon	*Xenon*	"Stranger": last one of the series Kr, Ne, Xe to be discovered
56	Ba	Barium	*Barys*	"Heavy": present in barite or heavy spar, $BaSO_4$
57	La	Lanthanum	*Lanthano*	"To hide": escaped detection in the mineral cerite until 1839
59	Pr	Praseodymium	*Praseios + Didymos – Di*	"Green twin": has properties very similar to the "twin element" neodymium and has greenish salts
60	Nd	Neodymium	*Neos + Didymos – Di*	"New twin": has properties similar to its "twin", lanthanum
61	Pm	Promethium	*Prometheus*	Named for the Greek god who gave mankind fire
66	Dy	Dysprosium	*Dysprositos*	"Difficult to obtain": refers to its difficult isolation
73	Ta	Tantalum	*Tantalos*	Named for the Greek god, banished to hell, standing up to his head in water; when he bent down to drink, the water sank: similarly Ta_2O_5 is not able to take water—not dissolving in acids
76	Os	Osmium	*Osme*	"Smell": the volatile OsO_4 has an unpleasant smell
81	Tl	Thallium	*Thallos*	"Young twig": refers to a newly found green line in its spectrum
85	At	Astatine	*A + Statos*	"Not standing or lasting": short-lived radio-isotope
89	Ac	Actinium	*Aktinos*	"Ray": refers to its radioactivity
91	Pa	Protactinium	*Protos*	"Prior, first": Pa is before Ac in a series of radioactive decay

as well the translation and a brief explanation of the meaning. Further information regarding the naming of these elements can be obtained from additional sources *(16–24).*

Naming Chemical Compounds

Chemical compounds can be named according to the IUPAC system, which makes liberal use of the Greek numbers, some of which are shown in Table 4. Numerical prefixes mono-, di-, tri-, tetra-, penta-, hexa-, hepta- and octa- are used extensively in naming compounds and complexes, such as dinitrogen tetraoxide (N_2O_4), carbon monoxide (CO) and tetraaquadichloro chromium(III) chloride $[Cr(H_2O)_4Cl_2]Cl$. It is interesting to note that the prefix "nona-", used to indicate nine, comes from Latin, not Greek.

Names such as hypochlorite (ClO^-) and perchlorate (ClO_4^-) refer to the number of oxygens in the formula relative to the related reference compound or ion: the Greek prefix "*hypo*" indicates "less than, under", meaning that the hypochlorite ion has one less oxygen atom than the reference ion chlorite, while the prefix "*per*", although Latin meaning "more than" is allied to the Greek word *para*, and refers to the fact that there is one more oxygen atom present in the structure of perchlorate than in the chlorate ion.

The name thiosulfate carries the prefix "*thio*", meaning sulfur, and it refers, in this case, to the replacement of an oxygen atom in the sulfate ion by a sulfur atom to form the thiosulfate ion. The prefix "*hydro*", derived from the Greek word for water, *hudoor,* is used to indicate water-derived species: for example, when hydrogen chloride gas dissolves in water it forms *hydro*chloric acid. The term "*hydro*nium" ion employs the same prefix.

To indicate the number of coordinating groups or ligands within a complex ion or molecule, the prefixes *bis-, tris-, tetrakis-,* and so on are used: for example, $[Co(en)_3]Cl_3$ is named tris(ethylenediamine)cobalt(III) chloride, where three ligands are used in the complex. It is interesting to note that the prefix "*bis*" is not Greek, but Latin standing for "twice"; the other prefixes are Greek-derived.

Classes of Compounds and Complexes

Tetrahedral (four-sided) complexes and *tetragonal* (four-angled) structures together with *octahedral* and *octagonal* structures abound in inorganic chemistry. The term "*chelate*" comes from the Greek word *chele* meaning "claw " because their attachment to a metal ion resembles the grasping of an object by the claws of a crab *(25).* A well-known chelating agent is EDTA, ethylediaminetetraacetate ion ($EDTA^{4-}$), which is a *hexa*dentate ligand *(25):* the latter name is an interesting mix of Greek and Latin, with *hexa* being Greek, while *dentate* is Latin and is derived from *dens,* meaning "tooth".

The word "isomer" derives from the word components *iso* and *mer*, meaning literally "*same parts*", referring to compounds that consist of the same composition; that is, having identical formulas, but with a different arrangement of their constituent atoms. The word *stereoisomer* refers specifically to different spatial arrangement, since *stereos* means "solid", or a three-dimensional substance. *Chirality* is another important term used to indicate spatial arrangement within a compound. It indicates "handedness" and it comes from the Greek word for hand, *cheir.*

Table 4. Selected Greek Numbers and English Equivalents

Greek Word	English Equivalent
Eis (Mon-)	One
Duo	Two
Treis	Three
Tetra (Tessares)	Four
Pente	Five
Hex	Six
Hepta	Seven
Octo	Eight
Ennea	Nine
Deka	Ten
Dodeka	Twelve
Treiskaideka	Thirteen
Pentekaideka	Fifteen
Eikosi	Twenty

Using Etymologies of Greek Word Derivations To Enhance Chemistry Teaching and Learning

General Words Used in Introductory Chemistry

Numerous Greek-derived words are used to teach general chemistry courses. For example *atom* ("not divisible"), *isotope* ("same place" in the periodic table), *ion* ("to go, to wander"), *cation* ("to go down or to go in a negative direction"), *anion* ("to go up, in a positive direction"), *cathode* ("negative electrode"), and *anode* ("positive electrode") are used in a first-year course. Even the word *stoichiometry* derives from *stoichion* meaning "element" and *metron*, "to measure".

Physical Chemistry Terms Derived from the Greek

Physical chemistry especially abounds with terms derived from the Greek. The term *thermodynamics* indicates "movement of heat" and refers to the science (founded in 1824 by the French scientist Nicolas Léonard Sadi Carnot) that aimed to put the working of steam engines on a sound theoretical foundation *(21).* The word *enthalpy* is made up of two words—*en* ("in") and *thalmos* ("warm")—and indicates the study of the heat content of a substance. The term *entropy*, first coined by the German physicist Rudolf Julius Emanuel Clausius in 1850 *(21),* is made up of *en* and *tropos*, meaning "change", refers to some property of a material that becomes significant when the material undergoes a phase change: generally the entropy of a substance increases significantly during a phase change. The prefixes *exo-* and *endo-*, as used in *exothermic* and *endothermic* reactions indicate "out" and "in", respectively, and refer to reactions either giving out heat or requiring heat. The term *adiabatic* literally means "not passing through", and refers to situations where there is no heat flow taking place across a barrier. The old-fashioned unit of work, the *erg,* comes straight from *ergos*, the Greek word for "work"; the *synergic* effect (*syn* means "together"), literally means "working together". Actually the word *energy* refers to something produced in or during work.

Terms associated with phase changes also demonstrate Greek influence. The word *phase* comes from *phasis*, meaning "appearance or phase", while the word *azeotrope* can be broken up into *a* + *zeo* + *trope*, literally meaning "to boil without change", which refers to the fact that when an azeotropic liquid mixture boils it gives rise to vapor of the same composition as the liquid; this can only happen at one temperature, and hence the boiling point of an azeotropic mixture remains constant during the distillation, giving off vapor of constant composition. A good example of an azeotrope is the hydrochloric acid/water mixture, containing 80% water by mass, which boils unchanged at 108.6 °C *(26)*.

The term *eutectic* can be broken into *eu* + *tectic*, meaning "easy to melt", referring to a particular solid mixture of two components that has a lower melting point than either of the two pure components: a good example of a eutectic compound is solder, having a mass composition of 67% tin and 33% lead, melting at 183 °C *(26)*.

A word related to eutectic is *peritectic*, meaning "around the melting point", which refers to incongruent melting when the melting point is not observed because of the instability of a compound formed *(26)*.

The term *kinetics* derives from the Greek word *kineo*, meaning to move and refers to the rates of chemical reactions. The term *piezoelectric* derives from the Greek word *piezo*, meaning to press and refers to the fact that piezoelectric crystals produce an electric current when a pressure is applied on them.

Analytical Chemistry Terms Derived from the Greek

Analytical chemistry terminology reflects numerous words of Greek descent. The word *meniscus* actually comes from the Greek word *meinei*, meaning "small moon", while the word *parallax* derives from *paralassein*, meaning "change, deviation".

The term *monochromatic* literally means "one color" and refers to the use of one wavelength radiation. A related term, *chromatography*, literally means "writing in color" and aptly describes the first chromatographic experiment carried out by Michael Tswett *(27)*. In this experiment he used a column of calcium carbonate to separate the various plant pigments present in a petroleum ether extract of green leaves: as the mixture seeped down the column, the various pigments separated in colored bands, representing the various chlorophylls and carotenes; the pigments were written in color along the length of the column, hence he coined the technique *chromatography (27)*.

The term *pyrometry* contains the Greek prefix *pyro-*, meaning "fire", and therefore this term extends to mean the measurement of high temperatures. The word *pyro*sulfate is used to indicate the salt formed by heating a metallic hydrogen sulfate.

Organic Chemistry Terms of Greek Origin

The homologous series of alkanes again illustrates the use of the Greek numeric system. Actually the term "*homologues*" refers to a group of compounds, literally with the "same words" or properties, and therefore belonging to a series of the same generic formula. The names of selected members of this series of compounds (*pentane, hexane, heptane,* etc.) are seen to be derived from Table 4, where the name refers to the number (in Greek) of carbons in the formula. An exception is *nonane*, which derives from Latin.

The first four members of the series (*methane, ethane, propane,* and *butane*) are not named strictly according to the Greek number system. This indicates that these first four were named before any systematic naming of compounds was introduced. The early chemists named a compound on the basis of its history. Methyl alcohol, CH_3OH, was named "wood spirits" because it was obtained from the destructive distillation of wood.

Actually the word *methyl* derives from the Greek prefix *meta* (after) and the word *hyle* meaning "wood": hence the name methane for the parent compound *(28)*. Similar reasoning can be used to derive the names of the other members of the alkane group that are not named numerically.

The organic notation *ortho-*, *meta-*, and *para-* used so often in the naming of organic compounds derives from Greek words, meaning "next", "after" and "opposite", respectively and is used to differentiate between isomers, such as *ortho-, meta-,* and *para*-xylenes.

The term *aliphatic* arises from the fact that the first compounds of this class studied were the fatty acids, and the Greek word for "fat" is *aliphos (28)*. The term "*aromatic*" derives from the Greek word *aroma*, meaning "fragrant smell or spice", because they referred to a large number of compounds obtained from natural sources, such as resins, balsam, and oils. Although their structures were unknown at the time, they all had one thing in common: a pleasant smell or fragrance *(28)*.

Conclusion

This article has shown not only that many Greek-derived terms are used in chemistry, but also that an elementary knowledge of Greek prefixes and suffixes, together with a few selected Greek words, can lead to a better understanding of the exact meaning of these terms.

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