

Supplementary Material

Uncovered Faces: A Resource to Support Decolonization of the Undergraduate Chemistry Curriculum

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1. Illustrated Biographies of Black American Chemists

Lewis Howard Latimer (1848–1928)



He was a Black American inventor born by Black slave parents, who manufactured the carbon filament that made the light bulb a useful device. He invented the evaporative air conditioner and also improved toilet system for railroad cars. Latimer also wrote the first book on electric lighting and helped to patent the telephone.

Photo source: <https://www.lrc.rpi.edu/resources/news/pressReleases/img/Lewis.jpg>

1. <https://www.biography.com/inventor/lewis-howard-latimer>
2. <https://www.lrc.rpi.edu/resources/news/pressReleases/img/Lewis.jpg>.

Alice Ball (1892-1916)



She was an African American scientist. She was known for her discovery of the 'Ball Method' which was the most effective in the treatment for Leprosy in the 20th century. She extracted the ethyl esters from chaulmoogra oil which she modified chemically to make them water-soluble. This modification to the ethyl esters make them easily absorbed by the bloodstream. Her works can be included in teaching esters and in curriculum design of pharmaceutical Chemistry.

Photo source: <http://www.hawaii.edu/offices/bor/distinction.php?person=ball>

1. https://en.wikipedia.org/wiki/Alice_Ball
2. <https://www.biography.com/scientist/alice-ball>.

<https://scientificwomen.net/women/ball-alice-121>

Percy Lavon Julian (1899-1975)



He was a renowned African American Chemist who was the first to synthesize the physostigmine (a natural product). He also championed the synthesis of human hormones. (Progesterone and testosterone) from plant steroids on an industrial large scale. His works were focused on synthesis of natural products *e.g.* He synthesised steroids intermediates from Mexican wild yams.

Photo source: <http://encyclopediaofalabama.org/article/m-5666#>

1. Stille, Darlene R. Percy Lavon Julian: Pioneering Chemist (Signature Lives series), Capstone, 2009, ISBN 0756540895, ISBN 978-0756540890.
2. https://en.wikipedia.org/wiki/Percy_Lavon_Julian

Patents

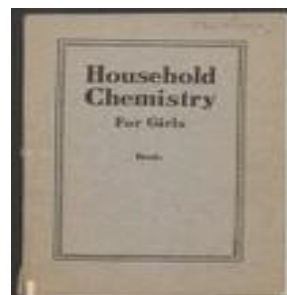
- i. U.S. Patent 2,218,971, October 22, 1940, Recovery of sterols
- ii. U.S. Patent 2,373,686, July 15, 1942, Phosphatide product and method of making
- iii. U.S. Patent 2,752,339, June 26, 1956, Preparation of cortisone

- iv. U.S. Patent 3,149,132, September 15, 1964, 16-aminomenthyl-17-alkyltestosterone derivatives
- v. U.S. Patent 3,274,178, September 20, 1966, Method for preparing 16(alpha)-hydroxypregnenes and intermediates obtained therein
- vi. U.S. Patent 3,761,469, September 25, 1973, Process for the manufacture of steroid chlorohydrins; with Arnold.

Saint Elmo Brady (1844-1966)



He was a physical organic chemist and the first African American to receive a Ph.D. in the United States. His thesis was on divalent oxygen atom, a research focused on sorting out the scientific conflict of idea between his supervisor and a Harvard University chemist Arthur Michael, who does not agree on the fact that the acidity of carboxylic acids is affected by replacing hydrogen atoms on the carbon chain with other chemical groups. Brady's research work was in agreement with the idea. His



contributions on chemical profession, leadership and chemistry curriculum programs design could be mentioned as a source in chemistry education curriculum design.

Photo source: Public Domain

1. <https://inchemistry.acs.org/acs-and-you/st-elmo-brady.html>
2. <https://www.sciencehistory.org/historical-profile/st-elmo-brady>
3. https://en.wikipedia.org/wiki/St._Elmo_Brady
4. [https://iif.lib.harvard.edu/manifests/view/drs:31156549\\$7i](https://iif.lib.harvard.edu/manifests/view/drs:31156549$7i).

Mary Elliott Hill (1907 – 1969)

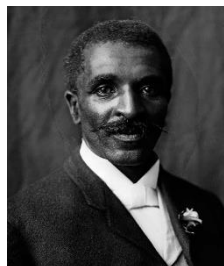


She was an organic and analytical chemist and one of the earliest African American women to become a chemist. She worked on developing analytical methodology and properties of ultraviolet light. Hill also worked to develop spectroscopic methods and using solubility to track the progress of chemical reactions. She worked in collaboration with her husband to develop the ketene synthesis which contributed strongly to the development of plastics. She was known as both an organic and analytical chemist.

Photo credit: Louisville courier Journal

1. Rayner-Canham, Marelene F; Rayner-Canham, Geoffrey, 2001. Women in chemistry: their changing roles from alchemical times to the mid-twentieth century. Philadelphia: Chemical Heritage Foundation. ISBN 0941901270.
2. https://en.wikipedia.org/wiki/Mary_Elliott_Hill
3. Mrs. Carl M. Hill, Educator's Wife, Dies at 62". The Courier-Journal (Louisville, Kentucky). February 13, 1969. Retrieved February 15, 2017
4. <https://cen.acs.org/people/profiles/Six-black-chemists-should-know/97/web/2019/02>

George Washington Carver (1864– 1943)



He was an African American Agricultural Organic chemist who invented methods to prevent soil depletion and promoted alternative crops to cotton. He was the most prominent black scientist of the early 20th century and spent many of his working and promoting products from peanuts.

Photo source: <https://www.britannica.com/biography/George-Washington-Carver/images-videos#/media/1/97606/194855> accessed 3 march 2022.

1. <https://www.britannica.com/biography/George-Washington-Carver>
2. https://en.wikipedia.org/wiki/George_Washington_Carver
3. <https://www.biography.com/news/george-washington-carver-facts-national-peanut-month>

Patents

- i. [US 1522176](#), issued January 6, 1925
- ii. [US 1541478](#), issued June 9, 1925
- iii. [US 1632365](#), issued June 14, 1927

Lloyd Noel Ferguson (1918 –2011)



He was an African American organic chemist who invented a moth repellent, a silverware cleanser, and a lemonade powder in his backyard laboratory as a child. His work was centred around chemo receptors and organic chemistry and he contributed strongly to the knowledge of taste in relation to structures chemical compounds. He strong knowledge contributions helped in summarizing the mechanisms for many chemical carcinogens and methods for the determination of structure-function relationships in anticancer agents. He authored many chemistry test books and research papers.

Photo source: <https://www.blackpast.org/african-american-history/ferguson-lloyd-1918/accessed-07/03/2022>

1. <https://www.nobcche.org/LloydNFerguson>
2. Gabrielle S. Morris, *Head of the Class: An Oral history of African-American Achievement in Higher Education and Beyond* (New York, Twayne Publishers, 1995)
3. Spangenburg, Ray; Moser, Diane (2003), African Americans in science, math, and invention, A to Z of African Americans, Infobase Publishing, pp. 79–82

Bettye Washington Greene (1935 – 1995)



She was an African American Physical chemist in industrial research. She was the first African American female Ph.D. chemist to work at Dow Chemical Company. Greene worked on polymers, latex and colloids chemistry, probing interactions between latex and paper. She received her first patent entitled "Stable latexes containing phosphorus surface groups" in which she described a method of preparing a paper coating composition comprising the addition of from about 2 to about 30 percent of a modified latex containing phosphorus surface groups. She was also awarded a patent in 1990 for the invention of a latex based pressure sensitive adhesive for coating conventional substrates to form an adhesive tape, entitled "Latex based adhesive prepared by emulsion polymerization"

Photo source: <https://digital.sciencehistory.org/works/t722h939f>

1. https://en.wikipedia.org/wiki/Bettye_Washington_Greene
2. "US Patent for Stable latexes containing phosphorus surface groups Patent (Patent # 4,506,057 issued March 19, 1985) - Justia Patents Search". patents.justia.com. accessed 2022-03-07.
3. "US Patent for Latex based adhesive prepared by emulsion polymerization Patent (Patent # 4,968,740 issued November 6, 1990) - Justia Patents Search". patents.justia.com. Retrieved 2022-03-07.

Walter Lincoln Hawkins (1911 –1992)



He was an African American chemist and engineer who is known as the father of polymer chemistry. He strongly contributed in designing a long-lasting plastic for telephone cables which lead to the introduction of telephone services to the remote American communities. Hawkins is also remembered for his efforts and contributions in advocating for minority students.

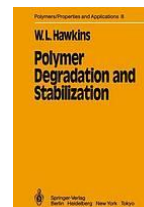


Photo source: Unknown

1. <https://samepassage.org/walter-lincoln-hawkins/>
2. <https://www.nae.edu/188556/W-LINCOLN-HAWKINS-19111992>
3. <http://worldcat.org/identities/lccn-n81015802/>

Alma Levant Hayden (1927 – 1967)

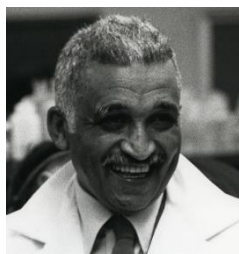


She was an African American chemist who is known for exposing that the common substance in a very expensive controversial anti-cancer drug Krebiozen was Creatine. Creatine is known to have no impact on cancer cells in animals. She was an expert in spectrophotometry which is an application used to measure the absorbance, reflectance, and transmission of light by solids, liquids, and gases.

Photo Source: NIH History Office <https://www.flickr.com/photos/historyatnih/32897938662/in/album-72157680816283366/>

1. <https://peoplepill.com/people/alma-levant-hayden>
2. <https://www.science-by-trianon.com/post/celebrating-black-history-month-with-alma-levant-hayden-the-woman-who-uncovered-a-cancer-fraud-drug>

Samuel Proctor Massie, Jr. (1919 – 2005)



He was an African American Organic chemist and the first black U.S Naval professor. He worked in the Manhattan project to develop the atomic bomb during the second world war. He researched on Uranium isotopes during this time. After the war, he worked on different chemicals which were geared towards the development of therapeutic drugs. He also researched on the chemistry of phenothiazine and was recognised as one of the distinguished contributors to chemistry in history.

Photo Source: Public Domain

1. <https://www.atomicheritage.org/profile/samuel-p-massie-jr>
2. <https://www.thehistorymakers.org/biography/samuel-massie-39>
3. <https://www.encyclopedia.com/education/news-wires-white-papers-and-books/massie-samuel-proctor-jr-1919>

Bertram Oliver Fraser-Reid (1934 – 2020)



He was a Jamaican born synthetic organic chemist who contributed immensely to the use of carbohydrates as starting materials for chiral materials. He also worked on exploring the roles oligosaccharides play in immune response. Fraser-Reid had a breakthrough in oligosaccharide synthesis by being able to develop a molecule which contains 28 monosaccharide units.

Photo Source: (Fair use) <https://www.blackpast.org/african-american-history/fraser-reid-bertram-o-1934/>

1. <http://old.jamaica-gleaner.com/gleaner/20091116/news/news1.html>
2. https://en.wikipedia.org/wiki/Bertram_Fraser-Reid

Marie Maynard Daly (1921 –2003)



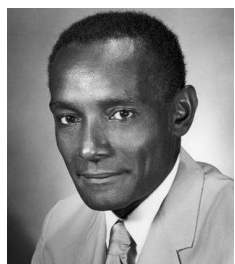
She was an African American biochemist who was the first African American woman in the United States to earn a Ph.D. in chemistry. She made very important contributions in different areas of research. Daly was the first to develop methods for the fractionation of nuclear material and the determination of its composition. This breakthrough was important in the separation of cellular materials into its components, without losing or destroying them. She was the first to benchmark that atherosclerosis occurs as a result of hypertension and also identify the relationship between

cholesterol and clogged arteries. These important discoveries lead to the understanding of what happens in a heart attack. Daly also developed methods for separating the nuclei of tissues which aids in measuring the base composition of purines and pyrimidines in deoxypentose nucleic acids. Her studies of histones, which are proteins found in cell nuclei lead to her contribution of being able to display the amino acid composition of various histone fractions. She also contributed strongly in understanding how creatine is taken-up by muscle cells.

Photo Source: Public Domain/ <http://philosophyofscienceportal.blogspot.com/2010/04/marie-maynard-daly1st-african-american.html>

1. <https://kathmanduk2.wordpress.com/2014/04/23/black-women-in-america-marie-maynard-daly/>
2. https://en.wikipedia.org/wiki/Marie_Maynard_Daly
3. <https://www.biography.com/scientist/marie-m-daly>

Dolphus Edward Milligan (1928-1973)



He was an African American chemist with expertise in spectroscopy. His research focused on using spectroscopy to study reaction intermediates at extremely low temperature. Dolphus work on free radicals and the spectra of molecular ions research earned him many different awards.

Photo Source: Public Domain

<https://nistdigitalarchives.contentdm.oclc.org/digital/collection/p16009coll5/id/491/>

1. https://plex.page/Dolphus_E_Milligan.
2. https://en.wikipedia.org/wiki/Dolphus_E._Milligan.

2. Illustrated Biographies of Asian Chemists

Sir Dr. Chandrasekhara Venkata Raman (1888-1970)



He contributed to the field of light scattering. He was an Indian physicist known for using a spectrograph that he developed to discover that when light traverses a transparent material, the deflected light changes its wavelength and frequency. This phenomenon which is recognised as a fundamental spectroscopy technique is known as Raman effect or Raman scattering. He won the Nobel Prize in physics in 1930.

Photo source: Nobel Foundation - From Nobel Lectures, Physics 1922-1941, Elsevier Publishing Company, Amsterdam, 1965.

https://commons.wikimedia.org/wiki/File:Sir_CV_Raman.JPG.

1. https://en.wikipedia.org/wiki/C._V._Raman
2. <https://www.nobelprize.org/prizes/physics/1930/raman/biographical/>

Tu Youyou (1930-)

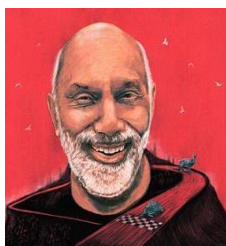


Tu, a pharmaceutical chemist was born in Ningbo, Zhejiang province in China. She discovered the use of artemisinin and dihydroartemisinin in the treatment of malaria and won the 2015 Nobel Prize in Physiology or Medicine with two other people for this work. Her work has saved millions of lives all over the world. She is the first Chinese woman from to receive a Nobel Prize in any category. Her works have also fetched her many awards.

Photo Source: https://commons.wikimedia.org/wiki/File:TU_Youyou_5012-1-2015.jpg

1. <https://www.scmp.com/yp/discover/lifestyle/features/article/3060632/5-women-scientists-who-changed-world>.
2. https://en.wikipedia.org/wiki/Tu_Youyou
3. https://en.wikipedia.org/wiki/Lasker-DeBakey_Clinical_Medical_Research_Award

Prasanna (AP) de Silva (1952-)



He is a Sri Lanka born professor of organic chemistry at Queen's University, Belfast, Northern Ireland. His important work includes the invention of molecular logic gates, and the construction of phosphorescent sensory systems. He invented a molecule sensor to measure the sodium levels.

Photo source: © Peter Strain @ Début Art

1. <https://www.chemistryworld.com/culture/prasanna-de-silva-kindness-plays-a-key-role-in-academia/4012876.article>.
2. <https://chemistrycommunity.nature.com/posts/the-fall-of-a-wall-inspires-small-scale-logic-integration-at-the-molecular-level-the-mornings-after>.

Professor Roger Yonchien Tsien (1952-2016)



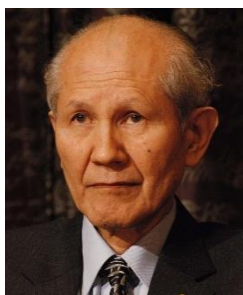
He was born into a Chinese family. Roger was a biochemist and worked in collaboration with an organic chemist, Osamu Shimomura to discover green fluorescent protein (GFP). The pair received the Noble prize in Chemistry in 2008 for this discovery. This work has contributed generously to the advancements in fluorescence microscopy widely used in cell biology. He was also well-known for his pioneering work in calcium imaging.

Photo Source:

https://commons.wikimedia.org/wiki/File:Roger_Tsienpress_conference_Dec_07th,_2008-2.jpg

1. <https://www.nature.com/articles/538172a>
2. https://en.wikipedia.org/wiki/Roger_Y._Tsien
3. <https://royalsocietypublishing.org/doi/10.1098/rsbm.2018.0013>
4. https://www.chemistryviews.org/details/ezone/9777101/Roger_Tsien_1952_2016.html

Professor Osamu Shimomura (1928-2018)

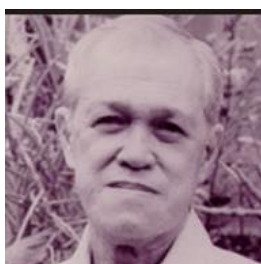


He was a Japanese born organic chemist and survivor of the Nagasaki bombing during the second world war. He worked with Roger Yonchien Tsien and others in the discovery of the green glowing proteins.

Photo Source: https://commons.wikimedia.org/wiki/File:Osamu_Shimomura-press_conference_Dec_06th,_2008-2.jpg

1. <https://www.nobelprize.org/prizes/chemistry/2008/shimomura/facts/>
2. <https://www.findagrave.com/memorial/194129821/osamu-shimomura>
3. <https://www.nature.com/articles/d41586-018-07401-1>

Professor Julian Banzon (1908-1988)



He is a Philippine born chemist. He discovered from his experiments on organic materials from his native homeland (Philippines), are good sources to produce alternative fuels called ethyl esters fuels. This discovery can strongly contribute to transformations in fuel technologies.

Photo source: Credit to the album Klarenz Kristoffer Magdaluyo Quiñones' photos.

1. <https://www.geni.com/people/Julian-Banzon/6000000120595805953>.
2. <https://www.flipscience.ph/news/features-news/features/national-scientist-julian-banzon/>

Professor Yuan T. Lee (1936 -)



He is a Taiwanese born chemist. He used advanced chemical kinetics processes to evaluate and manipulate chemical reactions. He has also contributed a lot in the areas of chemical elementary processes, chemical reactivity and chemical kinetics and has received a lot of awards in this regard including the Nobel Prize in Chemistry in 1986

Photo source: Public Domain

1. [https://www.nobelprize.org/prizes/chemistry/1986/lee/biographical/accessed 06/04/22](https://www.nobelprize.org/prizes/chemistry/1986/lee/biographical/accessed%2006/04/22)
2. <https://www.nobelprize.org/prizes/chemistry/1986/summary/>
3. <https://www.nobelprize.org/prizes/chemistry/1986/lee/25838-interview-transcript-1986-2/>

Dr Takamine Jōkichi (1854-1922)



He was a Japanese born chemist with focus on agriculture. He isolated the enzyme known as Takadiastase which catalyses the breakdown of starch from a fungus used in the manufacture of soy sauce and *miso*. He was also the first to isolated adrenaline hormone which is now called epinephrine from the suprarenal gland of an animal in 1901. This discovery has contributed strongly in the advancement of the treatment of asthma.

Photo source: Public Domain

1. <https://www.britannica.com/biography/Jokichi-Takamine>
2. [https://en.wikipedia.org/wiki/Japan_Academy_Prize_\(academics\)](https://en.wikipedia.org/wiki/Japan_Academy_Prize_(academics))

Professor Baldomero Oliver (1941-)

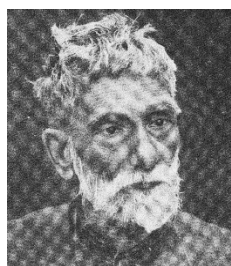


He is a Filipino born chemist who discovered the molecules conotoxins which are very important molecules used in neuroscience from the cone snail. He is renowned for his works in the chemistry of snail and snake venoms. This discovery led to breakthrough in the study of neuromuscular synapses and ion channels. He made an invaluable contribution to the field of genetic engineering and recombinant DNA technology by being the first to characterize *E. coli* DNA ligase, an important enzyme in this field.

Photo source: Unknown

1. <https://www.austinlim.com/blog/filipino-american-scientist-baldomero-olivera-cone-snail>
2. https://en.wikipedia.org/wiki/Baldomero_Olivera

Professor Acharya Sir Prafulla Chandra Ray (1861-1944)



He was born in the eastern part of India presently known as Bangladesh. He established the first modern Indian chemistry research school and is popularly known as the father of chemical sciences in India. He was also the founder of India's first pharmaceutical company, Bengal Chemical and Pharmaceuticals. His publication in the late 18th century on the preparation of a new stable compound mercurous nitrate led to further research exploring the nitrates.

Photo source: Public Domain

1. <https://www.famousscientists.org/prafulla-chandra-ray/>
<https://www.lindahall.org/about/news/scientist-of-the-day/prafulla-chandra-ray>

Contributions from ancient China, India, Arab and Africa to the development of chemistry

China

Region	Date/period (if known)	Chemical / Chemistry	Branch of Chemistry	Sources
China	9th century (Tang dynasty)	Fireworks	Inorganic	<ol style="list-style-type: none"> https://www.hotpotspot.co.uk/post/china-s-great-inventions-and-the-irony-of-fire-medicine https://www.ch.ic.ac.uk/local/projects/gondhia/history.html
China	9th century	Saltpetre (Potassium nitrate) and gun power	Inorganic	<ol style="list-style-type: none"> https://www.hotpotspot.co.uk/post/china-s-great-inventions-and-the-irony-of-fire-medicine
China	1100 B.C	Gold, Silver, Copper, iron, tin	Inorganic	<ol style="list-style-type: none"> The History of Chemistry in China, William Henry Adolph, <i>The Scientific Monthly</i>, Vol. 14, No. 5 (May, 1922), pp. 441-446 (6 pages)
China	750 B.C	Elements	Inorganic	
China		Mercuric chloride	Pharmaceutical	
China	10 th Century	Atomic Theory	Inorganic	<ol style="list-style-type: none"> The History of Chemistry in China, William Henry Adolph, <i>The Scientific Monthly</i>, Vol. 14, No. 5 (May, 1922), pp. 441-446 (6 pages)
China	10 th Century	Gun Powder	Inorganic	<ol style="list-style-type: none"> The History of Chemistry in China, William Henry Adolph, <i>The Scientific Monthly</i>, Vol. 14, No. 5 (May, 1922), pp. 441-446 (6 pages)
China	11 th Century	blue vitriol, copper carbonate, copperas, the iron salts, tin oxide, white lead, red lead, litharge, and all the common mercury compound	Inorganic	<ol style="list-style-type: none"> The History of Chemistry in China, William Henry Adolph, <i>The Scientific Monthly</i>, Vol. 14, No. 5 (May, 1922), pp. 441-446 (6 pages)

China	2800 B.C	Study of Medicine	Medicinal Chemistry	1. https://www.chinahighlights.com/travelguide/chinese-medicine/history.htm
Mesopotamia (West Asia)	7 th century	Smelting	Metallurgy	1. https://www.hotpotspot.co.uk/post/china-s-great-inventions-and-the-irony-of-fire-medicine
China	4000 BC	Sliver	Metallurgy	1. http://www.makin-metals.com/about/history-of-metals-infographic/

India

Region	Date/period (if known)	Chemical / Chemistry	Branch of Chemistry	Sources
India	2600-1900 B C (Indus valley people)	Cement,	Industrial Chemistry	<ol style="list-style-type: none"> 1. Significant contribution of chemistry in ancient Indian science and technology. 2. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016
India	2600-1900 B C (Indus valley people)	Hair shampoos	Polymer chemistry	<ol style="list-style-type: none"> 1. Significant contribution of chemistry in ancient Indian science and technology.
India	2600-1900 B C (Indus valley people)	Plasters, Medicinal Preparations	Pharmaceutical	<ol style="list-style-type: none"> 1. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016
India	2600-1900 B C (Harappan people)	Faience (Proto-glass)	Industrial Chemistry	<ol style="list-style-type: none"> 1. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016. 2. Ghosh, Amalananda (1990). An Encyclopaedia of Indian Archaeology. BRILL. ISBN 90-04-09262-5.
India	2600-1900 B C (Indus valley people)	Smelting of gold and copper into jewellery.	Industrial Chemistry	<ol style="list-style-type: none"> 1. https://www.azom.com/article.aspx?ArticleID=6101
India	2650 B C (Nippur)	Measuring standard (measuring rod)	Laboratory techniques	<ol style="list-style-type: none"> 1. S. R. Rao (1985). Lothal. Archaeological Survey of India. pp. 39–40
India	1000-400BC (Vedic age)	Tanning of leather, dyeing of cotton, polishing of ware.	Material Chemistry	<ol style="list-style-type: none"> 1. https://saddlesindia.com/history-of-leather-in-india/
India	1000-400BC (Vedic age)	Production of copper utensils, iron, seals, gold and silver ornaments.	Industrial Chemistry	<ol style="list-style-type: none"> 1. https://www.esamskriti.com/e/Culture/Indian-Culture/History-of-Copper-Utensils-1.aspx 2. Significant contribution of chemistry in ancient Indian science and technology.

India	1500 BC (Neolithic)	Production of terracotta discs and painted grey ware pottery	Industrial Chemistry	<ol style="list-style-type: none"> 1. https://en.unesco.org/silkroad/sites/default/files/knowledge-bank-article/vol_I 2. Kailash Chand Jain (1972). <i>Malwa Through the Ages, from the Earliest Times to 1305 A.D.</i> Motilal Banarsidass. pp. 96–. ISBN 978-81-208-0824-9.
India	1000-400 BC (Verdic age) (Documented in Kautilya's Arthashastra)	Production of salt from sea water.	Organic chemistry	<ol style="list-style-type: none"> 1. Richard M. Dane, <i>Journal of the Royal Society of Arts</i>, Vol. 72, No. 3729 (MAY 9, 1924), pp. 402-418 (17 pages)
India	1000-400 BC (Verdic age, Documented by Varahamihra)	Alum and sulphate or iron as mordants for dyeing fabrics	Textile	<ol style="list-style-type: none"> 1. Significant contribution of chemistry in ancient Indian science and technology.
India	3 th century	Paper making	Industrial Chemistry	<ol style="list-style-type: none"> 1. http://www.handmadepaper.org.uk/history-india.html
India	1000 BC	Natural dyeing chemicals and tanning of leather.	Organic chemistry	<ol style="list-style-type: none"> 1. https://thecoloursofnature.com/natural-dyes/a-brief-history/ 2. https://slightlyblue.com/culture/all-you-need-to-know-about-the-history-of-indigo-dyeing/
India	Mid-19 th century	Making of mordants	Organic chemistry	<ol style="list-style-type: none"> 1. https://www.unnatisilks.com/blog/indian-dyes-and-dyeing-industry-during-18-19th-century/oku500
India	18 th century AD	Making of soaps	Polymer Chemistry	<ol style="list-style-type: none"> 1. https://www.thesoapkitchen.co.uk/the-hub/the-history-of-soap
India	1500 BC-1000 BC (Verdic age)	Making of perfumes and cosmetics	Polymer Chemistry	<ol style="list-style-type: none"> 1. https://www.hinduwebsite.com/general/essays/perfume-history. 2. https://www.sanskritimagazine.com/history/perfume-distillation-in-ancient-india/ 3. https://www.perfumerflavorist.com/fragrance/ingredients/article/21857113/a-history-of-indias-perfumery-aromatics
India	1500 BC-1000 BC (Verdic age)	First to design retorts used to control the distillation of zinc.	Organic Chemistry	<ol style="list-style-type: none"> 1. https://www.infinityfoundation.com/mandala/t_es/t_es_agraw_zinc.html 2.

India	1500 BC-1000 BC (Vedic age)	Preparation of medicines from plant and animal extracts.	Pharmaceutical chemistry	1. Biljana Bauer Petrovska, Pharmacogn Rev. 2012 Jan-Jun; 6(11): 1-5
India	4 th century B C (documented at Takshila and in Rasaratnakara)	Ink and recipe for making ink from nuts and myro balans	Organic chemistry	1. http://chemistryinancientindia.blogspot.com/
India	700-1600 AD	Gold plating	Industrial chemistry	1. Significant contribution of chemistry in ancient Indian science and technology.
India	6 th century Dwaraka of Gujarat	Proposed the Indivisibility of an atom and matter being made up of atoms (atomic theory)	Inorganic Chemistry	1. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016
India	520 BC	Arrows tipped with iron	Industrial chemistry	1. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016
India	Medieval period	Gold making and elixir synthesis	Organic Chemistry	1. International Journal of Development Research, Vol. 06, Issue, 12, 10784-10788, December, 2016
India	1759	Shampoo	Industrial chemistry	1. https://www.independent.co.uk/news/science/how-islamic-inventors-changed-the-world-6106905.html
India	7 th century	Paper	Industrial chemistry	1. http://chemistryinancientindia.blogspot.com/ 2. https://www.infinityfoundation.com/mandala/t_es/t_es_tiwar_paper_frameset.htm

Arab

Region	Date/period (if known)	Chemical / Chemistry	Branch of Chemistry	Sources
Arab	11 th century	Pycnometer Laboratory flask Hydrostatic balance,	Laboratory techniques	<ol style="list-style-type: none"> 1. Robert E. Hall (1973). "Al-Khazini", <i>Dictionary of Scientific Biography</i>, Vol. VII, p. 346. 2. https://enacademic.com/dic.nsf/enwiki/6404308 3. David A. King and George Saliba, ed., "From Deferent to Equant: A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy", <i>Annals of the New York Academy of Science</i>, vol. 500 (1987), p. 427]
Arab	10 th century	First pin hole camera(Camera Obscura) created after studying the behaviour of light	Photochemistry	<ol style="list-style-type: none"> 1. https://www.independent.co.uk/news/science/how-islamic-inventors-changed-the-world-6106905.html
Arab	1570	Retort/ pure Distillation	Organic Chemistry	<ol style="list-style-type: none"> 1. Distillation, <i>Hutchinson Encyclopedia</i>, 2007. 2. Ahmad Y Hassan. Alcohol and the Distillation of Wine in Arabic Sources. www.history-science-technology.com. Accessed on 2022-04-10.
Arab	1121	Steelyard	Organic Chemistry	<ol style="list-style-type: none"> 1. Olga Pikovskaya, Repaying the West's Debt to Islam, <i>BusinessWeek</i>, March 29, 2005. 2. Robert E. Hall (1973). "Al-Khazini", <i>Dictionary of Scientific Biography</i>, Vol. VII, p. 346.
Arab	8 th century	Still	Organic Chemistry	<ol style="list-style-type: none"> 1. M. Rozhanskaya and I. S. Levinova, "Statics", in R. Rashed (1996), <i>The Encyclopaedia of the History of Arabic Science</i>, p. 639, Routledge, London. (cf. Khwarizm, Foundation for Science Technology and Civilisation.).

				2. Will Durant (1980). <i>The Age of Faith (The Story of Civilization, Volume 4)</i> , p. 162-186. Simon & Schuster. ISBN 0671012002.
Arab	11 th century	Thermometer	Laboratory techniques	1. Robert Briffault (1938). <i>The Making of Humanity</i> , p. 191.
Arab	8 th Century	Acetic acid	Polymer Chemistry	1. Olga Pikovskaya, Repaying the West's Debt to Islam, <i>BusinessWeek</i> , March 29, 2005
Arab	11 th Century	Conical measure	Laboratory wares	1. Marshall Clagett (1961). <i>The Science of Mechanics in the Middle Ages</i> , p. 64. University of Wisconsin Press.
Arab	8 th century	Filtration	Organic chemistry	1. Robert Briffault (1938). <i>The Making of Humanity</i> , p. 191.
Arab	8 th century	Crystallization purification, Liquefaction, evaporation and oxidisation	Organic chemistry	1. Paul Valley. How Islamic inventors changed the world. <i>The Independent</i> .
Arab	8 th century	Destructive distillation	Petroleum chemistry	1. Dr. Kasem Ajram (1992). <i>Miracle of Islamic Science</i> , Appendix B. Knowledge House Publishers. ISBN 0911119434.
Arab	9 th century	Calcination,	Inorganic chemistry	1. Georges C. Anawati, "Arabic alchemy", in R. Rashed (1996), <i>The Encyclopaedia of the History of Arabic Science</i> , Vol. 3, p. 853-902 [868]. 2. Ahmad Y Hassan, Transfer Of Islamic Technology To The West, Part III: Technology Transfer in the Chemical Industries, <i>History of Science and Technology in Islam</i> .
Arab	2600 BC	Discovery of Gold	Material chemistry	1. https://goldprice.com/project/the-history-of-gold/
Arab	9 th century	Ceration, sublimation, solution		1. Georges C. Anawati, "Arabic alchemy", in R. Rashed (1996), <i>The Encyclopaedia of the History of Arabic Science</i> , Vol. 3, p. 853-902 [868].

Arab	10 th century	Chemical compounds: lead(II) oxide (PbO), lead (Pb ₃ O ₄), tin(II) oxide, copper acetate, copper(II) oxide (CuO), lead sulphide, zinc oxide, bismuth oxide, antimony oxide, iron rust, iron acetate, Daws (constituent of steel), cinnabar (HgS), arsenic trioxide (As ₂ O ₃), alkali: sodium hydroxide (caustic soda),	Inorganic chemistry	1. Ahmad Y Hassan, Arabic Alchemy: Science of the Art.
Arab	11 th century	Steam distillation	Organic Chemistry	1. Marlene Ericksen (2000). <i>Healing with Aromatherapy</i> , p. 9. McGraw-Hill Professional. ISBN 0658003828.
Arab	13 th century	Law of conservation of mass	Physical Chemistry	1. Diane Boulanger (2002), "The Islamic Contribution to Science, Mathematics and Technology: Towards Motivating the Muslim Child", OISE Papers in STSE Education, Vol. 3.
Arab	7 th century	The isolation of ethanol	Organic Chemistry	1. Ahmad Y Hassan. Alcohol and the Distillation of Wine in Arabic Sources. www.history-science-technology.com . Retrieved on 2007-09-03.
Arab	10 th century	Large scale production of pure distilled alcohol	Organic Chemistry	1. Ahmad Y Hassan, Transfer of Islamic Technology To The West, Part III: Technology Transfer in the Chemical Industries, <i>History of Science and Technology in Islam</i> . 2. Dr. Kasem Ajram (1992). <i>Miracle of Islamic Science</i> , Appendix B. Knowledge House Publishers. ISBN 0911119434.

Arab	10 th century	Classification of chemical substances	Inorganic Chemistry	1. Ahmad Y Hassan, Arabic Alchemy: Science of the Art
Arab	7 th century	Artificial pearl	Industrial Chemistry	1. Ahmad Y Hassan, The Colouring of Gemstones, The Purifying and Making of Pearls, And Other Useful Recipes Mason (1995), p. 5
Arab	8 th and 9 th century	Opaque glazes and stone-paste ceramics	Industrial Chemistry	1. Zayn Bilkadi (University of California, Berkeley), "The Oil Weapons", <i>Saudi Aramco World</i> , January-February 1995, p. 20-27
Arab	7 th century	Manufacture of glue from cheese	Industrial Chemistry	1. Ahmad Y Hassan, The Colouring of Gemstones, The Purifying and Making of Pearls, And Other Useful Recipes Mason (1995), p. 5
Arab	11 th century	Essential oil	Polymer chemistry	1. Marlene Ericksen (2000). <i>Healing with Aromatherapy</i> , p. 9. McGraw-Hill Professional. ISBN 0658003828.
Arab	9 th century	Kerosene	Petroleum Chemistry	1. Zayn Bilkadi (University of California, Berkeley), "The Oil Weapons", <i>Saudi Aramco World</i> , January-February 1995, p. 20-27. 2. Dr. Kasem Ajram (1992). <i>Miracle of Islamic Science</i> , Appendix B. Knowledge House Publishers. ISBN 0-911119-43-4
Arab	9 th century	Petrol	Petroleum Chemistry	1. Deborah Rowe, How Islam has kept us out of the 'Dark Ages', <i>Science and Society, Channel 4</i> , May 2004
Arab	8 th century	Lustre-ware	Industrial Chemistry	1. Ahmad Y Hassan, Lustre Glass and Lazaward And Zaffer Cobalt Oxide In Islamic And Western Lustre Glass And Ceramics, <i>History of Science and Technology in Islam</i> .
Arab	7 th century	Mineral acids	Polymer Chemistry	1. Ahmad Y Hassan, Transfer Of Islamic Technology To The West, Part III: Technology Transfer in the Chemical Industries, <i>History of Science and Technology in Islam</i> .
Arab	10 th century	Refracting parabolic mirror	Physical/Photochemistry	1. Roshdi Rashed (1990), "A Pioneer in Anaclostics: Ibn Sahl on Burning Mirrors and Lenses", <i>Isis</i> 81 (3), p. 464-491 [464-468].

Arab	9 th Century	Production of Petrol using distillation method	Petroleum Chemistry	1. Deborah Rowe, How Islam has kept us out of the 'Dark Ages', <i>Science and Society</i> , Channel 4, May 2004.
Arab	11 th and 12 th century	Production of Perfumes	Organic Chemistry	1. Dunlop, D.M. (1975), "Arab Civilization", <i>Librairie du Liban</i>
Arab	810-887 BC	Silica glass and quartz glass		1. Lynn Townsend White, Jr. (Spring, 1961). "Eilmer of Malmesbury, an Eleventh Century Aviator: A Case Study of Technological Innovation, Its Context and Tradition", <i>Technology and Culture</i> 2 (2), pp. 97-111 [100].

Africa

Region	Date/period (If known)	Chemical / Chemistry	Branch of Chemistry	Sources
Africa (Egypt)	400 B.C (1260)	Fireproof clothing and dissolved talc for fire protection	Inorganic chemistry	1. Ahmad Y Hassan, Gunpowder Composition for Rockets and Cannon in Arabic Military Treatises In Thirteenth and Fourteenth Centuries, History of Science and Technology in Islam..
Egypt	3800 BC	Lead	Inorganic chemistry	1. http://www.makin-metals.com/about/history-of-metals- infographic/
Egyptian tombs	1500 BC	Mercury	Inorganic Chemistry	1. https://nature.berkeley.edu/classes/eps2/wisc/hg.html
Egypt	1260	Explosive canon	Inorganic Chemistry	1. Ahmad Y Hassan, Gunpowder Composition for Rockets and Cannon in Arabic Military Treatises In Thirteenth and Fourteenth Centuries, History of Science and Technology in Islam.
Egypt	1223 BC	Production of gold jewellerries	Industrial chemistry	1. https://www.metmuseum.org/toah/hd/egold/hd_egold.htm
Egypt	11 th century	Glass factory	Industrial chemistry	1. Ahmad Y Hassan, Transfer Of Islamic Technology To The West, Part III: Technology Transfer in the Chemical Industries, History of Science and Technology in Islam.
Egypt	12 th century	Hand cannons	Industrial/ inorganic chemistry	1. Ahmad Y Hassan, Gunpowder Composition for Rockets and Cannon in Arabic Military Treatises In Thirteenth and Fourteenth Centuries Archived 26 February 2008 at the Wayback Machine, History of Science and Technology in Islam
Egypt	1884	Breastplate armour made from horny back plates of crocodile.	Material chemistry	1. Ahmad Y Hassan, Gunpowder Composition for Rockets and Cannon in Arabic Military Treatises In Thirteenth and Fourteenth Centuries Archived 26 February 2008 at the Wayback Machine, History of Science and Technology in Islam

Nigeria (Ife)	13 th century	Life like status with brass	Industrial chemistry	1. Davidson, Basil (1971). African Kingdoms. New York: Time-Life Books, pp. 146(7).(4)
Nigeria (Benin)	16 th century	produced bronze tools using the lost wax process	Industrial Chemistry	1. Davidson, Basil (1971). African Kingdoms. New York: Time-Life Books, pp. 146(7)(4).
Mali (Timbuktu)	12 th -16 th century	1. Heliocentric view of the Solar system. 2. Diagrammatic mathematical representation of the planets and orbits	Physical chemistry	1. Dreyer 1953, pp. 135–148; Linton 2004, pp. 38f. 2. Heliocentrism at the Encyclopædia Britannica. 3. Meri, J. W. and Bacharach, Jere L. (2006). Medieval Islamic Civilization An Encyclopedia. Taylor & Francis. ISBN 978-0-415-96692-4.
Mali (Timbuktu)	August 1583	Record of meteor shower	Environmental chemistry	1. Abraham, Curtis. "Stars of the Sahara". New Scientist, issue 2617, 15 August 2007, page 39–41. 2. Holbrook, Jarita C.; Medupe, R. Thebe; Urama, Johnson O. (2008). African Cultural Astronomy. Springer. ISBN 978-1-4020-6638-2.
Morocco	Before the 12 th century	Moroccan leather	Material chemistry	1. Kevin Shillington (4 July 2013). Encyclopedia of African History 3-Volume Set. Routledge. pp. 736–737. ISBN 978-1-135-45670-2 2. Cyril Glassé; Huston Smith (2003). The New Encyclopedia of Islam. Rowman Altamira. p. 251. ISBN 978-0-7591-0190-6.
Tanzania (Haya)	1 st century	Medium-carbon steel in preheated, forced-draft furnaces	Petroleum chemistry	1. Africa's Ancient Steelmakers. Time Magazine, 25 Sep 1978.
Egypt	3000 B.C	Study of Medicine	Medicinal Chemistry	1. https://www.futurelearn.com/info/courses/study-medicine/0/steps/147884#
Egypt	3000 BC	Plant-based tanning of leather	Material chemistry	1. https://www.maharam.com/stories/barbe_the-history-of-leather-tanning

Egypt	4 th Century BC	Paper Making	Polymer chemistry	<ol style="list-style-type: none"> 1. https://delanceyplace.com/view-archives.php?p=3763 2. Tallet, Pierre (2012). "Ayn Sukhna and Wadi el-Jarf: Two newly discovered pharaonic harbours on the Suez Gulf" (PDF). British Museum Studies in Ancient Egypt and Sudan. 18: 147–68.
Egypt	1500 BC	Soap making	Polymer chemistry	<ol style="list-style-type: none"> 1. http://www.soaphistory.net/soap-history/history-of-soap/

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