Period	General	Cell	Photosynthesis	Nitrogen Metabolism	Mineral Nutrition	Water Relations	Translocation	Respiration	Growth	World Events
600 BC 1500 AD	*Theophrastus (Greek: 372-287BC)* father of botany	*R. Bacon (English: 1214-94)* le.t drawings of cells	*Aristotle (Greek: 384-322BC)* & *Theophrastus (Greek: 372-287BC)* taught elaborated plant food obtained from the soil	*Vergil (Roman: 70-19BC)* observed beneficial effect of growing legumes before cereals	*Aristotle (Greek: 384-323BC)* Plants obtain food from the soil	*Thales (Greek: 640-546BC)* all things made of water.			*Theophrastus (Greek: 372-287BC)* discussed seasonal periodicity.	*538BC* Fall of Babylon *332BC* Death of Alexander the Great *79AD* Destruction of Pompeii *1000* Lief Erickson to New England *1492* Columbus to America
1500-1600	*Van Helmont (Belgian: 1577-1644)* first recorded experiment in plant physiology		*VanHelmont (Belgian: 1577-1644)* concluded all plant substance from water		*Palissy (French: 1563)* manures & ash increase crops. *VanHelmont (Belgian: 1577-1644)* concluded plant substance not from soil.					*1513* Balboa discovered Pacific Ocean *1588* Spanish Armada defeated
1600-1700	*Malpighi (Italian: 1675)* & *Grew (English: 1682)* fathers of plant anatomy	*Hooke (English: 1665)* described plant cells	*Malpighi (Italian: 1671)* leaves elaborate food from crude sap	*Fuchs (German: 1534)* & *Malpighi (Italian: 1679)* pictured nodules on Vicia faba roots	*Glauber (German: 1650)* KNO_3 promotes plant growth *Woodward (English: 1699)* water culture experiment-believed soil contributes all plant substance		*Malpighi (Italian: 1671)* crude sap moves upward in wood, elaborated sap moves down.	*Malpighi (Italian: 1679)* seeds require air for germination		*1607* Jamestown settled *1620* Pilgrims landed *1636* Harvard founded *1683* Penn's treaty with Indians
1700-1800	*Hales (English: 1727)* "Vegetable Staticks"—father of plant physiology	*Corti (Italian: 1774)* observed protoplasm and protoplasmic streaming	*J. Priestley (English: 1771)* & *Ingenhousz (Dutch: 1779)* mouse bell-jar experiment-plants purify air in light *Senebier (Swiss: 1782)* carbon dioxide from the air decomposed by green leaves			*Hales (English: 1727)* measured root pressure, water flow, lifting power of transpiration, & amts. transpired.	*Hales (English: 1727)* swelling in ringed shoots above ring only.	*Scheele (Swede: 1777)* germinating seeds absorb O_2 and produce CO_2 *Ingenhousz (Dutch: 1779)* all darkened plants, & non-green plants in light, produce CO_2	*Hales (English: 1727)* measured growth of shoots & leaves—apical regions elongate most.	*1707* union of England and Scotland *1776* Declaration of Independence *1787* Constitution drawn up *1789-92* French Revolution
1800-1850		*Brown (English: 1831)* discovered nucleus. *Dujardin (French: 1835)* described protoplasm. *Purkinje (Czech: 1839)* named protoplasm. *Schleiden & Schwann (German: 1839)* cell theory, *Von Mohl (German: 1846)* applied term protoplasm to plant cells.	*De Saussure (Swiss: 1804)* quantitative measurement of gas exchange and water uptake. *Boussingault (French: 1843)* P.Q. = 1.0.		*DeSaussure (Swiss: 1804)* plants absorb soil salts in dilute solution form & in different proportions than they occur in the soil.		*T. A. Knight (English: 1801)* cut stems in dyes indicate that foods from leaves move in inner bark.	*DeSaussure (Swiss: 1804)* O_2 absorbed by germinating seeds = CO_2 evolved—*(1822)* Heat produced by flowers accompanied by O_2 absorption.	*DeSaussure (Swiss: 1804)* seed germination & growth depend on O_2	*1803* Louisiana Purchase *1812* War with England *1819* First steamboat crossed Atlantic *1833* Monroe doctrine *1846* Mexican war
1850-1900		*Schultze (German: 1861)* protoplasm doctrine *Faugl (German: 1879)* discovered plasmodesmata	*Sachs (German: 1862)* starch formed in chloroplasts in photosynthesis, carbohydrates converted to other organic compounds. von *Baeyer (German: 1870)* formaldehyde hypothesis *Timiriazev (Russian: 1896)* starch formation related to chlorophyll absorption spectrum	*Ville (French: 1857)* .*Boussingault (French: 1860)* & *Lawes & Gilbert (English: 1860)* conflicting results on N-fixation. *Schlossing & Müntz (German: 1877)* biological nitrification. *Hellriegel & Wilfarth (German: 1888)* nodulated legumes fix N. *Beijerinck (Dutch: 1888)* isolated nodule bacteria. *Winogradsky (Russian: 1890)* isolated nitrifiers-(1893) Isolated Cloetridium.	*Liebig (German: 1863)* law of the minimum *Sachs (German: 1860) Knopf (German: 1865) Pfeffer (German: 1900)* Water culture formulae.	*Strasburger (German: 1891)* flow in lumen of xylem vessels. *Dixon & Joly (British: 1894)* cohesion theory *Askenasy (1895)* tensile strength of water	*Hartig (German: 1858)* mass flow in sieve tubes. *Sachs (German: 1863)* sugars move by diffusion, proteins by mass flow. *DeVries (Dutch: 1885)* movement by cytoplasmic streaming.	*Pfeffer (German: 1885)* alcohol an intermediate in plant respiration. *Palladin (Russian: 1898)* respiration expressed on protoplasm basis	*Sachs (German: 1874)* growth rhythm, grand period, turgor effects, growth substance suggested. *C. Darwin (English: 1880)* regions of perception & response separate	*1855-7* Atlantic cable *1861-5* Civil War *1898* Spanish-American War *1898* Curies discovered radium
1900-1925	*F. F. Blackman (English: 1905)* limiting factor concept.		*Willstatter (German: 1918)* composition of chlorophyll, hypothesis of photosynthesis *Weevers (Dutch: 1921)* primary sugar in photosynthesis	*Beijerinck (Dutch: 1901)* isolated Azotobacter *Kraus & Kraybill (American: 1918)* carbon-nitrogen relation	*Mazé (French: 1915)* additional essential (trace) elements.	*Browne & Escombe (English: 1900)* diameter law. *Livingston (American: 1906)* atmometer & relative transpiration. *Briggs & Shantz (American: 1912)* wilting coefficient & water requirement. *Maximov (Russian: 1917)* efficiency of transpiration.	*Curtis (American: 1920)* up and down movement in phloem, inorganic solutes move up in phloem.	*Palladin (Russian: 1900)* respiration of starved leaves increased with sugar. *(1908)* chromogen theory. *Kostychev (Russian: 1910)* respiration theory *Dogyer (Dutch: 1915)* heat releases in respiration *Spoehr & McGee (American: 1923)* respiration increased by amino acids	*Boysen-Jensen (Dane: 1910)* conduction of photo-period stimulus. *Paal (1914)* flow of growth harmone. *Garner & Allard (American: 1920)* photoperiodism. *Robertson (1908)* autocatalysis formula	*1903* Wright brothers flight *1909* Peary discovered north pole *1911* Amundsen discovered south pole *1914-18* World War I

A Revised Chronology for Plant Physiology

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A chronological chart for plant physiology was first described at the fall meeting of the Indiana Academy of Science four years ago, but was not published. A revision has now been made by the inclusion of additional entries and by the insertion of the nationalities of the scientists listed, where known.

The chronology embraces a period of over 2500 years from the early Greeks to modern times. Subjects dealt with are: General, the cell, photosynthesis, nitrogen metabolism, mineral nutrition, water relations, translocation, respiration, and growth. A reference column of world events is included for the purposes of orienting scientific discoveries in the field of plant physiology with political history.

It is realized that this chronology has many gaps in it. Some of these gaps may be filled as the result of further search into the history of plant physiology. Other gaps undoubtedly represent definite lack of advancement in the subject over certain periods. It will be of considerable interest to extend the chronology to the present, or perhaps to the future-say the year of 1950. Obviously it will be necessary to wait several years before this additional step can be taken.

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