

**DICTIONARY
OF
THEORETICAL
CONCEPTS
IN
BIOLOGY**

Keith E. Roe and
Richard G. Frederick

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Introduction

Biologists have traditionally given symbolic names to the theoretical concepts they work with, names that act as a form of shorthand reference for what are often complex ideas. These symbols become an important part of scientific communication, sometimes bordering on a language itself. They serve much the same purpose, abbreviation, as do the scientific epithets assigned to species that are used in lieu of lengthy pre-Linnaean diagnoses. Concept names may be descriptive or colorful, such as *competitive exclusion* or "*big mother*" *hypothesis*, or they may be eponyms that honor the original formulator of the concept, such as *Allen's rule* and *Wallace's line*.

Each theoretical concept has a history of its own in the literature—initial statement, criticism, and review. The more familiar biological concepts are known as much by the people who originated or revised them, their dates of appearance in the literature, and bibliographic citations as they are by definitions. An awareness of the named concepts in one's field is essential both for understanding its history and for communication with colleagues.

Though named concepts are of everyday use in scientific papers, references to them are often lacking, and there is no source that leads a reader into the literature surrounding each of them. Biologists must either be sufficiently familiar with the theories, laws, and rules in their fields in order to know where to look for background papers on them, or they must dig through various texts hoping to find a lead to the subject. Nonspecialists in a subject area may be at a loss to know either the application of a conceptual term or where to find earlier references to it,

particularly when encountering the term out of context or when used with a presumption of familiarity. To the nonevolutionist, the *Red Queen hypothesis* may suggest a chess move or a character from Lewis Carroll (indeed, his queen is the inspiration for this name), while *Primordial Soup* may be interpreted as the first product of Campbell's.

The present work attempts to provide access to the literature on named theoretical concepts by citing original sources and reviews in which these concepts are elucidated. The reader is thus led not only to the foundation of each concept, but to its building blocks of criticism and historical analysis. With references through which to enter the literature, the reader can proceed by citation "networking" to work backward or forward in time, thus elaborating the search for relevant materials as much as desired. We have tried to exclude "factual" concepts, the definable, noncontroversial sort, which fall into the realm of terminology. However, the boundary between factual and theoretical concepts is not precise; consequently any list of these will contain examples that intergrade into one type or the other.

The 1,166 named concepts included in this work have been gleaned from journal articles, monographs, reviews, and histories of biological disciplines, primarily in the English language, published through the year 1979. Both plant and animal biology are covered, but neither human nor behavioral biology is heavily represented as these could take up a book of their own. Theoretical subject areas produce many more concepts than do experimental or descriptive fields, of course (evolution versus physiology, for example). With few exceptions, philosophical concepts, mathematical models, and experimental techniques are excluded. Current usage is emphasized, especially that of the past decade. However, some classical concepts from the nineteenth century and earlier still remain the bases for modern discussions; these have been included.

It is common for a single concept to be known by several names

"I have steadily endeavored to keep my mind free so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as facts are shown to be opposed to it."—
Charles Darwin, *The Autobiography of Charles Darwin*.

"Forming hypothesis is one of the most precious faculties of the human mind and is necessary for the development of sciences. Sometimes, however, hypotheses grow like weeds and lead to confusion instead of clarification. Then one has to clear the field, so that the operational concepts can grow and function."—Max Kleiber, *The Fire of Life*

(see, for example, *Primordial Soup*, *Gene Conversion*, or the *Neutral Theory*). We have used extensive cross-references to bring such equivalent names together; likewise those so closely related as to nearly always share discussion in any given paper; the *Red Queen hypothesis* and the *Law of Constant Extinction* are examples. To save space we have listed the set of references applying to these concepts under whichever name is most commonly cited, regardless of conceptual "levels." For instance, even though the *Red Queen* ranks below and is part of *Constant Extinction*, the former becomes the entry in this book because it is more commonly cited, probably because of its distinctive name. Specialized forms of certain concepts that are rarely encountered in the literature can often be found in reviews listed under the general term for the concept.

Some concepts have very definite origins. Many are named in the first articles in which they are discussed. Others may be discussed at some length without being named (in papers by Smith and Jones, let us say), while a subsequent paper may further elucidate the concept and bestow a descriptive name or the original author's surname(s) upon it (e.g., *Smith-Jones hypothesis*). In such clear-cut cases we have cited both the original articles and the one naming the concept. Very often, however, the origin of a concept may be shrouded in numerous premature glimmers published long before someone clearly states the generality. In such cases we have attempted to cite, when known, the first source to actually name the concept. From this paper and later reviews one can gain an understanding of the concept's history and prehistory. Some very general concepts have ill-defined beginnings or lack the thorough historical reviews that might illuminate their roots. For these we have listed available review articles rather than attempting to pinpoint origins.

Definitions are not included because they are generally inadequate, even misleading, for the understanding of theoretical concepts. Unlike the case with simple terms, for which concise definitions will suffice, one must usually read about the development, applications, and recent evolution of a conceptual idea or generality to grasp fully its significance to one's own research. The meanings and applications of concepts often change with the passage of time or from author to author. Therefore we have taken an objective approach in this book, indicating the general field in which a concept occurs and providing citations to authoritative discussions in the literature rather than trying to paraphrase these accounts with fixed definitions. In this regard W.B. Yapp has cogently written (*Nature* 167:160 [1951]): "The advice 'Define your terms' is bad counsel to give to biologists, for where the observations to be described have no sharp limits, if definition makes the argument simpler it does so at the expense of truth."

Citations are arranged chronologically under each entry to show the concept's historical development. However, all citations by a given author are listed together within an entry. Page numbers or chapters are given for books except: (1) in the case of an early reference that may form the basis for a concept but wherein the concept is never explicitly named; or (2) where the entire book or substantial part of it deals with the subject. Under each entry are listed any synonyms or concepts so closely related they are usually discussed together in papers and monographs. Such names that are capitalized can be found as entries themselves, while names in lower case are covered only with the primary entry under which they are assigned. Names of similar or conflicting concepts are listed below the citations for an entry as "confer" references. Journal title abbreviations generally follow those of the BIOSIS list, the *World List of Scientific Periodicals*, the *Botanico-Periodicum-Huntianum*, and the Royal Society's *Catalogue of Scientific Papers*.

We have attempted to treat as independent entries the clear-cut examples of homonyms but have not divided mere different applications of a single concept; for example, those applying to both plants and animals. Often the generalizations apply equally to both subjects, though each may be known by a very different set of citations in the literature.

In selecting references we have tried to include those that discuss the concept in question with some degree of thoroughness and that are in books and journals likely to be found in most academic libraries. It is not our intention, however, to fix as "correct" the names of concepts or to establish particular references as the only ones important to any concept. These will

- x change as authors revise the printed record of knowledge and speculation. New reviews are likely to cite the primary sources given in this book, however, so that citation searching will continue to make it a usable work.

We realize the potential for unintentional omissions or errors in a compilation such as this and will be grateful to users of the book for their suggestions of possible entries and corrections for future editions.

“... there is nothing more permanent
than a theory, and there is nothing more
temporary than a fact.”—Joseph S. Fruton

List of Journals (Alphabetized by abbreviation)

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Abh. Abt. Phytomorphogenese

Abhandlungen aus der Abteilung für Phytomorphogenese der Timiriaseff-Instituts für Biologie (Russia)

Abh. Königl. Akad. Wiss. Berlin

Abhandlungen der Königlichen Akademie der Wissenschaften in Berlin (Germany)

Abh. Königl. Böhm. Ges. Wiss.

Abhandlungen der Königlichen Böhmischen Gesellschaft der Wissenschaften (Czechoslovakia)

Abh. Abt. Phytomorphogenese

Abhandlungen aus der Abteilung für Phytomorphogenese der Timiriaseff-Instituts für Biologie (Russia)

Abh. Königl. Akad. Wiss. Berlin

Abhandlungen der Königlichen Akademie der Wissenschaft in Berlin (Germany)

Abh. Zool.-Bot. Ges. Wien

Abhandlungen der Zoologisch-Botanischen Gesellschaft in Wien (Austria)

Acta Biotheor.

Acta Biotheoretica (Netherlands)

Acta Path. Microbiol. Scand. B

Acta Pathologica et Microbiologica Scandinavica Section B Microbiology and Immunology (Denmark)

Actes Congr. Int. Hist. Sci.

Actes Congrès International d'Histoire des Sciences (International)

Adv. Ecol. Res.

Advances in Ecological Research (US)

Adv. Enzymol.

Advances in Enzymology and Related Subjects of Biochemistry (US)

- xii *Adv. Genet.*
Advances in Genetics (US)
- Adv. Immunol.*
Advances in Immunology (US)
- Adv. Insect Physiol.*
Advances in Insect Physiology (England)
- Advmt. Sci.*
Advancement of Science (England)
- Aliso*
Aliso (US)
- Amer. Assoc. Adv. Sci. Publ.*
American Association for the Advancement of Science Publication (US)
- Amer. Biol. Teach.*
American Biology Teacher (US)
- Amer. J. Anat.*
American Journal of Anatomy (US)
- Amer. J. Bot.*
American Journal of Botany (US)
- Amer. J. Hum. Genet.*
American Journal of Human Genetics (US)
- Amer. J. Orthod.*
American Journal of Orthodontics (US)
- Amer. J. Sci.*
American Journal of Science (US)
- Amer. Midl. Nat.*
American Midland Naturalist (US)
- Amer. Mus. Novit.*
American Museum Novitates (US)
- Amer. Nat.*
American Naturalist (US)

Amer. Orchid Soc. Bull.

American Orchid Society Bulletin (US)

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Amer. Sci.

American Scientist (US)

Amer. Zool.

American Zoologist (US)

Anat. Anz.

Anatomischer Anzeiger (Germany)

Anat. Rec.

Anatomical Record (US)

Anim. Behav.

Animal Behaviour (England)

Ann. Acad. Sci. Colon.

Annales Académie des Sciences Coloniales (France)

Ann. Assoc. Amer. Geogr.

Annals of the Association of American Geographers (US)

Ann. Biol. Anim. Biochim. Biophys.

Annales de Biologie Animale Biochimie Biophysique (France)

Ann. Bot.

Annals of Botany (England)

Ann. Chim.

Annales de Chimie (France)

Ann. Entomol. Soc. Amer.

Annals of the Entomological Society of America (US)

Ann. Entomol. Fenn.

Annales Entomologici Fennici (Finland)

Ann. Eugen.

Annals of Eugenics (England)

Ann. Génét.

Annales de Génétique (France)

Ann. Hum. Genet.

Annals of Human Genetics (England)

- xiv *Ann. Mag. Nat. Hist.*
Annals and Magazine of Natural History (England)
- Ann. Math. Statist.*
Annals of Mathematical Statistics (US)
- Ann. N.Y. Acad. Sci.*
Annals of the New York Academy of Sciences (US)
- Ann. Sci.*
Annals of Science (England)
- Ann. Sci. Nat. Bot.*
Annales des Sciences Naturelles (A)
Botanique (France)
- Ann. Sci. Nat. Zool.*
Annales des Sciences Naturelles (B)
Zoologie (France)
- Annu. Rep. Natl. Inst. Genet.*
Annual Report of the National Institute of Genetics (Japan)
- Annu. Rev. Biochem.*
Annual Review of Biochemistry (US)
- Annu. Rev. Ecol. Syst.*
Annual Review of Ecology and Systematics (US)
- Annu. Rev. Entomol.*
Annual Review of Entomology (US)
- Annu. Rev. Genet.*
Annual Review of Genetics (US)
- Annu. Rev. Microbiol.*
Annual Review of Microbiology (US)
- Annu. Rev. Phytopath.*
Annual Review of Phytopathology (US)
- Annu. Rev. Plant Physiol.*
Annual Review of Plant Physiology (US)
- Arb. Biol. Reichanst. Landw. Forstw. Berlin*
Arbeiten aus der Biologischen Reichsanstalt für Land- und
Forstwirtschaft Berlin (Germany)

Arbeiten des Botanischen Instituts in Würzburg (Germany)

Arch. Biochem. Biophys.

Archives of Biochemistry and Biophysics (US)

Arch. Biol.

Archives de Biologie (Belgium)

Arch. Entw. Mech.

Archiv für Entwicklungsmechanik der Organismen (Germany)

Arch. Int. Hist. Sci.

Archives Internationales d'Histoire des Sciences (France)

Arch. Int. Physiol. Biochim.

Archives Internationales de Physiologie et de Biochimie
(Belgium)

Arch. Mikr. Anat.

Archiv für Mikroskopische Anatomie und Entwicklungsmechanik (Germany)

Arch. Neerl. Zool.

Archives Neerlandaises de Zoologie (Netherlands)

Arch. Path. Anat.

Archiv für Pathologische Anatomie und Physiologie (Germany)

Arch. Protistenk.

Archiv für Protistenkunde (Germany)

Arch. Sci. Phys. Nat.

Archives des Sciences Physiques et Naturelles, Supplément à
la Bibliothèque Universelle (Switzerland)

Arch. Zool. Exp. Gén.

Archives de Zoologie Expérimentale et Générale (France)

Ark. Zool.

Arkiv för Zoologi (Sweden)

Auk

Auk (US)

- xvi *Aust. J. Biol. Sci.*
Australian Journal of Biological Sciences (Australia)
- Aust. J. Sci.*
Australian Journal of Science (Australia)
- Aust. J. Sci. Res. B*
Australian Journal of Scientific Research Series B Biological Sciences (Australia)
- Aust. J. Zool.*
Australian Journal of Zoology (Australia)
- Behav. Biol.*
Behavioral Biology (US)
- Behaviour*
Behaviour (Netherlands)
- Ber. Deut. Bot. Ges.*
Berichte der Deutschen Botanischen Gesellschaft (Germany)
- Ber. Deut. Chem. Ges.*
Berichte der Deutschen Chemische Gesellschaft (Germany)
- Bibliogr. Genet.*
Bibliographia Genetica (Netherlands)
- Bijdr. Dierk.*
Bijdragen tot de Dierkunde (Netherlands)
- Biochem. Biophys. Res. Comm.*
Biochemical and Biophysical Research Communications (US)
- Biochem. Genet.*
Biochemical Genetics (US)
- Biochem. J.*
Biochemical Journal (England)
- Biochem. Soc. Symp.*
Biochemical Society Symposia (England)
- Biochem. Z.*
Biochemische Zeitschrift (Germany)

Biogr. Mem. Natl. Acad. Sci.
Biographical Memoirs National Academy of Sciences (US)

Biol. Bull.
Biological Bulletin (US)

Biol. J. Linn. Soc.
Biological Journal of the Linnean Society (England)

Biol. Meddr.
Biologiske Meddelelser (Denmark)

Biol. Rev.
Biological Reviews (England)

Biol. Symp.
Biological Symposia (US)

Biol. Zblt.
Biologisches Zentralblatt (Germany)

Biol. Zhur.
Biologicheskii Zhurnal (Russia)

Biologist
Biologist (US)

Biometrika
Biometrika (England)

Biophys. J.
Biophysical Journal (US)

Bioscience
Bioscience (US)

Blumea
Blumea (Netherlands)

Bost. Stud. Philos. Sci.
Boston Studies in the Philosophy of Science (US)

Bot. Abh.
Botanische Abhandlungen aus dem Gebiet der Morphologie
und Physiology (Germany)

Bot. Arch.

Botanisches Archiv (Germany)

Bot. Gaz.

Botanical Gazette (US)

Bot. J. Linn. Soc.

Botanical Journal of the Linnean Society (England)

Bot. Rev.

Botanical Review (US)

Bot. Tidsskr.

Botanisk Tidsskrift (Denmark)

Bot. Zblt.

Botanisches Zentralblatt (Germany)

Brain Behav. Evol.

Brain Behavior and Evolution (Switzerland)

Brit. Birds

British Birds (England)

Brit. Ecol. Soc. Symp.

British Ecological Society Symposium (England)

Brit. J. Hist. Sci.

British Journal of the History of Science (England)

Brit. J. Philos. Sci.

British Journal of Philosophy of Science (England)

Brit. Med. Bull.

British Medical Bulletin (England)

Brit. Med. J.

British Medical Journal (England)

Brittonia

Brittonia (US)

Brookh. Symp. Biol.

Brookhaven Symposia in Biology (US)

Bull. Acad. Imp. Sci. St. Petersburg

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Bulletin de l'Académie Impériale des Sciences de Saint Pétersbourg (Russia)

Bull. Acad. Roy. Med., Paris

Bulletin de l'académie royale de médecine, Paris (France)

Bull. Amer. Mus. Nat. Hist.

Bulletin of the American Museum of Natural History (US)

Bull. Anim. Behav.

Bulletin of Animal Behaviour (England)

Bull. Biol. Fr. Belg.

Bulletin Biologique de la France et de la Belgique (France)

Bull. Bot. Soc. Bengal

Bulletin of the Botanical Society of Bengal (India)

Bull. Brit. Mus. Hist. Ser.

Bulletin of the British Museum (Natural History) Historical Series (England)

Bull. Entomol. Res.

Bulletin of Entomological Research (England)

Bull. Geol. Soc. Amer.

Bulletin of the Geological Society of America (US)

Bull. Hist. Med.

Bulletin of the History of Medicine (US)

Bull. Ill. St. Lab. Nat. Hist.

Bulletin of the Illinois State Laboratory of Natural History (US)

Bull. Math. Biophys.

Bulletin of Mathematical Biophysics (US)

Bull. Soc. Belg. Geol. Paleontol. Hydrol.

Bulletin de la Société Belge de Géologie de Paléontologie et d'Hydrologie (Belgium)

Bull. Soc. For. Franche-Comté

Bulletin de la Société Forestière de Franche-Comté et Belfort (France)