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SUPERIOR COURT
COUNTY OF SAN BERNARDINO
RANCHO CUCAMONGA DISTRICT

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SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF SAN BERNARDINO

CHINO BASIN MUNICIPAL WATER DISTRICT,

Plaintiff,

vs.

CITY OF CHINO, et al.

Defendants.

CASE NO. RCV 51010

[Assigned for All Purposes to the Honorable MICHAEL GUNN]

CITY OF CHINO HILLS' EVIDENTIARY OBJECTIONS TO WATERMASTER'S MOTION FOR APPROVAL OF WATERMASTER'S LONG TERM PLAN FOR THE MANAGEMENT OF SUBSIDENCE AND EXHIBITS A THROUGH J ATTACHED THERETO

Date: November 5, 2007
Time: 8:30 a.m.
Dept.: R8

TO WATERMASTER, ALL PARTIES AND THEIR ATTORNEYS OF RECORD HEREIN:

The City of Chino Hills ("City" or "Chino Hills") lodges the following evidentiary objections and moves to strike inadmissible evidence contained in

Watermaster's Motion For Approval of Watermaster's Long Term Plan For The Management Of Subsidence ("Watermaster's Motion"), including Exhibits A through J.

1. **Disputed Statements and Exhibits:** The City objects to the admissibility of statements made at page 6:7-9 and 6:18 through page 7:28, in the Section of the Motion entitled "Chronology of the Interim and Long Term Plans," and statements made at page 9: 20-28, page 10: 21-26, page 12:20-22, page12: 25 through page 13:2, page 13:7-11, page 14:23-27, and page 16: 16-19 ("Disputed Statements") and Exhibits B through J attached thereto. These Disputed Statements and Exhibits purport to describe the City of Chino Hills' actions and participation in the development of the Long Term Plan and how that participation affected the Technical Committee's consideration of the Long Term Plan from the period of March 2006 through October 2006. Watermaster attached Exhibits B through J as "evidence" to support the Disputed Statements.

A. Relevance: The Disputed Statements and Exhibits B-J are irrelevant in that they have no bearing on the appropriateness or adequacy of the Long Term Plan. Watermaster proffers these statements for the sole purpose of prejudicing the Court against Chino Hills. As such, they should be excluded.

B. Lack of Foundation: Chino Hills objects to the Disputed Statements and Exhibits B through J because Watermaster failed to lay a foundation. Watermaster ignored the Evidence Code by failing to provide declarations to support the factual statements made in the Motion. Watermaster failed to establish any of the necessary preliminary facts to warrant introduction of this evidence. Because Watermaster fails to provide evidentiary support for these statements, it is unclear which persons at Watermaster or Watermaster's counsel provided the evidentiary basis for these statements. As such, these statements lack foundation.

C. Privilege: The Disputed Statements at page 16:18 through page 7:28 and at page 12:25 through page 13:2 and Exhibits B through G are privileged communications because the parties agreed to treat these communications as good faith settlement discussions, these statements should be stricken because their inclusion violates Section 1.C. of the Interim Plan for the Management of Subsidence ("Interim Plan") and Exhibit A of the Interim Plan[1] ("Acknowledgement"), (collectively, "Agreements") as well as Evidence Code Section 1152.

Watermaster cited to these privileged Disputed Statements and Exhibits B through G in express violation of the Agreements, which provide that all written or oral communications made between members of the Technical Group and to Watermaster during meetings of the Technical Group are privileged communications protected from disclosure under Evidence Code §1152. *See* Interim Plan, §1.c[2] and the Acknowledgement.[3] In particular, *inter alia,* the Acknowledgement provided that: **"The privilege shall extend to all conversations among and between members of the Technical Group and any written work product that is developed and presented for the primary purpose of consideration by the Technical Group and its members."** (Emphasis added.) Thus, the privilege extends to more than just the actual conversations

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[1] Entitled the "Acknowledgement that Technical Group Communications are Privileged Communications and Technical Group Participation Shall Not Be Used As Evidence"

[2] Section 1.c provides as follows: <u>"Full and Fair Discussion.</u> Discussion between and among the members of the Technical Group shall be considered as good faith settlement discussions and therefore privileged as an offer of compromise. This will ensure an environment of full and candid discussion among professionals. Representatives of the Technical Group will be required to execute acknowledgments of the privileged character of the discussions as a precondition to participation in meetings in a form substantially similar to Exhibit "A" attached hereto. The privilege shall extend to all conversations among and between members of the Technical Group and any written work product that is developed and presented for the primary purpose of consideration by the Technical Group and its members. The existence of the privilege shall have no bearing on the existence or non-existence of other potential privileges that may be asserted with regard to any documents, reports or opinions."

[3] The Acknowledgement states, in pertinent part, that: "1. <u>Offer of Compromise.</u> It is hereby agreed by the following parties that all written or oral communications made between or among members of the Technical Group and to Watermaster during meetings of the Technical Group shall be considered privileged communications as good faith settlement discussions. As such, each party agrees that these communications shall be privileged and protected from disclosure as an "offer of compromise" under Evidence Code § 1152. The existence or non-existence of other privileges or the potential application of any privilege to the specific form of communication, whatever the privilege or communication may be, is not affected by this acknowledgment. [¶] 2. <u>Participation Not Evidence.</u> The decision by any party to the Judgment to participate in meetings of the Technical Group or to voluntarily modify their production in exchange for receiving Substitute Water or Alternate Water will not be used by a party as evidence of any fact regarding subsidence in any legal or equitable proceeding of any kind."

and documents in the physical Technical Group meetings. It extends to any conversations and documents that are "for the primary purpose of consideration by the Technical Group and its members." Further, the Interim Agreement provides that: "An important objective and work product of the Technical Group shall be its effort to serve in advisory capacity to assist Watermaster in its development of the Long Term Plan."

Watermaster included these Disputed Statements and Exhibits B through G in an effort to poison the well so that the Court would not consider Chino Hills' legitimate objections to the Long Term Plan. This is exactly why the Agreements included confidentiality provisions -- to shield parties so that they could participate openly without having their words and participation used against them in subsequent court proceedings.

D. Hearsay: The City further objects to the Disputed Statements and Exhibits "B" through "J" to the extent that they contain inadmissible hearsay. Without knowing on what evidentiary basis Watermaster seeks to introduce these exhibits, it is difficult to lodge the appropriate additional objections. If Watermaster is attempting to rely on an exception to the hearsay rule by qualifying some or all of these Exhibits as business records, for example, Watermaster failed to establish that these records were made in the regular course of a business at or near the time of the act, that a qualified witness testifies to their identity and the mode of their preparation; and that the sources of information and method and time of preparation were such as to indicate trustworthiness. See Evidence Code section 1271.

In addition, Watermaster makes bald, general assertions without attributing the statement to a speaker, without laying any foundation, and without establishing that the statements are not inadmissible hearsay. One such glaring example is Watermaster's statement that it "believes that the affected parties in MZ1 are sufficiently concerned with the potential to cause subsidence that the continuation of a voluntary program . . . is the most efficient and effective means to manage subsidence. . ." Motion at 13:7-11.

E. Authentication: Watermaster makes no effort to authenticate any of the statements, records or exhibits it presents to court. See, e.g., Motion at 12:20-22 and 13:7-

11. Because Watermaster fails to establish the genuineness of the Disputed Statements and Exhibits, they should be excluded. See, e.g., Evidence Code Section 1400.

F. Voluntary Curtailment of Production: The Watermaster breached the Interim Plan provision that prevents parties from asserting another party's voluntary curtailment of production against them in subsequent proceedings. *See* Interim Plan at §7(a) and Acknowledgement, §2. As the Court knows, the Interim Plan called for voluntary modifications to the City's groundwater production patterns in the MZ1. *See* Interim Plan, at p. 1. Now, the LTP simply proposes that the producers in the MZ1 continue to voluntarily curtail production from "managed wells" in the MZ1. *See* LTP at p. 2-1. In this connection the Watermaster makes numerous statements that violate this confidentiality provision and which the City now asks this Court to strike. *See* Motion at 6:7-9; 9:20-28; 10:21-26; 14:23-27; and 16:16-19.

2. **The Long Term Plan Itself is Inadmissible Because Its Scientific Basis Is Unsound.** The City objects to the admissibility of Exhibit A, entitled "Long Term MZ1 Subsidence Management Plan" June 2007 ("LTP"), because it was created in violation of accepted scientific method. Unsupported scientific conclusions are inadmissible pursuant to Evidence Code Section 801 (b). Scientific evidence cannot be admitted unless its basis and reliability are recognized by competent authorities. *See Huntington v. Crowley* (1966) 64 Cal.2d 647, 653, 414 P.2d 382, 388; *see also* Evidence Code Section 801 (expert opinion testimony "is limited to such an opinion as is: [¶] (b) Based on matter . . . that is of a type that reasonably may be relied upon by an expert in forming an opinion").

The crux of the LTP is its Subsidence Guidance Criteria for the MZ-1 Producers, which Watermaster concedes "is the basis of" the Long Term Plan. LTP, pp. 1-2. Yet, Watermaster's expert, Wildermuth Environmental, Inc., arrived at this Guidance Criteria after performing only one controlled aquifer pumping test conducted between June 2004 and September 2005. See MZ-1 Summary Report February 2006, attached to LTP ("MZ-1 Summary Report") at pp. 2-1 to 2-2 and 4-1. In essence, the Subsidence Guidance Criteria, under which Watermaster asks the City to continue to "voluntarily" forbear production in the MZ1, was formulated on the strength of <u>one test.</u> This incomplete scientific method cannot justify Watermaster's hypothesis as to the subsidence threshold (i.e. subsidence guidance level). This is in violation of the accepted scientific method, which requires, at a minimum, that scientists, collectively and over time, endeavor to construct an accurate (i.e. reliable, consistent and non-arbitrary) representation of the world.[4]

Nor can Wildermuth reproduce its result. Established scientific method holds that:

> "[t]he single feature that is most characteristic of science is its reproducibility. If scientists cannot duplicate their first results, they are forced to conclude that these were invalid. This problem occurs often. Its cause is usually some unrecognized, and hence uncontrolled, factor in the experiment (e.g., unrecognized variation in the properties of different batches of the materials used in the experiment)."

Kimball, J., online text, **Kimball's Biology Pages,** attached as Exhibit B found at http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/ScientificMethods.html.

Wildermuth themselves recognize the error in their analysis when they state in their MZ-1 Summary report (February 2006) that different pumping conditions may result in a different threshold water level (i.e. subsidence guidance level):

> "The applicability of this limit to increasing distances from the piezometer/extensometer facility is dependent on an approximate replication

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[4] The scientific method attempts to minimize the influence of bias or prejudice in the experimenter when testing a hypothesis or theory. The scientific method has four steps:
1. Observation and description of a phenomenon or group of phenomena.
2. Formulation of a hypothesis to explain the phenomena.
3. Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations.
4. Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

Villee, Claude E., Biology, Harvard University, pp. 3-4 (1957) (attached as Exhibit A).

of the tested pumping conditions (i.e. specific wells pumped, pumping rates, and pumping durations). A different areal distribution of pumping might cause localized inelastic compaction away from Ayala Park without drawing PA-7 below 250 ft or recording inelastic effects at the extensometer. A different vertical distribution of extraction will stress the aquifer system in a different manner, and may result in a different threshold water level in PA-7."

MZ-1 Summary Report at pp. 2-2 to 2-3.

Wildermuth clearly recognized that its one test was insufficient to justify the 245-foot Guidance Criteria and that any change in the wells pumped, in the pumping rates or durations, or well depth would likely lead to a different result.[5] Despite this fatal flaw, Watermaster asks for the Court's approval of the LTP that contains a Guidance Criteria that is based on a guess, not on scientific evidence. Therefore, the LTP is inadmissible pursuant to Evidence Code Section 801 and applicable case law, and the City of Chino Hills requests that Exhibit A be stricken.

Nor has Watermaster established the Wildermuth has the qualifications necessary to undertake the one test it did perform or opine on the adequacy of the Long Term Plan. Watermaster fails to establish in its Motion that Wildermuth has any of the requisite knowledge, skill, experience or training necessary to make the broad assertions set forth in the Motion and Long Term Plan.

CONCLUSION

For the foregoing reasons, the City respectfully requests that the Court strike the Disputed Statements as set forth above and Exhibits B through J. In addition, the City

[5] Before the Special Referee in 2005, Mr. Wildermuth himself testified that the Long Term Plan process would require "several more years of studies and model development and analysis . . . , followed by 12 months to reach an agreement on a long-term plan." Special Referee Report dated June 16, 2005, at 6:9-12 (attached to the Motion at Exhibit A, MZ-1 Summary Report, Appendix A). The Special Referee made this point as well. *Id.* at 8:22-26. Despite the recognition that more testing and analysis was required, Watermaster still put forth a Long Term Plan relying on this one test to establish its Guidance Criteria.

also requests that this Court strike the proposed LTP, Exhibit A, in its entirety on the grounds that it relies on an improper scientific method.

While the City has not formally noticed these objections as a Motion, the City requests the Court's guidance prior to the hearing on Watermaster's Motion.

DATED: September 17, 2007

MARK D. HENSLEY, CITY ATTORNEY
CITY OF CHINO HILLS; and
JENKINS & HOGIN, LLP

By: [signature]

MARK D. HENSLEY
Attorneys for CITY OF CHINO HILLS

EXHIBIT "A"

Claude A. Villee
Harvard University

BIOLOGY

Third Edition

W. B. Saunders Company
Philadelphia and London

REPRINTED AUGUST, 1957 AND JANUARY, 1958

LIBRARY OF CONGRESS CATALOG CARD NUMBER: 57-7051

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Chapter 1

Introduction: Biology and the Scientific Method

IN ONE sense, biology is a very old science, for men began many centuries ago to study living things in attempts to solve the fascinating riddle of life. There was a considerable body of knowledge and theories about living things in the time of Aristotle (384–322 B.C.), and even in the older civilizations of Egypt, Mesopotamia and China much was known about practical uses of plants and animals. In fact, the cave men who lived 50,000 and more years ago must have been first rate biologists for they drew accurate and artistic pictures on the walls of their caves of the deer, cattle and mammoths that lived around them. The survival of early man depended on a knowledge of such fundamental biologic facts as which animals were dangerous and which plants could be safely eaten.

Yet in another sense biology is a young science. The major generalizations which are the foundations of any science have been made comparatively recently in biology and many of them are still being revised. The development of the electron microscope, for example, and the recent discovery of ways to prepare tissues for examination in this instrument, have revealed a whole new order of complexity in living matter.

1. EARLY HISTORY OF BIOLOGY

Biology as an organized body of knowledge can be said to have begun with the Greeks. They and the Romans described the many kinds of plants and animals known at the time. Galen (131–200 A.D.) described the anatomy of the human body and was the unchallenged authority for 1300 years. His descriptions, however, were based on dissections of apes and pigs and contained many errors. Galen was the first experimental physiologist and performed many experiments, mostly on pigs, to study the functions of nerves and blood vessels. Men such as Pliny (23–79 A.D.) prepared encyclopedias which were strange mixtures of facts and fiction about living things. In the succeeding centuries of the Middle Ages men wrote "herbals" and "bestiaries," cataloguing and describing plants and animals respectively. With the Renaissance interest in natural history revived and more accurate studies of the structure, functions and life habits of countless plants and animals were made. Vesalius (1514–1564), Harvey (1578–1657) and John Hunter (1728–1793) studied the structure and functions of animals in general and man in particular and laid the foundations of anatomy and physiology. With the invention of the microscope early in the seventeenth century, Malpighi (1628–1694), Swammerdam (1637–1680) and Leeuwenhoek (1632–1723) investigated the fine structure of a variety of plant and animal tissues. Leeuwenhoek was the first to describe bacteria, protozoa and sperm.

Biology expanded and altered greatly in the nineteenth century and has continued this trend at an accelerated pace in the twentieth. This is due in part to the broader scope and more detailed knowledge available today and in part to the new approaches made possible by the discoveries and techniques of physics and chemistry. In the past hundred years many biologists have been drawn to the level of inquiry represented by biophysics and biochemistry. This book is not primarily concerned with that level, but some knowledge of the ultramicroscopic world of atoms and molecules is necessary for a real understanding of even the simplest biologic processes.

2. THE BIOLOGICAL SCIENCES

The usual definition of biology as the "science of life" is only meaningful if we have some idea of what life and science mean. Life does not lend itself to a simple definition and its characteristics—growth, movement, metabolism, reproduction and adaptation—will be discussed in Chapter 3. Biology is concerned with the myriad forms that living things may have, with their structure, function, evolution, development and relations to their environment. It has grown to be much too broad a science to be investigated by one man or to be treated thoroughly in a single textbook, and most biologists are specialists in some one of the biological sciences. The **botanist** and **zoologist** study types of organisms and their relationships within the plant and animal kingdoms respectively. The sciences of **anatomy, physiology** and **embryology** deal with the structure, function and development of an organism; these can be further subdivided according to the kind of organism investigated: e.g., animal physiology, mammalian physiology, human physiology. The **parasitologist** studies those forms of life that live in and at the expense of other forms, the **cytologist** investigates the structure, composition and function of cells, and the **histologist** inquires into the properties of tissues. The science of **genetics** is concerned with the mode of transmission of the characteristics of one generation to another, and is closely related to the study of **evolution,** which attempts to discover how new species arise, as well as how the present forms evolved from previous ones. The study of the classification of plants and animals and their evolutionary relations is known as **taxonomy.** One of the newest biological sciences is **ecology,** the study of the relations of a group of organisms to its environment, including both the physical factors and other living organisms which provide food or shelter for it, or compete with or prey upon it.

There are also specialists who deal with one kind of living thing—ichthyologists, who study fish, mycologists, who study fungi, ornithologists, who study birds, and so on.

3. SOURCES OF SCIENTIFIC INFORMATION

Where, you may ask, do all the facts about biology described in this book come from? And how do we know they are true? The ultimate source of each fact, of course, is in some carefully controlled observation or experiment made by a biologist. In earlier times, some scientists kept their discoveries to themselves, but now there is a strong tradition that scientific discoveries are public property and should be freely published. It is not enough in a scientific publication for a man to say that he has discovered a certain fact; he must give all the relevant details by which the fact was discovered so that others can repeat the observation. It is this criterion of **repeatability** that makes us accept a certain observation or experiment as representing a true fact; observations that cannot be repeated by competent investigators are discarded.

When a biologist has made a discovery, he writes a report, called a "paper," in which he describes his methods in sufficient detail so that another can repeat them, gives the results of his observations, discusses the conclusions to be drawn

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from them, perhaps formulates a theory to explain them, and indicates the place of these new facts in the present body of scientific knowledge. The knowledge that his discovery will be subjected to the keen scrutiny of his colleagues is a strong stimulus for carefully repeating the observations or experiments before publishing them. He then submits his paper for publication in one of the professional journals in the particular field of his discovery (it is estimated that there are more than 7,000 of them published over the world in the various fields of biology!) and it is read by one or more of the board of editors of the journal, all of whom are experts in the field. If it is approved, it is published and thus becomes part of "the literature" of the subject.

At one time, when there were fewer journals, it might have been possible for one man to read them each month as they appeared, but this is obviously impossible now. Journals such as *Biological Abstracts* assist the hard-pressed biologist by publishing, classified by fields, very short reports or **abstracts** of each paper published—giving the facts found, and a reference to the journal. A considerable number of journals devoted solely to reviewing the newer developments in particular fields have sprung up in the past twenty-five years; some of these are *Physiological Reviews, The Botanical Review, Quarterly Review of Biology, Annual Review of Microbiology* and *Nutrition Reviews.* The new fact or theory thus becomes widely known through publication in a professional journal and by reference in abstract and review journals, and eventually may become a sentence or two in a textbook.

Other means for the dissemination of new knowledge are the annual meetings held by the professional societies of botanists, geneticists, physiologists and other specialists at which papers are read and discussed. There are, from time to time, national and international gatherings, called **symposia,** of specialists in a given field to discuss the newer findings and the present status of the knowledge in that field. The discussions of these symposia are usually published as books.

4. THE SCIENTIFIC METHOD

The facts of biology are gained by the application of the scientific method, yet it is difficult to reduce this method to a simple set of rules that apply to all the branches of science. One of the basic tenets of the scientific method is the rejection of authority—the refusal to accept a statement just because someone says it is so. The skeptical scientist wants confirmation of the statement by the independent observation of another.

The basis of the scientific method and the ultimate source of all the facts of science is careful, close observation and experiment, free of bias and done as quantitatively as possible. The observations or experiments may then be analyzed, or simplified into their constituent parts, so that some sort of order can be brought into the observed phenomena. Then the parts can be synthesized or reassembled and their interactions discovered. On the basis of these observations, the scientist constructs a **hypothesis,** a trial idea about the nature of the observation, or possibly the connections between a chain of events, or even cause and effect relationships between different events. It is in the construction of hypotheses that scientists differ most and that true genius shows itself. The ability to see through a mass of data and suggest a reason for their interrelations is all too rare.

It must be emphasized that science does not advance by the mere accumulation of facts, or by the mere postulation of hypotheses. The two go hand-in-hand in most scientific investigations: hypothesis, observation, revised hypothesis, further observation, and so on. When a scientist embarks upon an investigation he has the advantage of the relevant facts already known with which to build a "working hypothesis" to guide the design of his experiments. When a scientist makes an observation that does not agree with his hypothesis he may conclude either that his hypothesis or that his observation is wrong. He then repeats his observation, perhaps altering the design of his experiment to get at the relationship in a new way, or perhaps using a different technique. If he can satisfy himself that his observation is valid, he either discards his hypothesis or amends it to account for the new observation. In the final analysis, each new observation must either agree or disagree with the hypothesis to be useful.

Hypotheses are constantly being refined and elaborated. There are few scientists who consider any hypothesis, no matter how many times it may have been tested, as a statement of absolute and universal truth. The hypothesis is simply regarded as the best available approximation to the truth for some finite range of circumstances. The Law of the Conservation of Energy (p. 72), for example, was widely accepted until the work of Einstein showed that it had to be modified to allow for the possible interconversion of matter and energy. Although this might have seemed to be an inconsequential distinction at one time, for it has no importance at all in ordinary chemical processes, it is the theoretical basis of atomic power.

Once a hypothesis has been set up to explain a certain body of facts, the rules of formal logic can be used to deduce certain consequences. In a science such as physics, and to a lesser extent in biology, the hypotheses and deductions can be stated in mathematical terms and elaborate and far-reaching conclusions can be drawn. On the basis of these deductions the results of other observations and experiments can be predicted and the hypothesis can be tested by its ability to make valid predictions. If the hypothesis is a simple generalization, it may be enough simply to examine more examples and see if the generalization holds true. More complex hypotheses, that perhaps cannot be tested directly, can be tested by seeing whether certain logical deductions from the hypothesis hold true. A hypothesis must be subject to some sort of experimental test—it must make a prediction that can be verified in some way—or it is mere speculation.

A hypothesis that fits a large body of different types of observations becomes a theory, which is defined by Webster as "a scientifically acceptable general principle offered to explain phenomena; the analysis of a set of facts in their ideal relations to one another." A good theory relates, from one point of view, facts which previously appeared unrelated and which could not be explained on common ground. A good theory grows: it relates additional facts as they become known. Indeed, it predicts new facts and suggests new relationships between phenomena.

A good theory, by showing the relationship between classes of facts, simplifies and clarifies our understanding of natural phenomena. In the words of Einstein, "In the whole history of science from Greek philosophy to modern physics, there have been constant attempts to reduce the apparent complexity of natural phenomena to some simple, fundamental ideas and relations." Science is really the search for simplicity. William of Occam, a fourteenth century philosopher made the dictum, *"Essentia non sunt multiplicanda praeter necessitatem"*, or "Entities should not be multiplied beyond necessity." This principle of parsimony (often called **Occam's razor** because it pares a theory to its bare essentials) means that no more forces or causes should be postulated than are necessary to account for the phenomena observed. In practice, this means that the simplest explanation which will account satisfactorily for all the known facts is to be preferred. A new theory in biology, by clearing away previous misconceptions and by pointing up new interrelations of phenomena, not only stimulates research in theoretical biology, it also provides the basis for a host of practical advances in medicine, agriculture, and similar fields.

A poor theory, in contrast, when its consequences are followed, will sooner or later lead to absurdities and clear, irreconcilable contradictions. It frequently happens that at some stage in our knowledge two, or even more, alternative theories provide equally good explanations for the data at hand. But as more observations or experiments are made, one or the other (or perhaps both!) are ruled out.

The scientific method, then, consists of making careful observations and arranging these observations so as to bring order into the observed phenomena. Then we try to find a hypothesis or a **conceptual scheme** which will explain not only the

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facts already observed but also new facts as they are discovered. Sciences differ widely in the extent to which they are predictable and there are some who claim that biology is not a science because it is not completely predictable. However, even physics, generally regarded as the most "scientific" of the sciences, is far from completely predictable. Although we can predict the occurrence of eclipses, we cannot make predictions in the field of quantum mechanics, nor can we predict an earthquake, or even tomorrow's weather.

In most scientific studies one of the ultimate goals is to explain the cause of some phenomenon, but the hard-and-fast proof that a cause and effect relationship exists between two events is extremely difficult to obtain. If the circumstances leading to a certain event always have a certain factor in common in a variety of cases, that factor may be the cause of the event. The difficulty lies in making sure that the factor under consideration is the *only* one common to all the cases. For example, it would be wrong to conclude from finding that Scotch and soda, bourbon and soda, and rye and soda all produce intoxication, that soda is the only factor in common and therefore the cause of the intoxication! This method of discovering the common factor in a variety of cases that may be the cause of the event (known as the **method of agreement**) can seldom be used as a valid proof because of this difficulty in being sure that it really is the only common factor. The finding that all people suffering from beriberi have diets which are low in thiamine is not proof that this deficiency causes the disease, for there may be many other factors in common.

Another method for unraveling cause and effect relations is the **method of difference:** If two sets of circumstances differ in only one factor, and the one containing the factor leads to an event and the other does not, the factor may be considered the cause of the event. For example, if two groups of rats are fed diets which are identical except that one contains all the vitamins and the second contains all but thiamine, and if the first group grows normally and the second group fails to grow and ultimately develops polyneuritis, this would be a strong suggestion, but not absolute proof, that polyneuritis or beriberi in rats is caused by a deficiency of thiamine. By using an inbred strain of rats that are as alike as possible in inherited traits, and by using litter mates (brothers and sisters) of this strain, one could make certain that there were no hereditary differences between the **controls** (the ones getting the complete diet) and the **experimentals** (the ones getting the thiamine-deficient diet). It could conceivably be that the diet without thiamine does not have as attractive a taste as the one with it, and the experimental group simply ate less food, failed to grow and developed the deficiency symptoms because they were partially starved. This source of error can be avoided by "pair-feeding," by pairing a control and an experimental animal, weighing the food eaten each day by each of the experimental animals and then giving only that much food to each control member of the pair.

A third way of detecting cause and effect relationships is the **method of concomitant variation:** If a variation in the amount of a given factor produces a parallel variation in the effect, the factor may be the cause. Thus if other groups of rats were given diets with varying amounts of thiamine and if the amount of protection against beriberi varied directly with the amount of thiamine in the diet, we could be reasonably sure that thiamine deficiency is the cause of beriberi.

It must be emphasized that it is seldom that we can be more than "reasonably sure" that X is the cause of Y. As more experiments and observations lead to the same result, the probability increases that X is the cause of Y. When experiments or observations can be made quantitative—when their results can be measured in some way—one can, by the methods of statistical analysis, determine the probability that X is the cause of Y, or the probability that Y follows X simply as a matter of chance. Scientists are usually satisfied that there is some sort of cause and effect relationship between X and Y if they can show that there is less than one chance in a hundred that the observed

X — Y relationship could be due to chance alone. A statistical analysis of a set of data can never give a flat yes or no to a question—it can only state that something is very probable or very improbable. It can also tell an investigator approximately how many more experiments he must do to reach a given probability that Y is caused by X.

Each experiment must contain a control group—one treated exactly like the experimental group in all respects but one, the factor whose effect is being tested. The use of controls in medical experiments raises the difficult question of the moral justification of withholding treatment from a patient who might be benefited by it. If there is sufficient evidence that one treatment is better than a second one, a physician would hardly be justified in further experimentation. However, the medical literature is full of treatments now known to be useless or even harmful, which were used for years but finally were abandoned as experience showed they were ineffective and that the evidence which had suggested their use originally was improperly controlled. There is a time in the development of any new treatment when the medical profession is not only morally justified but really morally required to do carefully controlled tests on human beings to be sure that the new treatment is better than the former one.

In such tests it is not sufficient simply to give a treatment to one group of patients and not to give it to another, for it is widely known that there is a strong psychologic effect in simply giving a treatment. For example, a group of students at a large western university served as subjects for a test of the hypothesis that daily doses of extra amounts of vitamin C might help prevent colds. This grew out out of the observation that people who drank lots of fruit juice seemed to have fewer colds. The group receiving the vitamin C showed a 65 per cent reduction in the number of colds contracted during the winter when they were receiving treatment compared to the previous winter when they were not receiving treatment. There were enough students in the group (208) to make this result statistically significant. In the absence of controls, one would have been led to conclude that vitamin C does help prevent colds. But a second group was given "placebos," pills identical in size, shape, color and taste to the vitamin C pills but without any vitamin C. The students were not told who was getting vitamin C and who was not, they only knew they were getting pills that might help prevent colds. The group getting placebos showed a 63 per cent reduction in the number of colds; thus, vitamin C had nothing to do with the result and the reported reductions in both groups were probably psychological effects.

In all experiments, the scientist must ever be on his guard against bias in himself, bias in the subject, bias in his instruments, and bias in the way the experiment is designed. The proper design of experiments is a science in itself, but one for which only general rules can be made.

~~A hypothesis that has been tested and found to fit the facts and capable of making valid predictions may then be called a theory, a principle, or a law.~~ Although there is some connotation of greater reliance in a statement called a "law" than in one called a "theory," the two words are used interchangeably.

5. APPLICATIONS OF BIOLOGY

Some of the practical uses of a knowledge of biology will become apparent as the student reads on through this text—its applications in the fields of medicine and public health, in agriculture and conservation, its basic importance to the social studies, and its contributions to the formulation of a philosophy of life. There are esthetic values in a study of biology as well. A student cannot expect to learn all or even many of the names and characteristics of the vast variety of plants and animals, but a knowledge of the structure and functions of the major types will greatly increase the pleasure of a stroll in the woods or an excursion to the seashore. The average city-dweller gets only a small glimpse of the vast panorama of living things, for so many of them live in places where they are not easily seen—the sea, or parts of the earth that are not easily visited. Trips to botanical gardens, zoos,

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aquariums and museums will help give one an appreciation of the tremendous variety of living things.

It is impossible to describe the forms of life without reference to their habitats, the places in which they live. This brings us to one of the major unifying conceptual schemes of biology, that the living things of a given region are closely interrelated with each other and with the environment. The study of this is basic to sociology. The present forms of life are also related more or less closely by evolutionary descent. As we deal with each of the major life forms, the facts about them will be easier to understand and remember if we try to fit them into their place in the closely interwoven tapestry of life.

In our discussions of biologic principles we will focus our attention primarily on man, to gain an appreciation of man's place in the biologic world. It is only in man's somewhat biased opinion that he stands in the center of the universe, with other animals and plants existing only to serve him. In numbers, size, strength, endurance and adaptability he is inferior to many animals and in his adjustment to the environment—which, as we shall see, may be considered to be the most important biologic attribute of any living organism—he often fails. However, in a survey study of general biology, both practical considerations and interest demand that our discussions focus on man, for we are primarily concerned with such things as the human stomach ache, the human gestation period, and the endurance of the human body.

QUESTIONS

1. How would you define "science"?
2. Contrast a hypothesis and a law.
3. How would you go about testing the hypothesis that beriberi is caused by a deficiency of thiamine?
4. What would you consider to be proof that beriberi is caused by thiamine deficiency?
5. To which of the biologic sciences would you assign the following scientific papers:
   The Flora of Northern Michigan.
   The Fate of the Aortic Arches in the Development of the Chick.
   The Regulation of the Heart Rate.
   The Geographical Distribution of the Species of Wheat.
6. Describe in your own words the mode of operation of the scientific method.
7. Contrast the "method of agreement" and the "method of difference" as means of establishing cause and effect relationships.
8. What characteristics and attitudes do you think would be helpful for a career in science?
9. What is meant by a "controlled experiment"?

SUPPLEMENTARY READING

There are a number of fine books on the history of science: The development of the sciences in general is described in Sedgwick, Tyler and Bigelow's *A Short History of Science*, and a discussion of the role of science in society is given in J. B. Conant's *On Understanding Science*. The histories of the biologic sciences by Nordenskiöld and by Singer are well written and informative. The *History of Medicine* written by Douglas Guthrie describes the beginnings of anatomy, physiology and bacteriology.

The scientific method and its application to research problems are discussed in Conant's *Science and Common Sense* and Cohen's *Science, Servant of Man*. E. Bright Wilson's *An Introduction to Scientific Research* gives an excellent discussion in nontechnical terms of the methods of science and some of the problems involved in scientific investigation. W. B. Cannon's *The Way of an Investigator* gives some interesting examples of the scientfic method in medical research. *In the Name of Science*, by Martin Gardner, describes many pseudosciences and, in showing up their shortcomings, gives an appreciation for scientific evidence and standards.

EXHIBIT "B"

Scientific Methods

Index to this page

There is nothing mysterious or even particularly unusual about the things that scientists do.

There are many ways to work on scientific problems. They all require common sense. Beyond that, they all display certain features that are especially — but not uniquely — characteristic of science.

For example:

- Skepticism. Good scientists use highly-critical standards in the judging of evidence. They approach data, claims, and theories (ideally, even their own!) with healthy doses of skepticism.
- Tolerance of uncertainty. Scientists often work for years — sometimes for an entire career — trying to understand one scientific problem. This often involves finding facts that, for a time, fail to fit into any coherent pattern and that even may support mutually contradictory explanations.

  Sometimes, as one listens to scientists vigorously defending their views, their confidence seems absolute. But deep in their hearts, they know that their views are based on probabilities and that a new piece of evidence may turn up at any time and force a major shift in their views.

- Although they certainly have no monopoly on hard work, their willingness to work long hours and years pursuing a problem is the mark of all good scientists. For science is hard work.
- Before undergoing the frustrations — tempered by occasional joys — of wresting more secrets from nature, you must learn the foundations on which your subject is based.

Although scientific methods are as varied as science itself, there is a pattern to the way that scientists go about their work.

Scientific advances begin with observations.

- A census of the members of a species in some habitat is an observation.
- The readings on the display of a laboratory instrument are observations.

But science is more than a catalog of facts.

The goal of science is to find **an explanation for why the facts are as they are**. Such an explanation is a **hypothesis.**

Link to a case study illustrating the scientific method at work.

Testing Hypotheses

A good hypothesis meets several standards.

- It should provide an adequate explanation of the observed facts.
- If two or more hypotheses meet this standard, the simpler one is preferred.
- It should be able to **predict** new facts.

So if a generalization is valid, then certain specific consequences can be **deduced** from it.

One of the most exciting events in science is to

- predict the results of an experiment not yet performed if the hypothesis is valid and then to
- perform the experiment.

Link to an example.

The Null Hypothesis

Experimental biology often involves setting up an experimental treatment and — at the same time — a **control**. Then one compares the results of the experimental treatment with the results in the controls. If there is a difference, what is the probability that it is due to chance alone; that is, the experimental treatment really had no effect?

The hypothesis that the experimental treatment had no effect is called the **null hypothesis**.

Most workers feel that if the probability (designated *p*) of the observed difference is less than 1 in 20 ($p = <0.05$), then the null hypothesis is disproved and the observed difference is **significant**.

Link to discussion of statistical methods.

But significance is not proof. In fact, hypotheses can never be proven to be absolutely "true" is the sense that a theorem in geometry can. The most we can say is that there is a high probability that the hypothesis provides a valid explanation of the phenomenon being studied.

Hypotheses that are supported by many observations come to be called **theories**.

Reproducibility of Scientific Work

The single feature that is most characteristic of science is its reproducibility. If scientists cannot duplicate their first results, they are forced to conclude that these were invalid. This problem occurs often. Its cause is usually some unrecognized, and hence uncontrolled, factor in the experiment (e.g., unrecognized variation in the properties of different batches of the materials used in the experiment). With luck, the inability to reproduce experiments will be discovered by the same scientists who did the first experiments. This is why scientists generally repeat their experiments several times before reporting them in a scientific paper.

Link to a description of the format of scientific papers.

On other occasions, workers in another laboratory fail to secure the same results when they

- repeat experiments that have been published or, more often,
- perform experiments designed to carry the study into new areas, but these fail because of a flaw in the original experiments.

When this happens, all the parties concerned should get together to see if they can find out why their results differ.

- Often it is simply a matter of not using precisely the same materials and methods.
- Sometimes, however, a serious flaw may be discovered in the design and/or execution of the original experiments.
- And sometimes it proves impossible to find out why experiments that once seemed to work no longer do so.

In any of these cases, the failure to confirm the experiments must be reported.

Although this is acutely embarrassing for the original investigators, it represent one of the great strengths of science: its **built-in system for self-correction.**

Scientific Fraud

In the vast majority of cases, irreproducible results in science are caused by honest errors.

On rare occasions, however, laboratory reports cannot be confirmed because they are fraudulent. This is distressing to all concerned. If such a fraud becomes widely known, it is also likely to cause a great deal of excitement among the general public.

I believe, however, that rather than casting a cloud over the scientific enterprise, these rare aberrations reveal its great strength.

There is probably no other area of human activity where error is detected and corrected more rapidly. I am confident that you can think of a number of other fields of human study and activity where errors have been made that went uncorrected for years and caused widespread harm.

Dishonest scientists usually harm only themselves. They are disgraced; their careers often at an end.

But the progress of science usually moves forward as fast as (sometimes faster than) before.

Building on the Work of Others

Only rarely does a scientific discovery spring full-blown on the scene. When it does, it is likely to create a revolution in the way scientists perceive the world around them and to open up new areas of scientific investigation. Darwin's theory of evolution [Link] and Mendel's rules of inheritance [Link] are examples of such revolutionary developments.

Most science, however, consists of adding another brick to an edifice that has been slowly and painstakingly constructed by prior work. In fact, it is possible to construct a genealogical tree that traces the historical development of any scientific discovery (even, to a degree, Darwin's and Mendel's). The way in which science builds on the work of others is another illustration of what a communal activity science is.

The development of a new **technique** often lays the foundation for rapid advances along many different scientific avenues. Just consider the advances in biology that discovery of the light microscope and, later, the electron microscope have made possible. Throughout these pages, there are many examples of experimental procedures. Each was developed to solve a particular problem. However, each was then taken up by workers in other laboratories and applied to their problems.

In a similar way, the creation of a new explanation (**hypothesis**) in a scientific field often stimulates workers in related fields to reexamine their own field in the light of the new ideas. Darwin's theory of evolution, for example, has had an enormous impact on virtually every subspecialty in biology (and in other fields as well). To this very day, biologists in specialties as different as biochemistry and animal behavior are guided in their work by evolutionary theory.

Basic Versus Applied Science

The distinction between basic and applied science is more one of goals than of methods. The same rules and standards apply to each.

However, the motivation behind the work is somewhat different. Researchers in applied science have before them a practical problem to be solved. Much of the research that goes on in medicine and in agriculture is applied.

The researcher in basic science, on the other hand, is primarily driven by curiosity - the desire to find out more about how nature works.

Both types of research are not only honorable and demanding professions, but they are mutually dependent as well.

- Applied science repeatedly loses momentum without periodic infusions of fresh ideas and discoveries from basic research. (The light bulb would never have been discovered in the research and development (R and D) department of a candle manufacturer!)
- On the other hand, much basic research has depended on the development of new tools and instruments and, more often than not, these have been developed in laboratories devoted to applied research.

Welcome&Next Search

20 June 2007

<u>CHINO BASIN WATERMASTER</u>
Case No. RCV 51010
Chino Basin Municipal Water District v. The City of Chino

PROOF OF SERVICE

I declare that:

I am employed in the County of San Bernardino, California. I am over the age of 18 years and not a party to the within action. My business address is Chino Basin Watermaster, 9641 San Bernardino Road, Rancho Cucamonga, California 91730; telephone (909) 484-3888.

On September 18, 2007, I served the following:

1) **CITY OF CHINO HILLS' EVIDENTIARY OBJECTIONS TO WATERMASTER'S MOTION FOR APPROVAL OF WATERMASTER'S LONG TERM PLAN FOR THE MANAGEMENT OF SUBSIDENCE AND EXHIBITS A THROUGH J ATTACHED THERETO**

/_x_/ BY MAIL: in said cause, by placing a true copy thereof enclosed with postage thereon fully prepaid, for delivery by United States Postal Service mail at Rancho Cucamonga, California, addresses as follows:
See attached service list: Mailing List 1

/___/ BY PERSONAL SERVICE: I caused such envelope to be delivered by hand to the addressee.

/___/ BY FACSIMILE: I transmitted said document by fax transmission from (909) 484-3890 to the fax number(s) indicated. The transmission was reported as complete on the transmission report, which was properly issued by the transmitting fax machine.

/_x_/ BY ELECTRONIC MAIL: I transmitted notice of availability of electronic documents by electronic transmission to the email address indicated. The transmission was reported as complete on the transmission report, which was properly issued by the transmitting electronic mail device.

I declare under penalty of perjury under the laws of the State of California that the above is true and correct.

Executed on September 18, 2007 in Rancho Cucamonga, California.

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