thermore, bacteriologists not only make common use of the expression "anaerobic respiration," but they speak of "acetic acid fermentation" in which free oxygen is involved.

Respiration may be defined as any oxidative process in living matter which releases energy. In this case we are forced to accept the chemists' definition of oxidation, namely, "The withdrawal of electrons from a substance, with or without the addition of oxygen, or the withdrawal of electrons, with or without the withdrawal of hydrogen or elements analogous to hydrogen." Thus, whether respiration is viewed in the broader sense of a biological concept, or the narrow sense of a specific chemical reaction, the end is the same, oxygen need not be involved.

I believe that I express the consensus of opinion when I say that plant physiologists do not think it necessary or wise to substitute the term fermentation for anaerobic respiration. I believe, also, that I express the point of view of the majority of medical physiologists when I say that respiration should be used as a general term for all biological, energy-yielding reactions. The bacteriologists are of the same opinion; they regard respiration as referring primarily to energy relations, and fermentation as indicative of end products formed and substrates acted upon.

Several changes could be made. The term respiration could be dropped and reference made only to energy exchange. Or, the expression "internal respiration" could replace "anaerobic respiration." Of all possible changes, the least scientific is the substitution of fermentation for anaerobic respiration. But why make any change? Why not broaden the meaning of respiration, just as the chemists did that of oxidation when they found the need for doing so?

There is no objection to retaining fermentation to indicate certain anaerobic reactions, but when these reactions are substitutes for energy-yielding aerobic processes, they become anaerobic forms of respiration.

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BASIS FOR SCIENTIFIC TERMINOLOGY AND CLASSIFICATION

THE formulation of the following remarks was catalyzed by the article by Dr. Fox on "Biochromes," appearing in SCIENCE for November 24, 1944. I wish to make it quite clear at the outset that the following matter is intended as constructive criticism of principle designed for stimulation of discussion; it is not intended as an individual criticism of the specific content of the above article.

It is proposed by Dr. Fox that a certain group of substances be designated by a certain label on the basis of two facts—(1) their occurrence in living matter and (2) their possession of color, *i.e.*, selective absorption of parts of the visible spectrum. Certainly the name selected (biochromes) is well chosen for this particular purpose. Let us examine, however, the basic principle underlying the "excuse" for increasing the technical vocabulary. The mere existence of a certain group of substances only in living matter, as far as we know to-day, seems hardly enough of a justification for setting them apart under a new class-name; the possession of color is even less of a reason for so doing. The entire problem of color and light absorption is too large a subject for an offhand discussion; however, setting apart a group of substances merely because their selective absorption happens to fall into that region of the spectrum which is perceptible to the human eye and without apparent consideration to their structure and function types seems to be a fallacy. This is especially true when one considers that an increasingly greater part of our observations of matter is being done with the aid of the extra-visible regions of the spectrum, *i.e.*, photographic and instrumental observation and recording of ultra-violet and infra-red regions. If we continue to succumb to the temptation of designating and classifying the world around us merely on the basis of our five human senses, the systematization of science will be in a very sorry state indeed. Consider for a moment the possible appearance of the "Beilstein" based on this theory. The result makes me shudder.

The whole matter can be considered logically only if one considers the principles underlying scientific terminology and vocabulary. It is readily seen, I believe, that the classificational function of any science (referring, of course, only to the "exact" sciences) is a function subordinate to the investigational and creative function. The former can be held to be no more than a useful or usable tool for the latter. It is difficult to imagine the circumstances under which the former function can, per se, cause any significant advance of our knowledge of the world around us. It can be hardly denied that the latter statement covers the true aim of any scientific pursuit. Granted this thesis, it is readily seen that the classification and nomenclature must be so designed as to be truly useful, simple and durable. Much can be said about the first two conditions. I prefer to stress the last one. In the past century there have been all too many occasions for complete overhauling of classification and designation systems in almost all branches of science. Regrettably, in some branches it has not been done. In others, the changes were frequently made only to require revisions almost upon birth. The main reason for this has been the rather

short-sighted attitude in the original nomenclature; too much stress was laid on the obvious, or shall I say directly perceptible, differences in form and behavior. As the fundamental reasons for specific forms and forces of the material world began to emerge, the older systems of nomenclature began to lose their usefulness in the sense of being utilitarian tools. A bit more of deliberation and less haste might well have laid a foundation for truly comprehensive schemes, which would have allowed for future extension without fundamental revisions for relatively long periods of time. I fully realize that in the early pioneering days of many of the physical sciences in the past century a foresight of quality able to perceive even a fraction of what was to come must be merely wishful thinking. However, at the present time we have at our command vast amounts of information from which we are beginning to untangle a much more fundamental picture of the physical world than appeared possible not so very long ago. We are on the borderline of more and more marvelous revelations unpredictable as yet, but we do have at least a crude pattern of what is around us. On the basis of the information already at hand a concerted effort should be made to effect, over the period of a reasonable number of years, a thorough overhauling of the classification and nomenclature systems of the physical sciences to bring them into closer correlation with each other and to use much more general bases for such a system than has been the practice in the past.

The reason for my feeling so strongly on this matter can be explained rather briefly. It deals primarily with the nature of the scientific education and training we give to our students at the various levels of our educational systems. Consider what a student sees when he opens a brand-new text on any given branch of science to which he eventually comes in the school curriculum. Almost universally the first paragraph states, in one form or another, that the "science of ——— deals with ———," followed by a more or less long list of narrowly defined set of terms used. Relatively few texts admit that several other sciences have contributed and are contributing to the advancement of the particular branch in question. More frequent is the statement that for the proper understanding of the course the student must have had so many "years" of such-and-such sciences. The neophyte is thus rigidly channelled in his manner of thinking at the outset. No wonder that, after several years of training, his mind automatically selects the "physics" way of thinking when he walks into the physics classroom, only to switch to "chemistry" way when he enters the chemical laboratory, etc. Only the exceptionally perceptive students begin to grasp the true interrelation of all scientific bases during their school training years. The majority begin to get the glimmering of this long after they begin their more or less gainful occupation; all too frequently this happens much too late to do them any good. On many occasions I have been on the sidelines of an argument over a problem by physicists and chemists; much heat is frequently generated unnecessarily merely because of lack of mutual understanding at the base.

It is true that generally the scientific curricula call for a fairly diversified selection of courses. However, all too infrequently are there courses available for correlation of the points of view and techniques of the various sciences; when these are available, they are usually at the graduate level and not at an earlier level where they would be of more fundamental good. Certainly it is high time to drop the still-used definitions of, at least, chemistry and physics (those referring to "physical changes" and "chemical changes" and to "changes in form" and "changes in nature" of things). According to these older definitions the workers with the elementary particles of matter should be definitely classified as chemists, rather than physicists, as they are to-day. The dividing line between these two sciences is an outmoded illusion to-day. Similar division and partition lines between other physical sciences are no less tenuous. Isn't it time to realize this fact?

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SCIENTIFIC BOOKS

FLIGHT IN AMERICA

The First Century of Flight in America. By JEREMIAH MILBANK, JR. 248 pp. Illustrated. Princeton University Press. 1943. $2.75.

THIS is a very good book and it certainly is captivating, once one begins reading it. The title, however, contains two restrictions which may make some reader reluctant to start reading the book at all. Why restrict the subject to the first century, when obviously the last forty years have added so much to our knowledge of flying? Why restrict the subject to America when Europe has done so much for the advancement of the science of flying? Reading the book gives the answer to these two questions.

By restricting his subject to this hemisphere, although he obviously can not stick too closely to this rule, the author cuts off some technical details which may not interest the average reader as much as the palpitating tale of flight progress in this country. By