ent comparison, and different from DNA.

This suggests that provided base pairing can take place, the actual structure of double-helical RNA does not depend on the type of bases taking part.

The apparent generality of the double-helical RNA structure means that the DNA's from wound tumor virus, the postulated double-helical segments of ribosomal RNA, transfer RNA, and the regions of secondary structure in a single-stranded RNA such as tobacco mosaic virus RNA probably adopt this configuration.

We might speculate that, when single-stranded RNA acts as a "messenger," the double-helical regions might be the punctuation marks in the code. The similarity in structure to transfer RNA could cause the messenger to occupy the transfer RNA site on the ribosome when these regions are reached during the "reading of the code," thus displacing the completed polypeptide chain.

In any case a careful analysis of the excellent diffraction patterns given by reovirus RNA should provide a detailed knowledge of the structure of all double-helical RNA and may form a basis for an understanding of its biological function.

Summary

X-ray diffraction patterns from fibers of the sodium salt of reovirus RNA are the most detailed so far obtained from RNA. The structure differs from any presently known form of DNA. The diffraction patterns given by reovirus RNA and transfer RNA show very similar features, which suggests that these structures are identical, and which implies that all double-helical RNA adopts this configuration (see *13*).

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The Humanities in the Scientific Curriculum

In both North and South America greater emphasis on the humanities is needed in secondary education.

Marcel Roche

The confusion between science and technology has arisen only since man, after watching the effect of their combined power, has become convinced that their large-scale development is necessary. Practical evidence of this effect—such as the speed of a plane, the cure of a disease, or the ability to destroy one's enemy—has filled man with awe and reverence. Francis Bacon had prophesied that his new philosophy would not "come down to the apprehension of the vulgar except by its utility and effects" (*1*).

This is only natural—and political as well—since public opinion, and no longer the good pleasure of a Prince, is what determines the spending of state funds. Scientists themselves have contributed to this point of view. To sway politicians, most of whom think of the future as within the scope of a single political mandate, scientists have emphasized only a by-product of science: practical application. They deem it necessary to justify pure science, and to apologize for it. It is a well-worn cliché that theoretical studies lead to unexpected applications. The saying is true and easy to prove. That it should have to be constantly repeated shows that the contemplative nature of science is not generally appreciated.

Now, anything valid which will help to further knowledge has my wholehearted support. I have myself used such arguments, and their value as motivators cannot be denied. But what worries me is that such considerations may obscure the true nature of science. For when the contemplative aspects of science are given their proper emphasis, the gap between science and the humanities disappears. Both are seen as manifestations of man's creativity, hence as activities that should be supported primarily because of their intrinsic value, not because of their practical usefulness. Lest I be accused of mysticism, let me hasten to say that "contemplation" for me is not belly-button-gazing and a nirvana of the will but rather an active, purposeful, and systematic perception of reality.

Inventive Technology

Even the difference between science and the humanities on the one hand and technology on the other is not as clear as it seems. There is an inventive technology which implies creative spirit, imagination, and, I should say, a humanistic point of view. For the humanities embrace any en-

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deavor which exercises and enriches man's intellectual faculties. The humanistic spirit is an attitude toward the world. In this context, pure mathematics is humanistic, while engineering per se is not. Pure biology is humanistic, while medicine is not (although it may be, and usually is, humane). The creation of new and original tools, especially for the purpose of furthering human spiritual welfare (think of the invention of printing!), has truly humanistic aspects. "Science is a humanistic activity to the extent that it is more than a body of facts and techniques and that it deals with material meaningful to the preoccupations of mankind" (*2*).

Purely applicative technology, on the other hand, is not humanistic. It is neutral. Properly used, it may enrich man's nature, and improperly used it may become inhuman. It is ideas put to work; and for such work there is no intrinsic need of the humanistic spirit. It is enough that the technician apply, with adequate skill, the proper methods, invented if need be by others, to do his job. In our present civilization there appears to be room for such a man. And when science and inventive technology are confused with applicative technology, we can agree with Ortega y Gasset's sally (*3*), *"La ciencia de nuestros días, a la vez especializada y metodizada, permite el aprovechamiento del tonto, y así vemos a toda hora que hacen obra estimable personas que no podemos estimar,"* which could be translated: "Contemporary science, with its systems and methods, can put blockheads to good use; and thus we often see worthy results coming from men of little worth."

The Humanities

If this is so, why do we attempt to teach the humanities to blockheads? There are congenital blockheads, but there are many others who owe their defect to environment, to a society which values only the practical and will not spend money and time on teaching that which is not of immediate use. For these the humanities will be, paradoxically, useful. They will increase these individuals' understanding of the broad issues which their technical activity is helping, even in a humble way, to modify. They will help them relate such activities to human values. They will give them better insight into the nature of the fellow men with whom they must work and whom they must direct. And, finally, the humanities can be taught for their own sake and for the sake of enjoyment; this in itself is an excellent reason!

When is the teaching of the humanities to be done? The scientific curriculum becomes every day more complex and overloaded with the learning of necessary tricks of the trade. If we look at professional education not in narrow morsels but, rather, as a long process in the life of a man, every step—primary, secondary, college, professional, postgraduate—is just as important as every other step. I believe that, in this scheme, study of the humanities should be most intensive at the secondary level, when the human mind is particularly receptive and already mature enough to profit from *idées générales*. This teaching of the humanities should be at the expense of instruction that provides technical information. By the latter I mean the teaching, within a branch of science or of technology, of details which are totally useless unless the student is to enter that branch as a profession. If he does plan a career in science, he should, in due course, acquire such detailed information in professional school. At the secondary school level the student of biology, for example, should become familiar with the general laws and meanings of evolution; it will be a waste of time to teach him every genus, species, and subspecies in the botanical scale unless and until he is to become a practicing botanist.

I do not mean that the high school student should not be given training in certain manual and general skills. On the contrary, this is the time when, while his mind is being shaped, his hands could well be trained in work with machine tools, in welding, in carpentry, and in electrical work. In a utopian way I see the high school as a crucial period in which the student should develop the ability to handle ideas and to work with tools, but during which he is not to be bothered with specific applications, except insofar as they will give him an understanding of contemporary man.

By the time the student reaches professional school, his basic education has been completed and there should be no need to teach him humanistic subjects formally. There is then little time for it, and all his efforts are to be concentrated on learning his profession. His humanistic reflexes have been conditioned; culture need not then be offered in nice packages as "courses" (music appreciation and the like) intended to give birth, in so many easy lectures, to a humanistic culture. After his basic conditioning, the student need only be exposed, during his years of professional study, to culture in the form of museums, concerts, conferences, or simply books. He will find himself in familiar landscapes wherein he will breathe with ease and grace the air of the humanistic spirit, while he bends his mental and manual skills toward the efficient performance of his technical functions.

An exception to this rule is the teaching of the history of the science in which he is specializing. It is at the time when the student of technology or science comes to grips with the "hand problems" of his field of specialization—at the professional school level—that he should learn the broader meaning of his future activity. By understanding the historical development of his subject he will be able to fuse his general humanistic background and his immediate practical training into a meaningful complex.

Education in Venezuela

Whereas the general principles thus far outlined apply in both Latin and Anglo-Saxon America, there are differences in educational practices. In Venezuela (*4*), until World War II, our secondary studies were patterned after the European, and especially the French, model; a great deal of importance was attached to classical studies, literary criticism, and the like. Since the war, largely due to the influence of practices in the United States, the emphasis has been shifting toward the teaching of experimental sciences and toward pragmatism. In the United States, the often defective high school education is corrected in part by the institution called "college." At its best this is a hybrid between secondary school and our university, where basic education can be rounded out and technical, specialized knowledge can be roughhewn before the student goes on to professional school. At its worst it is a dumping place in which those who must advance or justify their social status, without needing to drink deep of knowledge, spend four delightful years. Not so with us; after finishing high school, our boys and girls are

supposed to have completed their basic humanistic education, and they enter professional school directly, in what we call the university (*5*). If the Latin-American high school curriculum is inadequate for providing the basic humanities, as I believe it to be now, the student will be left without a cultural background, and he will never be able to make up for this lack. For there are few cultural courses indeed in the busy schedule of science, or of the scientific specialties, such as medicine, engineering, and pharmaceutics. There are signs that at least the heads of our largest university, the Universidad Central, are aware of the problem and are taking steps to overcome it (*6*).

Such humanities as poetry and literature are cultivated among us in a way undreamed of in the United States. I do not mean necessarily that we have greater poets and writers, only that a certain literature is more a part of our daily preoccupations and lives. In Venezuela, our main daily newspapers, such as *El Nacional, El Universal*, or *La Esfera*, devote a full, very well-placed page to art reporting. Although we do have exceptionally great writers, much of our devotion to the written arts is rhetorical rather than truly poetic and profound. And because of this rhetorical attitude, some of us scientists have felt—perhaps wrongly, it seems to me now—that the immediate fight should be directed, not, as many educators think it should be in the United States, toward developing the humanities, but rather toward stimulating a proper interest in science. We have felt that one of the factors in the continued underdevelopment of Venezuela is the reluctance of many of our young people to take up a scientific career. And, being backward in our scientific development, we tend to be a bit missionary on this point. We proclaim to all that fewer words and more science is what is needed if we are to come out of our backwardness; that science is the one cumulative factor of progress which we cannot afford to neglect.

Such is our present political—if I may so call it—attitude. But I am concerned lest this attitude become extreme and be taken too literally. For our country is in even greater need of discovering a humanistic point of view than many countries with a long scientific tradition. I see great danger in our sudden shift from a semi-idyllic poetic society to an aggressively technological one. In our scientific proselytizing, we may have been emphasizing the practical and technological aspects too much. It is natural that we should do so. Our material needs are great; there are people who go hungry; housing is primitive and frightful for many; theoretically eradicable diseases are rampant. We have a primary and immediate duty to use the available powers of science to attempt to solve those problems. But it would be a mistake not to stimulate, at the same time, the humanistic spirit. We are dealing in our country with a complex society in which, at one extreme, stands the totally naked Indian and, at the other, the cultural descendant—be he black, Indian, white, or mestizo—of the Greco-Latin civilization. The brutal and tangible presence of physical hunger should not make us forget the no less real spiritual hunger in our midst. And, without falling into sterile skepticism, it is well to keep in mind that there is a large element of utopia in humanity's frantic rush toward more and more technology, as René Dubos has pointed out (*2*). When seen in this perspective, the application of knowledge as a panacea for the world's ills will lose some of its magic, and pure science will be brought into focus as a properly human, worthwhile undertaking.

At the same time that educators in the United States are beginning to worry about going back to the humanities, we tend in our latitudes to abandon them. We want to rush head on, not into science, or even inventive technology, but into purely applicative technology. We continue to cultivate poetry and writing and, to some extent, painting and music. But our study of such important areas as classical languages, ancient and modern history, philosophy, and advanced mathematics—truly important humanistic subjects—is poor. There is a gradual abandonment of the humanities at the high school level—not yet enough science, and already too little of the humanities.

Conclusion

Whether all this represents insoluble practical problems is for the educators to say. The problem will not be insoluble if, instead of paying lip service to the value of the humanities, they become deeply convinced that the humanities provide the best means through which man's full potentialities can be realized.

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