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Journal address: Sociedad Argentina de Fisiología, Universidad Favaloro, Solís 453 (1078),
Ciudad de Buenos Aires Argentina.
Tel.-Fax: (54) (0)11 43781151
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TEACHING PHYSIOLOGY: WHAT, TO WHOM, HOW, WITH WHOM, WHY, FOR WHAT?

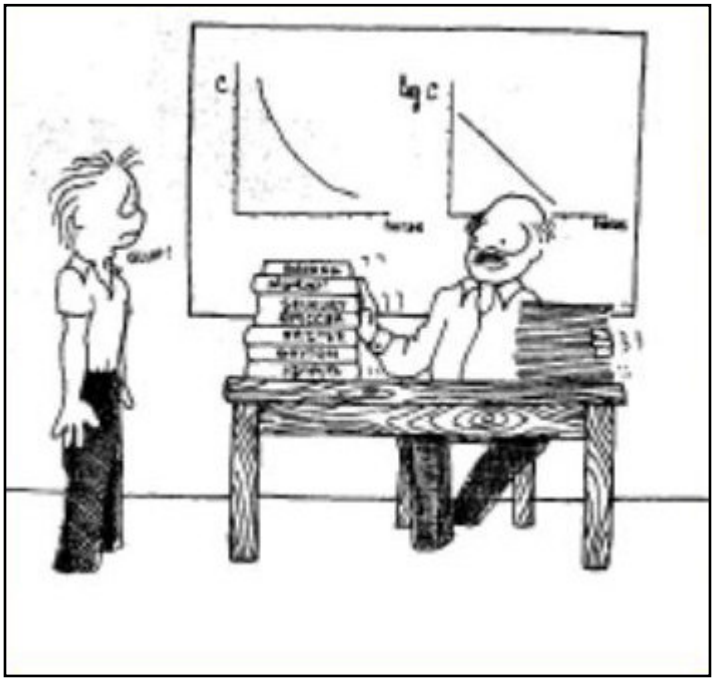
Ricardo Montoreano.
Instituto BIOMED-UC. Facultad de Ciencias de la Salud. Universidad de Carabobo, Maracay, Venezuela.
(rmont344@cantv.net)

All of us who have taught physiology to undergraduate students have had to answer the questions in the title. Nevertheless, it is practically impossible to outline a general panorama. Each physiology professor will relate his personal background and this mini-review, as will be seen, is actually a history of a professor's life related to physiology.

What?

On the question of "what", physiology's contents have been relatively easier to solve, especially in schools of medicine. Choosing and recommending a textbook of physiology is not a problem there being several acceptable ones, particularly that by Houssay, Ganong, Guyton, Selkurt, Barnes-Levy, Best & Taylor. In countries of Hispanic language we have tended towards books written or translated into Spanish, but almost always, the recommended book of physiology is accompanied by a text written by the professors of the assignment, often in note form. The justification is that "*the students are not prepared to learn all of the book*", or "*they need a more basic knowledge*". The latter reflects the fact that secondary schools do not provide students with an education that trains them to use, to apply or to solve new situations.

***Figure 1**. (By Norberto Rey).*



To whom?

The second question takes us to the entrance system used to select the students for admittance to the school. These vary considerably depending on the country and the prevailing local socio-political situation. Among the many models for selection for entrance to university in Latin America we can mention:

- Free admission
- Performance at secondary school plus a national examination·
- Performance at secondary school plus national examination plus examination of the school
- Basic course plus admission examination·

- College plus examination

College + examination can be excluded since we does not have “college” in the education system of Argentina or Venezuela.

In “free admission”, the only requirement is a secondary school education. It was used, for example, in 1954 and the following years in Argentina to select the admittance of about 5000 students to the School of Medicine of the University of Buenos Aires. The school was not sufficiently prepared to receive this volume of students and so the level of education fell to minimum, an impact that was later reversed by more testing examinations. The desertion in the first years was enormous, and self-teaching, using only books, allowed many students to complete their studies. With the establishment of the military regime of 1955 (the so called Revolución Libertadora), another scheme prevailed (with the aid of light tanks and tear gases): a course and an admission examination. The number of students in the first years in the school was reduced, but the faculty continued teaching very little whilst demanding what they thought a medical student should know. The idea that when you are teaching little you must demand less was considered wrong, since medical students, upon receiving their qualification, simply have to treat sick patients.

The “free admission” model is generally associated with the idea that universities are for the elite and, with its examinations or norms of admission, favors students from higher social classes, to the detriment of those of from a working class background. It is no secret that students from stable families, professional parents, an educated cultural background and private schools have a better chance to enter university and to remain there. The discrimination is not in the system of admission, but in the preceding primary and secondary education. When free admission system is restored, the discrimination does not disappear, it simply lowers the exigencies of the entrance, transferring the problem to the first years of the university education. Many of “the discriminated” students would have improved chances for entrance to the university if they were placed in a system of personalized education, something that the university does not, nor can not do.

Basic course plus an admission test. Theoretically, this model seems to be a good system, but when I taught physics in a basic course, I felt that there existed an enormous tension and a hostile climate, since the future depends on the lottery of a single admission examination. The students were not going to classes to learn but rather to guess what would be the questions set in examination.

How?

This question can only be solved by considering the physical space available in relation to the number of students, the number of professors, the capacity of the classroom, etcetera. Even though someone says, “*we cannot receive that number of students*”, the number will be imposed and… “*You will deal with it*” The subsequent consequence the obvious imbalance was the proliferation of theoretical classes with a corresponding decline of laboratory practical. The phrase “*To much teaching, not enough learning*” is very appropriate for this type of passive education, where the memory, and not reasoning, plays the fundamental role.

The book by Bernardo Houssay was my first contact as a student of physiology. One particular paragraph called my attention:

The osmotic pressure developed by a solution is the same one that would produce the dissolved substance if it were in the gaseous state in the same volume and to same temperature. Thus, one molecule-gram of any gas occupies 22.4 liters at 760 mm Hg and 0 º C, and taken to a liter a pressure of 22.4 atmospheres develops, also at 0º C. A molar solution is, one which has one molecule-gram (mol) of substance dissolved in a liter of water, and it also develops an osmotic pressure of 22.4 atmospheres at 0º C.

This was the only reference to this basic principle of chemical physics that students needed to know and to apply. The authors assumed that to read and to repeat the words was sufficient? So what was the intention of including that phrase? To demonstrate that was necessary to know it and that Houssay and its collaborators knew it and hoped it their students also learn it? Not surprisingly, very few students explore the physics or chemical physics textbooks to understand these words and the professors never interrogated us in order to determine whether we had a fundamental understanding of the underlying concepts. I read Houssay 4 times and passed with the minimum. It was, I believed, a discouraged to try to understand.

In 1960 I entered as assistant to Biological Physics in the School of Medicine. Many of us hoped that the biophysics would give a scientific foundation to classic physiology, an objective that until that moment was lacking. In the group of assistants were, among others, M. Parisi and N. Rey, and our goal was to teach a reasoned physiology, in which comprehension of the biophysics and physiological phenomena prevailed on memorization. An education based on the resolution of problems would be our goal. Thus, in order to provide what we considered to be the basic background for the understanding of physiology, we taught basic physics. For example, our laboratory practicals included the balance of double disk and the determination of its dynamic zero (the Mettler was already in all laboratories), the Wheaston bridge or the Venturi tube. We assumed that understanding these basic concepts would open the minds to students to reasoning. Sadly, very few students saw any relation between basic physics and medicine.

The publication of the work of Ussing and Zerahn (1) and the short circuit current to measure ionic flows gave us new hope. Finally all would see the relevance of training in the basic concepts of science for medicine. The paper by Kedem and Katchalsky (2) took us much more ahead and excited us, but realistically we understood that the concept of irreversible thermodynamics was too much for our students.

In 1963 I traveled to the US, working in the Eye Research Laboratory of the University of Kentucky and with J. Zadunaiky, O. Candia and J. Fischbarg, where I learn a lot but I did not have much to teach.

Returning to Buenos Aires as a scholarship holder of the CONICET, I met Alfredo Lanari, director of the Institute of Medical Researches (IIM), a hospital school, where medicine was taught, beginning with physical examination on patients in 3er. year. He asked us to organize the medical school with education starting with anatomy. It was call the "*little school of Lanari".* There, students were in the hospital from the first day and were taught by surgeons as professors of anatomy, pathologists as professors of histology and biochemistry by members of the central clinical laboratory. Physiology was taught by the experts in nephrology, neurologists, neumonologist and endocrinologist, while the work of Mario Parisi and I was to teach biophysics.

In the "*little school*" we received annually about 40 students who voluntarily chose to study there and we decided on a sequential approach to medical education: for example, if

we were teaching the renal system, first the classes was given by the physiologists, then came biophysicists and finally the biochemists, so that during the weeks of each subject the student focused on a single matter in a progressive didactic design. It was rewarding and successful, but, in the end, an irreproducible experience. A. Lanari was the only full-time professor teaching medicine. The IIM was an outpost center. There were an elevated number of postgraduate scholarship holders to whom Lanari forced to give classes. The library was well stocked and the students and professors "lived there".

In 1974 I returned to Biological Physics during a very turbulent and populist period. I remember the proposal that the students evaluate themselves at the end of a class. They refused: they did not want to be accomplices.

Exiled in 1977 by another military regime, I was contracted by the University of Carabobo, as professor of Physiology and Biophysics in Maracay, Venezuela. The country was then in an oil and economic boom and the lower social classes saw the possibility that its children, many of them already adult, were to have access to the university.

In Physiology we had, at the onset, about 110 students and 6 Grass polygraphs, and we thought that was possible to do almost everything. Finally, it was my opportunity to pursue a program of reasoned education. The chosen textbook and the complementary notes were used until 1988, when I published my "Manual of Physiology and Biophysics for Medicine students" (3). In my book, explain the phrase of Houssay on the molar solution, took to me about 15 pages. In spite of the apparent success of the physiology course, the population of students who did not pass and had to repeat the course was growing. The regulation allowing students to repeat the course *at infinitum,* encouraged students into multiple attempts to pass Physiology. The record was a student who repeated 17 times. To have more "repitientes" than regular students was soon the norm. At the time other courses, like immunology, psychology, medical practice and education for the health, were added the 2nd. Year curriculum. Physiology and Biochemistry ended in a corner and the students did not understand why, being so bright in medical practice and education for health, they did not manage to pass Physiology or Biochemistry.

Immunology came to accompany Physiology in the group of subjects considered to be "difficult" with the role, according to some students, to acts as a filter. If at the beginning we planned an education with practicals and seminars, we were taking refuge in the easiest option, simply to teach the theoretical classes.

As the failure persisted, the pedagogues "discovered" that the fault was in the lack of a good professor-student contact and decided that we had to teach to smaller groups. The argument that we had very few senior or experienced professors was ignored. Theoretical classes were assigned to newly appointed professors, who lacked experience, particularly in medical education.

Whith whom?

This has to do with the type of professional with the responsibility of giving a class or presenting a seminar. Obviously we need physiology professors that can teach not only the relevance of science to medicine, but also the basic principles of the subject. As it was impossible to obtain appropriately qualified professors for Physiology, biologists or veterinarians or biochemists came to accept the responsibilities. Dealing with 110 students, few professors are needed, but with 500 students it became necessary call to

teach students of superior courses that had approved an internal test of sufficiency. Result? Good, whenever there was the opportunity to discuss with the under graduate students the meaning of the seminars or to do several times the laboratory practical. However this goal not was achieved.

Why for?

For many it is a ridiculous question. Physiology is an essential matter for all physicians. Which physician? One thinks about the good doctor that understands medicine and updates his knowledge by reading medical journals. Is there another type of medical doctor? Yes, in some public health programs that give priority to common clinical problems, as the primary attention, popular medicine, "barefoot doctor", with the mission to see and to treat only the most frequent diseases. For these, when we try to deduce the Nernst equation it is understandable that they cry to heaven: "*Why you are teaching these if as graduates we will see asthma, colic, influenzas and sometimes a bronchitis?"*

I have left until the end the subject of motivation. Although perhaps surprising, we have heard students say, "*Physiology does not motivate me*". This, in spite of our efforts to show the relation between physiology, medicine and daily life. And we are not the only ones: R.M. Passes and others (4) published a paper titled: *"Pizza and paste help students learn metabolism"* in which they are attempt to convince the unbelievers that carbohydrates metabolism is essential knowledge. In my Manual of Physiology I pose the story of a shipwreck and the degree of dehydration that a man can sustain, for example, in the Caribbean Sea, having left the Bahia de Cata, 40 km from Maracay. Examples or hooks to motivate?

A sad reality is that medical students do not see the importance of Physiology. It is only one more assignature. Sometimes, after graduating, some of them re-revalue what we had tried to teach to them, but, alas, not enough to satisfy our ego.

As is obvious, I have made this essay a very personal story, but I firmly believe that to transmit experience is vital in our profession of professors.

Finally, we heard that in Sao Paulo, Brazil, from 200 students admitted to medical school, 190 graduate. Nice, but it would be very useful to know if they could answers our questions: ***what, to whom, how, with whom, why, for what.***

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Norberto Rey who died in 1987 did the draw for the first edition of the Manual of Physiology and Biophysics.

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