

AN AUTHOR'S PHILOSOPHY OF PHYSIOLOGY TEXTBOOK WRITING

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Last week I received a letter from Drs. Hansen and Roberts asking that I write an article tracing "the factors that have determined my approach to physiology education as it is realized in my textbooks." And they also stated that "my article could be of any length, as brief or as long as I want."

I immediately thought of a facetious answer to Drs. Hansen and Roberts: I would write the briefest possible article, containing a single sentence. This sentence would be: "Because I needed the money for writing the books."

And, true enough, I did need money because my wife and I were well on the way to producing multiple children, and I still did not know how I would be able to pay for their education, or even to pay their day-to-day support. But the truth of the matter was that I did not even think of money when I started writing my *Textbook of Medical Physiology*.

Then I thought of another answer almost as facetious as the first. This was that many textbooks of medical physiology had become very discursive, written primarily by teachers of physiology for other teachers of physiology, and written in language understood by other teachers but not easily understood by the basic student of medical physiology. This, I am afraid, is a failing of all of us in medical teaching. But, here again, I truly did not think of this at all when I began writing my own textbook of medical physiology.

So, what is the truth? The answer is that I began writing my *Textbook of Medical Physiology* for the W. B. Saunders Company entirely by accident. Before I tell you how the accident occurred, I must explain what my own situation was when I first began to teach medical physiology.

As I went through medical school training, at Harvard Medical School, I became deeply interested in physiology even as a medical student, especially as it provided a basis for training and study in virtually all clinical areas of medicine. In addition, I had a concurrent student research fellowship to do basic research on biophysics of ionic solutions and their use as treatment resources.

After medical school, my training was in the field of surgery, mainly at the Massachusetts General Hospital in Boston but also partly at the National Naval Medical Hospital in Bethesda, MD. And during World War II, I was assigned to do research on the abnormal physiology of bodily function under the influence of toxic chemical and bacterial warfare agents.

Unfortunately, though, while I was still in my surgical residency training program at the Massachusetts General Hospital after the war was over, I suddenly developed very severe polio that left me with so much paralysis in multiple areas of my body that it was clear I could never continue in clinical surgery. Instead, I chose to go back to the field of basic physiology and to teach and do research in that area.

Then still additional circumstances led to the textbook. To begin my career in physiology, I moved back to my home state of Mississippi, where we had a two-year medical school. Our school prepared medical students in the basic sciences (including physiology) but not in the clinical disciplines. After two years of training, our students transferred to other medical schools throughout the United States for completion of their MD degrees, a large portion of them going to the University of Tennessee Medical School in Memphis, located 70 miles from the University of Mississippi in Oxford, where I was teaching.

This was also in the days immediately after World War II, when virtually all medical students were on federal veteran's scholarships because there was special urgency to train many doctors, making up for the deficit in numbers trained during World War II. Also, tremendous numbers of students were applying for medical school so that virtually all of our students were "A" grade students. And, to make the story complete, our school taught *two* classes of medical students each year, not just one class.

At about this time, the previous head of our Department of Physiology at the University of Mississippi Medical School had been offered the Chairmanship of a Department of Physiology at a medical school in the North near his original home. This was too much of a temptation for him to refuse. But it left our school without a Chairman of Physiology—in fact, without any teacher in the department because the other teachers in the department had also recently moved. Obviously, this was a wonderful opportunity for me, and I immediately applied for the position. The Dean of the Medical School was extremely hesitant in allowing me to try this, principally because of my severe paralysis from polio. Yet I did have a more extensive curriculum vitae than the other applicants, based mainly on publication of articles and studies from medical research during World War II in the bacterial and chemical warfare areas. Therefore, finally, I did get the opportunity to try, but I was also warned that this was strictly a trial period.

Fortunately, too, just as I began to function as Chairman of the Department of Physiology I received a fairly extensive research grant, again from the biological warfare program of the US Armed Forces. The idea was to extend my previous research work on the basic biophysics and physiology of the actions of various chemical and bacterial warfare agents. From my point of view, this gave me far more research funds to work with at the University of Mississippi Medical Center than any of the other faculty members in our school had. Therefore, we began both a new teaching program in physiology and at the same time an extensive research program on the physiology and biophysics of the warfare agents. In addition, there was a very high monetary "overhead" item on the Armed Forces contract, which provided still many other thousands

of dollars to be used for any purposes we desired. By using these "overhead" funds, I was able to begin a research program on the basic causes of hypertension. This had been a research area of my special interest while I was still a student at Harvard Medical School.

The above gives the background for my beginning the teaching of physiology. The essentials were:

- 1) We were teaching two physiology courses to medical students each year—to two separate entering medical school classes, one class entering in July of each year and another class entering in January.
- 2) Because all the previous Physiology faculty members had recently left our school, I was the only one to teach these two courses. Therefore, I taught the entire course of physiology, not merely a part of it, two times a year.
- 3) We continued this schedule for 14 separate classes. For myself, this meant rapid review of the entire field of physiology again and again, all these many times, along with lecturing and discussing virtually all aspects of physiological principles with the medical students almost continually for a period of 7 years.

With this set of conditions, what were my problems in teaching physiology to these students? The answer was that both I and the students were in programs of rapid study and extreme amounts of hard work. On top of this, virtually all textbooks of medical physiology were well over 1,000 pages and usually in very small print, making it very difficult for the medical students to read and study these books in a way that they could emphasize in their own minds the basic principles of physiology rather than great multitudes of often indecipherable details. To try to solve this problem, I changed textbooks with almost every class, hoping to find one book that the students would indeed study with pleasure and with depth of understanding of basic physiology. My findings were that if we could have had three or four times as much classroom time and study time, we could have done a good job in teaching and learning all this great mass of material. What actually happened was that the students, instead of looking at me as the teacher, sat in their desks with heads bowed and hands moving as

rapidly as they could taking notes, trying to get all the “facts” of physiology written in longhand or shorthand or in cryptic phrases. This was their method of learning.

When it came time for tests, if the tests were made out also in a cryptic manner, asking details about specific items that had been listed one by one in the lectures, the students did very well. Yet any time a question was beyond that level, especially about some basic physiological principle discussed in detail in their text but not presented in the same detail in the lectures, their knowledge of physiology suddenly failed entirely.

Furthermore, it was almost impossible to have significant discussion in class because all the students’ intent drive was directed toward the cryptic notes, not toward thinking through basic mechanisms of physiological principles. This was the way the students had learned to approach their high-pressured courses in medicine. It was a way in which they could accomplish the tremendous load of work that was thrown at them and at least get by, not necessarily to learn the many concepts that they would need to know later in the practice of medicine. So, what was the answer?

At this point we began to experiment. I told the students that if they would sit up in class, listen, and join into discussions, I would, after class, dictate notes for them myself and have our secretary supply appropriate typed pages. Under these conditions, the students were not even allowed to bend over their desks to write the cryptic notes. Therefore, each day after I had presented the lectures, I went immediately back to my office and dictated all the basic principles and important points that I had just presented in the lecture, completing this dictation by about 1:00 or 2:00 in the afternoon. Then my secretary, who was superb in her own right, transcribed the dictated notes and had them multigraphed in time for issue to the class the next morning at 10:00, at the time of lecture.

This new procedure worked very well from the point of view of students passing the exams. But it also had a detriment. Now that the students had these “professor’s notes,” they found that they could do wonder-

fully well on tests by memorizing and remembering and putting the facts of these notes deeply in their minds. And they found it best not even to look at the complex textbook, not to allow the textbook to confuse them. Therefore, what would be their future in the field of physiology, or even in the application of physiology to medicine? Perhaps the future would be good if these notes covered very much. The notes themselves were about 120 pages of single-spaced typing—not a great amount to cover the great field of either basic or clinical physiology.

Now, what was to be the answer to this problem? Because I was an experimentalist at heart, I tried another experiment. This experiment was to go back and redictate the notes again but this time dictating in the form of full lectures, even extending some of the material to concepts and details that were not covered in class. I had this new dictated set ready for the next class and gave the dictated lectures to the students before the lectures themselves. Furthermore, it had been possible for me to draw onto the multigraph stencils several hundred figures presenting in quantitative form anatomic drawings, graphic drawings, or charts that summarized much of basic physiology. All of this had been put together in a period of about 5 months. This worked beautifully for our own class. It meant, however, that the students no longer looked at a commercial textbook of physiology and that they were not familiar even with the physiology textbooks that were available. In other words, the students left our school trained in the field of medical physiology as conceived and presented at the University of Mississippi School of Medicine. They were not trained in the depths of the worldwide scheme of physiology.

Even so, this worked well enough that I suspect we would have continued with the syllabus for many years, not with any intent ever of passing the dictated lectures on to other schools for their use.

Then came the accidental occurrence that led to the *Textbook of Medical Physiology*. A textbook representative from the W. B. Saunders Company, while attempting to sell me, as Chairman of the Department of Physiology, one or more of his company’s publications, became aware of our own Physiology Syllabus, and he asked if I would let him send a copy to the

editorial offices of the Saunders Company in Philadelphia, PA.

Within two weeks, I received a telephone call from the Medical Editor of the W. B. Saunders Company, Mr. John Dusseau, asking whether or not I would revise our syllabus still another time and work it into a commercially competitive textbook of medical physiology to be published by Saunders. Mr. Dusseau was very candid in telling me what the prospects for the book would be and also what the financial rewards might be. I quickly calculated the number of hours that I thought the book would require and rapidly derived that, on an hourly basis, I would make an extra amount of money approximately equal to what a good ditchdigger might make—perhaps a little better if things did very well.

But, again, financial rewards were not the reason for writing such a book. Therefore, I did tell Mr. Dusseau that I would take on the task. I did take my time, though, in getting to the job, finally beginning work about half a year later.

It had been my idea that I could complete this update of text to publishable quality with about the same amount of extra work that I had put into the previous syllabus for my own students. This was an absolutely false illusion. As I got into the book and began to study as much as I could about courses of physiology taught at other schools, asking the different chairmen of departments to send me syllabuses, exam questions, outlines of courses, and so forth, I suddenly began to realize that the amount of time needed would be about six times as much as I had already put into the syllabus. Even so, by that time I had already signed a contract with Saunders, and I pushed forward. The result was that I found myself staying in my office after working hours each day sometimes to as late as 8:00, 9:00, or 10:00 at night—studying, and more studying. Then writing, revising, writing, revising, and continuing on and on. In addition, I sent chapters to multiple physiologists throughout the United States and the rest of the world, especially to physiologists with a depth of background in specific areas of physiology. In most instances I received very nice letters back from the professors of physiology. Usually about midway in each letter it stated, “but—.” Then the

professor would begin to tell me what was wrong with the chapter.

Sometimes a conscientious professor would even rewrite a chapter for me. When rewritten, it was usually much altered from my own work and did not fit with the material that I would be writing in other chapters. Therefore, virtually none of the material rewritten in this way was usable in my own text. On the other hand, reviewers' discussions of physiological problems and why I might need to make changes in my own work—but in my own words—proved to be immensely helpful. Putting all this together, I now had material to begin again, to write what I hoped would be the final version for the *Textbook of Medical Physiology*.

And that is what I did do, working another year putting all of this together, developing bibliographies for the chapters, passing the new material out to my own students to determine how well they succeeded in using it, and so forth.

Finally, there had to come an end, so that eventually I did turn the book over to Mr. Dusseau, the Medical Editor of the W. B. Saunders Company.

Mr. Dusseau, in turn, had his own authorities read the new text, write appropriate critiques, correct either qualitative or quantitative details, and finally return all of this to me. I had been hoping that I was through with my work, but it was just beginning and has continued year after year, edition after edition of the book, becoming a major part of the physiology and philosophy of my own life.

I must say, however, that this is a wonderful way to learn more and more about any field: discussion back and forth with colleagues, discussion back and forth with unknown critique editors, finally publication of a book, then still more feedback from both teachers and students using the textbook—I wish that every student of physiology could take this same course of learning that I was taking. I especially was learning more and more physiology in those fields in which I had not worked extensively. And I was receiving training directly from some of the world's best specialists in the different basic, specific fields of physiology.

This extensive program of learning was taxing for my psyche. Yet, at the same time the entire field of physiology was beginning to take shape as a unitary whole, all fitting together as a glorious vista of the world's most beautiful field of knowledge: the human body—how it works, how it thinks, what it does, how it propagates itself, how it lives in a world of inanimate and animate bodies, and at least some degree of understanding why there is such a thing as a human being anyway.

Today, all instructors in the field of physiology teach the importance of feedback control systems for regulating virtually all the different functions of the body. But when I started writing physiology almost 50 years ago, the quantitative interrelationships among feedback control systems were just beginning to be appreciated. Special courses on control systems were beginning to be taught in engineering schools, but even the engineers did not realize that virtually all of the same principles that they were teaching on the mathematics and physics of physical control systems were equally applicable, and in even greater depth, to the controls of the human body. Fortunately for me, the fields of physiology and its allies biophysics and bioengineering were beginning to recognize this important new area for quantitative biological research investigation. In our department, we began especially to use the quantitative concepts of feedback control systems as worked out by control engineers, applying these principles to the controls for blood pressure, cardiac output, vascular resistance, and other aspects of function in the body's circulatory system. And we also began applying these same principles to control of the respiratory system and to the multitude of interacting controls in the nervous system (which itself is a spectacular display of thousands of mutually interacting systems). Therefore, the worlds of physical science and biological science were beginning to come together; this was also true in our own departmental research and departmental teaching.

It was about this time that the beauty of textbook writing suddenly occurred to me. Putting all the physiological functions together to help us understand the human body was dependent first on having knowledge of the separate functional systems—the

circulation, the respiratory system, the brain, and the digestive system—plus all their interacting controls. Then, with all these together you have the human body. Even to this day, no other scientific system in the universe has been found that is more highly dependent upon a great mass of accumulated functional systems and their interrelated controls. For more than 100 years we have called this amazing consortium of systems by the unitary name “physiology.”

Therefore, the principal goal of our *Textbook of Medical Physiology* has been to try to explain how the different organs and tissues of the body work together, to build in book form this beauty we call “physiology.” At the same time, the same effort has driven us as research physiologists to explore the quantitative field of physiological interrelationships.

I hope Dr. Hall and I have succeeded in our goal to make the *Textbook of Medical Physiology* a valuable basic teaching tool simply for understanding how the human body works. We hope, too, that what we know about basic function of the human body will lead to significant new medical therapeutics. Indeed, there is an entire field of physiology that attempts to explain how therapeutic procedures work, whether pharmacological procedures, physical, mental, or otherwise. We hope that we express to the students the physiological background they will require in all these basic areas as well as in the clinical disciplinary areas of internal medicine, surgery, neurology, urology, and so forth.

And, finally, physiology is equally as important in many other types of biological science as in the science of human medicine, requiring still more specialized books for teaching physiology in *a)* dental schools, *b)* biology departments, *c)* nursing schools, *d)* physical education departments, *e)* psychology programs, and so forth. This is all part of the integrated function of the whole animal body, the whole that we call “physiology.”

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