Letter to the Editor

I would like to comment on your statement in *The Journal of Chiropractic Education*, Vol. 14(1), 2000, that: "Students at every chiropractic college memorize the Krebs cycle without any real understanding of its significance . . . and it is clinically irrelevant." As a biochemist and an expert faculty member at NCC, I would like to make the following comments:

1. Krebs cycle (TCA cycle) is the major energy-generating cycle in the human mitochondria. Energy is required for every cell and tissue to survive, grow, multiply, carry out mechanical work (e.g., muscle contraction), electrical work (action potential), transmit nerve impulses, synthesize macromolecules, and transport nutrients and end products to and from the cells.
2. The efficiency of the Krebs cycle to generate energy to the body by its enzymes requires the presence of vitamins and supplements. These vitamins (precursors of coenzymes) are the electron carriers in the mitochondria for the formation of ATP (the energy currency of the body).
3. Many drugs, antibiotics, and over-the-counter medications were tested and analyzed biochemically and were shown to impair the function of the Krebs cycle and ATP formation (oxidative phosphorylation reactions) (e.g., aspirin [a common pain killer] and dinitrophenol [once used as a weight loss medication] were found to act as uncouplers [inhibitors] of the oxidative phosphorylation [ATP formation]. Patients taking these medications present with fatigue, muscle weakness, low-grade fever, sweats, and weight loss. Another common chief complaint among younger generation patients and athletes is anemia: either iron deficiency or pernicious anemia. These signs and symptoms are seen among patients due to impaired function of the electron transport chain and ATP formation.

In order for the Krebs cycle and other biochemical pathways to become "clinically significant" they must be taught to the students in an integrated and applied manner. Here at NCC, I teach biochemistry to my students utilizing clinical correlations and applications to help them learn and not to "memorize."

Our duty as active faculty members of the chiropractic profession is to promote our graduates to become equal to other primary care providers (e.g., allopathic students). In order to achieve this outcome among our students, an education based on strengthening and broadening their basic science foundation is essential.

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In Reply

I appreciate Dr. Shenouda's comments in his letter of March 24, 2000, and his willingness to engage in a substantive discussion on the topic of curricular content in chiropractic education. Like him, I am also a biochemist and a faculty member at a chiropractic college. However, I am also a chiropractor, have provided care for patients and interacted professionally with practitioners from other professions, and therefore may have some advantage in assessing the relative value of various elements of the curriculum for chiropractic students.

I believe that the first two points Dr. Shenouda raised with regard to the Krebs cycle are a fair approximation of what I believe that our students should know about the Krebs cycle. It is probably sufficient that a student be made aware of the Krebs cycle and oxidative phosphorylation as the primary source of ATP energy; what the various uses of this energy are; that this process requires oxygen; and the requirement for various micronutrients for these pathways to function properly. However, given the nature of chemistry questions on part I of the NBCE examinations, and the level of success experienced by students on this examination, it is a safe bet that the instruction delivered far exceeds these minimal requirements. There is absolutely no need for chiropractic students, or students of any other health profession, to be aware of the technical minutia associated with the Krebs cycle or other chemical pathways.

I would take issue with the arguments raised with regard to the clinical relevance of the Krebs cycle. Many of the experiments on the interactions of medicinal substances and the Krebs cycle are of questionable value. In my experience in pharmaceutical research, in vitro assessments of chemical interactions involving intracellular processes rarely reflect the effects seen in vivo. Additionally, the examples of clinical correlation provided are either incorrect or irrelevant. Dinitrophenol is no longer administered to humans and has not been for some time. Even if it were, its mode of action is of little or no importance to a practitioner of a drugless therapeutic art. Chronic aspirin (ab)users do not generally suffer from "fatigue, muscle weakness, low-grade fever, sweats, and weight loss"; they experience gastrointestinal distress, develop ulcers (usually of the proximal small intestine), and may develop anemia secondary to blood loss. The symptoms experienced by those with anemia are due to impaired oxygen transport by the blood, rather than any direct impairment of the Krebs cycle.

I also take issue with the statement that "for the Krebs cycle and other biochemical pathways to become 'clinically significant' they must be taught to the students in an integrated and applied manner." The method of instruction described is unquestionably useful in helping students understand the relevance of basic science information that *is* clinically significant. In order for the pathways to be considered clinically significant, they would have to be associated with some clinical entity or pathology that could be better understood and/or managed by a practitioner with knowledge of the pathways. Additionally, while the use of clinical correlation and application in the instruction of basic sciences is a valuable tool, if the assessment of students consists primarily of determining their ability to memorize science trivia (as is the largely the case with NBCE part I topics), students will prioritize their study efforts toward rote memorization. The use of correlation and application as a teaching tool is not sufficient in and of itself to ensure that conceptual learning and integration will be promoted.

I agree wholeheartedly that one of the responsibilities of chiropractic faculty is to prepare our graduates to assume a functional role as primary care providers in the modern and evolving health care industry. I equally wholeheartedly disagree with the contention that broadening the basic sciences curriculum is essential to

that goal. It is my contention that the depth and breadth of the current basic sciences curriculum is actually an impediment to this goal. To be a successful and competent primary care provider, chiropractic students need to develop the skills necessary to accurately assess the health of their patients; to provide quality care consistent with the patient's needs and contemporary standards of quality assurance; to communicate and collaborate effectively with practitioners in other professions; and to continually update their skills and knowledge base as health care evolves. While there is unquestionably a need for basic sciences instruction as a component of this process, time and resources devoted to the study of basic sciences of questionable relevance to clinical practice represents diversion of resources away from the acquisition of essential skills.

Many of the faculty at chiropractic colleges with responsibility for instruction in the basic sciences have no direct experience with the delivery of chiropractic health care. In any formal consideration of appropriate scope and nature of basic sciences education in chiropractic education, it is probable that the opinions of clinical faculty and those with ongoing practice experience are of more value than either historical precedent or a consideration of what would be appropriate for other health professions. I believe that such discussions need to occur, that educational priorities need to be revisited, and that curricula need to be revised. I believe that if we collectively undertake this task with open minds, looking toward the future rather than the past and at the entire educational process rather than being focused on our areas of personal responsibility within it, the end result will be graduates who are better prepared for the challenges of the future and far less traumatized by the process.

I commend Dr. Shenouda's willingness to engage in discussion of these issues, and sincerely hope that he will not remain the sole faculty member to do so. If the chiropractic profession and chiropractic education are to progress and evolve to meet the demands of the changing environment in which it exists, it is encumbent upon faculty to be willing to critically assess the importance and relevance of elements of the curriculum, both in the basic sciences and in the clinical sciences. I sincerely hope that others will join the discussion, whether in a public forum such as this or with their immediate colleagues.

Robert W. Ward, D.C.
Journal Editor