

THE ROLE OF MEDICAL BIOCHEMISTRY IN MEDICAL EDUCATION

BY

PROFESSOR REGINALD NWAZUE NWAOGUIKPE

Professor of Medical Biochemistry

**Department of Biochemistry, Federal University of
Technology, Owerri**

***Being a Lecture delivered to School of Basic Medical sciences
on the 30TH June, 2017.***



The role of medical biochemistry in medical education by Nwaoguikpe R. N. is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

PREAMBLE

During the last fifty years, biochemical principles and knowledge, concepts and technology have become increasingly important for the understanding of pathological basis and principles of human diseases, clinical treatments and medical research. Advances in biochemical sciences have led to advancement in medicine and this is entirely recognized by the medical profession.

INTRODUCTION

To elucidate or answer the question; the role of Medical biochemistry in Medical education; many scholars from different universities in the world have rendered a lot of answers, most of who are medical students and medical educators. It is pertinent at this level to unveil what biochemistry is all about.

Biochemistry is the science concerned with the chemical basis of life. It deals with the structure, properties and chemical reactions of biomolecules that are present in living systems. Living systems are composed of various biomolecules like carbohydrates, proteins, lipids, vitamins, minerals, water and nucleic acids. Life depends on the interaction of various biomolecules and biochemical reactions. Any abnormalities in these life processes may lead to a disease condition. Medical biochemistry is biochemistry in relation to human health and disease. It is also known as Human Biochemistry. Its applicative arm is clinical biochemistry, which is a field that focuses on the methodology and interpretation of chemical tests performed to support diagnosis and treatment. Previously, biochemistry was referred to as "biological chemistry" or "physiological chemistry".

In France, the term "*biochimie medicale*" is used as an equivalent of physiological chemistry. Similarly, some Polish University departments of physiological chemistry were named " medical biochemistry" (*biochemia lekarska*). Molecular biology is commonly regarded as part of biochemistry and this is reflected in a number of scientific research journals and societies. Medical biochemistry is regarded as biochemistry and Molecular Biology) applied to human organism. Medical biochemistry seeks to advance the understanding of chemical structure and processes in health and disease.

Clinical biochemistry is an important applied sub-discipline of medical biochemistry; it is also known by names such as –clinical chemistry, pathological chemistry or clinical pathology. Clinical biochemistry is concerned with methodology and interpretation of biochemical tests performed on body fluids and tissues to support diagnosis and monitoring of diseases.

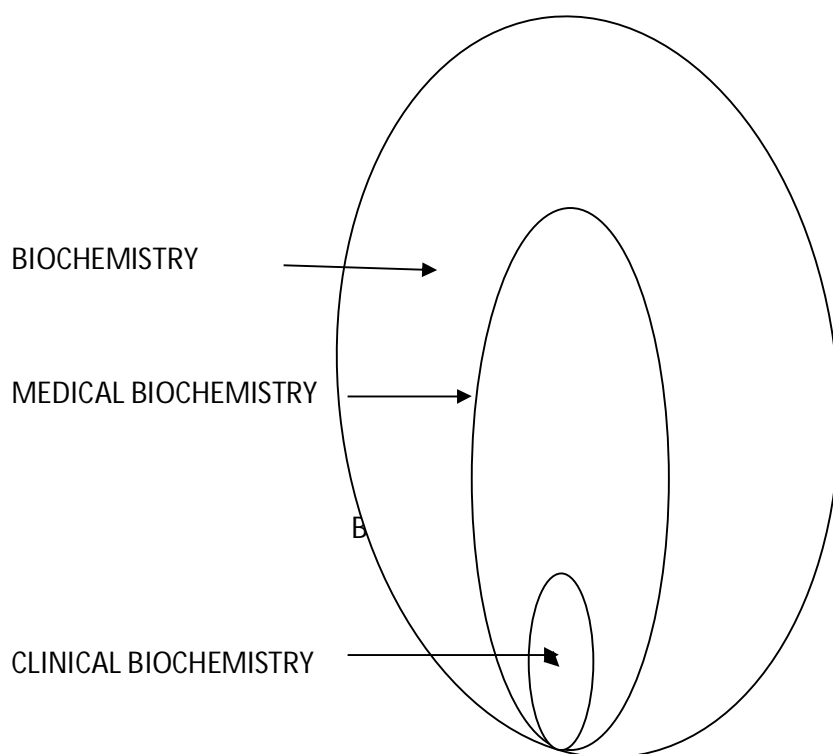


Fig. 1 Relationship between Biochemistry, Medical Biochemistry and Clinical Biochemistry

The scope of medical biochemistry which follows has been the basis for medical teaching in the discipline and encompasses most of its current clinical applications (Baynes and Dominiczak, 2009). The typical scope of medical biochemistry include the following:

The chemistry of structures comprising human organs. The chemical components of the human body- amino acids and proteins, simple carbohydrates and lipids, complex carbohydrates and complex lipids, components of the extracellular matrix. Components of blood and plasma. Biological membranes. Key chemical processes in the human body.

The nature of enzymes, membrane transport, transport mechanisms. Membrane receptors and signal transduction. Oxygen transport. The immune response and chemical mechanisms of hormone action. Structure and functions of neurotransmitters, cellular homeostasis, growth differentiation and cancer. The process of ageing.

NUTRITION AND METABOLISM

The assimilation of nutrients, the function of the gastro-intestinal tract and processes of intestinal absorption, macro and micro –elements, vitamins and minerals. Bioenergetics and oxidative metabolism. Mitochondria respiratory chain, main metabolic pathways, glycolysis, storage and synthesis of carbohydrates, the tricarboxylic acid cycle (krebs), oxidative metabolism of lipids ,biosynthesis and storage of fatty acids. Biosynthesis of cholesterol and steroids. Oxidation and role of free radicals.

INTEGRATIVE ASPECTS OF METABOLISM

Glucose homeostasis and the metabolism of body fuels . Calcium and bone metabolism. Nutrition and energy balance .The metabolic role of the liver. Muscle metabolism (its energy metabolism and mechanism of contraction). Water and electrolyte homeostasis and kidney function. Acid-base balance

ELEMENTS OF MOLECULAR BIOLOGY

Nucleic acids and molecular genetics. DNA, RNA and protein synthesis. Regulation of gene expression. Recombinant DNA technology. Genomics, proteomics and metabolomics (Dominiczak, 2015)

TEACHING AND LEARNING MEDICAL BIOCHEMISTRY

Many students of medicine and educators of the same discipline have found that advancement of medicine and that of biochemistry are inseparable and much more, modern medicine would not be practiced in the ways they are known today without our understanding of how genetic, pathogenic and environmental factors affect the human body at the biochemical level. Hence, the importance of teaching medical students medical biochemistry is self-evident. Ironically, many medical students and practicing physicians consider learning biochemistry, an unnecessary burden, that biochemistry has very little

relevance to their daily practice of medicine (Mehdi and Zhiyong, 2014). Also, many students, especially those interested in the fields, such as primary health and psychiatry, also complain that, there is too much anatomy in preclinical curricula (Clark, 1994). Thus, it seems that these students would prefer to selectively learn subject matters that they believe to be relevant to the medical specialities that they wish to acquire and practice. Such utilitarian thinking is in part responsible for the trend in medical curriculum that devaluates basic science and emphasizes apprenticeship experiences with clinical faculty (Brass, 2009).

WHY DO THESE MEDICAL STUDENTS CONSIDER IT UNNECESSARY TO LEARN MEDICAL BIOCHEMISTRY? WHAT CAN EDUCATORS DO TO CONVINCE THEM THAT LEARNING BIOCHEMISTRY IS IMPORTANT IN THEIR MEDICAL EDUCATION

Answers to these questions and others have been put up from the perspectives of MA(Mehdi Afshar), a fourth year medical student and ZH(Zhiyong Han), a medical biochemistry educator.

There are four factors that negatively affect many medical students to have unfavourable opinions about medical biochemistry. These factors are:

1. Medical biochemistry often repeats the materials of undergraduate biochemistry.
2. Medical biochemistry is presented mostly outside the context of medical relevance.
3. There is a large portion of the material that seems irrelevant to board examination.
4. Medical biochemistry requires too much rote memorization that does not last long.

FEEDBACK FROM STUDENTS AND EDUCATORS BASED ON VARIOUS RESPONSES TO QUESTIONNAIRES.

The objectives of the biochemistry course were not clear to majority of students: They could not appreciate the purpose or relevance of the bulk of biochemistry taught to them. Students enrol in the medical faculty to become

doctors and their major objective is the acquisition of skills needed for medical practice. Our objective as teachers is to equip medical students with an adequate biochemical background for the study of medicine, i.e. to facilitate the study and understanding of other medical disciplines. It is a course which should also prepare medical students for future years of medical education (GMC, 1980).

Many students have difficulty in coping with the first year medical curriculum. Of the three clinical subjects, biochemistry was ranked as the subject liked most by only 16% of the respondents. Students thought that biochemistry was taught excessively in terms of the amount of time devoted to the subject. It is therefore pertinent to ask if professional biochemists should decide what is important for a medical student. Universities decide how many hours that shall be spent on different subjects and they inevitably do so on the basis of tradition and estimates of importance. Views of consumers are generally not taken into account and so, curricular subject time importance, can be perpetuated in an authoritarian and empirical way.

Table 1: Students' responses to a questionnaire on the biochemistry course in medical curriculum

| | % Respondents |
|--|---------------|
| A Objectives not clear | 55 |
| B Difficulty in coping with the 1 st year Medical curriculum | 45 |
| C Application of biochemistry (taught in first year) to clinical years | |
| veryoften | 1 |
| quite often | 4 |
| sometimes | 50 |
| hardly ever | 45 |

| | |
|--|----|
| D Retention of biochemistry (as taught in first year)for application in clinical years | |
| good | 10 |
| fair amount | 9 |
| very little | 91 |
| E How well has the department of biochemistry prepared you for the clinical years? | |
| very well | 0 |
| quite well | 8 |
| satisfactory | 41 |
| poor | 50 |

TEACHING OF MEDICAL BIOCHEMISTRY SHOULD NOT REVOLVE AROUND BOARD RELEVANCE

Some students seem to like the idea of learning just " board examination relevant" materials. As such, they simply want biochemistry to be presented in bullet points format that shows " key words connections" that are easy to recall during board examinations. This is a bad idea. Board examinations only asses a physician's minimum competences, we should not set the bar to the height of minimum competencies and limit ourselves to teaching and learning just a minimal amount of materials for passing board examinations only. We believe for example, that it is not enough that physicians prescribe nucleoside analog -derived drugs such as AZT, to treat HIV/AIDS and equally , treatment of hypertension due to high level of cholesterol without knowing that some antihypertensive drugs for this type of syndrome, inhibit the enzyme HMG-CoA reductase, responsible for the synthesis of mevalonic acid from HMG-CoA .This inhibition by drugs known as "Statins" brings to a halt, the biosynthesis of cholesterol in the pathway. They should be able to articulate the biochemistry underlying the action mechanisms of these drugs. What we do not want is to produce physicians who can pass board examinations with knowledge deficiencies and who are unable to critically read and understand the sciences

in the articles published in medical journals , such as " Journal of Clinical Investigations ", The Lancet, and the New England Journal of Medicine.

STUDENTS MUST MINIMIZE ROTE MEMORIZATION AND MAKE INFORMATION STICK

Needless to say, students can attest that they memorize a huge amount of biochemistry materials before passing their examinations. However, rote memorization is not synonymous to learning and the understanding of materials; this produces learning fatigue. To test the understanding of metabolic pathways and their interconnection is by assessing whether they know where and what information to look for in the metabolic pathway charts when solving problems and not the reproduction of the entire pathway. Thus, it is best, for example, if a student knows how to diagnose a metabolic defect that causes methylmelonic academia, using a metabolic pathway reference. This idea was proposed by Professor Edward J. Wood 23 years ago and he suggested that it would be better if we stop " asking students to reproduce detailed information (of a metabolic pathway and to reproduce it accurately under stressful time-limited examination conditions and in competition with their peers (Wood, 1990)

Medical biochemistry need to be taught in ways that stick with students, the stickier, the better, this eventually reduces memorization. There are many ways to make things stick (Heath and Healh, 2007), and it require personalities, presentation styles, use of vivid and sticky examples, clarity and even something that shocks. For example, the shocking case of a 66 years old "man" who turns out to be genetically a woman with Turner's syndrome plus virilising 21-hydroxylase deficiency .Stories of this nature and more will grab students attention to visualize the biological role and significance of 21-hydroxylase. This will induce students' curiosity and interest, unfold the biochemical/ medical investigative events and this will stick

WHAT BIOCHEMISTRY SHOULD A PRACTISING PHYSICIAN KNOW

It is appropriate for us to ask the question above as we prepare students to be physician-scientists or for teaching/ research oriented career, or of course, clinicians. The teaching of medical biochemistry must take into consideration, the course content which has to be reviewed to take into account, the context

in which it is taught, the students and teachers. Medical biochemistry educators need first to define core concepts and biochemical principles that teachers and students could review (or relearn) in a short period. Then the educator will teach new concepts and medical applications of biochemistry in an in-depth fashion, via a series of carefully designed PBL (problem- based learning) or CBL (case-based learning) modules. Alternatively, medical biochemistry could be taught in various ways that integrate basic and clinical sciences that are being adapted by medical schools world- wide (Davis, 2003; Harden 2000 and Bandiera et al, 2013). A clear scenario emerges if there is an integrative curriculum involving biochemists and other related disciplines like nutrition, pathology and nonetheless, pharmacology. For example, a medical biochemist starts the day by teaching students, the biological roles of cholesterol, its synthesis, absorption, transportation and disposition and how alterations in any of these processes change the laboratory value of blood lipid tests. The pathologist then continues by teaching the disease processes resulting from dysregulation of the processes mentioned above involving cholesterol. The nutritionist follows up by teaching dietary management of cholesterol and related disorders. Finally, the pharmacologist ends by discussing various treatment options and potential for future therapies. This integrative method of teaching allows the students see cholesterol metabolism in relationship to diseases and medicine from different perspectives without delay. Some of the suggestions made by students for improving medical biochemistry are listed in tables 2 and 3 respectively, and some of the factors that may influence students' attitude towards biochemistry are given in table 4

Table2. Students' suggestions for improving the biochemistry curriculum

Reduce the quantity of "irrelevant " material taught

Improve the quality of lectures and lecturers

Highlight relevance to the practice of medicine

Table 3. Biochemistry Course Content: some points for consideration

What is the role of biochemistry in medical education and the training of doctors?

What are the areas of biochemistry which are of relevance to other medical disciplines and medical practice?

How should the biochemistry course be taught?

Table 4 .Factors that may influence students' attitudes towards biochemistry

Motivation of students towards medicine and biochemistry

Perception of the relevance of biochemistry taught to the clinical subjects and the subsequent practice of medicine

Are students' lecture and study time overloaded?

Are students too examination oriented?

NEW DEVELOPMENTS

Educators should be aware that a revised standard curriculum is available internationally for the accreditation of medical programmes. This revised curriculum include content from biomedical sciences which supports students' mastery of the contemporary scientific knowledge, concepts and methods fundamental to acquiring and applying science to the health of people. It is expected that the curriculum will be guided by clinically- relevant biomedical content from among others, the disciplines that have been traditionally titled:- anatomy, biochemistry, genetics, immunology ,microbiology ,pathology, pharmacology, physiology and public health sciences. It is worthy to note that large amount of knowledge generated by clinical biochemistry is now being accepted into clinical practice across medical and surgical disciples. The practically most important areas were the assessment of water and electrolyte

metabolism and hydrogen ion homeostasis, which lead to diagnosis and treatment of an entire range of "new " clinical disorders. Particularly important was the contribution of clinical chemistry to the diagnosis and monitoring of diabetes (that is, the introduction of glycated haemoglobin as a measure of time- averaged glycemic control in diabetic management.

THE GOAL OF MEDICINE AND MEDICAL COURSES IN FUTO

A university is an academic community and like any other community grows, expanding its length and breadth with increasing requirements to become a self perpetuating system, acquiring professionals in academics, engineering ,medicine, artisans/technicians ,technocrats and all calibre of professionals to attain equilibrium in its existence. Apart from being a community, other communities around depend on this academic community as their fore-runner and as a source of radiation for their own sustenance. FUTO is a university, desirous of a medical school as well as its catchment states. The administration should gird up its loins to fight this war of politics and intellectualism. We have all it takes to have a college or school of medicine in FUTO.

CONCLUSION

Anyone attempting to change the pattern of medical education is likely to face resistance from many quarters. Faculty and departmental staff consider such an action an encroachment on well established practices and a potential threat to academic autonomy and existing order. Any reforms on medical education, fundamental or not, should not only follow other successful new models. It must not be forgotten that biochemical knowledge must not be seen as a means to an end in the study of medicine rather than, as a discipline/subject which is satisfying by itself. Teaching biochemistry concepts and principles to medical and other students should be aimed at helping the students become scientifically literate, so as to gain the ability to be independent learners in the future, and be able to critically read and understand biomedical literatures, participate in biochemical research and projects and evaluate claims of efficacy and safety of new therapeutic strategies. This would help students become the best medical doctors and provide the best care for patients throughout their careers.

BIBLIOGRAPHY

Clark C.B.(1994). Medical graduates evaluate the effectiveness of their education. *Med. Edu.*, 28(5): 418-431

Ebomoyi M.I., Agoreyo FD (2007). Pre-clinical students' perception of their course and pre- clinical specialty choice. *Journal of Medicine and Biomed. Research*, 6(12): 47-68

Watmough S.O., Sulliman H. And Taylor D. (2009). Graduates from a traditional medical curriculum, evaluates the effectiveness of their curriculum through interviews. *Biomedical Education*, 9: 64-70

Brass P (2009). Basic medical sciences and the future of medical education, implications for internal medicine. *J. Gen. Internal Medicine*, 24(11):1251-1254

Fullon T.B., Ronner P., Lindsley J.E.(2011). Medical Biochemistry in the era of competences . Is it time for the Krebs cycle to go? *Med. Sci. Educ.*, 29(1): 29-32

Njolstad P.R., Sovik O., Cuesta-Minoz A, Bell G.I *et al.*(2001) Neonatal Diabetes mellitus due to complete glucokinase deficiency. *New Engl. Journal of Medicine*, 344:1585-1592

Wood E.J. (1990). Biochemistry is a difficult subject for both student and teacher. *Biochemistry Educ.*, 18(4):170-172

Heath C and Heath B. (2007). *Made to stick; why some ideas survive, why others die.* New York Random House

Lee, K.F., Chan AOK, Fox J.M.C. Mak M.W.H *et al.* (2013). Late presentation of viriling 21-Hydroxylase deficiency in a Chinese woman with Turner's syndrome, 19:268-271

Mehdi Afsher and Zhiyong Han (2014). Teaching and Learning Medical Biochemistry: Perspectives from student and Educator. *Med. Sci. Educator*, 24(3):339-341

Davis M.H. Harden R.M. (2003).Planning and Implementing an undergraduate medical curriculum: the lessons learned. *Med. Tech.*, 25: 596-608

Harden R.M.(2000).The integration ladder: a tool for curriculum planning and evaluation. *Med. Educ.*, 34:551-557

Bandiera G., Boucher A., Neville A., Kuper A. And Hodges B. (2013). Integration and timing of basic and clinical sciences education. Med. Teach., 35:381-387

Baynes J.W. Dominiczak M.H. eds. (2009). Medical Biochemistry, 3rd edn, 653pp. London: Mosby-Elsevier. [A current textbook of medical biochemistry, intended for medical students, with critical cases that refer to practical applications of clinical chemistry and biochemistry tests. An example of current scope of medical biochemistry and its relation to clinical biochemistry .



The role of medical biochemistry in medical education by Nwaoguikpe R. N. is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).