

The Teaching of Biochemistry In Nigerian Universities

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A. INTRODUCTION: HISTORICAL

Biochemistry may be defined as the study of the organization and function of biological systems at the molecular and atomic levels. Biochemistry is a relatively young science that emerged more strongly at the turn of the 19th Century. Biochemistry is not just the study of biology and chemistry, but has grown rapidly as a subject that deals firmly with the chemistry of substances and processes present in living things.

Progress in Biochemistry was quite impressive in the 20th Century. When Fischer (1902) first achieved the laboratory synthesis of the protein backbone (the peptide) it was not immediately realized that a major new concept in the study of living organisms has begun. The major routes or pathways in the utilization of proteins, sugars (carbohydrates), fats, amino acids and other biochemical compounds soon followed and were already being studied by the 1950s. At about this time a large number of enzymes had already been isolated in the crystalline form, and their structure, reaction mechanisms investigated. By making use of special analytical tools such as the X-ray system, and amino acid sequence analysers, linear structures of insulin. (Singer, 1953), the three dimensional structures of protein myoglobin (Kendrew, 1960) and haemoglobin (Perutz) were established.

All biochemical compounds found in living matters, namely, proteins, carbohydrates, vitamins, hormones, fats and so on, required energy to construct them. We eat and breathe to create the source of energy to build them up from simple chemical substances or to break them down, as the body requires. This has introduced a concept in Biochemistry, called bioenergetics. In 1931, Engiehardt discovered oxidative phosphorylation, a major route of energy generation for living organisms. Studies by European and American biochemists such as Engler, Kellin, Krebs, Lehninger, Chance and so on consid-

erably promoted the conceptual development of respiration mechanisms and bioenergetics. In 1961, the British biochemist Mitchell proposed the chemo-osmotic coupling theory for bioenergetics, which has now been accepted.

In 1953, Watson and Crick established the secondary structure of DNA (the molecules that carry heredity), which enabled scientists to gain deeper insight into the principles of the transfer of hereditary information. This discovery actually heralded the advent of a new trend in Biochemistry – molecular biology which is concerned with the molecular principle of the fundamental properties of all living matter, in particular, with the molecular basis of heredity. Later in 1961, Nirenberg and Mattaei discovered the genetic code, that is, the secret “point contact” arrangement between nucleic acid residues that enable the transfer of genetic information from parents to their offspring as well as in cell replication. In 1967, Konberg was the first to synthesize in the laboratory the DNA of a virus, and in 1970 Khorana (of Indian descent) synthesized an artificial gene. Thus, in the seventies, molecular biology gave birth to genetic engineering, which is now the “in thing” in Biochemistry. This is a new discipline concerned with the chemical design of genes, their transplantation in cells, their use in the correction of genetic defects and engineering enzymology.

Thus, in under a century, Biochemistry has undergone much rapid transformation. It has brought glory and international recognition to several biochemists. Many of them are winners of the Nobel prize. These include, to name just a few: Pauling, Perutz, Krebs. Monod, Kendrew, Mitchell, Watson, Crick etc.

Now, Biochemistry is making rapid in-roads in new areas such as brain and space research. Thus, in September, 1990, the longest space endurance effort was accomplished by an American biochemist in an American – Russian space cooperation programme.

Biochemistry has become an applied science, and advances in Biochemistry have found large-scale applications in various areas of industry, agriculture, medicine and pharmacy/pharmacology. Biochemistry, as an applied science, must therefore offer satisfying career prospects to biochemists. It benoves us, the stake holders, therefore, to ensure a proper training programme for the present and future biochemists. Africa should consider herself particularly in a hurry to ensure proper training of her biochemists whose important responsibility it is to handle various aspects of continental deprivations. Disease, hunger and environmental problems pose serious challenges to the Africa biochemist in particular. Therefore, properly articulated and coordinated training programme in Biochemistry is absolutely desirable. In this way, the African Biochemist must be truly seen to contribute strongly towards his own survival and carve out for himself a place of pride in scientific achievements and contributions.

B. THE NIGERIAN EXPERIENCE

1. Biochemistry in Nigerian Universities The advent of Biochemistry as a subject of study in Nigerian Universities derived from what was going on in British Universities on the subject. The establishment of the Biochemical Society in Britain in 1911 paved the way for a proper articulation of the subject and its introduction as a core subject in the University system. By the early 1950s to mid-1960s, Biochemistry was already being taught in about forty British Universities, from Aberdeen (Scotland) to York (England). Five Colleges of the University of London (Bedford, Chelsea, Kings, Queen Elizabeth, Royal Holloway and University College) were already well-entrenched in this subject.

In Nigeria, the first institution with University status was the University College, Ibadan, which was an affiliate of London University. When the University College eventually became a full-fledged University, with its own Senate, it did not take much time before a full-fledged Department of Biochemistry was set up. When the history of Biochemistry in Nigeria comes to be written, the pioneering efforts of the likes of Professor Olumbe Bassir and Agu Ogan can never be forgotten. This was in the 1960s. As more and more Universities became established in Nigeria, each of them incorporated the subject of Biochemistry in the curricula. There are Federal and State Universities in virtually all the thirty six States of Nigeria, including Abuja. In addition, of the forty two or so Monotechnics (Colleges of Agriculture,

Animal Health, Fisheries, etc) in Nigeria – State and Federal – no less than 90% of them offer some levels of biochemistry in their curricula.

In Nigeria today, there are five main categories of Universities:

- a) There are sixteen conventional Universities, of which the University of Port Harcourt is one. This university has a strong Department of Biochemistry
- b) There are five universities of Technology, such as the Federal University of Technology of Biochemistry.
- c) There are Universities of Agriculture of which there are three.
- d) There are State Universities of which there are fifteen.
- e) There are also Private Universities of which there are currently four in number. Reliable information is that most of these universities offer Biochemistry not only to award degrees, but also to service other programme areas such as medicine, agriculture, microbiology and pharmacy/pharmacology.

2. Basic Entry Qualification to Study Biochemistry

This paper will only limit the discussion on the process of acquiring the first degree in Biochemistry in Nigerian Universities.

First there is a brochure, published centrally by the Joint Admissions Matriculation Board (JAMB). This booklet contains detailed admission requirements and qualifications for admission into each of the Nigerian Universities. A potential student then studies the booklet properly before completing the accompanying JAMB examination registration form. For first degree course in Biochemistry he must have sat and passed English, mathematics, Biology, Physics and chemistry at not more than two sittings at the Senior Secondary Certificate Examination (West African Examination Council or the National Examination Council). These five core subjects must be passed at least at credit levels.

In addition to the SSCE performance, the JAMB examination results are critical because it is the JAMB examination performance that ensures the selection process into the university system. Successful candidates are selected for a minimum, of four, and maximum of six years to acquire their first

degree in Biochemistry. However, in addition to JAMB entry system, there are still a few Nigerian universities that take on some students with Advanced level passes for a shorter programme duration.

Many universities have also established a Basic or Preliminary programme for those who did not quite make it through JAMB. They are now put through a one-year pre-degree programme. Their subsequent performance in this preliminary Basic Programme determines their eligibility for entry into the first year of university study, without going through any further JAMB examination process.

3. The General Biochemistry programme

Since 1995, the National Universities Commission (NUC), a regulatory body set up by the Federal Government, has ensured that the university study programme or curricula meet certain minimum criteria. To this end, most courses a department offers its students for the purpose of the award of a degree are subject to accreditation by NUC. The process of accreditation is done every three or four years. The NUC only sets up the Minimum Academic Standard that must be attained but does not dictate to a university per se. Biochemistry is one such subject area that has been so structured such that every university in Nigeria that offers this course of study is expected to comply with the NUC Minimum academic Standard that must be attained otherwise the department may subsequently lose its accreditation. Furthermore, in addition to the NUC's guideline on Minimum Academic Standard, each biochemistry department is expected to emphasize on the concept of relevant broad-based training comprising biochemical, chemical and physical sciences as well as arts. The attainment of this objective is ensured in the various courses offered in each of the two semesters of the four-year programme of the biochemistry undergraduate study.

The study programme is such that failed courses can be re-taken, provided a student's workload per semester is not allowed to be too heavy. It is for the purpose of repeating failed courses or to allow for other exigencies such as temporary withdrawal from studies due to ill health or other cogent reasons that a degree programme can last for a period of 4-6 years.

c) BIOCHEMISTRY PROGRAMME: THE UNIVERSITY OF PORT HARCOURT EXPERIENCE

1. Introduction

In general, as a result of NUC intervention in ensuring that a Minimum Academic Standard is met by each university, there is hardly any serious deviation in the core courses taught from university to university. The standard of teaching could, however, vary slightly from university to university, depending on staff strength, basic infrastructure, etc. but NUC's accreditation exercise ensures that deviations are not glaringly different.

No serious attempt has been made here to obtain a growth chart for biochemistry admissions for each university in Nigeria. However, it is known generally that there has been tremendous growth in student population in this area in the last ten years or so nation-wide. University of Port Harcourt experience is hereby used as a model to demonstrate the process of biochemical education in Nigeria.

The University of Port Harcourt was initially established in 1975 as University college of Port Harcourt (at the Southern part of Nigeria). In 1977 the university was granted a full university status. The student population has grown from less than three thousand to nearly thirty thousand now.

On the 6th of February 1982 the University of Port Harcourt graduated 18 biochemistry students out of overall 288 students that graduated that year. In February 1983, 13 biochemists graduated out of a total of 272 students. This might seem a significant drop, but when compared in percentage terms, the biochemists constituted about 6% of overall graduands in 1982, compared with about 5% in 1983. Ten years after (1992) number of graduating students from the University of Port Harcourt had risen to 47.

In terms of actual student enrolment in the Department of Biochemistry, University of Port Harcourt (UNIPOINT) from 1997-2001, Table 1 illustrates:

Table 1

Year	No. of students enrolled
1997	85
1998	84
1999	102
2000	78
2001	98

Table 2: YEAR ONE (100 SERIES)**FIRST SEMESTER**

COURSE NO.	COURSE TITLE	UNITS
CHM 130.1	GENERAL CHEMISTRY I	3
FSB 101.1	GENERAL BIOLOGY I	3
GES 100.1	COMMUNICATION SKILLS IN ENGLISH LANGUAGE	3
MTH 110.1	ALGEBRA AND TRIGNOMETRY	3
MTH 120.1	CALCULUS	3
PHY 101.1	MECHANICS AND PROPERTIES OF MATTER	3
PHY 102.1	LABORTORY PRACTICE 1	1
		19
SECOND SEMESTER		
CHEM 131.2	GENERAL CHEMISTRY II	3
GES 101.2	COMPUTER APPRECIATION AND APPLICATION	2
CHEM 132.2	INTRODUCTION OF PRINCIPLES OF ORGANIC CHEMISTRY	3
FSB 102.2	GENERAL BIOLOGY II	3
GES 102.2	INTRODUCTION OF LOGIC AND PHILOSOPHY	
GES 103.2	NIGERIAN PEOPLE AND CULTURE	2
PHY 103.2	LABORATORY PHYSICS II	1
PHY 112.2	INTRODUCTION TO ELECTRICITY AND MAGNETISM	3
		19

It is observed from these figures that student admission figures over the last five years (1997-2001) have not significantly changed. This can be attributed to the fact that the NUC Minimum Academic Standards is being strictly adhered to, including an acceptable student: staff ratio and in line with available resources to run the programme efficiently.

The above enrolment figures do not tell all the story. They refer only to those students admitted to read for the Bachelor of Science degree. Biochemistry as established at UNIPORT is also a service course for the College of Health Sciences (Medicine), and for students studying Microbiology, Botany, Zoology, etc. when taken in that broad context, the Department of Biochemistry, UNIPORT, handles the teaching of over 3,000 students per session.

2. Registration for Courses

On admission into the university, the student proceeds immediately to register for those courses considered relevant for the biochemistry programme. Course registration is the responsibility of the student's parent department (Biochemistry). However, certain inter-departmental courses are also registered. For instance, a First Year Biochemistry student is expected to register for supplementary courses in the Departments of Chemistry, Mathematics/Computer, as well as register for university – wide courses in Communication skills in English (a part of the Gen-

eral Studies Programme). Since course registration is the primary responsibility of the parent department, designated lecturers in the department cross-check student's academic records and credentials and sign their registration forms. The lecturer who signs the registration form is also the student's course adviser. Students are not permitted to sit for examinations in courses for which they have not earlier registered. Failed courses must be re-registered by the student but the maximum of 24 credit units per semester must not be exceeded.

3. Courses Offered at Different Levels

A student who registered to read Biochemistry at UNIPORT does not really begin to study the subject in his first year at the University of Port Harcourt. He spends most of that year doing general courses in other departments/faculties. The table above shows the Year One (100 series) course structure for the First and Second Semesters, showing course Number, Title and number of Units assigned to that course.

It is in the second year of study that the student begins to study certain aspects of basic biochemistry. In addition, he takes courses in Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, Statistics for Biology, Introduction to Compute Programming, Physical Chemistry, Genetics, Heat, Light and sound and Community Service. It is also at this level

(Year Two) that students of the College of Health Science are introduced to Medical Biochemistry 1 (Metabolism – BCH 211.1). The Third Year of study takes about 70% of biochemistry courses. The rest are made up of biology and chemistry courses. Industrial Work Experience (a compulsory, nationally approved programme) is also a third year programme.

The Fourth (Final) Year of study is top-heavy with biochemistry courses. Tables 2 and 3 summarize the First and Second Semester Courses (Year Four) their Course Numbers. Students are given their research projects.

A Course Credit Unit (CU) is defined as a one – hour Lecture. Thus, if a course is taken three times a week, one hour per lecture, or two times a week (two hours and a practical class) the course is credited with 3 units. A semester lasts for about fourteen to sixteen weeks, and the academic session is made up of two semesters.

Each course (from 100 – 400 Series) has a course Description assigned to it to ensure that adequate coverage for the required knowledge is met. The Course Description enables a student to know what the course covers and the lecturer in charge so as to be properly guided also.

**Table 3: YEAR FOUR (400 series)
FIRST SEMESTER**

COURSE NO	COURSE TITLE	UNITS
BCH 408.1	BIOCHEMICAL REASONING	2
BCH 410.1	ENDOCRINE BIOCHEMISTRY AND BIOCHEMICAL REGULATION	3
BCH 415.1	CELL BIOLOGY AND GENETIC ENGINEERING	3
BCH 418.1	PLANT AND SOIL BIOCHEMISTRY	3
BCH 420.1	PHARMACOLOGICAL CHEMISTRY	3
BCH 422.1	ENVIRONMENTAL BIOCHEMISTRY	3
		17
SECOND SEMESTER		
BCH 409.2	SEMINAR	3
BCH 411.2	INDUSTRIAL BIOCHEMISTRY	3
BCH 425.2	FOOD AND NUTRITION	3
BCH 440.2	RESEARCH PROJECT	6
		15

Table 4: SUMMARY OF CREDIT UNITS

YEAR	TOTAL UNITS (FIRST SEMESTER)	TOTAL UNITS (SECOND SEMESTER)	TOTAL UNITS PER SESSION
1	19	19	38
2	24	14	38
3	18	18	36
4	17	15	32
TOTAL			144

4. Practical Training and Internships

There are two aspects of this:

a) The usual laboratory practical classes and projects, coupled with laboratory reporting. This aspect of practical training is well articulated and assigned course units for the purpose of calculating degree results. Practical classes allow for the in-depth knowledge of biochemical micro-and macromolecules such as amino acids proteins, lipids and so on. Semester examinations constitute 70% of the course grade. The remaining 30% is distributed between practical work and continuous assessment of student's performance. It is worthy of mention that computer programme is also practical in concept.

(B) STUDENTS INDUSTRIAL WORK EXPERIENCE (SIWES)

This is a well-entrenched, university-wide, nationally approved programme with a University Coordinating director appointed to supervise it. It is a skills training programme designed to expose and prepare students of Universities, Polytechnics/College of Technology/colleges of Agriculture/colleges of Education, for the industrial work situation they are likely to meet after graduation. The scheme also affords students the opportunity of familiarizing and exposing themselves to the needed experience in handling equipment and machinery that are usually not available in their institutions. The establishment of SIWES came as a response to growing public disquiet that graduates of our institutions of higher learning lacked adequate practical background. Subsequently, the Federal Government of Nigeria assigned the Industrial Training Fund. (ITF) a government industrial agency to design the SIWES Scheme. So far, the programme has been running well with funds provided by the Federal Government through the ITF.

In the SIWES scheme third year university students take up to 3-6 months to spend time in industries and establishments where they are supervised and report submitted at the end of the training period. This compulsory programme has been found useful and consistently maintained.

5. Grading Systems and the Classification of Degrees.

Examinations are set at the end of each Semester throughout the university. The following table shows the Grading System currently in use (since 1990).

Mark Score (%)	letter Grade	G r a d e point
70 and above	A	5.0
60-69	B	4.0
50-59	C	3.0
45-49	D	2.0
40-44	E	1.0
0-39	F	0.0

The information from this table is then used to compute the student's grade either for a single semester results (Grade point Average) or cumulatively (Cumulative Grade Point Average, CGPA)

The CGPA of 1.00 at the end of every academic session is required for a student to continue with his programme. Below CGPA of 1.00, a student is placed on probation. He is not allowed to register more than 18 credit units per semester. This is to enable him improve on his academic performance.

6. Writing and Presentation of Project Thesis

Final year (400 Series) students are assigned research project topics under the close supervision of an academic staff in the Department of Biochemistry. Presentation format is strictly adhered to.

An external examiner is usually invited to examine thesis and the student subjected to an oral examination.

7. Review of Examination Scripts

Students are entitled to see their marked examination scripts if they wish. Any student who felt aggrieved about the grading of a course examination may petition the Head of Department in the first instance.

8. Examination malpractices

Various forms of examination malpractices are recognized by the University. Any student found guilty of an examination malpractice shall be expelled from the University. The decision is given wide publicity and it takes immediate effect.

9. Textbooks

A list of biochemistry textbooks is normally recommended at the beginning of each academic session. But in addition, the students are encouraged to make full use of the University Library, especially for reference materials and periodicals.

The Department has often produced practical manuals for various levels of students to guide them adequately in their practical classes. Acquisition of foreign books, journals and periodicals is, however, a problem; as a result of foreign exchange difficulties.

10. Other Study Aids

Other study aids such as the use of projectors, video tapes, photomicrography materials and general practical materials are either non-existent or inadequate. The dearth of these materials poses a serious problem to the teaching process. Efforts are, however, being gradually made to redress the situation.

Now that Information Technology is growing rapidly, students have begun to make use of the available internet facilities to modernize their knowledge of Biochemistry. This is most encouraging.

D. SUGGESTIONS FOR IMPROVED TEACHING

Improved teaching is unlikely to be achieved if the following criteria are deficient or lacking:

1. Staff Development at Every level

This should be seen as provision of research facilities, opportunities to attend seminars, workshops and conferences (at home and abroad) and the opportunity to have access to current journals, periodicals and texts.

2. The Encouragement of Inter-Departmental contact Sessions

The purpose of this approach is to enable Biochemistry departments of different universities meet and exchange views and teaching experiences. In this way peculiar problems are likely to be x-rayed and solutions proffered. Nigerian Society of Biochemistry and Molecular Biology (NSBMB) is already promoting this ideal.

3. The Encouragement of Regular Tutorial Classes

As a result of rather high student: staff ratios in many subject areas, tutorial classes in which postgraduate students are expected to play an active role should be encouraged. The additional knowledge which students gain in this exercise should be expected to improve their understanding of formal lecture materials and consequently improve the overall learning process. There is, however, the problem of exploring adequate support staff for effective tutorial classes because of financial constraint.

4. International Exchange of Teachers

At the present time limited academic collaboration and linkages do exist between foreign universities. This arrangement should be seriously encouraged. It is hoped that the FASBMB and IUBMB should get together and work out a collaborative package which can be financed by UNESCO. Such a programme should finance short-term travels of experienced teachers to African universities to assist the latter to cover deficient teaching areas in their biochemistry programme.

5. The Use of the Information/Communication Technology (ITC) Systems.

The use of the computer and the access of vast amount of information through the Internet is a fast-growing process of unimaginable advantage. Every possible pressure should be mounted by each university on the government of the day to provide the enabling environment that provides the opportunity for the teacher and student to have wide access to the IT through the internet. Biochemistry departments within and outside the country can exchange ideas which may prove extremely beneficial to teach. To this end, the FASBMB should expand its website to incorporate the contact addresses of all affiliate biochemistry bodies, including their fax and e-mails.

6. Assessment of Teaching Standard by Students

This concept is usually considered controversial because of its possible abuse by students. But if properly handled it will definitely enhance the teaching process. But we must ensure that the teacher is adequately provided with teaching materials.

7. Teacher/Student Interactive Sessions

This should be encouraged to offer a good opportunity for staff and student to exchange useful ideas over matters of mutual academic interest.

8. Reading habit

Student must be encouraged to cultivate serious reading habit to supplement the teaching session.

9. Incessant Disruption of Teaching by Strikes

It is unfortunate that this has become a regular event in many universities. Efforts must be made to discourage this and create the enabling environment for industrial peace.

10. External assistance to procure for current journals/periodicals, laboratory equipment and biochemicals.

Though this process is currently on-going, the scope

is so far limited. It is suggested that FASBMB should expand this scope by involving more international donors and the IUBMB.

E. CONCLUSION

Advancement in the academic processes is growing on daily basis. Consequently, it behoves the university system – the center of knowledge and learning – to continually modernize the teaching sector. This involves, among other things, collaboration/cooperation at both national and international levels. There must be the deliberate need to grab the modern technologies such as the information technology system. Both staff and students must have access to it.

The establishment of minimum teaching standards such as we have in the Nigerian universities should be emulated by other countries. There are several advantages from this arrangement.

FASBMB should collaborate more effectively with IUBMB to redouble efforts for the sourcing of teaching materials particularly for African universities who need such assistance.

Although this paper has concentrated on biochemical education at the undergraduate level, postgraduate education is equally important. Both the practical and theoretical aspects at this level should not be underrated. For instance, it is at this higher academic

level that the more challenging areas of molecular biology and biochemistry, acquired through a higher degree in Biochemistry is better appreciated. The postgraduate can better understand the use of biochemistry as a tool to fight hunger, disease and ignorance in the African continent in particular, and in the world general

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