

UNIVERSITY OF PORT HARCOURT

**“LIFE WITHOUT ENZYMES –
A MIRAGE?”**

A Valedictory Lecture

By

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PROGRAMME

- 1. GUESTS ARE SEATED**
- 2. INTRODUCTION**
- 3. THE VICE-CHANCELLOR'S OPENING REMARKS**
- 4. CITATION**
- 5. THE VALEDICTORY LECTURE**

The lecturer shall remain standing during the citation. He shall step on the rostrum, and deliver his Valedictory Lecture. After the lecture, he shall step towards the Vice-Chancellor, and deliver a copy of the Valedictory Lecture and return to his seat. The Vice-Chancellor shall present the document to the Registrar.

- 6. CLOSING REMARKS BY THE VICE-CHANCELLOR**
- 7. VOTE OF THANKS**
- 8. DEPARTURE**

PROTOCOL

Vice-Chancellor, Sir

Members of the Governing Council,

Deputy Vice-Chancellors,

Registrar and other Principal Officers of the University

Provosts of College of Health Sciences,

Deans of Faculties,

Heads of Departments and Directors of Institutes,

Distinguished Professors and Colleagues,

Students of the University of Port Harcourt,

Ladies and Gentlemen of the Press,

Distinguished Guests.

DEDICATION

To the numerous students (undergraduate and postgraduate) who passed through my Enzymology and other Biochemistry classes and undertook researches under my supervision over the past 39 years

PREAMBLE

I wish to appreciate the 9th and ‘Golden’ Vice Chancellor of this great and unique University of Port Harcourt, Prof. Owunari Abraham Georgewill, for approving that I deliver this parting lecture number 39 today. It is notable that he was amongst the students in my Introductory Biochemistry lectures many years ago!

Valedictory lecture commonly describes a parting lecture at the end of a career and could take any slant depending on the choice of the lecturer. In my case, choosing what to talk on oscillated from giving a discourse that is generalized, to being tailored to my foray in the academic life of our university system, and a stewardship account of my contributions mainly in the field of my specialization of Enzymology in Biochemistry. I finally settled to direct my lecture on the topic: ‘Life without enzymes: a mirage?’. This was midwived from the titles of the 6th Inaugural lecture on 9th July, 1987 (“In Praise of Enzymes” by Late Professor Emeritus E. O. Anosike) and the 124th on September 10, 2015 (“Continuing the praise of Enzymes” by my humble self).

ACKNOWLEDGMENT

I would wish to begin this segment by thanking the Almighty God for keeping me to this day and guiding me through the many stages of life, some challenging, others feeble and filled with joy. He alone guided me through the expanded career as a university worker for over 39 years and for making this day a reality. I appreciate the roles played by some of the various past substantive and acting heads of this University with particular mention of Prof. Sylvanus J. S. Cookey, late Prof. Ademola Salau, late Prof. Emeritus Nimi Briggs, Professors Don Baridam, Joseph A. Ajienka, Ndowa. E. S. Lale, and Steve Okodudu, for providing enabling environment in the University for me to serve the institution. I cannot fail to appreciate my lovely wife (Dr. Nkechinyere) and children (Okechukwu -civil engineer, Chukwudi -civil engineer, and Chinenye -geologist). All are alumni of Unique Uniport, for their unalloyed support as I took the steps in my academic career as an Enzyme Biochemist. They provided enabling environment both at home and other places to ensure the success. To my late parents (Pa Rufus and Ma Paulina), your efforts in ensuring we, your children, had good education that propelled us to where we all are today, was not in vain. Proudly, all of your nine children are graduates with two, attaining Professorial ranks in Nigerian Universities.

My siblings went a long way to catalyse my development of the academic status, especially during the 6 years I was in Canada, by upholding the home front. Special mention is my eldest sister, Prof. Patience Onokala (retired Professor of Geography, UNN) who paved the way for my postgraduate training. I appreciate all of them.

I must not fail to recall the financial support as a Federal Scholar from the Federal Government of Nigeria during my undergraduate year as well as the Province of Alberta, Canada, whose fellowship went a long way to enabling me obtain a doctoral degree in Biochemistry. Together with my able supervisor, Dr. Neil Madsen and her laboratory supervisor, Shirley Shechosky, both of blessed memory, as well as the numerous postdoctoral fellows in Madsen's laboratory, they all made my day! I remain grateful to you all.

To my St. Nicholas (Anglican) Church, Omuoko-Aluu, Uniport, I am deeply grateful for the spiritual warmth provided to enable me see this day (past and present Vicars, too numerous to mention).

What can I say of the comradeship enjoyed with my membership of the Port Harcourt branch of Government Secondary School Owerri, my secondary school alma mata. In particular, I remember, late Professor Emeritus S. N. Okiwelu (a very senior Old Boy) and our indefatigable past and present Chairmen (Engr. Degbara Nwilene and Dr. Richard Ofuru). You all indeed are part of the success story. Not to forget Agulu Boys' Secondary School in Anambra that provided me the final avenue to conclude my secondary education in 1974 after series of events made it difficult to conclude at Owerri the previous year.

To my numerous students (undergraduate and post graduate), it was rewarding being there for me as I toured the journey of life with the wonder molecules, Enzymes! I must not forget my colleagues (past and present) in the Department of Biochemistry, Faculty of Science, and the entire Unique Uniport. Words fail me to express your invaluable contributions to my story. I also wish to acknowledge our

family physicians, Alabo Dr Boma Lawson (former Director of Health Services of Uniport) and Professor John Raphael, who God used to keep us going in event of health issues. Your role in our lives cannot be forgotten. Finally, to those I have failed to acknowledge due to memory gaps and time constraints, including those in the wonderful audience in this auditorium, I appreciate you all for being here to listen to my narrative.

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INTRODUCTION

What are enzymes?

From the onset of science, matter was subdivided into non-living and living things, with the remarkable difference being that living things undergo many chemical processes that sustain their living-nature. With further developments, it was observed that these processes were complex, requiring the action of components of the living systems for the life in these forms of matter.

However, the nature of the major players in this important characteristic was plagued with disagreements as some scientists proffered that they were chemical in nature while others supported the view that they were biological matter. The term 'enzyme' was introduced in 1877 by Wilhelm Friedrich Kühne, a Professor of Physiology at the University of Heidelberg. It stands for the Greek word 'en leaven' but could also stand for 'in yeast' as later reports stated, and represented the vital force for the various chemical reactions that characterised living things.

Many centuries before this important development numerous observations on the activity of this biological matter were made but no definite agreement was reached on their nature and characteristics. On historical note, as far back as 400 B. C., Ancient Egyptians were reported to have used processes of preservation of foods and beverages, as well as cheese making, all driven by what we now know as enzymes. In 1783, the famous Catholic priest, Lazzaro Spallanzani, working on biogenesis of biomolecules, concluded that a force exists which makes living organisms to create self if given sufficient time in certain kinds of organic matter and called it 'life-generating force'. By 1812, Gottlieb Sigismund Kirchhoff,

during investigation of the conversion of starch to glucose, demonstrated the involvement of this biological matter. The action of diastase was reported in 1833 by the French chemist, Anselme Payen, and this was quickly followed in 1835 by the report of the hydrolysis of starch by the same material by Swedish scientist, Jöns Jacob Berzelius. Subsequently, Dubonfout demonstrated the action of invertase in 1846.

A major breakthrough in the discoveries was seen in 1862 in the work of Louis Pasteur, along with Ferdinand Cohn and Robert Kuch, which concluded that fermentation of sugars to alcohol by yeast was done by a vital force contained in the yeast cell called 'ferments', thought to function only within living organisms. By 1884, the Japanese Jokichi Takamine discovered takadiastase, a form of diastase from the microorganism *Aspergillus oryzae*.

Eduard Buchner demonstrated the conversion of glucose to ethanol by a cell-free extract from the yeast cell in 1897, suggesting that the so-called 'living force' or 'ferments' could be active outside living systems. In 1908, Otto Rohn, a German scientist, introduces application of pancreatic enzyme with inorganic salt in tanneries for 'bating' of hides. Despite these advancements, the nature of this biological matter remained controversial.

A feat by James B. Sumner of Cornell University in 1926 provided the strong evidence on the nature of enzymes. Sumner and other colleagues purified in pure form and crystallized the enzyme, urease from jack bean. This achievement earned him a Nobel Prize which he shared with John H. Northrop and Wendell M. Stanley in 1947. The latter two discovered a complex procedure for isolating pepsin, a procedure since applied to crystallize several enzymes

(Bennett and Frieden, 1969). With this development, the controversy on the nature of the 'vital force' or 'ferments' reported earlier by several researchers, was laid to rest. Since then, over 10,000 different enzymes have been described.

As stated by Anosike (1987), "the story of enzymes is the story of the subject 'Biochemistry', for it is impossible to talk about biochemical reactions without the enzymes that catalyse or speed them up".

NATURE OF ENZYMES

Following the purification to purity, it was deduced that enzymes are biological macromolecules called proteins which are made up of amino acids that are linked to each other by peptide bonds to form polypeptides. These polypeptides are folded in nature to produce the 'native' or 'natural' structure of enzymes. These biological catalysts convert substrates to products through well-known chemical events. The region where the enzyme interacts with its substrate is the 'active site'. Some enzymes contain non-protein materials, required for their activity and these are called 'prosthetic groups' or 'coenzymes'. Several factors such as enzyme concentration, concentration of the substrate, hydrogen ion concentration (pH), temperature and effector molecules (activators and inhibitors), are known to affect enzyme activity. These factors have been exploited in many ways towards modulating the activities of enzyme to solve a number of industrial and medical issues and may become evident as this lecture progresses.

APPLICATIONS OF ENZYMES

A wide range of applications have been described for enzyme in different industrial applications such as biotechnology products of food/beverages, cleaning supplies, clothing, paper

product, transportation fuels, pharmaceuticals and monitoring devices. Enzymes have also been used in medicine for diagnosis, diagnostic and therapeutic applications.

Industrial applications

- a. Animal feeds – plant materials, cereal, vegetables proteins that are found in feeds are not fully digested without addition of external enzymes. This arises from non-starch polysaccharides (NSP, commonly called fibre) and complex proteins. Examples of enzymes applied include α -amylase, xylanase, protease, β -glucanase, phytase, cellulase, in various combinations
- b. Baking – basic materials is flour which contains gluten, starch, NSP and lipids, among other compounds. Dough preparation requires the action of yeast which ferments the sugars present into alcohol and CO₂ which causes the dough to 'rise'. These events are enzymatic (involving starch-degrading enzymes like amylase). For biscuits/crackers, 'soft flour' is used with low protein content. Weakening of gluten requires introduction of reducing agents, the common one being sodium bisulphite (damages vitamin B1). This agent has been banned in many countries including Nigeria. Protein-degrading enzymes are softer alternatives (bacterial/fungal protease).
- c. Detergents – various compounds known to soil fabrics are best removed by enzymatic action, for example:
 - i) grass, blood, egg, human sweat by protease as non-enzymatic detergents produce oxidation/denaturation caused by bleaching and drying
 - ii) grease spots are problems with blends of cotton and polyester; as well as fats, butter, salad oil, and sauces but removed easily by lipases, which are incorporated in dish-washing detergents

- iii) starch-based foods like potatoes, spaghetti, custard, gravies, chocolate, removed by amylase
 - iv) fluffy-look on cotton/cotton blended cloths arise from micro fibrils but brightening can be achieved with cellulose which degrade these micro fibrils; also removed are dust particles
- d Textile/Leather- hides and skins contain protein and fats in between collagen fibres, and must be removed before tanning. Protease and lipase used for soaking, bating and enzyme-controlled dehairing. Bating de-swell swollen pelts and prepares leather for tanning (makes leather pliable). Starch and size lubricants is added to yarn before fabric production for fast and secure weaving. De-sizing achieved by amylase and lipase actions
- e. Brewing – traditional beer production begins with ‘mashing’, a process in which crushed barley malt and hot water is mixed at raised temperatures. The product is called ‘wort’. Apart from malt, other starch-based cereals like maize (corn), sorghum, rice or pure starch are added as adjuncts. Proteins also play roles as part of the fermentation of the wort by providing soluble nitrogen compounds needed by the yeast to react. The addition of proteases could add more soluble products for the yeast. Furthermore, slow filtration of wort and the final beer is a common problem arising from certain polysaccharides (β -glycans and pentosans). The addition of β -glucanase during the mashing circumvents the problem. The enzymes applied in brewing include heat-stable α -amylase, glucoamylase, bacterial proteases, and β -glucanase.
- f. Alcohol production – the starting materials for fermented alcohol drinks include maize/corn, rye and barley, and wheat for whisky, and other cereals for grain spirits. Starch is the basic ingredient of these materials, and is

acted on by yeast to form alcohol. The process occurs in two stages (liquefaction and saccharification). Commonly, enzymes are provided for the process by adding malt, but industrial enzymes offer advantages over the malt. Liquefaction (gelatinization of starch by pressure-cooking) which has been replaced in modern times by lower temperatures using α -amylase, and saccharification using glucoamylase to break down the starch molecules and dextrin. When other cereals are used, the low soluble nitrogen gives rise to slow yeast growth which is overcome by the addition of β -glucanase and pentosanase. Other enzymes applied include α - and β -amylases for liquefaction, glucoamylase and fungal α -amylase for saccharification, bacterial proteases for better yeast growth and reduced fermentation time.

- g. Food industry- the modification of food flavour achieved by presence of synthetic esters of short-chains fatty acids and alcohols. Lipases are applied as natural modes of fragrance and flavour determinations. Other roles for lipases include the fermentation step in sausage manufacture requires lipases; fat-removal during the processing of meat and fish (bio lipolysis); refining rice flavour; modifying soya bean milk, enhancing aroma and speed of fermentation of apple wines. Mention has to be made of the research done by Anosike and others which provided the basis for the control of browning process of foods through addition of inhibitors of the browning-causing enzyme, polyphenol oxidase.

Applications in medicine

A number of enzymes are used as 'diagnostic enzymes' and this arises because of the specific actions of enzymes that make it feasible to determine their activities even when other compounds and proteins are present. Normally, very few

enzymes are found in body fluids, with most of them arising from normal cell death in a living organism. There are some though that naturally occur in body (example. enzymes involved in the blood clotting process). In disease conditions, cell death rate increases leading to rise in amount and number of enzymes in body fluids. The measurement of the levels of such marker enzymes known to be specific to the organs and tissues play significant roles in medicine. Two classifications are made in use of enzymes in medicine: (a) in diagnosis and (b) in diagnostics (biosensors).

Use in diagnosis:

S/n	Disorder/disease state	Enzyme(s)
1.	Bone disorders, autoimmune and Alkaline phosphatase, Cathepsin D, Rheumatoid arthritis Tartarate-resistant acid phosphatase	Inflammatory disorders Gelatinase B, Lysozyme Periprosthetic joint infection Leucocyte esterase
2.	Cancer Breast Bone metastasis	Cathepsin D, Lactate dehydrogenase Tartrate-resistant acid phosphatase (isoform 5b)
	Hepatocellular carcinoma	Alanine Transaminase
	Gastric cancer	Glucose-6-phosphate dehydrogenase
	Prostate cancer	Prostatic acid phosphatase (PAP)
	Premalignant lesions in colon, thyroid, brain, liver, breast, prostate Germ cell malignancy	Cysteine cathepsins Lactate dehydrogenase
3.	Diabetes (type-2)	Alkaline phosphatase
4.	Gaucher's disease	Acid phosphatase
5.	Liver disease	
	Jaundice/hepatitis	Alanine transaminase
	Liver fibrosis	Aspartate transaminase
	Liver damage	Lactate dehydrogenase -5

6.	Myocardial infarction	α -amylase, creatine kinase (MB), gelatinase A and B, Glycogen phosphorylase b, Lactate dehydrogenase -1
7.	Pancreatitis	Amylase and Lipase
8.	Dental disorders	Aspartate transaminases, Cathepsin D
9.	Renal disorder	Urinary lysosomal glycoside, Urinary lysozyme
10.	Skin disorder	Lipase
11.	Schizophrenia	Butyl choline esterase
12.	Intracerebral haemorrhage	Aspartate transaminase

Diagnostics (biosensors):

The emergence of biosensors (devices made up of biological sensing element that is linked to a transducer that could produce detectable data of the event) has gone a long way to assist in many industrial but mostly biomedical applications. Some examples are:

Glucose - a quick and reliable measurement of glucose levels in fluids involves the interactions of three enzymes (hexokinase, glucose oxidase and glucose-1-dehydrogenase). The actions of these enzymes are linked to develop a colour reaction that can be used to quantify the glucose levels in fluids, a valuable tool for diagnosis of diabetes mellitus.

Lactate - blood lactate level is a sensitive determinant of oxygen deprivation of tissues arising from ischaemia, trauma and haemorrhage. A number of lactate sensors have been described based on immobilized lactate monooxygenase and lactate oxidase.

Creatinine - estimation of creatinine is vital for renal, thyroid and muscle function evaluations. A number of biosensors developed generally employ creatinine deaminase.

Urea - fast and accurate measurements of urea in urine and blood samples are necessary to evaluate renal and liver disorders. Biosensors based on urease, which catalyses the conversion of urea to hydrogen carbonate and ammonium ion has been developed. In fact, the action of urease is crucial for the effective renal dialysis for patients with kidney disease or failure.

Other diagnostics (biosensors) are listed in the following table:

S/n	Compound detected	Enzyme(s)	Disorder/disease state
1.	Creatinine/Creatine	Creatinine amidohydrolase, Creatinine amidino hydrolase Sarcosine oxidase	Renal/thyroid muscle function
2.	Glutamate	Glutamate oxidase	Neuropathology
3.	Carnitine	Carnitine dehydrogenase & diaphorase	Carnitine deficiency, renal insufficiency, diabetes mellitus, etc
4.	Theophylline	Theophylline oxidase	Determination of theophylline (e.g. asthma)
5.	Cholesterol	Cholesterol oxidase	Atherosclerosis
6.	Amino acid (D-serine)	D-amino acid oxidase	Brain disorder (e.g. schizophrenia)

7.	Acetyl choline & choline	Acetyl choline esterase & choline oxidase	Neurological problems
8.	Bilirubin	Haemoglobin & Glucose oxidase	Jaundice
9.	γ -amino butyric acid	Gabase & Glutamate oxidase	Neurological problems
10	H ₂ O ₂	Horse radish peroxidase	Determination of cerebral peroxides

Enzyme therapy:

This deserves mention here as it is currently an important area of application of enzymes in medical practice. In focus are lesions that arise due to either lack of or presence of defective enzymes in the human body. Several factors could produce this. The most logical way of treatment is to make available the enzyme that is either lacking or defective. Ways to introduce this include oral administration, but several difficulties occur that include ensuring target sites are reached in addition to antigen-antibody reactions. Encapsulation has been introduced as a way of shielding the exogenous enzyme. In fact, successes have been made by the Canadian commercial product, Caelyx, licensed for treatment of Kaposi's sarcoma, a cancer found more commonly in AIDS patient (the stealth technology).

My journey with enzymes

Phase I

Like many human affairs of destiny, this started by default as the study of enzymes in Biochemistry training posed a frightening stance for us during my early undergraduate studies at the University of Nigerian, Nsukka where notable Biochemists (Late Professor G. Umezurike and Late Professor

Emeritus E. O Anosike, amongst others) where our lecturers. Upon graduation in 1978, and completion of the mandatory NYSC service (1979), I ended up enrolling for an M. Phil. Degree in Biochemistry at the University of Nigeria, Nsukka. I had then Dr. C. O. Echetebe as my project supervisor with the research titled ‘sourcing of local raw materials for brewing’, and this entailed malting sorghum (Guinee corn) as an alternative to barley for beer production. At that time, there was a strong interest in seeking alternative sources for barley malt, a major raw material for the brewing industry, with the plan to ‘regulate’ the importation of this material into the Nigeria to stem drain of foreign funds.

The focus was to determine the optimal conditions for malting, which requires measurement of α -amylase activity during germination (malting) of the sorghum. While this research was ongoing, I secured a Graduate Teaching assistantship, through the assistance of my elder sister, retired Professor P. C. Onokala of the University of Nigeria, Nsukka, who was undertaking her Junior Fellowship training in Geography at the University of Alberta, Edmonton, Canada. By this time, the dearth in procurement of reagents together with poor power supply (enzyme research requires maintain working environment at regulated temperatures) presented challenges with my furthering my postgraduate studies at the University of Nigeria. Thus, I opted to relocate to Canada in September, 1980 to take up the offer from a renowned enzymologist, Dr. Neil. B. Madsen (of blessed memory). Thus started my academic career with enzymes and as it turned out, I ended up as his first Ph. D. product of the numerous postgraduate student he trained. Notable was the fact that his previous students usually end up with a Master’s degree due to the seemingly ‘tough’ requirements to conclude enzyme research. I researched on substrate-level regulation of protein

phosphatases involved in modulation of the key enzyme, glycogen phosphorylase, in glycogen metabolism. Some synergistic effect was seen by glucose and caffeine on the activity of the phosphatase. Glucose is found commonly in human system but caffeine is not. Earlier findings from researchers, notably Madsen and collaborators had identified a distinct site on glycogen phosphorylase, the substrate for the phosphatase, to which caffeine binds, producing conformational changes to the enzyme, but the natural compound that interacts with this site *in vivo* was undefined. However, the function of this caffeine-binding site was therefore probed by the use of this compound. My assistantship after a year, yielded a Fellowship of the Alberta Heritage Trust Fund for Medical Research award that enabled me to complete a Ph. D. programme at the University in 1986. The funding afforded decent living that saved me from doing odd jobs as many foreign students undertook to foot their tuition and upkeep!

Phase II

As far back as 1979, the scourge in improved conditions of academic career in Nigeria had set in with many relocating abroad (Jappa syndrome started long ago!). However, I remained committed to the vision of assisting with a halt in the slide after my programme and thus, upon completing the Ph. D. program in 1986, sought a return to Nigeria and contribute my quota to national development. At the time, it was evident that acquiring reagents for biochemical and other scientific research in Nigeria was becoming difficult due to lack of local organizations and marketers for such fine biochemicals and other specialized reagents. So, my first desire was to have it as a priority. Events showed my dreams were frustrated by the state of affairs on ground as poor facilities put a hold on the dream.

I was offered lectureship positions by several Nigerian Universities while in Canada, but settled for the University of Port Harcourt where my then undergraduate lecturer, late Professor Emeritus E. O. Anosike turned out to be the Head of the Department of Biochemistry at the University. He facilitated my temporary appointment with the approval of Professor S. J. S. Cooke, the 2nd Vice Chancellor of Uniport whom I was to encounter later as member of the congregation of St. Nicholas (Anglican) Church, Omuoko-Aluu, Uniport where I had several occasions to serve in various committees under him in the church. And so, my romance with Enzymology was given a boost as late Anosike and I partnered to advance this aspect of Biochemistry of the Department of Biochemistry which is the reason we are here today to listen to my narrative at the formal end to a rewarding academic career, on these wonder molecules that are central to living things!

Phase III (My roles/vision)

It is traditional for Enzymologist to tag unto an enzyme for their research where they go through various aspects of it (purifying, characterization, regulation, mechanism of action, among others). I had that vision. However, upon returning after my postgraduate training in the University of Alberta, Edmonton, Canada, I found I could not follow-up which the glycogen phosphorylase a phosphatase, particularly the objective of identifying the natural occupant of the caffeine-binding site shown by previous studies. I had even planned further experiments, but what I met on ground deflated my dreams. I had also noted the serious deficiency in the procurement of fine biochemicals needed for enzyme studies. This was further handicapped by lack of steady electricity, a necessary requirement for keeping enzymes active and ‘happy’ during purification, storage and even experimentations (one really needs 24-hours daily supply to operate refrigerated

centrifuges, perform experiments at about 4° C and commonly cold rooms are vital but lacking in our environment). The dream to also challenge local production of the fine biochemicals for not only enzyme research but other aspects of research in Biochemistry were made highly difficult to attempt foray into this aspect.

I cannot forget an experience late Professor Emeritus E. O. Anosike and I had sometime in the late 1980's. We had a postgraduate student whom we were jointly supervising. He needed a common biochemical ATP (adenosine triphosphate) a component of the assay mixture for Na^+/K^+ -ATPase for his research. In those 'good' old days, University Senate research grants were available and we applied and secured N184,000.00 for a proposal that encompassed his project. Part of this sum was made available to our PG student to procure the white-crystalline salt. When he presented the result of his experiment to us, we could not make any sense of it, so he was asked to bring the ATP salt he used. Behold, it was a black-coloured reagent which he bought at Ariaria market in Aba. What a drain of resources!

Since it was becoming frustrating to follow the traditional research track for enzymologist due to the limitations addressed above, it dawned on me that a re-direction was need. Thus, the foray into shifting focus to general aspects of enzyme biochemistry. Most of the researches conducted during my career span delved of local sourcing of industrial enzymes from microbial organisms, using enzymatic analysis to monitor efficacy of bioremediation of crude oil polluted soils, investigating protective and ameliorative effects of numerous indigenous plant products that have been purported to have positive medicinal applications. Some of these were

highlighted in my Inaugural lecture and others followed after, and would receive brief mention here.

(i)The medical condition of Sickle cell syndrome, which afflicts a good number of people of black race was receiving increased interest when I joined the Department as a Staff. I teamed up with other researchers (Professor Emeritus E. O. Anosike, Professors G. I. Ekeke and G. O. Ibeh, all of blessed memories) and Professor (then Dr.) A. A. Uwakwe) to study three key enzymes known to play some part in the metabolism of the human erythrocyte. The enzymes involved were Glutathione-S-transferase, NAD(P)H Diaphorases and three ATP-ases (Na^+ , K^+ -; Ca^{2+} -; and Mg^{2+} -). Our findings showed notable variances or otherwise in human erythrocytes from the three genotypes (HbAA, HbAS and HbSS) as well as possible molecular mechanisms of ameliorating effects of plant extract relating to the roles of these enzymes in permeability/fluidity of the red cell membrane. It is notable that some of the background research findings aided the development of Sicklervit, a formulation from *Cajanus cajan*, developed further by Late Professor G. I. Ekeke. This has remained a mediator for assisting sicklers deal with the haemolytic crisis seen in Sickle cell disease management. Another plant product with promising effects we studied, was *Garcinia kola* seeds (bitter cola).

Other research activities undertake centred on enzyme activities applied in the evaluation of impact of *Carica papaya* (paw-paw) for anaemia, *Jatropha curcas* seed for wound healing, effects of some hepato-protective and ameliorative actions of *Ocimum gratissimum* (O. G.) (scent leaf) and others. In addition, the application of - *Citrullus lanatus* (Water melon) seed, *Teracarpidium conophorum* (Walnuts) and

Vernonia Amygdalina (Bitter leaves) for treatment of diabetes were evaluated in experimental animals.

Furthermore, involvement of enzymes in bioremediation of crude oil impacted soils by some microorganisms (*Schwenkia americana* L. and *Spermacoce ocymoides* Burm. f.) was undertaken. In the Niger Delta where crude oil exploration is heavy, cases of spillages occur regularly with negative consequences to the environment. This research demonstrated the effective degradation of crude oil contaminants, achieved by enzymatic activity inherent in these microorganisms studied. Such natural processes offer better route for restoring impacted soils without introducing complications from conventional chemical approaches widely used.

Time will not permit to elaborate on the details of many of these researches. Moreover, delving into these would make this presentation too academic! However, it is pertinent to point out that they all pointed to significant relevance of enzymes in all these processes.

Global Market for Industrial and Medical applications of enzymes

It had been estimated that global market for industrial and medical enzymes respectively stood at US\$3.3 billion and US\$3.3 billion in 2010, projected to reach US\$4 billion and US\$7.2 billion in 2015. Further projections now show a global market value of \$13.94 in 2024 and 20.31 in 2030 for industrial enzymes. Figures for medical applications projects from \$14.0 billion in 2024 to \$20.4 billion in 2029, a substantial growth as enzymes are the bedrock of analytical/biosensors for medical applications and used in therapeutics. The Industrialized continents notably North America and Europe have a lion share of over 80% with Africa

contributing an abysmal 1-2%! There is need to refocus our activities in Africa (Nigeria in particular) to delve into this growing business enterprise.

SOME REFLECTIONS

University-wide Research Development:

As the University forayed into research development, creations of enabling units to foster this important activity blossomed. One of such is the Endowment of Professorial Chairs with Chair Occupants. Some were endowed by Professional organizations while other were by individuals. Following endowment of a N5 million (N1million per annum) Emmanuel Anosike Chair of Biochemistry by Family and friends of late Professor Emeritus E. O. Anosike in 2012, I was appointed the first Chair Occupant in December, 2012. This endowment was envisaged to lead to a Centre for Enzymology Research. However, after the initial seed fund of N1million, further progress was hampered by the travails of dearth in functional laboratory and other handicaps highlighted earlier. It took till November 2013 to execute the Trust Deed due to administrative bottle necks. In fact, the seed fund was never expended and this discouraged further funding. It is sad to note that there are many listed Professorial Chairs that have fizzled out in this University over the years. Efforts should be geared to ensure streamless take-off of this noble venture of encouraging research developments.

Secondary roles as Academic Staff:

Another area of concern is the attitude of Academic staff involved with secondary activities with Institutes, Research Centres and other ventures, who pay more attention to them than their primary place of employment. Some do not give any decent time for the programs in their parent place of academic responsibilities. Students in parent departments are given

second-hand placements to the advantage of the institutes and centres because of financial perquisites. Granted, these additional academic activities are important to the growth of the University but should not overshadow the quality of delivery to the primary engagements. Granted, they have additional loads but there should be conscious effort to strike a balance!

PARTING WORDS

On future research point of view, there are numerous frontiers yet to be delved in. For instance, the tirade of concussions that we see being paraded as wonder drugs with numerous claims of what ailments they can cure need to be investigated with a view to determining their efficacy and safety. This, no doubt, would require inter-disciplinary efforts by such researchers as pharmacists, clinicians, botanists, chemists, to mention but a few. Indeed, the concept of reverse-pharmacology is relevant here. It is notable that many research findings showing promissory outcomes to the efficacy of many plant products in protecting and ameliorating numerous medical derangements using experimental animal models are dotting the shelves of departmental and personal libraries, further investigation to clinical studies with human subjects are lacking. This trend needs to be reversed so that the benefits of the rich foray of plants in our localities can be exploited for humanity, not only in earnings (consultancy seem to have vanished in our clime: I recall the past establishments like CORDEC which went a long way in bridging the town and gown divide with mutual benefits to all) but to advance the science so far encountered. Today, not enough control is exerted on what benefits come from individual researches as relates to the University that provides most of the enabling environment.

However, for meaningful progress there should be steady and consistent effort at providing the enabling environment that would ensure adequate electricity supply to maintain the fine biochemicals and other materials employed in such fine biochemical investigations. Thankfully, with high hopes for the commissioning of the Solar farm in the University soon, this drawback will be history!

There is need for concerted effort at providing relevant equipment and conditions that will facilitate the ‘feel’ of students of enzymology since present conditions leave much to talk of. In fact, a good number of graduates in the field of Biochemistry and related fields do not demonstrate any level of understanding of the role, character and practical applications of enzymes. A major difficulty is lack of adequate equipment and reagents for enzyme research. While some efforts have been made in centralizing equipment through the Central Instruments Laboratory of the University, more input is required to achieve meaningful results. The practice in developed world is for joint ventures by related disciplines in acquisition of equipment of common use since independent units cannot afford to have all that is required for excellent research activities.

It is indeed heart-warming that this University is to host Zonal Centralized Research Facility being developed by the Federal Government of Nigeria. While this would go a long way in resolving this matter, it is worrisome that levels of suitable feasibility and inputs from relevant end-user academia in this venture, to the best of my knowledge, are not convincing. For research in Enzyme biochemistry, without ‘cold rooms’, not much progress will be made!

Furthermore, I join those who advocate that the system of academic evaluation of multiple authorship publications should be reviewed such that academics are not disadvantaged in their assessment scores since it is clear that multi-disciplinary research has come to be a trend that provide more meaningful outcome to result-oriented research.

With the great economic potential of industrial and medical enzymes in global market, if the environment is improved significantly, Nigerian enzymologist can key into the market with the obvious implications for improved earnings to the country. There are a lot of requirements for these enzymes in our industrial and medical practice. It is however regrettable that the increasing demand and usage of enzymes in industrial and medical practice in Nigeria and Africa is largely skewed in favour of foreign supply. It is hoped that this trend will be reversed in the near future when cogent steps are taken to encourage our scientist in developing this highly profitable venture in science development.

Town and Gown interplay:

There has always been the need for town and gown to interface for maximum benefits of academic discourse in provide meaningful development of nations. This gained a lot of traction during my years as an academic staff in this University. However, while preparing for this lecture I had a perusal of the first in the series of Valedictory lecture presented on 4th November, 2006, by my revered mentor, Professor Emeritus E. O. Anosike of blessed memory. His lecture, titled ‘Desecration of the Ivory Tower’ jolted me when I observed that many of the issues he raised then (about 19myears ago) remained in the midst of University affairs. These range from the abrogation of the concept of ‘University’ having an international component, to the present low-morale of the

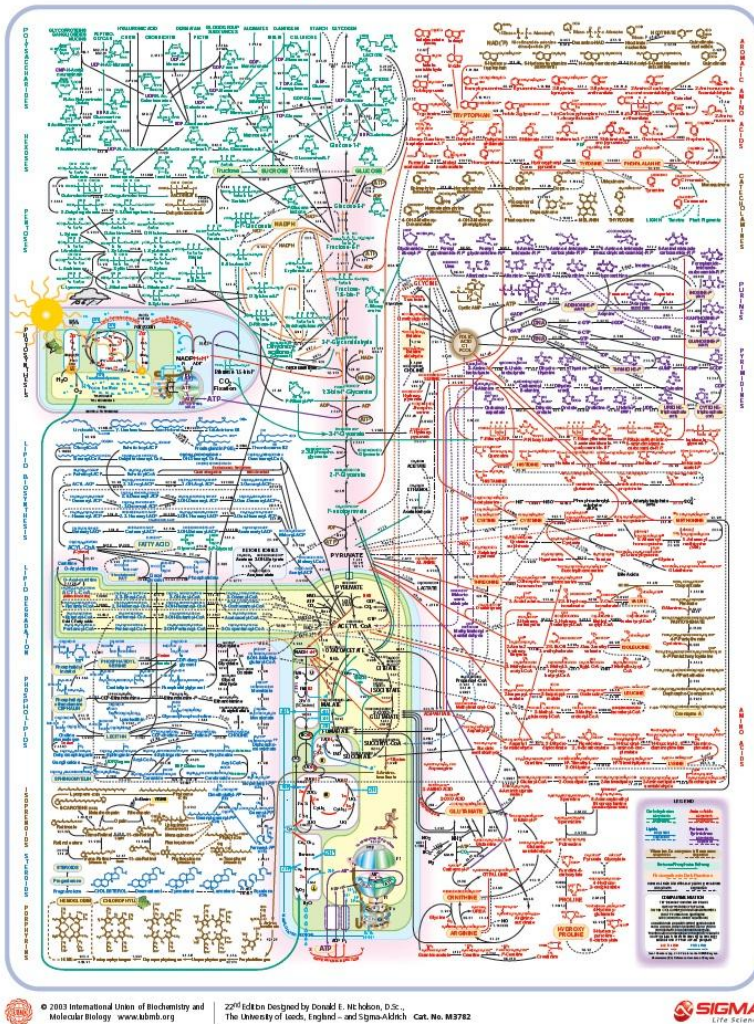
workers (academic and non-academic) due to poor working conditions that included wages that cannot see them provide the basic necessities of live. Sad enough, the attitude of the proprietors of the public universities (Federal and States) in not paying due attention to improved funding to the Universities have led severally to industrial actions being the norm of the day. Many nations, both developed and developing, have taken the need for educated populace as a major trust to industrial revolution. Ours should not lag behind and it is feared that if a turn-around is not make quickly, Nigeria will definitely be left far behind as the world transits to the future. The wake-up call is very pertinent at this moment in our life as a nation.

Finally, serious considerations need be given to improve the emoluments of university workers, as this will reduce the brain drain that has produce serious shortage of committed staff. Ours should not be different. It is sad that the emoluments presently cannot attract foreign staff, a situation that was prevailing during my early days in the service of this University. Crossbreeding of experiences and ideas do a lot to uphold/ improve the results of research. Improved funding is no doubt required if we want to break into the advancements being recorded by some of the nations who had lagged behind Nigeria in the past reconning.

CONCLUSION

It is pertinent to point out that enzymes have been shown to catalyse more than 4,000 biochemical reactions involved in the maintenance of living organisms. Nature has ‘packaged’ these reactions in form of metabolic pathways, inter-linked in so many ways that makes the whole process intriguing to an appreciative mind.

Metabolic Pathways



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A map of different metabolic pathways identified in living organisms

Vice Chancellor, Sir and distinguished audience, from the above discussions, it is germane to conclude by reaffirming the important roles played by enzymes in life processes, that there is no other verdict therefore than resting my submission that indeed, life without enzymes is a mirage! I rest my case!

THANK YOU FOR LISTENING!

CITATION ON



PROFESSOR MICHAEL OKECHUKWU MONANU B. Sc. (Nigeria), Ph. D. (Alberta)

Born on September 29, 1955, to Late Pa Rufus Onyemaechi and Late Ma Paulina Uzoamaka (nee Okoli) of Igbo-Ukwu town in Aguata LGA of Anambra, Professor Michael Okechukwu Monanu demonstrated quite early in life his academic prowess. He had accelerated promotions in the Primary school (St. Paul's College Practising School, Awka, Anambra State), ending with a credit pass at the 1st School leaving certificate exams in 1966. His secondary education

started at the prestigious Government Secondary School, Owerri, Imo State in January, 1967 but was disrupted by the Nigeria civil war. At the end of the war, he returned to Owerri but had the WASC examinations of Owerri zone cancelled in June of 1973. He subsequently obtained a Grade 1 (distinction) at Agulu Grammar School, Anambra state in 1974. He gained admission into the University of Nigeria, Nsukka (UNN) to study Biochemistry. Professor Monanu was a Federal Government Scholar for 3 of the 4-year programme and obtained a Second Class (Upper Division) honour degree in June of 1978. Following the NYSC service at Lafia of the then Plateau State, he started a postgraduate program at UNN before securing a Graduate Teaching Assistantship at the University of Alberta, Edmonton, Canada in September 1980 to pursue an M. Sc. Degree but switched to a straight Ph. D. upon completion of course work under the supervision of Dr. Neil B. Madsen (of blessed memory), a renowned Enzymologist. He was awarded an Alberta Heritage Trust Fund Fellowship for Medical Research, which provided stipends/research grants that funded his postgraduate training. He bagged the Ph. D. degree in August, 1986, and was the Secretary of the Nigerian Union of Student, U of A (1982 to 1983).

His quest to make contributions to stem the brain-drain phenomenon in Nigeria, which was at its infant stage in the '80s made Professor Monanu to apply for employment to Nigerian Universities, and was attracted to the University of Port Harcourt, by his lecturer at UNN, Professor Emeritus E. O. Anosike, the then HOD, at the nick of being 'snatched' by

ABU, Zaria. Since joining this University as Lecturer II in 1986, Professor Monanu has made meaningful contributions to the growth of the discipline, the Department and the University at large, in many ways, and was promoted to Professor of Enzymology/Protein Chemistry in 2009.

Professor Monanu served as the General Secretary, Biochemical Society of Nigeria (BSN) (1988-1990), Financial Secretary, BSN (1990 - 1994); was an International Union of Biochemistry Travel Fellow (Jerusalem, 1990), Acting HOD (1994-1996), Chairman University Time Table Committee (1994 to 1996); member of several Departmental, Faculty and University-wide Committees including Business Manager, Scientia Africana (publication of Faculty of Science, Uniport, 1994 to 1997), University Exams Committee (2008 to 2012), Senate Degree Results Verification Committee (2004 to 2013), 19th and 20th Convocation Committee (2002 and 2003), and Chairman, Certificate Verification Committee (2010 to 2017), pioneer Dean, Faculty of Chemical Sciences of the defunct College of Natural & Applied Sciences (2013-2015). He has served as External Examiner (Undergraduate & Postgraduate) for UNIZIK, ABSU, UNICAL, MOUA, NDU and FUTO at various times. Prof. Monanu served ASUU, Uniport branch as Treasurer and Financial Secretary (1987 to 1994), Chairman ELECO for Branch Elections (2005 and 2025), as Interim Management Committee Member (2007 to 2010), Vice President (2010 to 2018) and President (2018 to 2022) of Unique Choba Amiable Cooperative Investment & Credit Society (alias ASUU Cooperative). Professor Monanu has taught and supervised numerous undergraduate and

postgraduate students of which over twelve are now Professors of Biochemistry.

Professor Monanu is a Knight of St. Christopher of the Anglican Communion of Nigeria, and is happily married to Dr. (Mrs.) Nkechinyere (nee Aguta). They are blessed with three children (Okechukwu and Chukwudi, both Civil Engineers, and Chinenye, a Geologist). All are graduates of UNIPORT! Distinguished ladies and gentlemen please permit me to introduce an academic icon of many feathers, an astute manager, chorister and organist, a committed Unionist, a stand-out organizer and academe per excellence. I present to you Professor Michael O Monanu as our 38th Valedictory Lecturer.

Professor Owunari Abraham Georgewill
Vice-Chancellor